Lemmata Linguistica Latina

Volume I: Words and Sounds

Edited by
Nigel Holmes, Marijke Ottink, Josine Schrickx and
Maria Selig

DE GRUYTER

ISBN 978-3-11-064518-7
e-ISBN (PDF) 978-3-11-064758-7
e-ISBN (EPUB) 978-3-11-064572-9

Library of Congress Control Number: 2019946357

Bibliographic information published by the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at http://dnb.dnb.de.

Cover image: ‚Zettelarchiv' of the Thesaurus Linguae Latinae, Munich
Typesetting: Integra Software Services, Pvt. Ltd
Printing and binding: CPI books GmbH, Leck

www.degruyter.com

Giovanna Marotta & Irene De Felice

Patterns of prosodic distribution of Latin long vowels

Abstract: In Classical Latin, vowel quantity (VQ) plays a fundamental role in stress assignment, since it contributes to the assignment of lexical stress in polysyllabic words. However, no Romance languages inherited the original VQ contrast. In this contribution, we aim to find quantitative evidence for the tendency of Latin long vowels to occur in stressed syllables more frequently than in unstressed syllables, a tendency that possibly correlates with the progressive loss of the length contrast in the evolution of the language. Our research is based on the Latin lexicon annotated with a number of prosodic features, related to vowel length, syllable structure, syllable weight, and lexical stress. The analysis of our data clearly reveals a strong preference for long vowels to occur in stressed syllables, and in particular in the open ones, i.e. in the same context in which many Romance languages show long vowels. Quantitative evidence therefore indicates that in Classical Latin, the contrast of VQ, although still prevalent, was already prefiguring the prosodic system of the Romance languages, in which the inherited vowel quantity is no longer phonologically relevant and vowel length is largely determined by stress.

Keywords: Latin linguistics, Latin lexicon, vowel length, syllable structure, stress, corpus annotation

1 The contrast of vowel length in Latin

Even if the standard Latin orthography does not systematically distinguish between short and long vowels (Leumann 1977: 3–15; Weiss 2009: 29; Loporcaro 2015: 3–5), there is evidence supporting the relevance of vowel length and

---

Note: This paper is the result of the close collaboration of both authors. For the specific concerns of the Italian Academy, Giovanna Marotta is responsible for Sections 1, 2 and 6, and Irene De Felice is responsible for Sections 3, 4 and 5.

Giovanna Marotta, Irene De Felice, University of Pisa

https://doi.org/10.1515/9783110647587-027

phonological contrast between short and long vowels in the classical era (at least at some sociolinguistic level, cf. *infra*).

That Romans actually pronounced long and short vowels in different ways is reflected in the various strategies with which they sporadically notated long vowels in epigraphic texts, such as *geminatio vocalium* (e.g. CIL I^2 1299, Rome, 130–100 BC: VAARUS), I *longa* (e.g. CIL I^2 721, Rome, 82–79 BC: VICUS), or *apex* (e.g. Gordon 1, 61, Veii, 25 AD: UT AUGUSTÁLIUM NUMERÓ HABEÁTUR).[1]

The relevance of vowel quantity also emerges from metrics, since Latin poetry, as is well known, is based on patterns of syllable quantity. In this regard, we know that syllable length was not only relevant to the written poetry but also to its oral performance: Roman writers tell us that syllable length was in fact conveyed by actors, and clearly perceived by the audience. Therefore, even common people, who probably lacked any conscious knowledge of metrics or rhythm, were able to distinguish segmental length during theatrical performances. Some testimonies by Cicero are particularly interesting in this respect.[2]

Vowel quantity contrast in Latin may be indirectly reconstructed through interlinguistic comparison (e.g. PIE **máh₂ter* > Gr. *μήτηρ*, Lat. *māter* 'mother' vs. PIE **h₂áǵ-e/o-* > Gr. *ἄγω*, Lat. *ago* 'to drive'), or through considering the borrowings into or from other languages (e.g. Lat. *cattus* > Old High German *kazza* 'cat' vs. Lat. *strāta* > *strāz(z)a* 'street'; Sihler 1995: 73; Loporcaro 2015: 4–5).

Moreover, contrasts at the level of vowel length distinguish different lexical entries, as many minimal pairs demonstrate, such as *lēvĭs* 'smooth' ~ *lĕvĭs* 'light', *ōs* 'mouth' ~ *ŏs* 'bone', *pŏpŭlŭs* 'people' ~ *pōpŭlŭs* 'poplar tree'. Vowel quantity also creates morphological contrasts. This regularly happens in the nominal system, as for the *-ă*/*-ā* endings of the I decl. (*pŏētă* 'poet', nom./voc. sing. ~ *pŏētā*, abl. sing.), or for the *-ŭs*/*-ūs* endings of the IV decl. (*lăcŭs* 'lake', nom./voc. sing. ~ *lăcūs* gen. sing./nom./acc./voc. pl.). Morphophonological contrasts in terms of vowel quantity exist in the verbal system too, since the present and perfect stems are sometimes distinguished only by quantitative vowel gradation (ablaut), as in the case of the verbs *vĕnit* 'he/she comes' ~ *vēnit* 'he/she came', *ĕmit* 'he/she buys' ~ *ēmit* 'he/she bought', *lĕgit* 'he/she reads' ~ *lēgit* 'he/she read'.

Interestingly, Roman grammarians were aware of the fact that the difference in vowel length created a phonological contrast in Latin, as testified by the comments they made on some minimal pairs. For instance:

> *Eadem littera alium atque alium intellectum, prout correpta vel producta est, facit: ut 'malus' arborem significet an hominem non bonum apice distinguitur, 'palus' aliud priore syllaba*

1 Lazzeroni (1956); Allen (1978: 64); Weiss (2009: 29); Loporcaro (2015: 3–4).

2 See CIC. orat. 173; parad. 3, 26 and the recent comments by Marotta (2018).

> *longa, aliud sequenti significat, et cum eadem littera nominativo casu brevis, ablativo longa est, utrum sequamur plerumque hac nota monendi sumus.* (Qvint. inst. 1, 7, 2–3)
>
> 'The same letter produces different senses if it is long and if it is short. Thus, in *malus*, an apex indicates that it means 'apple tree' and not 'bad man'; *palus* also means one thing if the first syllable is long and another if the second is long; and when the same letter is found as short in the nominative and as long in the ablative, we commonly need to be reminded which interpretation to choose.'[3]

Vowel length, however, is not only relevant to Latin phonology (for its contrastive value) but also to prosody, since it affects syllable weight (Mester 1994; Marotta 1999, and Marotta 2000), and consequently plays a central role in assigning word stress in polysyllabic words. Latin is a quantity-sensitive language: according to its stress algorithm, in a word of three or more syllables, the accent falls on the penultimate syllable if this is heavy; otherwise it falls on the antepenultimate (e.g. *prṓvĕnĭt ~ prōvḗnĭt*). As is well known, syllable weight is entirely determined by the structure of its rhyme:[4] a syllable is heavy if it has a heavy nucleus (i.e. a long vowel or a diphthong), or a coda in the rhyme; syllable onsets (i.e. consonants that precede the nucleus) have no effect on syllable weight.

2 Vowel length in Romance languages

While in the phonological system of Classical Latin vowel length had great importance for the reasons discussed in Section 1, no Romance languages inherited the original contrast between short and long vowels. The vowel length contrast occurring in some varieties (e.g. Friulan) does not descend from the Latin contrast, but developed more recently for different reasons (Loporcaro 2015).

In fact, many Romance languages have long and short vowels, but this difference does not have a phonological status. Notably, in those varieties that present long vowels, it is lexical stress that has a phonological value, i.e. a contrastive function, whereas vowel length is generally a consequence of stress (i.e. stressed vowels lengthen, under some conditions; cf. Weiss 2009: 508; Loporcaro 2011a, Loporcaro 2011b, and Loporcaro 2015; Marotta 2016). For instance, in Standard

3 Trans. by Russell (2002: 185–187).

4 A syllable rhyme is composed of the phonemes from the vowel to the end of the syllable, that is the nucleus (i.e. a vowel or a diphthong) and the following consonants belonging to the same syllable, which constitute the so-called coda; see Marotta (1999) and the theoretical references there quoted.

Italian, vowels in stressed open syllables are longer than unstressed vowels or vowels in closed syllables (especially in the penultimate position: see Marotta 1985), regardless of the original quantity of the vowel (e.g. Lat. *pătrem* > It. [ˈpa:dre] ‘father’; Lat. *rŏtam* > It. [ˈrwɔ:ta] ‘wheel’). Allophonic vowel lengthening depending on stress and syllable structure is also found in other Romance languages and varieties, such as Portuguese, Sardinian, Catalan, central and southern Italian dialects (Marotta 2016).

Therefore, at some point in the history of Latin, short vowels must have begun to lengthen in stressed open syllables, and long vowels to shorten in unstressed ones; the phenomenon is known as *Open Syllable Lengthening* (OSL, in Loporcaro 2011a, Loporcaro 2011b, and Loporcaro 2015). Some passages from Pompeius, Consentius, and Augustine[5] have been interpreted as indicating African Latin as the variety from which the loss of length contrast first spread (cf. Herman 1982), but the phenomenon cannot be understood as confined to Africa (as discussed in Adams 2007: 260–270 and Adams 2013: 43–51; Loporcaro 2015: 20–25).

When vowel length ceased to be contrastive, the distribution of long vowels, which could occupy any position within a word, began to be determined by stress and by syllable structure; the original contrast of quantity was progressively lost, whereas differences in the degree of openness in mid vowels became more relevant. The fact that there was a quality distinction parallel to the quantity distinctions of short and long vowels (except /a/) in Latin is testified by grammarians, for instance by Servius and Victorinus, who explicitly write that <E> and <O> sound differently when long or short.[6] Also, inscriptions show

5 Pomp. gramm. V 285, 5–7 *est alter [barbarismus], qui fit in pronuntiatu. plerumque male pronuntiamus et facimus vitium, ut brevis syllaba longo tractu sonet aut iterum longa breviore sono* ‘there is another (barbarism), which is committed in pronunciation. Often we utter a bad pronunciation and commit the fault of sounding a short syllable long or, again, a long syllable short’; Consent. gramm. V 392, 3 *ut quidam dicunt* piper *producta priore syllaba, cum sit brevis, quod vitium Afrorum familiare est* ‘as some people say *piper* with a long first syllable, when it is short, a vice which is characteristic of Africans’; Avg. doctr. christ. 4, 10, 24 *cur pietatis doctorem pigeat imperitis loquentem* ossum *potius quam* os *dicere, ne ista syllaba non ab eo quod sunt* ossa*, sed ab eo quod sunt* ora*, intellegatur, ubi afrae aures de correptione vocalium vel productione non iudicant?* ‘Why should a teacher of piety when speaking to the uneducated have regrets about saying *ossum* (‘bone’) rather than *os* in order to prevent that monosyllable [i.e. *ŏs* ‘bone’] from being interpreted as the word whose plural is *ora* [i.e. *ōs* ‘mouth’] rather than the word whose plural is *ossa* [i.e. *ŏs*], given that African ears show no judgment in the matter of the shortening of vowels or their lengthening?’ (trans. by Adams 2007: 261–264).

6 Serv. gramm. IV 421, 16 *Vocales sunt quinque,* a e i o u. *Ex his duae,* e *et* o, *aliter sonant productae, aliter correptae* ‘There are five vowels, *a e i o u*. Two of these, *e* and *o*, sound in one way when long, in another when short’ (trans. by Sturtevant 1940: 111); Ps. Mar. Victorin.

a growing confusion between the long mid vowels and the short high ones (cf. Marotta 2015), starting from the third century BC but spreading from the third century AD (e.g. MENOS for MINUS, CIL VIII 9984; VERTUTE for VIRTUTE, CIL V 6244; ERODITA for ERUDITA, CIL I^2 1214/2; COM for CUM, CIL IV 39359).

There are different hypotheses indicating when (and how) contrastive vowel length ceased to exist in spoken Latin, and when a quality distinction acquired a phonological status in large parts of Romània (for a general overview, cf. Loporcaro 2015: 18–19). We believe that this change did not affect all the levels of the Latin diasystem at the same time. Following the opinion of other scholars (e.g. Pulgram 1975; Vineis 1984; Giannini and Marotta 1989), we think that vowel length could have already lost its phonological status, and have been already substituted (or at least complemented) by a tenseness contrast since the Republican age (probably from the third century BC) in the basilectal (i.e. lower) varieties of Latin (Benedetti and Marotta 2014; Marotta 2015 and Marotta 2017).

In this regard, it is worth noting that the tendency to reduce the functional load of the vowel length contrast can be traced back to changes that took place in the (pre)history of Latin, such as the shortening processes that variously affected unstressed (especially final) syllables (e.g. *correptio iambica*, shortening of final vowels followed by a consonant unlike *-s*; Loporcaro 2015: 9–12; Marotta 2017).

In this contribution, we argue that the seeds of the changes that led to the definitive collapse of the vowel length contrast were already taking root in the lexicon of Classical Latin: although long vowels could occur in any position of the word, vowel length was largely conditioned by lexical stress and syllable structure. Therefore, in this study we aim at finding quantitative evidence for a tendency for long vowels to occur in stressed syllables more frequently than in unstressed syllables, and thus for a general drift towards the progressive loss of the length contrast in Latin.

3 Previous quantitative studies

Among the previous studies that address the relation between vowel length and stress in Latin with a quantitative approach (e.g. Gaeng 1968; Omeltchenko 1977; Herman 1982 and Herman 1985), the analysis proposed by Herman (1968) is the closest one to our research, in terms of method and purposes. The author

gramm. VI 33, 3 *O, ut* e, *geminum vocis sonum pro condicione temporis promit* '*O*, like *e*, produces two vowel sounds according to the quantity' (trans. by Sturtevant 1940: 119).

examined the distribution of ca. 11,000 vowels and diphthongs, extracted from the *Epistolae Selectae* of Cicero (ed. by Dietsch 1911 [1854]), with respect to lexical stress (stressed vs. unstressed syllable) and the position within a word (initial, internal, or final position).

In light of the purpose of our study, the most important result of Herman's analysis is that even if short vowels turn out to be more numerous than the long ones (70.5% out of the total number of vowels and diphthongs extracted), the proportion of long vowels is significantly higher in stressed syllables than in the unstressed ones. Table 1 shows that long vowels or diphthongs occur in 41.8% of stressed syllables, but in only 22.5% of unstressed syllables.

Table 1: The distribution of vowels and diphthongs in stressed and unstressed syllables, expressed in percentage values (adapted from Herman 1968: 244).

	ă	**ā**	**ĕ**	**ē**	**ĭ**	**ī**	**ŏ**	**ō**	**ŭ**	**ū**	**ae**	**au**
Stressed syllable	8.4	7.9	19.3	11.5	14.3	5.6	8	8.6	8.1	4.6	2.3	1.3
Unstressed syllable	12	4.3	22.6	3.4	22.1	7.2	6.5	5.1	14.2	0.8	1.3	0.4

These data suggest that the contrast of vowel quantity in Classical Latin was already strongly limited to stressed syllables. Moreover, Herman (1968) analyses the distribution of Latin vowels considering not only their length but also their quality. As previously indicated in Table 1, there are relevant differences between the phonemes. For instance, *ī* is more frequent in unstressed syllables as opposed to the other long vowels. However, we shall not comment further on this point, since in this chapter we are only focusing on the distribution of long vowels and diphthongs without considering their quality, leaving this more detailed analysis for future research.

Although Herman's study still represents a model of quantitative analysis on a corpus of data relative to an ancient language, he did not consider syllable structure. In our opinion, this is a relevant factor that cannot be neglected within the general framework of Latin prosody. In other words, we believe that the interplay of syllable structure and lexical stress could have significant effects on the distribution of long and short vocalic segments in Latin.

4 Corpus and method of analysis

Following Herman's legacy, our goal is the research of distributional patterns of vowel segments in the Latin lexicon. Our quantitative analysis is based on a pre-existing lexicographical resource, the *Pocket Oxford Latin Dictionary* (Oxford University Press, 2012). This dictionary covers more than 11,000 entries that represent the essential vocabulary of the Latin language.[7] Compared to larger dictionaries, such as the *Oxford Latin Dictionary*, it has the advantage of excluding many rare forms, most words of foreign origin, and technical terms; moreover, it provides information about vowel length, marking long vowels with a macron.[8]

First of all, from the total number of dictionary entries (tot. 11,052), we deleted the forms that did not constitute a lemma (e.g. the entry *adl-*, which simply points to *all-*). Moreover, in order to avoid redundant information in the corpus, we reduced the pairs of homographs, when words were also identical in terms of vowel quantity (e.g. *truncus*_1: noun, 'trunk, bust'; *truncus*_2: adjective, 'cut, imperfect'). The total number of forms that constitute the corpus thus obtained is 10,874.
Secondly, all lemmas were automatically divided into syllables using a specific set of rules[9] (e.g. *lin.gua, auc.si.li.um, pa.tri.a, cas.trum, pos.tu.lo*; tot. syllables: 34,905). In the case of compounds or derived forms, hyphenation complies with morphological boundaries (e.g. *ab.a.vus*, and not *a.ba.vus; ad.i.ci.ō*, and not *a.di.ci.ō*). All lemmas were then automatically classified according to their number of syllables (cf. Figure 1).

Finally, for each syllable of the corpus, we annotated the following phonological and prosodic features:
- number of syllables constituting each lemma;
- position of the stress in the lemma;[10]

---

7 The dictionary mainly presents the lexicon of the Classical period, with only some additions from the works of Plautus and Terence, and from the period of Silver Latin (but not from Medieval Latin). The online version of the dictionary can be accessed at www.oxfordreference.com/view/10.1093/acref/9780191739583.001.0001/acref-9780191739583 (accessed: 30 July 2018).

8 However, this dictionary does not explicitly distinguish short vowels from those whose length cannot be determined for certain (cf. *infra*, Section 5.3). For the purpose of our study, and since we focus on the distribution of long vowels, we decided to consider as short all vowels that are not definitely marked as long.

9 This operation was conducted in collaboration with the Department of Humanities of Ca' Foscari University of Venice (with Paolo Mastandrea, Luigi Tessarolo, and Silvia Arrigoni), and following the general framework of the Latin syllable as described in Marotta (1999).

10 Since the position of Latin stress is governed by the so-called penultimate rule, we were able to individuate for each lemma the exact position of stress, by knowing the word length and the weight of syllables. For the few lemmas that do not comply with this rule (cf. Allen

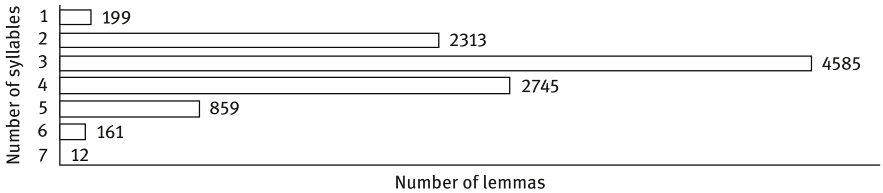

Figure 1: Classification of the lemmas with regard to the number of syllables.

– prosodic status of each syllable in the lemma (stressed, post-tonic, pre-tonic);
– syllable structure, i.e. open vs. closed syllable;
– syllable structure in relation to the nucleus, i.e. short vowel vs. long vowel or diphthong.[11]

A preliminary *caveat* should be pointed out: since the current analysis is based on the paradigmatic entries of the dictionary, morphological alternation is not taken into account. We are perfectly aware that this constraint represents a limit, since Latin is a language with a very rich and pervading inflection. However, we do believe that the data collected, despite this limitation, could supply relevant cues regarding the prosodic drift taking place in the history of the language, because they refer to the prototypical forms present in the mental lexicon of Latin speakers. At the same time, we plan to couple these data concerning lexical entries with those occurring in written texts (cf. Section 6).

5 Results and discussion

A first discrimination concerns monosyllabic and polysyllabic words. All of the 199 monosyllables of our corpus (e.g. *vir, nunc, dē*) consist of a heavy or superheavy rhyme, in accordance with the bimoraicity constraint on the minimal word in Latin (Mester 1994; Marotta 1999 and Marotta 2000). If the syllable is open, the nucleus always has a long vowel or a diphthong.

1978: 87; Weiss 2009: 109–111), such as oxytones resulting from apocope (e.g. *illīc* < *illi* + *-ce*), the position of stress was manually corrected.

11 We considered *ae, au, oe, ei, eu, ou* as Latin diphthongs (Sturtevant 1940: 123–138; Allen 1978: 60–63).

Since our goal is to find a possible correlation between lexical stress and the occurrence of heavy nuclei, we will describe the distributional patterns of long vowels in polysyllables only, i.e. in 10,675 lemmas.

We will initially focus on the distribution of long vowels with respect to lexical stress (Section 5.1) and then on the distribution of long vowels with respect to the syllable structure (Section 5.2). In the last paragraph (Section 5.3), we will draw some general conclusions about the interaction between vowel length, stress and syllable structure.

5.1 Long vowels and stress

Table 2 reports the distribution of short and long vowels and diphthongs in stressed and unstressed syllables, divided into pre-tonic and post-tonic ones. The data are presented in absolute as well as in percentage values.

Table 2: Vowel length in stressed and unstressed (pre-tonic/post-tonic) syllables (tot. 10,675 lemmas, 34,706 syllables).

	Short V	Long V	Diphthong	Total
Stressed syllable	5,954	4,389	332	10,675
	55.8%	41.1%	3.1%	100%
Pre-tonic syllable	6,335	1,982	300	8,617
	73.5%	23%	3.5%	100%
Post-tonic syllable	11,107	4,250	57	15,414
	72.1%	27.5%	0.4%	100%

The data confirm that in Classical Latin both long and short vowels could occur in any position within a word, although short nuclei appear to be more frequent than long vowels, generally speaking. However, the different percentages of vowel occurrence show that the distribution is not entirely independent of lexical stress. In particular, the proportion of short nuclei is very high in the post-tonic position (72.1%), whereas long vowels are more frequent in the stressed syllables than in the unstressed ones. As Table 2 shows, long vowels occur in 41.1% of the stressed syllables (e.g. *tāc.tus*), but only in 23% of the pre-tonic (e.g. *ō.rā.tor*) and in 27.5% of the post-tonic ones (e.g. *e.dō*).

Diphthongs are quite rare. Their percentages range from 3.1% in stressed syllables (e.g. *poe.na*) to 3.5% in the pre-tonic ones (e.g. *lae.ti.ti.a*), but are less than 1% in the post-tonic position, due to their sporadic occurrence in the morphological endings of the Latin lemmas (e.g. *nū.gae*).[12]

These results are largely consistent with those presented by Herman (1968), even if that study is based on a very different corpus (cf. *infra*), i.e. a prose text, whereas the present study is based on the lexicon. In particular, in Herman's study, 38.2% of the stressed syllables contain a long vowel, and 3.6% contain a diphthong. The results emerged from our analysis are therefore very similar: 41.1% of stressed syllables present a long vowel, 3.1% present a diphthong. If we also include monosyllables in our analysis (as Herman did, in considering monosyllabic words as stressed syllables; cf. Herman 1968: 244), the percentages remain very similar (41.2% and 3.2%).

The agreement between Herman's data and ours confirms the legitimacy of a quantitative analysis based on the entries of the Latin dictionary for studying the distribution of prosodic features.

5.2 Long vowels and syllable structure

We can now turn to consider the distribution of short and long vowels and diphthongs in open and closed syllables (Table 3).

Table 3: Vowel length in open and closed syllables (tot. 10,675 lemmas, 34,706 syllables).

	Short V	Long V	Diphthong	Total
Open syllable	11,437	8,995	614	21,046
	54.4%	42.7%	2.9%	100%
Closed syllable	11,959	1,626	75	13,660
	87.5%	11.9%	0.6%	100%

12 A chi-square test confirms that the distribution of long and short vowels and diphthongs in stressed and unstressed (pre-tonic/post-tonic) syllables is not due to chance (χ^2 (4, 34706) = 1273.69; $p < 0.001$). The chi-square statistical test is used to compare the observed data (reported in Table 2) with the expected ones (which we would expect under the null hypothesis, i.e. that there is no significant difference between stressed, pre-tonic and post-tonic syllables with respect to the presence of a long or short vowel or a diphthong), and to determine whether the difference between the expected and the observed frequencies is significant. A p value < 0.001 means that the probability that the distribution observed is due to chance is less than one in a thousand.

Both in the stressed and in the unstressed position (cf. *infra*, Table 4), long vowels are much more frequent in open syllables (8,995 occurrences) than in the closed ones (1,626 occurrences), with a ratio of almost 6:1. In contrast, the distribution of short vowels is concentrated in closed syllables: out of 13,660 closed syllables, 11,959 of them, i.e. 87.5%, present a short vowel.[13]

The distribution of diphthongs is very similar to that of long vowels, since they most frequently occur in open syllables (614 vs. 75 occurrences), although the occurrence percentage of diphthongs remains quite low.

In conclusion, the distribution of long and short vowels and diphthongs in a Latin word is sensitive to the syllable structure,[14] in that long vowels (or diphthongs) mostly occur in open syllables.

5.3 General results: stress, syllables, and syllable weight

In this section, we summarise the relevant results of our lexical and prosodic analysis on the Latin lexicon. In Table 4, we draw a general picture of our data showing the interaction between vowel quantity, lexical stress, and syllable structure over a total of 10,675 lemmas and 34,706 syllables.

From the data reported in Table 4 we can observe that the great majority of stressed syllables (77.1%) present a heavy or super-heavy rhyme, which can be due to a long vowel (or diphthong) and/or a consonant in coda position. Long vowels are more frequent in the open syllables than in the closed ones (with a ratio of almost 6:1). In open stressed syllables only they are even more numerous than short vowels (35.1% vs. 22.9%).

As for unstressed syllables, they generally (in more than 70% of cases) present short vowels. Despite the high presence of short vowels, a high percentage of unstressed syllables (64.5% of the pre-tonic and 61.5% of the post-tonic ones) present a heavy rhyme: however, in most cases, this is not due to the presence of a long vowel (as is the case in most of the stressed syllables), but rather to the presence of a short vowel followed by a consonant in coda.

If we now consider the internal structure of the open stressed syllables, we see that the distribution of long and short nuclei is different, since the first ones are much more frequent than the second ones (cf. Table 5). The picture is specular in closed stressed syllables, where the number of long vowels remarkably

13 This fact may be partly due to the problem of the 'hidden' quantity, for which cf. Section 5.3.

14 As confirmed by a chi-square test conducted on the data reported in Table 3: χ^2 (2, 34706) = 4162.69, $p < 0.001$.

Table 4: The interaction between vowel length, stress, and syllable structure (total 10,675 lemmas, 34,706 syllables).

	Open syllable				Closed syllable				Total
	Short V	**Long V**	**Diphthong**	**Long V + Diphthong**	**Short V**	**Long V**	**Diphthong**	**Long V + Diphthong**	
Stressed syllable	2,445	3,743	292		3,509	646	40		10,675
	22.9%	35.1%	2.7%		32.9%	6%	0.4 %		100%
				37.8%				6.4%	
Pre-tonic syllable	3,057	1,593	265		3,278	389	35		8,617
	35.5%	18.5%	3.1%		38%	4.5%	0.4 %		100%
				21.6%				4.9 %	
Post-tonic syllable	5,935	3,659	57		5,172	591	0		15,414
	38.5%	23.7%	0.4%		33.6%	3.8%	0 %		100%
				24.1%				3.8 %	

Table 5: Vowel distribution according to stress and syllable structure.

		Short V	Long V	Diphthong	Long V + Diphthong	Total
Stressed	Open syllable	2,445	3,743	292		6,480
		37.7%	57.8%	4.5%	62.3%	100%
	Closed syllable	3,509	646	40		4,195
		83.6%	15.4%	1%	16.4%	100%
Unstressed	Open syllable	8,992	5,252	322		14,566
		61.7%	36.1%	2.2%	38.3%	100%
	Closed syllable	8,450	980	35		9,465
		89.3%	10.3%	0.4%	10.7%	100%

decreases. On the other hand, in the unstressed position, the percentage of short vowels increases, especially in the context of a closed syllable.

It is worth commenting briefly on super-heavy syllables, which constitute only 5% of all syllables on average. In this position, the length of a vowel cannot be directly observed (i.e. it is 'hidden'), because closed syllables are already prosodically heavy due to the consonant being in coda position. The occurrence of a long vowel in a closed syllable can mostly be reconstructed in an indirect way, i.e. with comparative analysis and etymology (even if some direct evidence can be found in some notations used in inscriptions and papyri, such as *apex* or I *longa*; cf. Section 1). As is well-known, metrics does not treat heavy and super-heavy rhymes differently, and in this position vowel quantity is irrelevant for stress assignment. In other words, in closed syllables, vowel length is a redundant feature. This makes it reasonable to speculate that the contrast of vowel length was first lost just in this position.

To conclude the analysis of our results, we can state that stressed and unstressed syllables show a different distribution of light and (super-)heavy rhymes (Table 6; cf. also De Felice 2018):

Table 6: Light and (super-)heavy rhymes in stressed and unstressed syllables.

	Light rhyme	(Super-)heavy rhyme	Total
Stressed syllable	2,445	8,230	10,675
%	22.9%	77.1%	100%
Unstressed syllable	8,992	15,039	24,031
%	37.4%	62.6%	100%

The difference between stressed and unstressed syllables becomes evident. The distribution of light and (super-)heavy rhymes in stressed and unstressed syllables, with a higher proportion of (super-)heavy rhymes in the stressed position, is also highly significant from a statistical point of view.[15]

6 Conclusion and future research

The empirical evidence presented in this chapter clearly indicates that the distribution of Latin long vowels was not entirely independent from syllable structure (long vowels are mainly found in open syllables rather than in closed ones), nor from stress (long vowels are more frequent in stressed than in unstressed syllables). As stated in Section 1, vowel length still had a contrastive value in the age of Classical Latin (at least, in the higher varieties of the language), and hence in one sense should be independent of stress and syllable structure. However, our analysis clearly reveals a strong preference for long vowels to occur in stressed syllables, especially in the open ones, i.e. in the same context in which many Romance languages (like Italian) present long vowels. The lexicon of Classical Latin, therefore, already contained the seeds of the long drift towards the loss of vowel quantity along the typologically unmarked path already highlighted in various natural languages.

The quantitative analysis presented here is based on a Latin lexicon (i.e. the *Pocket Oxford Latin Dictionary*) which has the advantage of providing evidence from a large number of lexical stems, although it does not account for the actual frequency of the different prosodic patterns in the real spoken and written language, where the morphologically inflected forms occurred too, with

15 χ^2 (1, 34706) = 704.77; $p < 0.001$.

the consequence of increasing the number of words of three or more syllables. For instance, in the current research, only nominative forms like *caput, ordo*, or *rex* are included, whereas allomorphs like *capitis, ordine* or *regem* are excluded; the same for verbal forms like *amo, lego* (included) vs. *amaverunt, legimus* (excluded). For this reason, we plan to extend our research and to apply the same methodology to a large corpus of Latin literary texts, in order to verify whether the distributional patterns observed in the lexicon could be confirmed when dealing with different material. However, since the results obtained so far with regard to lexical data are largely consistent with those presented by Herman (1968), who based his quantitative study on Cicero's letters, we do not expect that the outcome of our future analysis based on literary texts could differ significantly from what we have presented here.

Abbreviations

Gr.	Greek
Lat.	Latin
PIE	Proto-Indo-European

Bibliography

CIL = *Corpus Inscriptionum Latinarum* (1862–). Berlin/Boston: De Gruyter.
Pocket Oxford Latin Dictionary: www.oxfordreference.com/view/10.1093/acref/9780191739583.001.0001/acref-9780191739583 (accessed: 30 July 2018)

Adams, J. N. (2007). *The regional diversification of Latin, 200 BC–AD 600*. Cambridge: Cambridge University Press.
Adams, J. N. (2013). *Social variation and the Latin language*. Cambridge: Cambridge University Press.
Allen, W. S. (1978 [1965]). *Vox Latina: The pronunciation of Classical Latin*. Cambridge: Cambridge University Press.
Benedetti, M. & Marotta, G. (2014). Monottongazione e geminazione in latino: Nuovi elementi a favore dell'isocronismo sillabico. In P. Molinelli, P. Cuzzolin, & C. Fedriani (Eds.), *Latin vulgaire-latin tardif X: Actes du Xe Colloque international sur le latin vulgaire et tardif* (vol. I, pp. 25–43). Bergamo: Sestante.
De Felice, I. (2018). Strutture sillabiche nel lessico latino. In L. Costamagna, E. Di Domenico, A. Marcaccio, S. Scaglione & B. Turchetta (Eds.), *Mutamento linguistico e biodiversità. Atti del XLI Convegno della Società Italiana di Glottologia* (pp. 235–241). Roma: Il Calamo.
Dietsch, R. & Klotz, R. (1911 [1854]). *M. Tulli Ciceronis Epistolae selectae*. Leipzig: Teubner.
Gaeng, P. A. (1968). *An inquiry into local variations in Vulgar Latin, as reflected in the vocalism of christian inscriptions*. Chapel Hill: University of North Carolina Press.

Giannini, S. & Marotta, G. (1989). *Fra grammatica e pragmatica: La geminazione consonantica in latino*. Pisa: Giardini.
Herman, J. (1968). Statistique et diachronie: Essai sur l'évolution du vocalisme dans la latinité tardive. *Word*, *24*, 242–251.
Herman, J. (1982). Un vieux dossier réouvert: Les transformations du système latin des quantités vocaliques. *Bulletin de la Société de Linguistique de Paris*, *77*, 285–302.
Herman, J. (1985). Témoignage des inscriptions latines et préhistoire des langues romanes: Le cas de la Sardaigne. In M. Deanovíc (Ed.), *Mélanges de linguistique dédiés à la mémoire de Petar Skok* (pp. 207–216). Zagreb: Jugosiavenska Akademija Znanosti i Umjetnosti.
Lazzeroni, R. (1956). La 'geminatio vocalium' nelle iscrizioni latine. *Annali della Scuola Normale di Pisa*, *25*, 124–135.
Leumann, M. (1977). *Lateinische Laut- und Formenlehre*. München: Beck.
Loporcaro, M. (2011a). Syllable, segment and prosody. In M. Maiden, J. Smith & A. Ledgeway (Eds.), (pp. 50–108).
Loporcaro, M. (2011b). Phonological processes. In M. Maiden, J. Smith & A. Ledgeway (Eds.), (pp. 109–154).
Loporcaro, M. (2015). *Vowel length from Latin to Romance*. Oxford: Oxford University Press.
Maiden, M., Smith, J. & Ledgeway, A. (Eds.). *The Cambridge history of the Romance languages*. Cambridge: Cambridge University Press.
Marotta, G. (1985). *Modelli e misure ritmiche: La durata vocalica in italiano*. Bologna: Zanichelli.
Marotta, G. (1999). The Latin syllable. In H. van der Hulst & N. A. Ritter (Eds.), *The syllable: Views and facts* (pp. 285–310). Berlin/New York: Mouton de Gruyter.
Marotta, G. (2000). Sulla massimalità dei piedi trocaici: Il caso del latino. *Lingua e Stile*, *35*(3), 387–416.
Marotta, G. (2015). Talking stones: Phonology in Latin inscriptions? *Studi e Saggi Linguistici*, *58*(2), 39–63.
Marotta, G. (2016). Prosodic structure. In A. Ledgeway & M. Maiden (Eds.), *The Oxford guide to the Romance Languages* (pp. 484–494). Oxford: Oxford University Press.
Marotta, G. (2017). Tra fonologia e sociofonetica: Il tratto di lunghezza in latino. In G. Marotta & F. Strik Lievers (Eds.), *Strutture linguistiche e dati empirici in diacronia e sincronia* (pp. 57–81). Pisa: Pisa University Press.
Marotta, G. (2018). On Cicero's fine-grained perception of prosodic features in Latin. *Journal of Latin Linguistics*, *17*(2), 259–278.
Mester, R. A. (1994). The quantitative trochee in Latin. *Natural Language and Linguistic Theory*, *12*, 1–61.
Omeltchenko, W. (1977). *A quantitative and comparative study of the vocalism of the Latin inscriptions of North Africa, Britain, Dalmatia, and the Balkans*. Chapel Hill: University of North Carolina Press.
Pulgram, E. (1975). *Latin-Romance phonology: Prosodics and metrics*. Munich: Fink.
Russell, D. A. (2002). *Quintilian: The orator's education, vol. I, books 1–2* (Loeb Classical Library 124). Cambridge, MA: Harvard University Press.
Sturtevant, E. H. (1940 [1920]). *The pronunciation of Greek and Latin*. Philadelphia/Baltimore: Linguistic Society of America.
Sihler, A. L. (1995). *A new comparative grammar of Greek and Latin*. New York/Oxford: Oxford University Press.

Vineis, E. (1984). Problemi di ricostruzione della fonologia del latino volgare. In E. Vineis (Ed.), *Latino volgare, latino medioevale, lingue romanze: Atti del convegno della Società Italiana di Glottologia* (pp. 45–62). Pisa: Giardini.

Weiss, M. (2009). *Outline of the historical and comparative grammar of Latin*. Ann Arbor/ New York: Beech Stave Press.