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The emergence of foot structure as a factor in the formation of Greek verbal nouns in -μα(τ)-

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1 Introduction[1]

This study is concerned with the relationship between word formation and foot structure in Ancient Greek. Evidence for foot structure in the language has previously been primarily sought in patterns of versification and in accentual phenomena, especially the recessive accent calculus.[2] Here, I offer an analysis of a change in word formation that affected the productive class of verbal nouns in -μα(τ)- (§2). I propose that the innovative word formation pattern reflects Trochaic Shortening, a process whereby word-final H(eavy)L(ight) syllable sequences are converted to LL sequences (§3.1). Since Trochaic Shortening is thought to be found only in languages with moraic trochaic feet, the analysis presented here corroborates studies such as Golston 1990 that have analyzed Greek as such a language on independent grounds (§3.2).

Trochaic Shortening in -μα(τ)-stem noun formation turns out to be restricted in an interesting way. Speakers only adjusted the prosodically

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[1] This study, which derives from my 2010 UCLA dissertation, has benefited especially from the criticism of my advisor, Brent Vine, and my committee members Bruce Hayes, Stephanie Jamison, and Craig Melchert.

[2] One gets a sense of this from the impressive collection of data that Devine and Stephens martial for their theory of Greek foot structure (1994: 102-117), where one of the thirty-five phenomena they set out to explain has to do with word formation, namely the well-known morphophonological stem vowel alternation in comparatives and superlatives in -τερος and -τατος to o-stem adjectives. For an excellent survey and discussion of recent generative analyses of Greek foot structure, cf. Probert 2010.

problematic word-final HL sequence if they could do so by affixing -μα(τ)- to a pre-existing stem allomorph, i.e. one that they already knew from a (synchronically) root-related word. In other words, they were unwilling to create new allomorphs or introduce new alternations to satisfy the phonological preference for a word-final LL sequence. A number of word formation processes restricted in precisely this way have been analyzed recently by Donca Steriade (1999a, 1999b, 2008), who refers to the avoidance of novel alternations as Lexical Conservatism (§4).

2 χεῦμα versus χύμα: two word formation patterns[3]

The class of verbal nouns in -μα(τ)-, such as χεῦμα, (gen. sg.) χεύματος 'that which is poured', was one of the most productive in Greek. The word list in Buck and Petersen 1945: 221 ff. exceeds 3,600 lexical items, and most of these exhibit the compositional (i.e. synchronically predictable) semantics associated with productivity.[4] The nouns typically have a result or action reading. It is thanks to this high degree of productivity that we are able to obtain an accurate picture of the change, since the word formation patterns before and after the change produce different outputs only under very specific circumstances: the base verb must exhibit morphological stem alternation (ablaut), and one of the stem allomorphs must end in a short vowel. Since most Greek verbs do not ablaut at all, and since those that do ablaut do not necessarily have a stem allomorph in a short vowel, the vast majority of deverbal nouns in -μα(τ)- are formed in the same way according to both patterns.

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[3] The following scholars discuss this change in word formation: Buck and Petersen (1945: 222); Chantraine (1933: 175-190 and *passim*); Fraenkel (1910: 187); Glaser (1894: 52-59, 81-83); Hatzidakis (1895: 111; 1897: 103); Osthoff and Brugmann (1881: 132-141); Peters (1980: 333); Schwyzer (1898: 47-49; 1939: 522-524); Specht (1931: 50); Stratton (1899); Wackernagel (1916: 76, fn. 1).

[4] This, of course, does not hold for the small group of lexicalized items such as αἷμα 'blood', ὄνομα 'name', σῆμα 'sign', σῶμα 'body', etc.

2.1 An overview of the two patterns

In Archaic Greek, verbal nouns in -μα(τ)- basically reflect one productive word formation pattern, which I will refer to as the conservative, or χεῦμα type. There, if the base verb exhibits (strong ~ weak) ablaut, -μα(τ)- is suffixed to the strong stem allomorph. For example — using stem forms in favor of citation forms for the moment — the verb meaning 'pour' ablauts χευ- ~ χυ-. The derivative in -μα(τ)- is formed to the strong allomorph χευ-, yielding χευ-μα(τ)-. The same holds for

πω- ~ πο- 'drink' → πω-μα(τ)- (Aeschylus+) 'drink'
εὑρη- ~ εὑρε- 'find' → εὑρη-μα(τ)- (Herodotus+) 'discovery', etc.

In short, in the conservative-type formations, the choice of the base of affixation is morphological, and may be described as Strong + -μα(τ)-, as sketched out in (A) below.

(A) The conservative pattern

Strong ~ Weak	Strong + -μα(τ)-	Weak + -μα(τ)-
χευ- ~ χυ-	χευ-μα(τ)-	
πω- ~ πο-	πω-μα(τ)-	
εὑρη- ~ εὑρε-	εὑρη-μα(τ)-	
δηκ- ~ δακ-	δηγ-μα(τ)-	
ζευγ- ~ ζυγ-	ζευγ-μα(τ)-	
λειπ- ~ λιπ-	λειμ-μα(τ)-	

Beginning with Pindar's use of πο-μα(τ)- 'drink', an innovative word formation pattern is attested. According to the innovative pattern, -μα(τ)- is suffixed to the weak stem of ablauting verbs if and only if that weak stem ends in a short vowel, e.g.

εὑρη- ~ εὑρε- → εὑρε-μα(τ)- (Hippocrates+) 'discovery'
χευ- ~ χυ- → χυ-μα(τ)- (Aristotle+) 'that which is poured'.

If the weak stem does not end in a short vowel, -μα(τ)- continues to be suffixed to the strong stem. For example, to δηγ- ~ δαγ- 'bite', speakers continue to derive the noun from the strong stem: δηγ-μα(τ)- (Aristotle+) 'bite, sting'. The same holds for

ζευγ- ~ ζυγ- 'join' → ζευγ-μα(τ)- (Thucydides+) 'that which is used for joining'
λειπ- ~ λιπ- 'leave' → λειμ-μα(τ)- (Herodotus+) 'remains', etc.

No changes are attested in formations to those stems. In short, in the innovative, χύμα-type formations, the choice of the base of affixation must be stated in *morphological and phonological* terms. The overview of the innovative pattern given under (B) reflects the distinction that has emerged between roots whose weak allomorph ends in -V and those that end in -(V)VC (where V represents any short vowel, and VV any long vowel or diphthong).

(B) The innovative pattern

Strong ~ Weak	Strong + -μα(τ)-	Weak + -μα(τ)-
Weak in -V		
χευ- ~ χυ-		χυ-μα(τ)-
πω- ~ πο-		πο-μα(τ)-
εὑρη- ~ εὑρε-		εὑρε-μα(τ)-
Weak in -(V)VC		
δηκ- ~ δακ-	δηγ-μα(τ)-	
ζευγ- ~ ζυγ-	ζευγ-μα(τ)-	
λειπ- ~ λιπ-	λειμ-μα(τ)-	

The innovative formations become more frequent in the Hellenistic κοινή, where they exist side by side with conservative ones, suggesting that the two word formation patterns were in competition in that period. The innovative type is stigmatized in prescriptive statements of the Atticists (cf. Buck and Petersen 1945: 222).

2.2 Presentation of the data

Below I present the -μα formations to the alternating roots with a strong allomorph that ends in a long vowel or diphthong (e.g. πω-, χευ-), and a weak allomorph that ends in a short vowel (e.g. πο-, χυ-). I will refer to the class as °VV- ~ °V- roots. I then present the -μα formations to the alternating roots with a strong allomorph that ends in a long vowel or diphthong plus a consonant (e.g. δηκ-, ζευγ-), and a weak allomorph that ends in a short vowel plus a consonant (e.g. δακ-, ζυγ-). I will refer to that class as

the °VVC- ~ °VC- roots. The phonological aspect of the innovative -μα formation pattern emerges from a comparison of the two classes. Above each set of forms, I list the root allomorph alternation and the citation form of the verb in parentheses. Immediately below that, I juxtapose the citation forms of the conservative -μα formation to the strong allomorph (S) with the innovative formation to the weak allomorph (W).

χευ- ~ χυ- 'pour' (χέω)
(S) χεῦ-μα (*Iliad*+) 'that which is poured or flows'
(W) χύ-μα (Aristotle+) 'id.'

The rest of the set consists of root-related forms that also contain the weak allomorph — the allomorph adopted for the χύμα-type formation. First, I list a verb form with the weak allomorph (V). In the °VV- ~ °V- class, this is typically the perfect medio-passive.

(V) κέ-χυ-μαι (*Iliad*+)

If no such perfect medio-passive is attested, I list the aorist passive.

(V) ἐ-χύ-θη-ν (*Odyssey*+)

The root-related action noun in -σις closes the set.

(N) χύ-σις (Aeschylus+) '(act of) pouring'

The root-related items with the weak allomorph may be viewed as the donors, or the sources, of the innovative weak phonological base, the intuition being that the χυ- in χύ-μα results from borrowing the χυ- form χύ-σις, κέ-χυ-μαι, etc., as has been suggested in previous discussions of the change (§6).[5] For clarity of exposition, I list only one (simplex or prefixed) form per verbal root. In addition to the *innovative* simplex formation εὕρε-μα, our first example below, there are five derivatives to compound verbs: καθεύρεμα, ἐξεύρεμα, ὑπερεύρεμα, ἀφεύρεμα, and ἀναφεύρεμα. In

[5] It is clear that verbal nouns in -μα (like other deverbal nominals) inherit phonological material peculiar to particular inflectional stems of the verb, such as the -σ- in κέλευσμα and the numerous derivatives in °σ-μα, which was clearly adopted from the perfect medio-passive (cf. Blevins and Garrett 2009).

addition to the *conservative* simplex formation εὕρημα, there are seven derivatives to compound verbs. I list the total number of conservative and innovative formations to the root below each lexical configuration.

(C) °VV- ~ °V- roots: conservative-innovative juxtapositions[6]

1) εὑρη- ~ εὑρε- 'find, discover' (εὑρίσκω)
(S) εὕρη-μα (Herodotus+) 'invention, discovery'
(W) εὕρε-μα (Hippocrates+)[7] 'id.'
(V) εὑρέ-θη-ν (Aeschylus+)
(N) εὕρε-σις (Herodotus+) 'discovery'
Total S: 8
Total W: 6

2) ἑψη- ~ ἑψε-[8] 'boil' (ἕψω)
(S) ἕψη-μα (Plato+) 'that which is boiled'
(I) ἕψε-μα (*Septuagint*)[9]
(V) ἥψε-μαι (*Anthologia Graeca*) [stem: ἑψε-]
(N) *ἕψε-σις [unattested]
Total S: 7
Total W: 1

3) θη- ~ θε- 'put, place' (τίθημι)
(S) ἀνά-θη-μα (*Odyssey*+) 'thing dedicated or set up'
(W) ἀνά-θε-μα, ἄν-θε-μα (Theocritus+) 'id.'
(V) ἀν-ε-τέ-θη-ν (Herodotus+) [stem: θε-]
(N) ἀνά-θε-σις (Lysias+) 'dedicating'
Total S: 14
Total W: 21

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6 The data was obtained from Buck and Petersen 1945: 222 ff., TLG searches, and the literature cited. I attempted a complete collection from the literary sources through the 2nd c. CE. The references to inscriptional attestations are meant to be representative, not exhaustive.

7 Cf. the inscriptional attestation at IG VII 3074, Boeotia, 2nd c. BCE.

8 The weak stem ἑψε- is a late, weakly attested innovation. It is metrically secure at *Anthologia Graeca*, *Oracula*, Epigram 264.15 in a 3sg. perfect medio-passive ἥψεται. Its rarity may explain the absence of *ἕψεσις.

9 Cf. the inscriptional attestation at IG VII 3064, Boeotia, 301 CE.

4) κρῑ- ~ κρι- 'distinguish, choose, decide' (κρῑ́νω)
(S) κρῖ-μα (Aeschylus+) '(matter for) decision'
(W) κρί-μα (JWI 2.366[10]) 'id.'
(V) κέ-κρι-μαι (*Iliad*+)
(N) κρί-σις (Parmenides; Aeschylus+) 'decision'
Total S: at least 1[11]
Total W: at most 8

5) πω- ~ πο- 'drink' (πῑ́νω)
(S) πῶ-μα (Aeschylus+) 'drink'
(W) πό-μα (Pindar+) 'id.'
(V) πέ-πο-μαι (Theognis+)
(N) πό-σις (*Iliad*+) 'drink(ing)'
Total S: 3
Total W: 4

6) ῥευ- ~ ῥυ- 'flow' (ῥέω)
(S) ῥεῦ-μα (Aeschylus+) 'that which flows, current, stream'
(W) ῥύ-μα (*Orphica* 10.22)[12] 'id.'
(V) ἐ-ρρύ-η-ν (*Iliad*+)
(N) ῥύ-σις (Plato+) 'flow'
Total S: 2
Total W: 2

7) σχη- ~ σχε- 'hold, have' (ἔχω)
(S) σχῆ-μα (Aeschylus+) 'form, figure'
(W) σχέ-μα (Hesychius)
(V) ἔ-σχε-μαι (Philoxenus)
(N) σχέ-σις (Aeschylus+) 'state, condition'
Total S: 4
Total W: 1

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10 A 1st c. CE metrical inscription, according to the LSJ Supplement (*non vidi*).

11 Since the length of the *iota* is not noted in the spelling, the only secure example of a long vowel is the metrically secured one in Aeschylus, and it is not possible to tell whether formations like κρίματα in prose contain the strong stem or the weak stem.

12 Cf. the inscriptional attestation at IG IX,1 692, Kerkyra, late 2nd c. BCE.

8) φορη- ~ φορε-[13] 'bear, wear' (φορέω)
(S) φόρη-μα (Sophocles+) 'that which is carried or worn'
(W) φόρε-μα (Hippolytus) 'id.'
(V) ἐ-φορέ-θη-ν (Cyanides), ἐ-φόρε-σ-α (Diodorus Siculus+)
(N) φόρε-σις (Scholiast to Aristophanes *Birds* 156) 'wearing (of clothes)'
Total S: 18
Total W: 2

9) χευ- ~ χυ- 'pour' (χέω)
(S) χεῦ-μα (*Iliad*+) 'that which is poured or flows'
(W) χύ-μα (Aristotle+)[14] 'id.'
(V) κέ-χυ-μαι (*Iliad*+)
(N) χύ-σις (Aeschylus+) '(act of) pouring'
Total S: 3
Total W: 15

In addition to the examples given immediately above, there are numerous χύμα-type formations that are not matched exactly by a χεῦμα-type predecessor with respect to the prefix. There are various reasons for this. In part, this may be ascribed to the fact that a -μα derivative to the particular compound verb was only formed by authors of later periods when the innovative pattern was better represented. In other cases, morphological blocking was likely involved. For example, there is no simplex form *δῆμα attested, which we would predict either as the Greek outcome of an Indo-European **déh$_1$-mn̥* (cf. Vedic *dā́man-* n. 'band, bond'), or as a later Greek-internal χεῦμα-type formation to the strong allomorph of δη- ~ δε- 'bind' (δέω). It was presumably not formed during that period because δεσμός 'band, bond', which had likely been lexicalized since the Mycenaean period (cf. *de-so-mo*), meant essentially the same thing. It is absolutely clear, however, that *δῆμα would have been the conservative-type formation, from comparison with the -μα formations made to compounded forms of the same verb, such as ἀνάδημα (Pindar+) 'hair band', to ἀναδέω 'bind on top, crown'. Thus, the inexact juxtapositions between

[13] There is a late development of a weak stem φορε- in this verb, comparable to the development of ἐψε-. It is relatively well attested in the aorist active and middle ἐφόρεσα, and eventually makes its way into the aorist passive.

[14] Cf. the inscriptional attestation at IG VII 303, Oropos, ca. 240 BCE.

conservative and innovative -μα formations given in (D) below reflect the same change in word formation as the exact juxtapositions presented above in (C). In each case, -μα is suffixed to a weak allomorph of a °VV- ~ °V- root. I list one example of each verbal root involved. In place of an exact χεῦμα-type match, I supply a root-related conservative form where possible.

(D) °VV- ~ °V- roots: inexact juxtapositions

10) αἱρη- ~ αἱρε- 'take' (αἱρέω)
(S) παρ-αίρη-μα (Thucydides+)
(W) ἀφ-αίρε-μα (*Septuagint*+) 'that which is taken away; tribute'
(V) ἀφ-αιρέ-θη-ν (Aeschylus+)
(N) ἀφ-αίρε-σις (Plato+) 'taking away'
Total S: 7
Total W: 10

11) βη- ~ βα- 'step, go' (βαίνω)
(S) βῆ-μα (*Homeric Hymns*+)
(W) παρα-σύμ-βα-μα (Chrysippus+) 'secondary accident or circumstance'
(V) ξυμ-βέ-βα-σθαι (Thucydides+)
(N) σύμ-βα-σις (Euripides+)
Total S: 4
Total W: 5

12) δη- ~ δε- 'bind' (δέω)
(S) ὑπό-δη-μα (Homer+)
(W) δέ-μα (Polybius+) 'band, tow rope'
(V) δέ-δε-μαι (Theognis+)
(N) δέ-σις (Plato+) 'binding'
Total S: 8
Total W: 4

13) δω- ~ δο- 'give' (δίδωμι)
(S) *(-)δω-μα 'gift' [unattested][15]
(W) δό-μα (Plato *Definitiones*, Plutarch+) 'gift'

15 In addition to the presence of lexicalized items meaning 'gift', such as δῶρον, *δῶμα 'gift' may have been avoided due to potential homonymy with δῶμα 'house' (cf. Chantraine 1933: 179).

(V) δέ-δο-μαι (Homer+)
(N) δό-σις (Herodotus+)
Total S: 0
Total W: 10

14) ἡ- ~ ἑ- 'release' (ἵημι)
(S) ἧ-μα (Homer+)
(W) ἔν-ε-μα (Dioscorides+) 'injection'
(V) ἐν-έ-θη-ν (Dioscorides+)
(N) ἔν-ε-σις (Hippocrates+) 'injection'
Total S: 3
Total W: 3

15) κλῑ(ν)- ~ κλι- '(make) lean, slope' (κλίνω)
*?(-)κλῑ-μα [unattested?][16]
κλί-μα (Pseudo-Scymnus+) 'inclination, direction, region'
κέ-κλι-μαι (*Iliad*+)
κλί-σις (Euripides+) 'inclination; (place for) lying down; region, clime'
Total S: 0?
Total W: 9

The one apparent exception to the pattern above are the formations in -στε-μα to compounded forms of στη- ~ στα- 'stand' (ἵστημι) such as σύστεμα (well attested inscriptionally from the 2nd c. BCE on), διάστεμα, παράστεμα, κατάστεμα, and ὑπόστεμα, where we might expect *-στα-μα. Attributing these to an irregular phonological shortening of η → ε seems problematic, since the change happens regularly in -μα formations to that root. It is exactly what we would expect to find if there were a weak stem στε-. Here, there are two possibilities. The stem στε-, attested in ἐ-στε-σ-α, could have served as the base (Hatzidakis 1895: 111; 1897: 103), but

16 I have not been able to find evidence for the κλῖμα cited by Chantraine (1933: 179) as the older form. It may well never have been formed during the attested period, since the strong root/stem allomorph was arguably κλῑν- (or perhaps κλῐν-) by that point in time, as evidenced by its presence in the aorist ἔ-κλῑν-α, as well as in the present, where the -ν- originated as a suffixal element. If the -ν- was reanalyzed as part of the strong root/stem early enough, a strong formation *(-)κλῑν-μα would have been avoided due to the illicit phonotactic sequence *-νμ-.

ἔστεσα is first attested two or three hundred years later than σύστεμα, which may or may not be problematic. A second possibility is that the aorist subjunctive forms στῶ, στῇς, στῇ, etc. were synchronically analyzed as derived from the contraction of στε- + inflectional endings, and that the stem στε- was essentially extracted from those, and used as a derivational base for the formations in -μα.[17] Various analogical proportions have been suggested as well (Schwyzer 1898: 47-49). It is difficult to judge between the explanations.

Below, I give a survey of the -μα formations to °VVC- ~ °VC- roots. Here, the distribution of the weak root allomorph in the verbal paradigm and related nominal formations is somewhat different from the °VV- ~ °V- roots.[18] Most notably, the action nouns in -σις do not exhibit the weak root allomorph. Since the change in the -μα formation pattern does not affect this class, it is impossible to tell whether a given formation to the strong allomorph reflects the conservative formation pattern or the innovative one.

(E) No innovation in formations to °VVC- ~ °VC- roots

1) δηκ- ~ δακ- 'bite, sting' (δάκνω)
(S) δῆγ-μα (Xenophon, Aristotle+) 'bite, sting'
(W) *δάγ-μα [unattested]
(V) ἔ-δακ-ον (Homer+)
(N) δάκ-ος (Aeschylus+) 'bite, sting; biting, stinging (beast)'
Total S: 4

2) ζευγ- ~ ζυγ- 'join' (ζεύγνῡμι)
(S) ζεῦγ-μα (Thucydides+) 'that which is used for joining'
(I) *ζύγ-μα [unattested]

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17 This possibility was pointed out to me by Pavlos Sfyroeras (p. c.). From a synchronic standpoint, if the subjunctive forms were derived from the weak stem στα-, we would expect *στᾷς, *στᾷ, etc.

18 This is due in part to an earlier morphophonological change discussed by Kuryłowicz (1956: 185, 203-204; 1968: 249) and Peters (1980: 345-349), whereby the weak allomorph was replaced with the strong allomorph before consonant-initial morphemes including -σις. The change seems to have taken place very early, and the inherited weak stems in those formations are only found in scattered remnants.

(V) ἐ-ζύγ-η-ν (Pindar+)
(N) σύ-ζυγ-ος (Aeschylus+) 'paired, united'
Total S: 4

3) λειπ- ~ λιπ- 'leave (behind)' (λείπω)
(S) λεῖμ-μα (Herodotus+) 'that which is left; remains'
(W) *λίμ-μα [unattested]
(V) ἔ-λιπ-ον (*Iliad*+)
(N) ἐλ-λιπ-ής (Thucydides+) 'omitting'
Total S: 9

4) ληβ- ~ λαβ- 'take' (λαμβάνω)
(S) λῆμ-μα (Sophocles+) 'that which is taken in or received'
(W) *λάμ-μα [unattested]
(V) ἔ-λαβ-ον
(N) λαβή (Alcaeus+) 'grip, hold'
Total S: 11

5) πηγ- ~ παγ- '(become) fix(ed)' (πήγνῡμι)
(S) πῆγ-μα (Aeschylus+) 'thing fastened or congealed'
(W) *πάγ-μα [unattested]
(V) ἐ-πάγ-ην (*Iliad*+)
(N) πάγ-η (Aeschylus+) 'thing that fixes or fastens'
Total S: 8

6) ῥηγ- ~ ῥαγ- 'break, tear' (ῥήγνυμι)
(S) ῥῆγ-μα (Eupolis+) 'break, tear'
(W) *ῥάγ-μα [unattested]
(V) ἐ-ρράγ-η-ν (Aeschylus+)
(N) αἱμο-ρραγ-ίᾱ (Hippocrates+) 'hemorrhage'
Total S: 9

2.3 Significance of the distributional differences

It emerges clearly from the data that according to the innovative pattern -μα was suffixed to the weak allomorph if and only if it ended in a short vowel, and otherwise to the strong allomorph. One might argue, however, that taking the absence of Weak + μα(τ) formations to the °VVC- ~ °VC- roots to be significant is an *argumentum ex silentio*, and that the absence of such formations can be attributed to an accident of attestation. We can

quantify the probability of such a claim from the overall distribution given in the contingency table below.

(F) Distribution of Strong + μα(τ) and Weak + μα(τ) in °VV- ~ °V- and °VVC- ~ °VC- roots

	Strong + μα(τ)	Weak + μα(τ)	Total
°VV- ~ °V-	81	84	165
°VVC- ~ °VC-	45	0	45

It is virtually impossible that the differences in the distribution of the weak allomorph between these two classes of ablauting verbs could be attributed to chance, given samples of this size. The probability value given by a Fisher's Exact Test is 2.531×10^{-12}. In short, we are dealing with a statistically highly significant *argumentum ex silentio*.

3 The phonological aspect of the innovation

We have noted that in the innovative formations the weak root allomorph was only used as the base of affixation if it ended in a short vowel. This is descriptively true, but by stating the phonological aspect of the innovation in prosodic terms, we may bring the change in line with a phonological process that we find in other languages, namely Trochaic Shortening (§3.1). The innovative formations based on the weak root allomorph all end in a sequence of two light syllables:

L L#	H L L#	L L#	L L#	
πό.μα,	εὔ.ρε.μα,	κρί.μα,	ῥύ.μα,	etc.

Putative (unattested) Weak + μα(τ) formations to roots of the other type would all have ended in a heavy-light sequence:

*H L#	*H L#	*H L#	
*δάγ.μα,	*ζύγ.μα,	*πάγ.μα,	etc.

That is to say that from a synchronic standpoint, the adoption of the weak allomorph occurs only where it results in LL#. In prosodic terms, the innovative grammar has a process H → L / __ L#. Note that the continued use

of the strong root/stem allomorph elsewhere (e.g. πῆγμα not *πάγμα) reflects that the morphological preference for Strong + μα(τ)- remains active in the grammar, though it is overridden under a specific set of circumstances. We will return to this below in §4.

3.1 Trochaic Shortening

The adjustment of word-final HL sequences to LL sequences, or differently stated, the conversion of H → L / __ L#, is known as Trochaic Shortening. In this section, I introduce Trochaic Shortening by way of Fijian and Samoan, where the change in the weight of the penultimate syllable is brought about by various phonological processes including shortening underlying long vowels (e.g. /e:/ → [e]), monophthongizing diphthongs (e.g. /ai/ → [e]), breaking diphthongs and long vowels (e.g. /ai/ → [a.i], /e:/ → [e.e]), etc. (Hayes 1995: 145 ff.; Zuraw, Orfitelli and Yu: 2008). The following examples are from Fijian (cf. Hayes 1995: 145).

(G) Trochaic Shortening in Fijian

(1) /nre:-ta/ → [nréta] 'pull'	H → L / __ L#
(2) /ta:-y-a/ → [táya] 'chop it'	H → L / __ L#
(3) /rai-ða/ → [réða] 'see it'	H → L / __ L#

In examples (1) and (2), the word-final HL sequence is converted to LL via phonological shortening of the underlying long vowels, i.e. V: → V __ CV#. In example (3), the diphthong is monophthongized. In other dialects, the diphthong is broken into a disyllabic sequence ra.í.ða, both strategies resulting in LL#. Samoan exhibits similar processes, as in these examples cited in Homer 2007 and Zuraw, Orfitelli and Yu 2008.

(H) Trochaic Shortening in Samoan

(1) /tsu:si/ → [tsús'i] 'write'	H → L / __ L#
(2a) /pele:-ŋa/ → [peléŋ'a]	H → L / __ L#
(2b) or → [pèle.éŋ'a]	H → L / __ L#

In (1), the underlying long vowel is shortened. In (2a) and (2b) there is some variation: (2a) reflects shortening of the long vowel; (2b) reflects an alternative strategy whereby the long vowel is broken into two short

vowels. Both effect the same change to LL#. Note that the slight lengthening of the consonant following the stressed vowel occurs regardless of the underlying length of the preceding vowel. From a prosodic standpoint, the innovative -μα formations to the °VV- ~ °V- roots reflect the same adjustment.

(I) H → L / __ L# as reflected in the innovative -μα formations

(1) χεῦμα > χύμα 'stuff poured' H → L / __ L#
(2) πῶμα > πόμα 'drink' H → L / __ L#
(3) εὕρημα > εὕρεμα 'discovery' H → L / __ L#

Note that the only forms in the inflectional paradigm that are effectively prosodically optimized on this analysis are the nominative/accusative singular, since the context __ L# is not met anywhere else in the paradigm. With the exception of the genitive plural, all other forms end in LL# regardless of which root/stem allomorph they are derived from.

3.2 Trochaic Shortening and moraic trochees

Trochaic Shortening is usually ascribed to foot construction, i.e. the grouping of syllables into prosodic units called feet, specifically to the construction of moraic trochaic feet (Prince 1992; Hayes 1995: 145-149). Moraic trochees are one of the three types of (bounded) feet in the inventory proposed in Hayes 1995, and they are standardly assumed in prosodic phonology and morphology. I assume them for the analysis of Greek foot structure proposed here. Each moraic trochaic foot consists of two moras, such that a foot may consist of either one heavy syllable (H), or two light syllables (LL). Trochaic Shortening is found in languages where the most prominent of the moraic trochees is preferentially aligned with the right edge of the word. A word-final HL sequence poses a problem for footing in languages with right-aligned moraic trochees because it is impossible to align a bimoraic foot with the right edge of the word. For example,

/tsu:si/ → *(tsu:si) yields a trimoraic right-aligned foot,
/tsu:si/ → *(tsu:)si yields a bimoraic foot that is not right-aligned, and
/tsu:si/ → *(tsu:)(si) yields a monomoraic right-aligned foot.

Shortening the long vowel, or making whatever other phonological adjustments effect a change of H → L / __L#, allows for a complete parse of the word-final sequence into a bimoraic right-aligned foot: /tsuːsi/ → (tsú.sˈi).[19]

Greek has been analyzed on independent grounds as a language with right-aligned moraic trochees in Golston 1990, building on Sauzet 1989. These studies treat the recessive (i.e. the default, phonologically calculated) accent as their primary evidence for foot structure.[20] Below, I provide a brief description of moraic trochee formation in Greek, according to what I will refer to as the Sauzet-Golston analysis.[21] According to their analysis, Greek speakers grouped syllables into moraic trochees proceeding from right to left through the word. In Greek, as in a number of other languages, one word-final consonant is extrametrical, which is to say that for purposes of the recessive accent calculus, it is not included in the final syllable (Steriade 1988; Probert 2003: 28-33).[22] Thus, the final syllable of ἄνθρω-πος 'man, human being' is a light πο, not a heavy πος, for purposes of the recessive accent calculus. Following the standard convention, I mark the extrametrical consonant with angled brackets (e.g. πο<ς>), syllable boundaries with a dot, and feet with parentheses. Where syllable boundaries align with foot boundaries, I do not mark them with a dot; the foot boundary implies the syllable boundary. Forming moraic trochees (LL) or (H) from right to left, beginning with the most prominent foot at the right edge

19 For footing-related (morpho)phonological processes in Latin such as *brevis brevians*, "cretic shortening", and the selection of *-u-* versus *-s-* in perfect formations, cf. Mester 1994 and Fortson 2008: 176 ff.

20 The Sauzet-Golston approach to the recessive accent is in my opinion superior to that of Devine and Stephens (1994: 117-156) in two important respects. First, Sauzet and Golston relate the accent calculus to foot structure, whereas Devine and Stephens consider the two prosodic systems to be unrelated. Second, Sauzet and Golston operate with the far more restrictive foot inventory proposed in Hayes 1995. For Devine and Stephens, feet in Greek alone can be bimoraic, trimoraic, iambic and trochaic.

21 Cf. fn. 2.

22 For evidence for extrametricality, and the analysis thereof, cf. Hayes 1995: 56-60, 105-108.

of the word, we arrive at the following foot structures (where the accent is momentarily left off):

(J) Syllabification and construction of moraic trochees

(1) ἐδυναμην → ἐ(δυ.να)(μη)<ν>
(2) ἐδυναμεθα → ἐ(δυ.να)(με.θα)

The word-initial syllable ἐ cannot be incorporated into a bimoraic foot, and is left unfooted. Words like ἄνθρωπος, with word-final HL sequences, present the same problem for footing that is "fixed" by Trochaic shortening in Fijian and Samoan, since it is impossible to group that sequence into a bimoraic foot at the right edge of the word:

(3) ἀνθρωπος → (ἀν)(θρω)πο<ς>

Unlike Fijian and Samoan, however, Greek does not exhibit widespread phonological Trochaic Shortening. Thus, in most instances, a word-final HL sequence is not altered.

According to the Sauzet-Golston analysis, the recessive accent placement results from the association of a High+Low* tonal melody with the most prominent syllable of the most prominent foot of the word, i.e. the first syllable of the word-final moraic trochee. The Low* part of the melody "docks" directly to that syllable (and is therefore marked with a postposed asterisk). The High part of the melody, which is what is represented by the graphic acute accent in out texts, is thereby located on the mora preceding that syllable.[23] In the examples given in (K) below, the melody is represented H+L*. I use boldface type to highlight the syllable to which the melody docks.

(K) Moraic trochees as reflected by the recessive accent

H+L*
(1) ἐ(δυ.νά)(μη)<ν>
H+L*
(2) ἐ(δυ.νά)(με.θα)
H+L*

[23] For a discussion of the phonetic correlate of the accent as high pitch, cf. Devine and Stephens 1994: ch. 4, with refs.

(3) (ἄν)(θρω)πο<ς>

The Sauzet-Golston analysis elegantly relates the recessive accent calculus to foot structure, specifically to a moraic trochee at the right edge of the word, bringing the recessive accent calculus in line with prosodic systems of other languages. Furthermore, it supports our association of the innovation in the χύμα-type with Trochaic Shortening, since Trochaic Shortening is only found in languages with moraic trochees. In short, if Greek speakers grouped their syllables into moraic trochees, it would be typologically unsurprising to find evidence for Trochaic Shortening.

4 The lexically conservative aspect of the innovative word formation process

That Greek does not exhibit across-the-board, purely phonological Trochaic Shortening is clear from a comparison between the small group of alternating roots of the °VV- ~ °V- sort, and the far larger group of non-alternating roots/stems, sketched out below.

(L) **Trochaic Shortening is not purely phonological**

	HL#		LL#
Non-Alternating			
γευ-	γεῦ-μα		
καρπω-	κάρπω-μα		
μετρη-	μέτρη-μα		
Alternating °VV- ~ °V-			
χευ- ~ χυ-	χεῦ-μα	>	χύ-μα
πω- ~ πο-	πῶ-μα	>	πό-μα
εὑρη- ~ εὑρε-	εὕρη-μα	>	εὕρε-μα

If Greek exhibited purely phonological Trochaic Shortening, we would find hundreds of formations like *γύμα, *κάρπομα, *μέτρεμα, etc. Speakers only fixed the footing problem where they didn't have to create novel allomorphs, which *γυ-, *καρπο-, *μετρε-, etc. would have been. That is to say that we only find Trochaic Shortening in these formations where

suffixing -μα to a pre-existing weak root allomorph yielded a word-final LL sequence: (χύ.μα), (πό.μα), (εὖ)(ρε.μα), etc.

In recent work on Lexical Conservatism (1999a; 1999b; 2008; typescript), Steriade has described and analyzed a number of word formation processes which reflect a similar interaction between phonology, morphology, and the lexicon. The basic notion is this: under certain circumstances, speakers are unwilling to create new phonological variants of a stem to satisfy a phonological (or morphosyntactic) preference, but they are willing to use pre-existing variants to do so. Differently stated, in lexically conservative word formation processes, the phonological modification of a stem is blocked, unless that modification already exists in the paradigm of the derivational base, or in a root-related word. This quite accurately captures the innovative -μα formation pattern. Speakers would like to avoid the sequence HL# by converting the H → L / __ L#. However, they are unwilling to phonologically modify the strong (or only) verbal root/stem to avoid HL#. They are unwilling, for example, to delete the /e/ in γευ- in order to generate a *γύμα that would avoid HL#. And so they continue to produce the prosodically problematic γεῦμα (Euripides+) 'taste' as the verbal noun formed to γεύω (Homer+) 'taste', which has only one root allomorph γευ-. When forming a result noun to χέω 'pour', however, they are willing to break with the morphological preference for Strong + μα(τ) and "borrow" the weak root allomorph χυ- to satisfy the prosodic preference for LL#. When they form a result noun to ζεύγνῡμι 'join', they adhere to the Strong + μα(τ) pattern because none of the pre-existing allomorphs (ζευγ-, ζυγ-) allows them to avoid the footing problems. For more formal, constraint-based modelling of the grammars involved, the reader may consult Gunkel 2010: 28-33. The change is summarized in (M).

(M) Overview of the change

	HL#		LL#
Non-Alternating			
γευ-	γεῦ-μα		
Alternating °VVC- ~ °VC-			
ζευγ- ~ ζυγ-	ζεῦγ-μα		
Alternating °VV- ~ °V-			
χευ- ~ χυ-	χεῦ-μα	>	χύ-μα

5 Further evidence for HL# avoidance

In order to make this analysis of the change in word formation patterns reflected in χεῦμα > χύμα more plausible, we might look for further Greek-internal evidence for the avoidance of HL#, keeping in mind the possibility that speakers were unwilling to perform purely phonological operations in order to avoid the sequence. Further evidence could therefore be morpho-phonological in nature.[24] At this point, I can only suggest that it may be fruitful to study complex suffixes of the shape -VCo- that are diachronically analyzable into -V-Co-, and appear to have the replaced (or be replacing) suffixes of the shape -Co- in a similar function. An example is the -ιμο- found in ἄλκιμος 'brave', φαίδιμος 'shining' (both *Iliad*+) which is analyzable as *-ι-μο-, and seems to have partly replaced the older adjectival -μο- that is preserved in θερμός 'hot' and δοχμός 'oblique, aslant' (both *Iliad*+) and to be competing with functionally similar -Co-shaped adjectival suffixes (-ρό-, -νό-, etc.). For example, κῡ́διμος 'glorious' (Hesiod, *Homeric Hymns*+) competes with κῡδρός 'id.' (*Iliad*+) and κῡδνός 'id' (Hesiod).

As pointed out by Alan Nussbaum (1976: 76-8), the formation of a number of adjectives in -ιμο-, e.g. κῡ́διμος, ὄψιμος 'late' (*Iliad*+), seems to have been conditioned by the fact that the allomorph in -ι appears as the first member of a compound, either belonging to the "Caland System," e.g. κῡδι-άνειρα 'bringing glory to men', or not, e.g. ὀψί-γονος 'born late(r)' (both *Iliad*+).[25] It may be attractive to view the conditioning factor seen by Nussbaum as Lexical Conservatism and to suggest that the factor

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[24] It could also involve subcategorical adjustments to heavy syllables / __ L# (i.e. adjustments that make the heavy syllable lighter but not categorically light; on subcategorical weight in Greek, cf. Ryan 2011). It is also possible that Dionysius of Halicarnassus' statements in *de compositione verborum* 17-21 (Aujac-Lebel) provide evidence for such durational adjustments. Recent contributions to the problematic interpretation of these passages are Ruijgh 1987 and Prauscello 2001.

[25] On the formation of adjectives in -ιμο- and other complex Caland formations, cf. Probert 2006: 238-242, 259-288, 294, with further references.

motivating the use of the stem in -ι as HL# avoidance.[26] There is quite a robust set of complex suffixes of this shape: -ανο-, -ινο-, -αρο-, -ερο-, -υρο-, to name just a few. It is by no means clear that all the functional variants in -VCo- are due to a prosodic constraint against HL# sequences, though such a constraint might well be reflected in the general pattern of diachronic development whereby nominal formations ending in -VC-CoC are replaced with formations of the shape -VC-VCoC.[27] Below, I briefly treat a slightly different case, where I suggest that a number of adjectives in -α-ρό- may reflect the avoidance of -ᾱ-ρό-.

From a morphosyntactic point of view, these adjectives seem to be derivatives in -ρό- from ᾱ/η-stem nouns. In these derivatives, the suffix -ρό- serves its well-attested function as a denominal suffix that forms adjectives with possessive (or more broadly exocentric) semantics. This seems likely from a semantic standpoint as well. As an example, we may take σκιαρός 'shady'. The derivational base, from a morphosyntactic and semantic standpoint, seems to have been σκιᾱ́ 'shade'. What is unexpected in formations like σκιαρός is the phonological shape of the base of affixation. The α-vowel of the derivative σκια-ρό- is short, while the ᾱ of the derivational base σκιᾱ- is a long. Usually, in -ρό- (as generally in -Co-shaped) derivatives from ᾱ/η-stem nouns, the long stem-final vowel of the derivational base is retained.

(N) The usual N → A derivation X-ᾱ/η → X-ᾱ/η-ρός[28]

ἀνίη (Homer+) 'grief' → ἀνιηρός (Homer+) 'grievous'
ἄτη (Homer+) 'delusion' → ἀτηρός (Theognis+) 'delusional'
ὀδύνη (Homer+) 'pain' → ὀδυνᾱρός (Pindar+) 'painful'

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[26] I will assume here that it was particularly important to speakers to optimize the citation form of the nominal, that usually being the (masculine) nominative singular. Other approaches to this are possible, e.g. approaches where the token frequency of particular slots makes them more important to optimize. Without a much larger collection of data reflecting HL# avoidance, there is no use in debating the issue.

[27] Recall that one word-final consonant is extrametrical (cf. §3.2).

[28] On apparently deverbal nominals in -αρο-, cf. Rau 2009: 166, fn. 110.

To judge by equations like that of Latin *barbātus* with OCS *bradatŭ* and Lithuanian *barzdótas*, the resulting -ā-Co- is also the inherited pattern (< I-E *-eh$_2$-Co-).[29] It seems significant that these -α-ρό- adjectives with the unexpected short α always have a nominal formation in -άδ- in their lexical paradigm. The -άδ- stems, which were also originally derived from nouns in -ᾱ/η according to Rau 2004, are arguably the source of the short α-vowel in the -α-ρό- adjectives, via a lexically conservative word formation process. In (O), I list the -α-ρό- adjectives, the morphosyntactic base nouns in -ᾱ, and the lexically related nominal in -άδ- (in the citation form -άς).

(O) -α-ρό- adjectives beside ᾱ-stem nouns and nominals in -άδ-

σκιαρός (Pindar+) 'shady'
σκιᾱ́ (Homer+) 'shade, shadow'
σκιάς (Eupolis+) 'providing shade'

σοβαρός (Aristophanes+) 'rushing, violent'
*σοβᾱ́ '(act of) rushing, rush(er)'[30]
σοβάς (Eupolis+) 'insolent, capricious'

The following two formations are nouns that are plausibly derived from older adjectives in -α-ρό-. οἴναρον (Cratinus+) 'tendril, leaf' is plausibly a substantivized neuter form of *οἰναρός 'of or belonging to the vine', and νομάριον· σκεῦος τραγικόν (Hesychius) may plausibly be derived from *νομαρός 'of or belonging to the pasture'.

(P) Nouns plausibly derived from -α-ρό- adjectives

οἴναρον (Cratinus+) 'tendril, leaf'
οἴνη (Hesiod+) 'vine'
οἰνάς (Myc., Simonides+) 'vineyard'

νομάριον· σκεῦος τραγικόν (Hesychius)
νομή (Herodotus+) 'pasturage'
νομάς (Pindar+) 'nomad'

[29] Cf. (Hajnal 1993:130-131).
[30] Cf. μυιο-σόβη (Menander) 'flyflap'.

To judge by their semantics, which are less compositional, and their dates of attestation, the word formation process that produced these adjectives in -α-ρό- (and their derivatives, such as οἴναρον) was no longer productive in the classical period. We seem to be dealing with a lexical residue of an earlier productive process. This makes it plausible that the following forms in -αρό- were also derived from ᾱ-stem bases, but that the bases, which are not attested, were lost or replaced. The related nominals in -άδ- are attested.

(Q) **-α-ρό- nominals beside -άδ- nominals**

σιναρός (Hippocrates) 'damaged'
σινάς (Hesychius) 'destructive'

στιβαρός (Homer+) 'sturdy'
στιβάς (Sophocles+) 'bed of straw'

λογάρια (Aristophanes+) 'petty speeches'
λογάς (Herodotus+) 'select' (of troops)

It is at least prima facie plausible that the pattern of attestation that we find in archaic and classical Greek reflects a moribund word formation process much like the one that produced the innovative formations of the χύμα type. Essentially, prosodically problematic HL# sequences were avoided only where a lexically related formation in -άδ- provided a phonological stem with a short -α, i.e. one that resulted in a LL# sequence. The grammar that would produce these is essentially the same lexically conservative grammar sketched out above.

6 Conclusion

The core contribution offered here is a description of the innovative -μα formation process that notes that systematic differences between derivatives depend on the phonological shape of the root-related stem allomorphs. This asymmetry has not been noted in previous treatments of the change, to my knowledge, and it must be accounted for under any future analysis. I have proposed to equate the phonological aspect of the innovation with Trochaic Shortening, a process found in other languages

which descriptively involves the adjustment of H → L / __L#. According to current phonological theory, Trochaic Shortening is only found in languages with moraic trochaic feet, and Greek has been analyzed as such a language on the basis of the recessive accent calculus.

In previous discussions and analyses of the change, the apparent borrowing of the weak allomorph from a root-related word is referred to as "contamination".[31] A further point of interest is that once the phonological shape of the root/stem allomorphs is taken into account and the concept of Lexical Conservatism is introduced, this change may be viewed as *regular*, insofar as a χύμα-type formation is attested for virtually every °VV- ~ °V- root to which such a verbal noun was productively formed, despite the fact that it is not purely phonological.

[31] The following scholars refer to the change as contamination: Buck and Petersen (1945: 222); Chantraine (1933: 175-190); Hatzidakis (1895: 111: 1897: 103); Peters (1980: 333); Schwyzer (1898: 47-49); Schwyzer (1939: 522-524); Specht (1931: 50); Stratton (1899), etc.

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