From Unicode to Typography, a Case Study: the Greek Script

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'Οδούσσεους 'χιεμένος κάϊ καπνὸν
ἀποτρόοσκοντα νοεέζαϊ χεὲς
γκάϊεες [Viz, p. 135]

The Greek script has a long history and, although the Greek language is spoken only by about 20 million people, the Greek script is one of the most widely known in the world. In this paper we will try to synthesize, from a typographical point of view, the various instances of Greek script. Globally, one can say that the Greek script is used for the following cases:

1. Greek language;
2. Mathematics;
3. Universally used symbols (such as μ for "micro," Ω for "Ohm," etc.);
4. International Phonetic Alphabet;
5. African languages.

The typographical behaviour of letters is quite different in each of these cases: not only the shape of letters can be quite different, but they also behave differently with respect to standard typographical transformations (change of case, italics, etc.). In the following table we summarize the behaviour of the Greek script *vs*. the context in which it is used:

	Example	Uppercase	Italics	Bold	Variants
Greek language	ἄνθρωπος	Yes	Yes	Yes	Yes
Mathematics	$\alpha = \sin(\omega - 2\pi)$	SD	Style dep.	SD	SD
Univ. symbols	10 μΩ	No	Yes	Yes	No
IPA	fɛʀ'ʃteən	No	Slanted	Yes	SD
African languages	tɔxɛtcxɛwo	Yes	Yes	Yes	No

where "SD" stands for "semantically different."

In the following sections we will investigate the first two cases:[1] the Greek language and Greek mathematical symbols. The purpose of this paper is to give directives for the proper use of the Greek script for all kinds of Unicode users: font designers, typesetters, authors, publishers, developers of Unicode-compliant software.

[1] Originally, the paper was intended to cover all five cases. Unfortunately because of lack of time (and space... the paper is already almost 40 pages long) only the first two cases are covered.

1 The Greek Language

1.1 Classification of the Greek Language, Notations

As for every language, Greek has evolved continually during its existence. Hence, any classification of it into different types can only be artificial; nevertheless we need to classify it from a typographical point of view, into three types and their sub-types: ancient Greek, which we will denote **A** (with two subtypes: **τA** and **αA**), *katharévousa*, for which we will write **K** and *dimotikí* written as **Δ** (with three sub-types: **κΔ**, **πΔ** and **μΔ**). Follows the rationale behind this classification:

1.1.1 Ancient Greek: A, τA, αA

We will call **A** the typographical representation of whatever dates from ancient times until the Renaissance.

Some history: until the 3rd century A.D. only capital letters were used; from the 4th century and afterwards the capital letters were slowly transformed into lowercase-only; finally, in the 10th century scribes started using both upper and lowercase letters [Mio, pp. 77-89]. Accents and breathings were introduced by Aristophanes the Byzantine (257-180 B.C.) but have been applied regularly only since the 8th century A.D. [Mio, p. 57].

Nowadays, when we represent texts of those periods typographically, we have three choices:

(a) to use epigraphical typefaces;
(b) to reproduce accents and breathings, whenever they are used in the original, faithfully, but with modern types;
(c) to follow modern rules of accentuation and complete the missing accents and breathings.

These three methods can all be applied to the same text, according to the targeted audience: solution (a) will apply best for an audience of epigraphologists and paleographers, and may be completely unreadable for the average Greek speaker or scholar; solution (b) is a good compromise: in most of the times it will be accurate enough for the paleographer, and still comprehensible (although sometimes obscure) by the common mortal; solution (c) is the one applied in text- and schoolbooks: content is more important than form and spelling is standardized by the editor of the text.

In this paper we will not enter into solution (a): Unicode does not cover (yet) epigraphical characters, and this subject would lead us too far. We will give more details on the differences between solutions (b) and (c) in §1.3.1, when we will describe the accent and breathing system. These two possible representations of **A** are our two "sub-types": **τA** stands for "standardized typographical representation" and **αA** for "non-standardized typographical representation." Here is an example: in Figure 1, the reader can see the "Nikandre" inscription (6th century B.C.). Here is the typographical representation of part of this inscription, given by [Fri, p. 274]:

ρōρη Δεινοδίκηι τοῖ Ναησίōι, ἔησοχος ἄλ(λ)ηōν.

In [Phi, `ins0090.txt`] we find an alternative typographical representation of the same inscription (some words in "rectified" forms):

κούρη Δεινοδίκηι τοῖ Ναχσίου, ἔχσοχος ἄλ(λ)ήōν.

Both representations are **αA**; here is a temptative representation in **τA** (standardized ancient Greek spelling), partly obtained by applying the Athenian spelling reform of 403 B.C. where long ε and ο were replaced by η and ω, and combinations χσ and φσ by ξ and ψ [Fri, p. 106]:

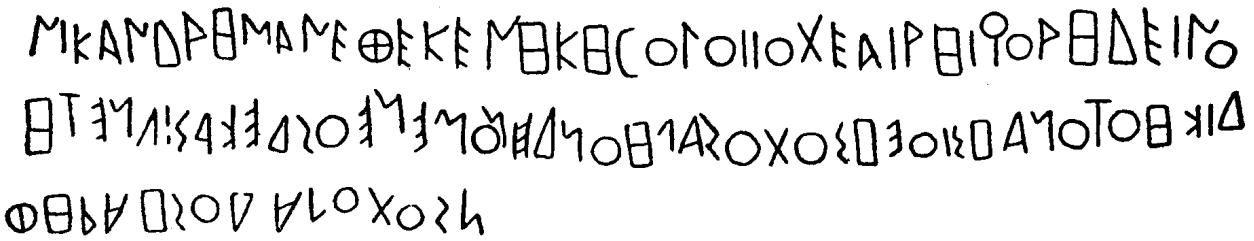


Figure 1: "Nikandre" inscription, 6th century B.C..

κόρη Δεινοδίκου τοῦ Ναξίου, ἕξοχος ἄλλων.

This **τA** form can be understood by any Greek reader; this is not the case of the first **αA** form, which requires knowledge of paleography to be understood.

The distinction between **τA** and **αA** is important to us, because *not* all characters necessary for the latter are provided by Unicode, nor can all of them be obtained by combining character sequences.

1.1.2 "Purified" Greek (katharévousa): K

In the early 19th century, as the modern Greek nation came to being, freeing itself from the Ottoman empire, a few Greek scholars, living in Europe, began a project whose goal was to "purify" the language actually spoken in Greece, by bringing it closer to ancient Greek. They aimed to replace words borrowed from Latin, Italian, Turkish, Slavic, Albanian, Armenian, Arabic, etc. by, either new words with Greek etymology, or original ancient Greek words. They also tried to establish a grammar of "purified" modern Greek. This project was taken over by scholars in Greece, and until the end of the 19th century was taken to such an extent that the result, the so called *arkhaïzousa katharévousa* "ancient-like," became totally uncomprehensible to the common reader. In the 20th century, under the pressure of supporters of the spoken language (*dimotikí*, see §1.1.3), **K** became simpler. Its latest version, *aplí katharévousa* "simple," was used in Greece until the 1970s, for official, technical and scientific documents, as well as for some newspapers.

This "purification" project could be compared to the project of revival of Hebrew language in post-war Israel. The project in Israel succeeded, as Ivrit has become a living language, while the *katharévousa* project was officially abandoned in 1982.

The spelling and hyphenation rules of **K** are the same as for **τA**.

1.1.3 Vernacular Greek (dimotikí): Δ, πΔ, μΔ, κΔ

Dimotikí, which could be the only form of contemporary Greek language if there had been no "purification" project in the 19th century, is the continuation of medieval and Renaissance Greek, as it had been spoken and written in Greece, before, during Ottoman occupancy and afterwards.

The three subtypes **κΔ**, **πΔ** and **μΔ** correspond to three stages in the (typographical) history of **Δ**. First, at the late 19th and early 20th centuries, **Δ** was still rarely printed. When this was the case, it was considered to be an "exotic," deviated form of **K**, and spelled accordingly. This is a very interesting period, because authors, in the absence of a standard **Δ** grammar, didn't know how to write **Δ** and invented weird spellings only to give their writings pseudo-grammatical foundations. In some sense, we can say that **Δ** was not *written*, but *transcribed*. It is this type of **Δ** which we will call **κΔ** ("*dimotikí* in a *katharévousa* context").

Later on, **Δ** was standardized and slowly replaced **K** in all facets of life. **Δ**, like **K** started by being written with three accents and two breathings. In the early fifties one of the accents (*varía*) was abolished,

but still two accents and two breathings remained. We will call **πΔ** ("polytonic" = multi-accent), **Δ** written with two or three accents and breathings. In 1981, one accent and the two breathings were abolished, so that only one accent remained (*oxía*). We will call **Δ** written with only one accent **μΔ** ("monotonic" = one-accent).

The 1981 and subsequent reforms have also simplified spelling and hyphenation rules. Here is an example of a sentence, first written in **κΔ** [Per, p. 30], then in **πΔ** (spelling as in [Wen]) and finally in **μΔ** (spelling as in [Teg]):

κΔ: *Χαρῆτε νεϱαῖς, χαρῆτε νεϱοὶ τὰ δροσερά σας νεϱᾶτα*
πΔ: *Χαρεῖτε νειές, χαρεῖτε νειοὶ τὰ δροσερά σας νειάτα*
μΔ: *Χαρείτε νιες, χαρείτε νιοι τα δροσερά σας νιάτα*

Once again, the distinction between **κΔ** and **πΔ** is important for us, because Unicode does *not* provide all necessary characters to typeset in **κΔ**. Also, the distinction between **Κ** and **πΔ** (and *a fortiori* **μΔ**) is important because hyphenation rules are different (see §1.5).

1.2 Letters

In this section we will describe the letters used by the Greek language, and the corresponding Unicode characters, and glyphs needed to typeset them. The basic Greek alphabet (common to **Α**, **Κ** and **Δ**) is:

$$\alpha\ \beta\ \gamma\ \delta\ \varepsilon\ \zeta\ \eta\ \theta\ \iota\ \varkappa\ \lambda\ \mu\ \nu\ \xi\ o\ \pi\ \varrho\ \sigma\ \tau\ \upsilon\ \varphi\ \chi\ \psi\ \omega$$
$$A\ B\ \Gamma\ \Delta\ E\ Z\ H\ \Theta\ I\ K\ \Lambda\ M\ N\ \Xi\ O\ \Pi\ P\ \Sigma\ T\ Y\ \Phi\ X\ \Psi\ \Omega$$

The letter sigma has a final form, written ς. Although this is a contextual property, there is a Unicode character for this letter: `U+03C2`; this is perfectly justified, because in some cases there is a semantical difference between the medial and final form of σ: for example, "φιλοσ.," is necessarily the abreviation of some word (like φιλοσοφία) while "φίλος." is a single non-abbreviated word, followed by a sentence period. In cases like this the form of the σ cannot be determined by a simple algorithm.

There is a typographical curiosum, involving the final sigma: the *Grammar of Pontiac Language* by K. Topkharas ([Top], reprinted in [Top$_2$]), published in 1928, in the Soviet Union, for the (Pontiac) Greek speaking minorities. This grammar completely abolishes accents, breathings, diphtongs, and uses only part of the alphabet. The ς is used for the sound 's', and a double ςς for the English 'sh'. Here is an excerpt of this book [Top, p. 49]:

> Σιν γλοςανεμυν επεμνεν ας αρχεον τιν γλοςαν κε το ακλιτον το λεκςοπον α πυ μεταχιριςκυςανατο ι παλιεμυν, ονταν εθελναν να φανερονε πος καπιον ιδιοτιταν πυ εςς εναν προςοπον για πραμαν, λιφταςςκετιατο καπιον αλο λ.χ. δινατος κε αδινατος.

1.2.1 Archaic letters

There are six additional letters, used in **Α** and in numerals (see §1.4.2).

1.2.1.1 The digamma ϝ F This letter represented the sound of Latin v (while β had rather the sound of b). It became an F in Latin. Its place in the alphabet is between ε and ζ.

In Figures 8a-e, the reader can see specially designed digammas in the various Monotype fonts (some digammas and other archaic letters designed by Monotype itself, others added by the author). It is interesting to note that in Greece, although the specially designed digammas have always existed in Monotype typefaces, the real Latin F has been preferred in typesetting, maybe because in a Greek-only context, a Latin letter is easier to distinguish than a specially designed letter whose goal is to be homogeneous with the rest of the typeface.

Here is an example, taken from [Oik, p. 180] (and below the same sentence, using the specially designed digamma):

παίω (= χτυπώ, θ. *πα*F-, *πά*F-*j*-*ω* = *παίω*), πρτ. *ἔπαιον*, ...
παίω (= χτυπώ, θ. *παϝ-*, *πάϝ-j-ω* = *παίω*), πρτ. *ἔπαιον*, ...

Indeed, in the first example the digamma can be more clearly distinguished; the price to pay is a slight loss of typographical quality: a capital upright letter in the middle of a word typeset in lower case.

Digamma has not had the same typographical evolution as other Greek letters. Because of this, it seems that a certain number of publishers and typographers wish to emphasize its epigraphical nature and sometimes typeset it in upper case (while not necessary) and even sometimes in a different font (for example, [Bai] uses a non-serif font while the Greek text is typeset in *aplá*). It is hard to say if this is a stylistic choice, or a technical necessity; nevertheless the author considers it to be bad typographical practice.

In Unicode v2.1, letter digamma is encoded by characters `U+03DD` and `U+03DC` (lower and upper case).

1.2.1.2 The stigma ϛ Ϛ This letter is used as a numeral only; it represents number six (see §1.4.2). There is a general confusion between stigma and digamma, in fact they have the same origin. Nevertheless, nowadays, digamma is used only in text and stigma only as a numeral. Some additional confusion comes from the fact that early Greek typefaces use the stigma as a sigma-tau ligature; so that, for example, τὸ στέρεο στήριγμα is written τὸ ϛέρεο ϛήριγμα. In modern Greek, in absence of a stigma, the letters στ are used for numeral 6.

The capital version of stigma has always been a problem for type designers. In Monotype fonts, one finds glyphs similar to the lowercase stigma, scaled to match the capital letters, as Ϛ (although this letter resembles more a final sigma ς than a stigma ϛ). The author has designed a capital stigma Ϛ for the *aplá* typeface, according to 19th and early 20th century originals: ἐν ἔτει ΑΩϘϚ′. Another version of capital stigma has been designed for use in **Δ**: Ϛ̣; this is a ligature between a capital sigma and a lowercase tau: according to the style of the surrounding text, one can choose between ϛ′ Ϛ′ or στ′ Ϛ̣′ for number six.

In Unicode v2.1, letter stigma is encoded by characters `U+03DB` and `U+03DA` (lower and upper case).

1.2.1.3 The textual koppa ϙ Ϙ This letter is the ancestor of the Latin q Q. In ancient Greece to treat a person as illiterate or ignorant, one would say: "οὐδὲ κόππα γιγνώσκων" ("he doesn't even know the koppa") [Ele, p. 6]. The place of ϙ in the alphabet is between π and ρ. It has been used widely in texts before the Athenian reform of 403 B.C. (as in our example on page 3, in the word ϙόρη, nowadays written κόρη). As in the case of the digamma, scholars sometimes use a Latin q instead of the specially designed ϙ, maybe because the latter can be mistakenly taken for a ρ (rho).

For the design of the capital textual koppa Ϙ, the author has followed [Boy].

This letter—both in upper- and lowercase form—is necessary for typesetting **αA**. Therefore the author considers that it should be included in Unicode.

1.2.1.4 The numeric koppa ϟ Ϟ This letter is used as a numeral only; it represents number 90 (see §1.4.2). It is a variant form of ϙ Ϙ, nowadays semantically different: at some time the two forms of koppa were used in parallel, and progressively the "straight" shape was used for numerals only, and the "round" shape only in text. There seems to be no standard glyph for the capital version of ϟ; often (certainly because of its geometric, non-alphabetical nature) the same glyph is used for lowercase and uppercase. The author has designed two uppercase ϟ candidates: ϒ and ϓ, the former being curly and the second carrying serifs; neither one of them is entirely satisfactory.

In Unicode v2.1, letter numeric koppa is encoded as characters `U+03DF` and `U+03DE` (lower and upper case).

1.2.1.5 The sampi ϡ Ͱ This letter is used as a numeral only; it represents number 900 (see §1.4.2). For the design of the capital sampi Ͱ, the author has followed [Boy]. In some references, sampi is written like an epigraphical M (see [Lid, p. 1562] for a detailed explanation).

In Unicode v2.1, letter sampi is encoded as characters `U+03E1` and `U+03E0` (lower and upper case).

1.2.2 The letter yod

This letter is quite special. It is included in Unicode as `U+03F3`. It represents a phoneme which has never been written in ancient times. Nevertheless that phoneme is necessary to explain certain grammatical phenomena, for example the fact that a root like ἁρπαγ- produces the noun ἁρπαγή and the verb ἁρπάζω: we say that the verb ending is -jω and that ἁρπαγ + jω = ἁρπάζω [Oik, p. 38].

In fact it is not a coincidence that the sound of letter yod is precisely the sound of 'j' in German: this letter was introduced by German scholars and publishers. It is very interesting to note that the yod is *not* always written j: in fact it depends on the background language of the document.

This may well be a **unique case in the Unicode standard**: a character whose glyph depends on the *background* language, *i.e.* not of the language in which it is used (ancient Greek) but of the main language of the document (English if it is an English translation or critical edition, French if it is a French one, and so on). In France, the yod is often written y: [Fro, p. 114] and [Ver, p. 11] use y throughout, [Rag, p. 7] mentions both j and y but afterwards uses j, while [Bai, for example p. 562, μέθjoc] uses j.

According to [LeG], French scholars influenced by the German school first wrote the yod j. Later on the use of y prevailed. Finally, more recently, scholars have returned to j, considering it to be an IPA symbol.

This particular nature of yod justifies its presence in Unicode (taking a plain Latin j would not allow French users to represent it by a y). Nevertheless, the uppercase version of yod is missing: well understood, yod will never appear at the beginning of a word, but the uppercase version is necessary for all-caps titles: for example in [Oik, 32] we find the section title "Μετάθεση του j (επένθεση)." If that title was to be typeset in all-caps, it would become "ΜΕΤΑΘΕΣΗ ΤΟΥ J (ΕΠΕΝΘΕΣΗ)" and the uppercase yod would be necessary.

1.2.3 Variant forms

Some of the letters have variant forms. As we will see, they are all font-dependent, and are not semantically different from the original letters, at least in the context of Greek text; they can be semantically different in mathematics.

1. The beta without descender: ϐ. Sometimes the following rule is applied: β is used at the beginning of words, and ϐ otherwise, as in the words βλάϐη, βιϐλίο, βάρϐαρος. This rule seems to be geographically very restricted: the author has seen it applied in Greek books of the late 19th and early 20th century (**Α**, **Κ** and **κΔ**); it seems to be applied, rigorously and continuously until today, only in France: [Bai, p. 145], [Imp, p. 95], [Ver, p. 1], [Rag, p. 2], all mention it and apply it; the monumental [Ste] applies it strictly; all *Budé* and *Le Cerf* editions of classical Greek texts apply it as well. On the other hand, this rule is unknown in the rest of the world: neither [Oik] (Greece), nor [Käg], [Fri], [Wen] (Germany), or [Lid], [Chi], [Bet] (England/US), or [Bol], [Sov] (Russia), or [Nak] (Japan) mention it.
   The form of β can be easily determined by an algorithm and hence this property is purely contextual (like Arabic contextual forms, and *not* like the σ/ς case where there can eventually be a semantic layer). The variant beta `U+03d0` is called "Greek beta symbol" in Unicode, which implies that this character is intended for mathematics; nevertheless the author can hardly imagine this character used in mathematics since it would be hard to distinguish from a (more or less cursive) Latin b.

παλλασ. εϖει μονα ι ϛενσ τογε θνγατερων
λϖκεν αθαναιαι ϖατρϖια παντα φερεσθαι

Figure 2: Sample taken from a 1489 book, illustrating the random use of π and ϖ.

2. The "open" and "closed" letter pairs theta and phi: ϑ/θ, φ/ϕ (Unicode U+03D1, U+03B8, U+03C6, U+03D5). These variant forms are mentionned in most grammars and dictionaries, but the author was not able to detect any contextual rule involving them. It is interesting to note that [Imp, p. 95] suggests that the open theta ϑ be used at the beginning of words; this rule is mentioned only by [Imp] and the author has never seen it applied.
   Nevertheless, open and closed versions of theta and phi can be semantically different (again with certain restrictions) in mathematics. Concerning the open and closed theta, [Caj, §631] writes: *In limit and remainder theorems Cauchy designated by θ an undetermined value […] Some writers employ the form ϑ of the Greek letter,* and in [Caj, §657]: *Harkness and Morley represent Jordan's* $\theta, \theta_1, \theta_2, \theta_2$ *by* $\vartheta, \vartheta_1, \vartheta_2, \vartheta_2$ *respectively*. Goldberg, in [Gol], uses alternatively ϕ and φ whenever a new object is defined and called phi: this helps the reader switch between the different uses of the same letter as mathematical symbol.
   This semantical difference between open and closed phi and theta in mathematics justifies their presence in Unicode.
3. The "curly" capital Upsilon ϒ (U+03D2) and lowercase kappa ϰ (U+03F0). These are purely stylistic; in fact they are the normal versions of uppercase upsilon and lowercase kappa in the *aplá* font, while the "standard" versions Υ κ of the letters, in other words the glyphs shown in the Unicode book, belong to the Times family of fonts (see Figure 8).
   It is unfortunate that a glyph difference between two fonts has produced different Unicode characters. Even in mathematics, the choice between κ and $\varkappa$ seems to be stylistic, and the difference between Y (Latin Y) and Υ is too small to be immediately recognizable.
4. The "curly tail" rho ϱ (U+03F1). The difference between ρ and ϱ is simply that the latter is used mainly in italic fonts: τώρα *vs.* *τώϱα*. Again, in mathematics, the choice between ρ and ϱ seems to be purely stylistic.
5. The "round" pi ϖ (U+03D6). This letter has been a variant of π from the very first days of Greek typography: in Figure 2, the reader can see an excerpt of [Pol], a book printed in 1489 (!). In this excerpt both versions of pi have been used, apparently randomly.
   Once again, [Imp, p. 95] suggests that the round pi be used only at the beginning of word. According to [Tre], this rule has been applied in certain French journals (for example the *Mémoires de la Société de Linguistique* in the late 19th and early 20th century); [Tre] applies it in all of his writings; here is an extract of [Tre$_2$, §43]:

   > γέγωνέ μοι ϖᾶν τοῦπ' ὅπως εἰδω τίς εἶ Sophocle, *Phil*. 238 "il m'a tout révélé pour que je sache qui tu es" … ϖολλῷ ϖλέον γεγωνεῖ ἔστι νύκτωρ ἢ μεθ' ἡμέραν Antiphon 5,44 "la voix porte beaucoup plus loin la nuit que le jour…"

   [Imp] again, but in a different chapter (the one on typesetting of mathematics, p. 108) calls this letter "Doric pi."
6. The lunate sigma c C. This letter looks like a Latin c, but without the bulb. It is the Byzantine form of letter sigma (which led to the Cyrillic C c). It is mainly used in Byzantine fonts: ϹΩΤΕΡ ϹΩϹΟΝ ΗΜΑϹ. [Bet] uses it as a remplacement for σ/ς, with the following argument: *The [lunate] form of sigma […] is, for reasons of convenience, the one increasingly used in modern editions*. And indeed,

it is used by the *Oxford Classical Editions*.

One could say that the lunate sigma is again simply a stylistic variant of the regular sigma, without contextuality. Of course it would be interesting for the paleographer to mark up the different forms of sigma in a text, but this concerns also many other letters which have had variant forms. The only argument that could justify the presence of this letter in Unicode is to encode texts in which the contextual form of sigmas is not known.

It should also be noted *en passant*, that if we consider the lunate sigma to be a useful Unicode character, then there should necessarily also be a capital version of it in Unicode.

1.2.4 The turned letters iota and upsilon with tilde

Letters ι̽ and υ̽ are turned versions of letters iota and upsilon with tilde ι̃, υ̃. Their capital versions Ι̽ and Υ̽, used a breve-like accent instead of the tilde. These letters are widely used in **κΔ** to represent semi-consonants (ι̽α is pronounced like the German 'ja' or the Russian 'я', while, in the same context, ια would be rather 'i-a' in German or 'иа' in Russian).

It is interesting to note that the tilde of ι̽ and υ̽ has been used by typographers for reasons of convenience only (they simply turned around a type). In fact it should theoretically be a breve-like accent, like the one of the uppercase versions. This accent is called *ifén* or *enotikón*. In Unicode, there is already the character U+203F which has the same name and shape, but this character is a (spacing) punctuation mark, and not a combining mark, as needed in our case.

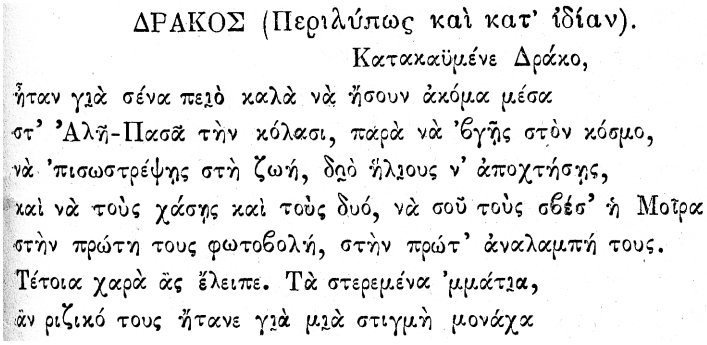
In Figure 3 the reader can see examples of the use of these letters, both in *aplá* and in Times fonts. These letters are not yet represented by Unicode characters. The author believes that they are necessary for the encoding of **κΔ** texts, and considers that their insertion in Unicode would be very useful.

1.2.5 The ου and καὶ ligatures

In early Greek prints, and until the early 19th century, a big numbers of esthetic ligatures was used in Greek fonts (the extreme case being the typeface *Les grecs du roi* by Claude Garamont, having thousands of ligatures). Some of these ligatures remained in titling or in the hand-written language and are still used today: the most important are the ου ligature ȣ and the καὶ ligature ϗ ("καὶ" meaning "and"). [Myl] has included the former in his Euclid font. Ligature καὶ is included in Unicode v2.1 U+03D7 and [wEve] proposes the insertion of ligature ου. The author does not consider either of these ligatures to be necessary because these ligatures are simply esthetic (like the ff ligatures in Latin typefaces). Furthermore, they do not appear in ordinary printed text (the example given in [Myl, p. 49] is purely experimental). [wEve] argues that the Latin "et" has undergone a similar process and finally became the independent character &. This is of course true, but in Greece there is a tendancy of using the καὶ ligature in ordinary printed text, and, in the author's opinion, it is not the role of Unicode to cause such an artificial evolution.

Of course, it would be marvelous to have fonts with the ligatures of the early Greek typefaces, as one can find today Latin, Fraktur and Arabic fonts with more and more esthetic ligatures. This issue is independent of Unicode. In Figure 4 the reader can see a sample from a book printed in Constantinople in 1810 ([Pat], taken from [Kef, p. 117]), showing the ου and καὶ ligatures, as well as λλ, ει, αι, εν and στ (stigma-like) ligatures.

It should be noted, *en passant*, that in Greek titling, uppercase versions of the καὶ and ου ligatures are used as well.



ΔΡΑΚΟΣ (Περιλύπως καὶ κατ' ἰδίαν).

Κατακαϋμένε Δράκο,
ἦταν γι̯ὰ σένα πε̯ὸ καλὰ νὰ ἤσουν ἀκόμα μέσα
στ' Ἀλῆ-Πασᾶ τὴν κόλασι, παρὰ νὰ 'ὀγῆς στ̣ὸν κόσμο,
νὰ 'πισωστρέψ̣ης στὴ ζωή, δ̣ο̣ὸ ἥλ̯ους ν' ἀποχτήσ̣ης,
καὶ νὰ τοὺς χάσ̣ης καὶ τοὺς δυό, νὰ σοῦ τοὺς σβέσ' ἡ Μοῖρα
στὴν πρώτη τους φωτοβολή, στὴν πρώτ' ἀναλαμπή τους.
Τέτοια χαρὰ ἂς ἔλειπε. Τὰ στερεμένα 'μμάτ̯ια,
ἂν ριζικό τους ἤτανε γι̯ὰ μ̯ὰ στιγμὴ μονάχα

Example in *aplá* font [Per$_2$, p. 53]. Line 1 is in **K**, lines 2-9 in **κΔ**. Words containing ̯ι: γι̯ὰ (lines 3, 9), πε̯ὸ (line 3), ἥλ̯ους (line 5), 'μμάτ̯ια (line 8), μ̯ὰ (line 9). The word δ̣ο̣ὸ on line 5 contains ̣ο.

καὶ 'ς τὴ θερμή μου δέησι θὲ νὰ τοῦ 'πῶ πῶς εἶναι
τὸ ἕνα γι̯ὰ τὴν κόρη μου, τὸ ἄλλο γι̯ὰ τὸ γυι̯ό σου.

ΓΙΑΝΝΑΙΝΑ (ἤτις ἠγέρθη).

Τί λές, κυρά; τί ἄκουσα; ἕνα κερὶ θ' ἀνάψ̣ης,
ἕνα καιρὶ ὁλάκερο γι̯ὰ τὸ καλὸ τοῦ γυι̯οῦ μου;
Ὤ! ποῦ νὰ ἰδῇς χίλ̯ια καλὰ γι' αὐτὸ τὸ ψυχικό σου
καὶ ὅλαις σου ἧ λύπαις σου, γιὰ ξένους πάντα νὰ ἦναι.
Πᾶμε, κυρά, 'ς τὸν Ἅϊ Λι̯ά, ἐκεῖθε εἶν' ὁ δρόμος.

Example in Times font [Kor, p. 7]. Line 4 is in **K**, lines 1-3 and 5-9 in **κΔ**. Words containing ̯ι: γι̯ὰ (lines 3, 6), γυι̯ό (line 3), γυι̯οῦ (line 6), χίλ̯ια (line 7), Λι̯ά (line 9). The spelling of ἧ λύπαις and ἦναι (both line 8) is typical of **κΔ**; today these words would be written οἱ λύπες and εἶναι.

Figure 3: Two examples of the use of turned iota and upsilon with tilde, in *aplá* and Times font.

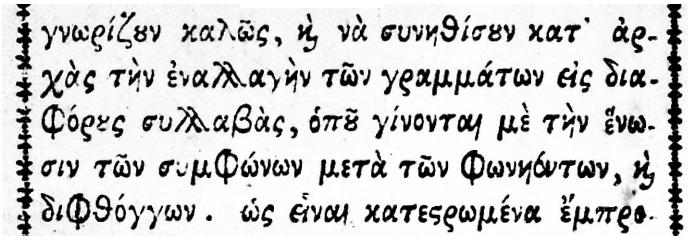

γνωρίζων καλῶς, ἢ νὰ συνηθίσῃ κατ' ἀρ-
χὰς τὴν ἐναλλαγὴν τῶν γραμμάτων εἰς δια-
φόρους συλλαβὰς, ὅπως γίνονται μὲ τὴν ἕνω-
σιν τῶν συμφώνων μετὰ τῶν φωνηέντων, ἢ
διφθόγγων. ὡς εἶναι κατεσκευασμένα ἔμπρο-

Figure 4: Sample from [Pat]: the ligature ου is used on lines 1 and 3; και is used on lines 1 and 4; λλ on lines 2 and 3; ει on lines 2 and 5; αι on lines 3 and 5; εν on line 4; στ (ς) on line 5.

1.3 Accentuation and Diacritics

1.3.1 Accents and breathings

Greek vowels (α ε η ι ο υ ω) can take the following three accents: acute *oxía*, grave *varía*, circumflex *perispoméni*. While the glyphs of *oxía* and *varía* are simply those of acute and grave accent, the glyph of *perispoméni* can have many forms: historically it started as a combination of acute and grave, but in modern typographical representation we encounter either a tilde (in *aplá* and Times: ῆ) or an inverted breve (in Porson and Greek Sans: ἧ) or a macron (in Linotype Helvetica: ῑ, and other "modern" fonts).[2] When two vowels form a diphthong (two vowels pronounced as one, for example ου, pronounced 'ou'), then the accent is placed on the second vowel.

If the vowel is the first letter of the word, it must also take a breathing *pnévma*. There are two breathings: the rough one (*dasía*, asper) ' and the smooth one (*psilí*, lenis) '. When combined with a breathing, the accent is placed to the right of it when it is *oxía* or *varía*, or on top of it, when it is a *perispoméni*; in some typefaces, the breathing is connected to the *perispoméni* so that they seem to form a single accent: ἦ ἧ (Linotype Helvetica), ᾖ ᾗ (Linotype New Century Schoolbook). If the word starts with a dipthong, it is the second vowel that carries the breathing: οὐδέν.

Uppercase letters do not take accents nor breathings, in all-caps typesetting: ἄνθρωπος → ΑΝΘΡΩΠΟΣ. In mixed lower/uppercase mode, accents and spirits are placed in front of the capital letter: ἄνθρωπος → Ἄνθρωπος.

In **A** (and some overzealous versions of **K**) there is also a consonant taking breathings: the rho ῥ ῾Ρ. Its behaviour is special: at the beginning of a word, the rho takes a *dasía*: ῥάθυμος, inside a word it takes no breathing: ὅριον, but in the case of two consecutive rhos, the first takes *psilí* and the second *dasía*: Πύῤῥος [Käg, p. 3]. The latter rule seems not to be applied in France (neither [Bai] nor [Rag] mention or apply it).

A few rules: let us count word syllables from the end; accents can be placed only on syllables 1, 2 and 3. Syllable 3 can only take the *oxía* accent, syllable 2 can take *oxía* or *perispoméni*, syllable 1 any of the three accents. On syllable 1, the choice between *oxía* and *varía* is contextual: when the word is followed by a punctuation mark or an enclitic (see [Bet, p. 252]) we use *oxía*, otherwise *varía*: ἐσὺ καὶ ἐγώ, ὁ πατήρ μου. In the case of the enclitic, if the first word is accented on syllable 3, then a second *oxía* accent is placed on syllable 1: ἄνθρωπός τις.

In **τA** there are some accentuation restrictions: vowels ε and ο cannot take the *perispoméni* accent; vowel υ cannot take the *psilí* breathing. These restrictions do not apply to **αA**. Other irregularities can occur in **αA**, for example accents and breathings written separately on diphthongs: ὅϊον, ἐΐναι, [Mio, p. 58],

[2] A typographer's joke would be that "the circumflex accent has three forms, none of them being a circumflex."

double accents on words μὲν and δέ [*idem*], words accented on syllable 4, etc.

There are three grammatical phenomena of importance to typosetters: crasis *krásis*, elision *ékthlipsis* and suppresion *aféresis*.

- Crasis is the contraction of a vowel or diphthong at the end of a word, with the vowel or diphthong of the following word: τὸ ὄνομα → τοὔνομα. As we see in this example, the breathing appears to be inside the word. This breathing has the form of a *psilí* but is actually called *koronís*; when the second word is accented on that syllable, then the accent is combined with the *koronís*. When the first word takes a breathing then the resulting contracted word appears to have two breathings: ἐγὼ οἶμαι → ἐγῷμαι. When the first word is an aspirated monosyllabic (a one-syllable word with *dasía* breathing) then instead of a *koronís* we write a *dasía*: ὁ ἀνήρ → ἁνήρ (in this case the breathing seems to keep its name: the author has found no trace of a different name for the "*dasía*-shaped *koronís*."
- Elision is the juxtaposition of a final vowel and an initial vowel: ἀπὸ οἰκίας → ἀπ' οἰκίας. The mark that replaces the final vowel of the first word has again the shape of *psilí* and is called apostrophe *apóstrofos*.
- Suppresion (or inverse elision) is the opposite phenomenon: instead of removing the final vowel of the first word, we remove the initial vowel of the second word: ἢ ἐγώ → ἢ 'γώ. Again, the mark used is an apostrophe, but this time it may happen that the initial syllable of the second word already carries an accent: in that case the accent is combined with the apostrophe and we obtain constructions like: ὦ ἄναξ → ὦ ᾽ναξ (this is indeed strange because accents and breathings are never placed upon, or in front of, consonants).
- Elision and suppresion can be combined in the same word: ποῦ ἐστι ὁ Πλοῦτος; → ποῦ 'σθ' ὁ Πλοῦτος; ἢ ἐπί ἀσπίδων → ἢ 'π' ἀσπίδων [Rag, p. 9].

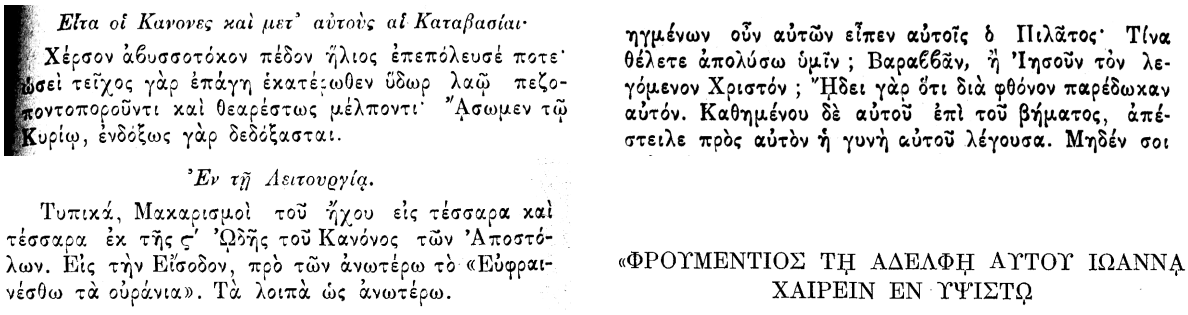
It should be noted that, although the Greek apostrophe shares both the name and function of its French counterpart (*de ombre* → *d'ombre*) the fact that it can be combined with accents, in cases like ὦ ᾽ναξ, makes the distinction between stand-alone diacritic and spacing punctuation mark unclear. And the task of representing them in Unicode even harder: indeed, in Unicode there is a combining mark *koronís* `U+0343`, but what about cases such as ἁνήρ, where the *koronís* is *dasía*-shaped? In cases such as ὦ ᾽ναξ should the *koronís* be combined with an acute accent and a space, or should `U+1fce` "Greek *psilí* and *oxía*" be used, which is already a spacing character?

1.3.2 Diaeresis

Diaeresis *dialitiká* is used when a diphthong is to be pronounced as two separate vowels: ου is pronounced 'ou', while οϋ is 'o-i'. It can be combined with any one of the three accents: ΐ ΰ ῗ, but never with a breathing since, by definition, it can never be placed on the first letter of a word. Unlike other diacritics, dieresis is also placed in all-caps typesetting: Ποΐδης → ΠΟΪΔΗΣ. There is a variant form of capital iota with vertically centered diaeresis: Ɨ, in which case the same word looks like: ΠΟƗΔΗΣ.

Diaeresis is *not* used whenever it is clear from the context that the diphthong is "broken." For example, when the word starts with a diphthong, the breathing is placed on the first vowel and diaeresis is not written: ἀυτή instead of ἀϋτή. When the first vowel is accented, again the diaeresis is not written: χάιος instead of χάϊος. When a word is hyphenated between the two vowels of a broken diphthong, the diaeresis is not written: Μαΐου will be hyphenated Μα-ΐου.

There are other cases where diaeresis is used: one of them is to show that the letter iota is pronounced (and not mute). Normally a mute iota is written as a subscript (see §1.3.3): τῷ Θεῷ. But it can also be written in normal size. To show that this is not the case, and that the iota must indeed be pronounced, we



Εἶτα οἱ Κανονες καὶ μετ' αὐτοὺς αἱ Καταβασίαι·

Χέρσον ἀβυσσοτόκον πέδον ἥλιος ἐπεπόλευσέ ποτε· ὠσεὶ τεῖχος γὰρ ἐπάγη ἑκατέρωθεν ὕδωρ λαῷ πεζοπορουντι καὶ θεαρέστως μέλποντι· Ἄσωμεν τῷ Κυρίῳ, ἐνδόξως γὰρ δεδόξασται.

Ἐν τῇ Λειτουργίᾳ.

Τυπικά, Μακαρισμοὶ τοῦ ἤχου εἰς τέσσαρα καὶ τέσσαρα ἐκ τῆς ς' Ὠδῆς τοῦ Κανόνος τῶν Ἀποστόλων. Εἰς τὴν Εἴσοδον, πρὸ τῶν ἀνωτέρω τὸ «Εὐφραινέσθω τὰ οὐράνια». Τὰ λοιπὰ ὡς ἀνωτέρω.

ηγμένων οὖν αὐτῶν εἶπεν αὐτοῖς ὁ Πιλᾶτος· Τίνα θέλετε ἀπολύσω ὑμῖν ; Βαραββᾶν, ἢ Ἰησοῦν τὸν λεγόμενον Χριστόν ; Ἤδει γὰρ ὅτι διὰ φθόνον παρέδωκαν αὐτόν. Καθημένου δὲ αὐτοῦ ἐπὶ τοῦ βήματος, ἀπέστειλε πρὸς αὐτὸν ἡ γυνὴ αὐτοῦ λέγουσα. Μηδέν σοι

ΦΡΟΥΜΕΝΤΙΟΣ ΤΗ ΑΔΕΛΦΗ ΑΥΤΟΥ ΙΩΑΝΝΑ
ΧΑΙΡΕΙΝ ΕΝ ΥΨΙΣΤΩ

Figure 5: Four instances of capital letters with subscript iota: Ἄσωμεν on top left figure, line 4, Ἤδει on top right figure, line 3, Ὠδῆ on bottom left figure, line 3 [Pro, p. 489, 540, 770]. The bottom right figure is from [Roi, p. 150]: the three letters Ἀ, Ἠ and Ὠ can be found in the same sentence.

use a diaeresis: for example, there is the word πρῴ (pronounced 'pro') which can be written πρώι and still pronounced the same way; and there is another word, πρωΐ, which is clearly and unambiguously pronounced 'pro-i'.

The use of diaeresis goes even farther: a diaeresis is placed even if there is absolutely no grammatical necessity to do so, just to facilitate pronunciation: πιγκουΐνος, ἐπιπλοποιΐα, etc.

In **μΔ** some of these spellings are unauthorized: [Teg] writes πρωί (even in the etymological **Α** version of the word), επιπλοποιία, but βουΐζω, κουΐζ, κουϊντέτο, πιγκουΐνος, σουϊπστέικ, τουΐστ (while, always in [Teg], other similar words again take no diaeresis: αλτρουισμός, ινδουισμός, καζουισμός, σάντουιτς).

1.3.3 Subscript and adscript iota

The vowels α η ω can be followed by a mute iota. In that case, the iota is written in smaller size, under the letter (in the middle of α or ω, and under the left stem of the η).

There is some confusion about the uppercase Α Η Ω with mute iota. The glyphs displayed in the Unicode book show the subscript iota below these letters; on the other hand, in the name of these characters the mute iota is called *prosgegraméni*; this is a neologism meaning "written next to" (while *ipogegraméni* means "written under"). This does not agree with the glyphs, where the mute iota is indeed placed *under*, and not *next to* the letter.

It seems that there have been many ways of typesetting these letter + mute iota combinations. In Greece, one of the traditional methods is to center the iota under the letter: Ἀ, Ἠ, Ὠ. This seems to be rather shocking for Western scholars; Jeffrey Rusten [Rus], while reviewing the Palatino Unicode font, writes: *...an oddity every classicist will notice right away, namely iota subscripts under capital letters. This mistake is not the fault of the Palatino design team, but a longstanding error made already by Unicode and ISO before it, which it is too late to correct*. In Figure 5 we show that this is indeed *not* an error, but conforming to Greek typographical tradition.

Nevertheless, the usual spelling of capital vowels followed by mute iota is: Αι Ηι Ωι, where the iota is written at normal size. In the case of Αι there is no risk of confusion with diphthong αι because of the placement of the necessary breathing: Ἀι or Ἁι in the case of the mute iota, Ἀΐ or Ἁΐ in the case of the diphthong. Examples: Ἅιδης (mute iota), Ἀϊδωνεύς (broken diphthong), Αἴδομαι (diphthong).

Some typographers have tried other solutions: for example, in [Kal], a specially designed small iota is placed next to the capital letter, almost entirely under the baseline. Here are some examples using that

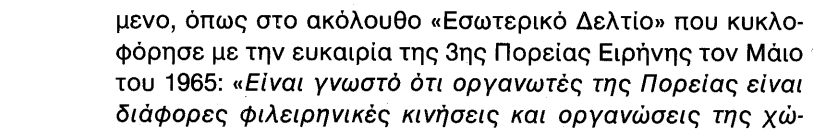

μενο, όπως στο ακόλουθο «Εσωτερικό Δελτίο» που κυκλο-
φόρησε με την ευκαιρία της 3ης Πορείας Ειρήνης τον Μάιο
του 1965: «*Είναι γνωστό ότι οργανωτές της Πορείας είναι*
διάφορες φιλειρηνικές κινήσεις και οργανώσεις της χώ-

Figure 6: In the early days of the monotonic system, some books were printed with a triangular accent. This book, of political content, uses the form of the accent to underline a cultural break with the past. Notice that the triangular accent remains upright, even on italic letters.

convention: Ἄιδης, Ἴιτε, Ὠιδή.

In all-caps typesetting, the mute iota is written as a small-caps iota (normal small-caps size, or even smaller): AɪΔHΣ, HɪTE, ΩɪΔH. There are also other conventions: sometimes the mute is written like a normal uppercase iota; in [Pro, p. 730] one finds lowercase iotas in an all-caps context: *ΤΗι ΑΓΙΑι ΚΑΙ ΜΕΓΑΛΗι ΠΕΜΠΤΗι*.

See §1.3.7 for the case of iota with iota subscript ι.

1.3.4 The monotonic system

In the early eighties, the Greek Government reformed the language. This reform had many aspects: **K** was officially abolished, as were breathings and subscript iota, and the rules of the accentuation system were modified so that only the *oxía* accent be used, and only on words with more than one syllable (with a few exceptions: for example ή, πού, πώς, previously ἤ, ποῦ, πῶς, to disinguish them from η, που, πως, previously ή, πού, πώς). Furthermore, the spelling of several words has been simplified.

It is very important to note that the reform did *not* introduce a new accent, but rather *removed* two of the existing ones: the remaining accent is *oxía*. The Unicode table glyphs show a vertical accent, called *tónos*. This word means "accent," and is exact, since in that context there is only one accent. But this accent has never been written as a vertical stroke. Since the reform some publishers have experimented with triangular and round accents; see for example Figure 6 [Sai], a book from the very early days of the monotonic system (1983), a period where publishers and typographers were trying to find other solutions. These experiments have nowadays come to an end: today the *oxía* accent is used, as in the example in Figure 18, p. 36. The official grammar states clearly that the accent of current [monotonic] Greek is the *oxía* [Tri, p. 22-23]; there is no mention whatsoever of "symmetrical," "vertical," "triangular" or any other form of accent.

This means also that the distinction between "tonos" and "oxia" in Unicode character names (for example, between `U+03AC` and `U+1F71`) is illusory. One could argue that this distinction allows a potential spelling checker to distinguish between text written in the monotonic and polytonic systems (for example, μιλώ is correct in **μΔ** but not in **πΔ**, πιό is correct in **πΔ** but not in **μΔ**) but this is a rather naïve argument: texts are very rarely mixed monotonic and polytonic, and when this happens it is almost always for distinguishing **μΔ** from **K** or **A**, in which case there are far more differences in spelling than the existence or not of more than one accent; in such a case, linguistic markup is far more appropriate.

Thats is why, the author considers that the glyphd ά έ ή ί ό ύ ώ Ά Έ Ή Ί Ό Ύ Ώ in the Unicode Greek table should be redrawn and the corresponding characters in the Greek Extended table re;oved, so that there is only one character representing a Greek vowel with *oxía*, whether in the monotonic or polytonic system. It is very unfortunate, but because of the mistakenly vertical design of the *oxía* accent in the (monotonic) Greek Unicode table, some font companies have already designed fonts with vertical *oxía*; these fonts will soon be used in Greece and may, in the long term, alienate Greek typographical

conventions...

1.3.5 The TONISMOS software

Speaking of Greek accentuation, let us mention the TONISMOS software [wTon], which converts monotonic text into polytonic text, with or without grave accent and subscript iota. This program can be very useful for the input of large quantities of text (the text is typed in the monotonic system, the accents are added by TONISMOS, and the result is compared with the original), or as a complement to optical recognition of Greek text. Nevertheless the program is not a spell checker/corrector: when the monotonic input is not accurate, the resulting polytonic text will be wrong as well.

1.3.6 Other diacritics used in Greek

1.3.6.1 Macron and breve To indicate if a syllable is short or long, vowels can take the macron *makrón* or breve *vrakhí* diacritics. If there is already an accent and/or a breathing on the vowel, the macron or breve is placed between the existing diacritic and the letter, as in the following example:

> Ἄνδρᾰ μοῑ ἔννεπεῑ Μοῦσᾰ πῐολύτρῡπῡν ὃς μάλᾰ πόλλᾰ̀
> πλᾰ́γχθῆ ἐπεὶ Τροΐης ἱῆρὸν πτῐολίεθρῡν ἔπερσε·

To keep the same leading, the combinations of macron/breve and accent/breathing often have to be specially designed.

1.3.6.2 Representing non-Greek phonemes There are cases where diacritics have been used to represent sounds not provided by the Greek alphabet itself. For example, [Geo] uses breve on letters ζ, σ, ξ and ψ—as well as special constructions such as double consonants at beginning of word—to represent the hard sounds of the Cypriotic dialect:

> Σ̆σ̆ύλλα ποὺ ἔμαθεν τζ̆αὶ τρὼ πετσ̆ιὰ ἔντζ̆ε προκόβκει, [...] τζ̆ι οἱ πίστες τζ̆ι οἱ πατρίδες ππέφτουν τζ̆αὶ γονατοῦν, [...] Νὰ φέντζ̆εις νὰ παρατηρῶ ὅπου λαξ̆ιὰ τζ̆αὶ σπήλιος, [...] τζ̆ι ὅπου ἐγένετουν κλεψ̆ιά, ἡ μοίρα του 'ταν μοίρα·

It is interesting to note that in [Geo] the letters ζ̆ and ξ̆ with breve have been specially designed so that the letter with diacritic fits in a normal line without changing the leading.

In [Ele], the dotted letters β, γ, δ are used to represent the sounds 'b', 'g', 'd' in foreign words, as in Ḃάγ̇δαδ̇ for 'Bagdad'; in [Des] (mentionned in [Kal, p. 44]) the translator uses the same dotted beta, gamma, delta, as well as upsilon and epsilon with diaeresis, zeta with (Latin-like) circumflex and sigma with tilde to represent the sounds of French 'b g d u e j ch'. A different method for obtaining the same result: in [Mes] (also mentioned in [Kal, p. 44]) the author uses Latin letters e u b g d ch in a Greek text context to represent certain Greek phonemes unavailable in Greek: bουφές, bαχτσέδες, dάλιες, gέμια, etc.

1.3.7 Other languages written in the Greek script

The Greek script has been used for a certain number of minority languages [wMac]: Albanian (Tosk), South Slavic (Macedonian), Aroumanian (Vlach), Gaguz, Surguchi, Urum (Greek Tatar), Turkish (Karamanli). These languages often use diacritics to represent special sounds, not present in Greek: [Fau, p. 182] gives a list of characters for Elbassan Albanian in which we find dotted gamma, nu, sigma and chi, sigma with diaeresis, Latin j and underlined epsilon. But, the same author in [Fau$_2$, p. 539-541], gives samples with dotted lambda and pi, Latin d and b, overlined alpha and upsilon, epsilon with diaeresis, and even a digamma (!):

> Γιάτι ἴνε̲ ἀὲ̲ γέ μπὲ̲ κίελ̇ κιόφτε̲ ὅεντε̲ρουάρε̲ ἔμε̲ρι ἴτ· [...] ἐ δὲμὸς νὰ λε̲ΰότζ νέβετ ντὲ̲ ντονὲ̲ πιρασμό, πὸ ὅπε̲τόνα νάβετ γκὰ ἰ λιϝου, σὲ γιὸτιγια ἔϋτε̲ μπρετε̲ρία. ἐ δὲ φουκία, ἐ δὲ λε̲βδίμι, ντὲ̲ γέτε̲ τὲ̲ πασύσουρε̲ βε̲ρτέτ.
>
> [...]Λjαβδόν bουκουρίνε̲, αΰίκου νε̲ κε̲τέ̲ ζεμάν.
> [...]E dρëτ ποσί kjιρίνε, μερρ νοῡρ χ̇άλκουτ, o jαdιγ̇jάρ !

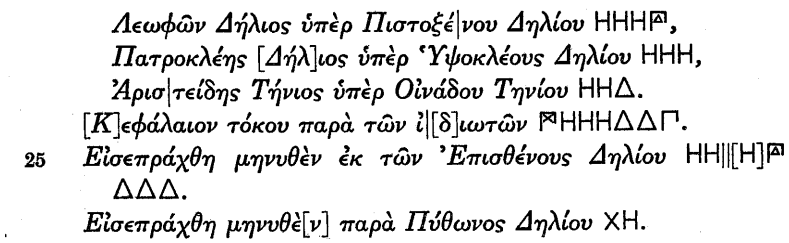


Figure 7: Sample of acrophonic numerals. Greek text is in Porson.

On the other hand, [Gos, §5] uses a capital Cyrillic Б and an overlined iota, in a sample of the same language, dated 1879. In [Gos, §512] we also find an interesting example of Osmanli Turkish, written in Greek script:

> Ζίρα Ἀλλὰχ τὸυνγιαγιὴ πὸὺ κατὰρ σεβτὶ, κὶ κεντὶ Ἴπνι βαχιτινὶ βερτὶ, τά κι ἀνὰ χὲρ ἰμὰν ἐτὲν χελάκ ὅλμαγιηπ̈ ἄντζακ ἐπετὶ χαγιατὰ μαλὶκ ὀλά.

where we find dotted pi and tau, as well as a iota with... subscript iota. The same sample is given in Arabic and Armenian script. By comparing them we see that the dotted pi corresponds to a non-standard pronunciation of the Arabic script: ὅλμαγιηπ̈ is the transcription of اولمايوب, and hence p̈ corresponds to a 'p' pronunciation of Arabic letter ب (normally pronounced 'b'); the ṫ corresponds to the sound of 'd', and finally the weird ɩ̣ is the transcription of Arabic letter ي: τὸυνγιαγιὴ is دنيايى.

[wMac] also mentions uses of dotted beta and delta, and underlined sigma.

1.4 The Greek Numbering Systems

There are two systems of Greek numbers: *acrophonic* and *alphabetic* ones.

1.4.1 The Acrophonic Numbering System

"Acrophonic" from *ákron* (limit) and *foní* (voice); what is meant is the first letter of a word, in this case the first letter of the number's name. So we have a Pi for 5 (= *pénte*), a Delta for 10 (= *dhéka*), a Chi for 1,000 (= *khília*), a Mu for 10,000 (= *miriás*). For one hundred, we have an Eta, because the eta at that time was used also for the rough breathing, and one hundred (ἑκατό *ekató*) indeed takes a rough breathing. Two exceptions: a Iota is used for the unit, and a Tau for 6,000. When fractions are needed, then the Iota = 1 is written with an horizontal stroke to the right, the real Iota means $\frac{1}{6}$, a C means $\frac{1}{12}$, a Tau $\frac{1}{24}$ and a Chi $\frac{1}{48}$ [Caj, §33-35]. And finally, when we want to multiply one of the numbers above by 5, we include a smaller version of the corresponding letter in a normally sized Pi.

How do we represent these numbers typographically? There are two ways:[3] either we consider them as abstract geometric shapes and represent them in an "epigraphical style," or we consider them as Greek letters and represent them in the same typeface and style as the surrounding Greek text. Here are these numbers, first in epigraphical style:

Ⅰ Γ Δ 𐅄 H 𐅅 X 𐅆 M 𐅇 T 𐅈 Ⱶ C

and then in "typographical style" [Ste]:

Ⅰ Π Δ 𐅄 H 𐅅 X 𐅆 M 𐅇 T 𐅈 Ⱶ C

[3] A similar choice is needed for the Berber alphabet Tifinagh, which, like acrophonic numerals, did not have the same typographical evolution as did the Latin or the Greek alphabet: one can represent it in an epigraphical, purely geometrical way, or one can try to simulate what an hypothetical typographical evolution would be, and adapt it to an existing Latin typeface. Such an attempt has been made by the author (see [Har, p. 145-146], [wHar, p. 11]).

The reader can see in Figure 7 an example of printed text [Tod, p. 73] using these characters. The text is typeset in Porson, and the acrophonic numerals in epigraphical style. Here is how the same text would look typeset in Times with acrophonic numerals in typographical style (to bring the result closer to Figure 7 we keep the numerals upright while the text is typeset in italics):

Λεωφῶν Δήλιος ὑπὲρ Πιστοξέ|νου Δηλίου HHHΓ,
Πατροκλέης [*Δήλ*]*ιος ὑπὲρ Ὑψοκλέους Δηλίου* HHH,
Ἀρισ|τείδης Τήνιος ὑπὲρ Οἰνάδου Τηνίου HHΔ,
[*K*]*εφάλαιον τόκου παρὰ τῶν ἰ*|[*δ*]*ιωτῶν* ΓHHHΔΔΠ.

The acrophonic numerals are also called *Herodianic*, after Herodianus, a Byzantine grammarian of about 200 A.D. It would be useful to include them in Unicode, for the purpose of encoding scholarly **A** texts, as the one in Figure 7.

1.4.2 The Alphabetic Numerals

The alphabetic numerals have suceeded the acrophonic numerals; they allow a more compact representation of numbers, while demanding a higher mental effort. Here is the correspondence between Greek alphabetic and Arabic numbers:

α′	1	ϛ′ or στ′	6	κ′	20	ο′	70	τ′	300	ω′	800
β′	2	ζ′	7	λ′	30	π′	80	υ′	400	ϡ′	900
γ′	3	η′	8	μ′	40	ϟ′	90	φ′	500		
δ′	4	θ′	9	ν′	50	ρ′	100	χ′	600		
ε′	5	ι′	10	ξ′	60	σ′	200	ψ′	700		

where ϛ, ϟ and ϡ are the letters stigma, numeric koppa, sampi, described in §1.2.1.2, §1.2.1.4, §1.2.1.5. The notation στ′ is used in Greece today, when the ϛ character is absent from the font. The mark ′ (U+0374) is *not* an apostrophe (as it is, unfortunately, often typeset in Greece) but a spacing acute accent, called *keréa* (= mast, protuberance, today: antenna). To represent thousands, an inverted *keréa* is placed in front of the letter: ͵α is 1,000, ͵θ is 9,000. Units are combined with decades, hundreds, thousands to form numbers: ͵ρκγ′ is 123, ͵αϡϟθ′ is 1,999.

With the rules given above, the highest possible representable number is ͵θϡϟθ′ = 9,999; up to this number, Greek alphabetical numbers have always been unique and non-ambiguous, until today. This is not the case for numbers above 9,999.

According to [Ele], one can continue this way, placing the inverted *keréa* in front of numbers ι,... ϡ, so that the highest representable number is ͵ϡϟθϡϟθ′, that is 999,999. [Oik, p. 134] avoids the question by not giving examples above ͵κ (20,000). According to [Mio, p. 100], to represent ten-thousands, Greeks either used the alphabetic number followed by the word μυριάδες (meaning "ten-thousands"), as in ε′ μυριάδες, or a diaeresis on the letter, like in ë. [Caj, §36] states some additional conventions: sometimes the number of ten-thousands was written before a capital M, (the initial of *miriás*, actually a remainder of the acrophonic numbering system) and the whole number was overlined: $\overline{\text{εM}\,͵\delta\tau\kappa\alpha'}$ for 54,321; in some cases a centered dot $\overset{\varepsilon}{\cdot}$ is used instead of M; finally, one encounters the alphabetic number placed upon the capital M, as in $\overset{\varepsilon}{\text{M}}$, or the coefficient of the myriads written as an exponent to a lowercase μ, like in $\mu^{\varepsilon}\,͵\delta\tau\kappa\alpha'$.

One could ask: why not follow [Ele] and continue defining ͵ι as 10,000 and so on? A probable answer is the fact that then the system would be ambiguous: is ͵ρκγ′ 120,003 or 100,023?

It is obvious that the way of representing numbers beyond 9,999 has never been standardized and notations have varied. On the other hand, for numbers under 9,999 there has been no variation until

today; indeed the alphabetic numbering system is still widely used in Greece today, *for ordinals only*. Counting by α′, β′, ... is a very common form of enumeration in Greece (similarly to i, ii, iii, ... in the West) and everybody can instantly recognize these numbers, at least until κγ′ (29). Laws have also been numbered in the Greek system; in that case one can easily find numbers covering the whole range of (standard) alphabetic Greek numerals.

Just like Roman enumeration, Greek alphabetic enumeration can be lowercase or uppercase; in fact one can easily have independent enumerations in the two cases, lower and upper. For this reason, the case distinction is essential for the three "numerals-only" letters stigma, numeric koppa and sampi. This distinction, while present in ISO 10646 v. 1, is absent from Unicode; it should be re-introduced to allow proper enumerations.

To return to **A**, there have been other interesting conventions [Caj, §§41-44]: for example, to express the fraction $\frac{17}{21}$, Heron writes ιζ′ κα″ κα″ (the denominator written twice, with double *keréa*), Archimedes and Eutocius write

$$\frac{\overset{\kappa\alpha'}{\iota\zeta}}{} \quad \text{or} \quad \begin{matrix}\kappa\alpha\\ \iota\zeta\end{matrix}$$

(note that the denominator is written on the top, and the nominator at the bottom). Diophantus, in expressing large numbers writes

$$\frac{\beta\psi\delta^{\sim}}{\gamma\cdot\varsigma\chi\kappa\alpha} \quad \text{for} \quad \frac{36,621}{2,704}.$$

Again, note that nominator and denominator are inverted. Unit fractions were written with a double *keréa*: ζ″ for $\frac{1}{7}$, ριβ″ for $\frac{1}{112}$, etc. The Byzantines sometimes wrote the denominator of a fraction as an exponent: $\theta^{\iota\alpha}$ in this notation means $\frac{9}{11}$ [Caj, §271].

About the 2nd century A.D., the Babylonian sexadecimal numbers were used in Greek astronomy. The letter ο̄ (omicron with a bar) or õ, was used to designate a vacant space in the writing of numbers (there was no zero provided, in any Greek numbering system); the opposite notation has also been used: all letters representing numbers have a bar, and the "zero" omicron has none, so that it is distinguished from ο′ (70). Ptolemy believed that the value of π is $3 + \frac{8}{60} + \frac{30}{60\times60}$ and he wrote this as γ̄ η̄ λ̄, or γ̄ η′ λ″ (this notation is strangely close to the modern notation $3^\circ\ 8'\ 30''$).

1.5 Hyphenation

Greek hyphenation rules are very simple to one who knows the language, and can be very difficult otherwise: they take into account etymology (**A**, **K**) and pronunciation (**Δ**). Furthermore there are important deviations between the rules applied in Greece and these used in the West.

The minimal number of letters that can be left on a line is 1 (unlike in English where this number is 3): one often sees hyphenations such as ἀ-εροπλανοφόρο, which do not seem to shock anyone.

1.5.1 Hyphenation of A and K

Let us start with the rules for **A** (and **K**), as formulated in Greece [Oik, p. 16] and [Aca]. Let $c_1, c_2, \ldots$ be consonants, and $v_1, v_2, \ldots$ vowels; then:

I $v_1c_1v_2$ is hyphenated v_1–c_1v_2: κα-τά, πρῶ-τος, ὕ-δωρ;

II $v_1c_1c_2v_2$ is hyphenated v_1–$c_1c_2v_2$ if there is a (**A** or **K**) Greek word starting with c_1c_2: κύ-κνος (κν like κνισμός), ῥά-βδος (βδ like βδέλλα), θε-σμός (σμ like σμῆνος). Otherwise it is hyphenated v_1c_1–c_2v_2: ἄλ-λος, ἔορ-τή, λαν-θάνω.

III $v_1c_1c_2\ldots c_nv_2$, for $n \geq 3$ is hyphenated v_1–$c_1c_2\ldots c_nv_2$ if there is a (**A** or **K**) Greek word starting with c_1c_2: κάτο-πτρον (πτ like πτύω), γά-στρα (στ like στρογγύλος), ἰ-σχνὸς (σχ like σχῆμα). Otherwise it is hyphenated v_1c_1–$c_2\ldots c_nv_2$: ἄν-θρωπος, μελάγ-χρως, ἄρ-κτος.

IV Compound words are divided into their original parts, except if the final vowel of the first word has been removed: συν-οικία, ἔξ-οδος, μετα-γραφή, but πα-ρέρχομαι (from παρ[ὰ] and ἔρχομαι), ἀ-πέχω (from ἀπ[ὸ] and ἔχω), πρω-ταγωνιστὴς (from πρώτ[ο-] and ἀγωνιστὴς).

The Western rules are expressed in a different way [Chi, §9.130-135]:

II′ $v_1c_1c_2v_2$ is hyphenated $v_1c_1{-}c_2v_2$ if either (a) the consonant is doubled $c_1 = c_2$, or (b) if c_1 is a mute consonant and c_2 its corresponding aspirate (γχ, κχ, πφ, τθ), or (c) if c_1 is λ, ρ, μ, or ν (with the exception of $c_1c_2 =$ μν, which is not hyphenated).

III′ $v_1c_1c_2 \ldots c_nv_2$ is hyphenated $v_1{-}c_1c_2 \ldots c_nv_2$, unless one of the conditions of rule II′ applies to c_1c_2.

IV′ Compound words are divided into their original parts.

These rules produce different hyphenations than II, III, IV:

- according to II, αἰχμὴ is hyphenated αἰχ-μή, because there is no Greek word starting with χμ; according to II′, it is hyphenated αἰ-χμή.
- rule IV′ does not take into account the exception of rule IV, namely the case where the first component of a compound word has lost its final vowel. This makes an *enormous* difference: according to IV′ we have hyphenations ἔφ-οδος (ἐπὶ + ὁδός), ἀπ-έχω (ἀπὸ + ἔχω), κατ-έχω (κατὰ + ἔχω), παρ-οξύνω (παρὰ + ὀξύνω), and there are hundreds (thousands?) other examples, all wrongly hyphenated for IV.

The author ignores the reasons for these deviations: intuitively, a combination of rules I, II, III, IV′, would be the best (αἰχ-μή sounds more natural than αἰ-χμή), and the purpose of hyphenation is, after all, to make reading of broken words easier, so that intuition is perhaps more important than universal grammatical rules.

1.5.2 Hyphenation of Δ

In **Δ** new combinations of consonants appeared (for example μπ, pronounced 'mb' or 'b') which made new hyphenation rules a necessity. The various grammatical reforms went even farther: rule IV was abolished (compound words are now treated like non-compound ones); this is sometimes very counterintuitive. Here are the two new rules which have been added [Tri, p. 20-21]:

V the pairs of consonants μπ, ντ, γκ are hyphenated if, and only if, their pronunciation is nasal: ἀμ-πέλι, ἔμ-πορος, πέν-τε but μπα-μπάς, ντα-ντεύω, ξε-μπλέκω.

VI vowel pairs αϊ, αη, οϊ, οη, and ι∗, υ∗, ει∗, οι∗, where ∗ is any vowel, are not hyphenated when they are pronounced without glottal stop: νεράιδα, Γιάννης, μυαλό, but ἀβο-ήθητος, πί-εση, πῦ-ον. A not so obvious case: πιάνω (pronounced *piáno* or like in Russian пяно) *vs*. μει-άνω (pronounced *mi-áno*, with a glottal stop, like in Russian миано).

Of course these rules are impossible to apply for somebody not speaking the language. Furthermore, both rules are quite ambiguous because people do not always pronounce words the same way, especially foreign ones. Rule VI is reminiscent of letters ϳ and ͻ of **κΔ** (see §1.2.4): the words that are not hyphenated are precisely those which would be written with those letters: νεράϳδα, Γϳάννης, μͻαλό.

1.6 Punctuation and typographical conventions

1.6.1 Punctuation

Greek punctuation is similar to Western punctuation, with a few exceptions: the semicolon is used as a question mark, and the role of the semicolon is played by the upper dot (·). A **Κ** and **πΔ** punctuation

mark which that is not found in Unicode is *ipodiastolí*: it has the glyph of the comma and is used in a single word: ὅ,τι to distinguish it from ὅτι:

Πές μου ὅτι σοῦ εἶπε (confirm to me that he told you)
Πές μου ὅ,τι σοῦ εἶπε (tell me everything he told you).

Typographically speaking, the distinction between comma and *ipodiastolí* is important, because, contrarily to the former, the latter is *not* followed by blank space. Fortunately the case of ὅ,τι is unique and unambiguous.[4] The *ipodiastolí* is also used as decimal separator: 3,14159...

For quoting, double guillemets are used; in the *aplá* typeface these guillemets are round: «ζήτω !». In 19th and early 20th century books the (French) convention of adding a double guillemet (often an inverted one) at the beginning of each line is often used.

The spacing of punctuation is very interesting: different amounts of white space are placed in front of colon, semicolon, exclamation: roughly 1 point before the colon, 1.5-2 points before the semicolon (Greek question mark) and 2.5-3 points before the exclamation mark. The author has found no precise reference for these values, so they should be considered purely empirical. No spacing is applied to the other punctuation marks (including the guillemets).

Also interesting is the case of the second level quotes. Here, quotes of the size and shape of the English ones are used, but the opening quotes are inverted, similar in form to raised small round guillemets: ‟εἰσαγωγικά”. Fortunately these quotes are provided by the Unicode standard (`U+201F` and `U+201D`, the latter being the same closing double quotes as in English); the author knows no other language in which this combination of double quotes might be used.

1.6.2 Hanging diacritics

Another interesting typographical convention: “hanging diacritics.” As in English one may have “hanging punctuation” [Knu, p. 394], in Greek poetry one uses hanging breathings and accents, in the sense that these marks, when in front of an uppercase vowel, are typeset on the left margin, and alignment is done with respect to the letter:

῾Ενοιωσεν ὅτι
τοῦ ἦσαν οἱ στίχοι
ἄχαρη τύχη
καὶ ματαιότη.

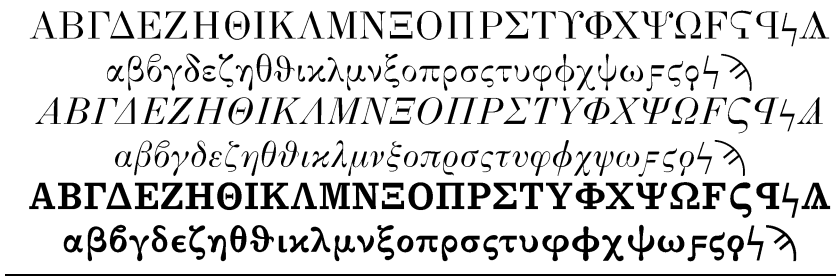
(The vertical line is inserted to show the left alignment of the paragraph.) This convention is *not* applied in prose text.

1.6.3 Letterspacing

Bold is never used inside Greek text, but only for titles. The role of bold in English is played by *letterspacing*, which in Greek (and German, and Russian) is very common (and there is no reason to compare it with the... stealing of sheep[5]): κάνω δ ι α σ τ η μ ά τ ω σ η, ἀλλὰ δ ὲ ν κλέβω π ρ ό β α τ α. Note that, as in German and Russian, letterspacing is done between letters only, and not between letters and punctuation, or, in the case of Greek, between diacritics and (uppercase) vowels. Also interword spacing must be slightly increased to avoid confusion with interletter space.

[4] In some typographical traditions of **A**, a blank space is used instead of the *ipodiastolí* to separate ὅ from τι.

[5] Quoting Frederic Goudy: “Anyone who would letterspace lowercase letters would steal sheep.” [Gou]



(a) Monotype Greek 90, 91, 92

(b) Monotype Greek Times, also called "Elsevier"

(c) Monotype Porson

(d) Monotype New Hellenic (*attiká*)

(e) Monotype Greek Sans 486

Figure 8: The Monotype Greek typefaces.

1.7 Typefaces

A good reference on the history of Greek typefaces is [Sch]; in this paper, we will restrict ourselves on the most common typefaces, used currently or in the last few years.

One century of Greek typography, whether in Greece, or in the Western world, and until the arrival of computer DTP, can be summarized in one word: "Monotype" [wMon]. In fact, most printed books are typeset in one, or more, of the following typefaces: *aplá* (which Monotype calls "Greek 90, 91, 92"), Times, Porson, New Hellenic, Greek Sans 486.

When the phototypesetting machines were replaced by computers, the situation changed rapidly: the Times fonts were taken over by the computer, bad quality imitations of the original Monotype Greek 90 were used for the *apla* style, new fonts were designed and used: Linotype released Greek Baskerville and New Century Schoolbook, Greek companies (like Magenta) have adapted many of the Latin typefaces to the Greek script.

We can roughly divide Greek text typefaces into five categories: *aplá* (Didot), the Times family (called Elsevier in Greece), "scholarly" fonts (Porson, New Hellenic, Sans 486), adaptations of Latin typefaces, and, finally, original creations of the last few years.

1.7.1 The typefaces in the aplá style.

This has been the most common style of Greek typefaces. Its ancestors are 19th century Didot typefaces. *Aplá* means "plain," "simple" in Greek, and this is what this typeface has been: the most common typeface for ordinary text. Many companies have released versions in this style: Monotype "Greek 90" (upright), "Greek 91" (italic), "Greek 92" (bold), Linotype "Greek No. 2," Magenta "Memories." The author considers the Monotype ones to be, by far the best choice, in fact the *most beautiful Greek types he has ever seen* (this paper is written in Monotype *aplá*).

Aplá seems to be omnipresent: before the arrival of the computer most books were typeset in this typeface; today, high quality typesetting is almost always done in *aplá*. See Figure 16, on page 34, for a sample of a book entirely typeset in *aplá*.

An intrinsic characteristic of the *aplá* family is that the ratio of lowercase height to uppercase height is smaller than the one of typical Latin typefaces. This makes harmonization between *aplá* and Latin typefaces harder.

1.7.2 The Times family typefaces.

What we call the "Times family," and in Greece is called the "Elsevier" typeface, is actually a style used since 1878 as an alternative to *aplá*. Compared to the latter, it is more modern and pragmatical. This is why it often has been chosen for technical books, or books by authors who wanted to avoid a conservative image.

Many companies have released Greek Times fonts, unfortunately not all of good quality. The best seems to be the original Monotype Greek Times (Figure 8b), which has afterwards been cloned to produce the homonymous, lower quality, standard Microsoft Windows 95/NT font (see [Har$_3$, Figure 4]).

1.7.3 The "scholarly" typefaces: Porson, Greek Sans 486, New Hellenic.

The Porson typeface (see [Mos]) is used in most Anglosaxon scholarly Greek editions, including the *Oxford Classical Texts* (Figure 14, p. 32). This font has also been used in Greece, as a replacement for Greek 91, or as a companion font to New Hellenic. The German-Greek Langesheidt dictionary [Wen] also uses Porson only for the Greek text. Only two Porson versions are known to the author: the one by Monotype (again, by far the best) and a recent one, by the Greek Font Society.

Greek Sans 486 is actually a bold font. It has been used for the entries of the *Oxford Lexicon of Greek Personal Names*; a font with strong resemblances to it is used by the *Association Guillaume Budé* (see Figure 15, p. 33) and *Le Cerf* editions as well as the Bailly dictionary [Bai].

New Hellenic is a very special font (see [Bow] for its history); in Greece it is called *attiká*; it is used both for scholarly editions outside Greece, as well as in Greece, for children books or schoolbooks. On Figure 17, p. 35, the reader can see a page from a typical children book of the late sixties, typeset in New Hellenic, with quotations and captions in Porson, and the copyright mention of the photo in *aplá*. There are two versions of this typeface known to be released: the one by Monotype (the best) and a recent one, by the Greek Font Society.

These typefaces are classics for scholarly editions; but they are also used outside this context and one can say that they have a special charm; when used adequately they can greatly contribute to the typographical quality of a document.

1.7.4 The adaptations of Latin typefaces.

As it very often happens that texts are mixed (Greek/Latin alphabet), many companies have tried to adapt Latin typefaces to Greek. To state only the most important, Monotype [wMon] has adapted Gill Sans and

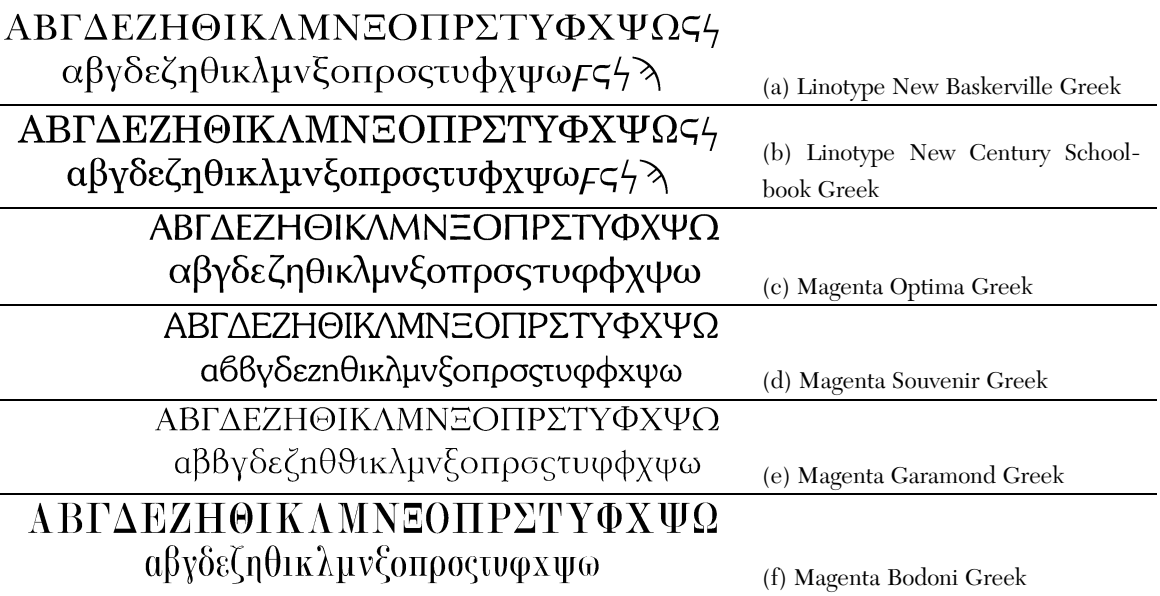


Figure 9: Some Linotype and Magenta Greek typefaces.

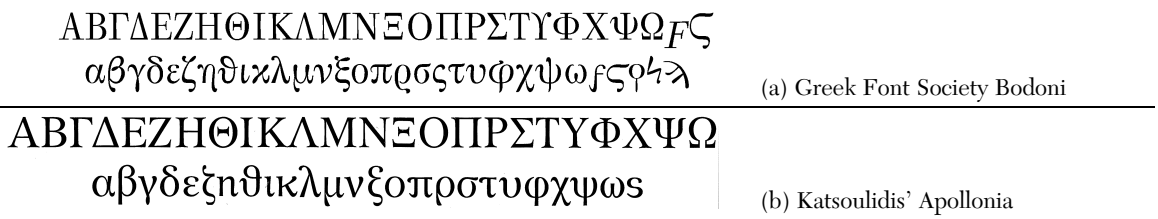
Figure 10: The infamous "gothic Greek" typeface.

Helvetica, Linotype [wLin] has adapted New Baskerville, New Caledonia, New Century Schoolbook, Optima, Souvenir, and others (see Figure 9a and b). The Greek company Magenta [wMag] has also adapted a wide range of Latin typefaces, including Univers, Garamond, Bodoni, and others (see Figure 9c-f).

The process of adapting Latin typefaces to Greek is hard—much harder than Cyrillic, Armenian or Georgian—because lowercase Greek letters have different design principles than Latin ones. For example, the notion of serif, very fundamental for Latin lowercase letters, is not very natural for Greek letters. In Magenta Bodoni (Figure 9f) the χ is just a Latin x, and the ι a dotless i; as for the λ, it could very well be a reflected Latin y. In the Garamond font, by the same company, the η is simply a Latin n, and the κ, a k with the ascender lowered. Many Greek magazines use these fonts and people get used to them. Naturally, in Greece there is a great demand for adaptations of Latin typefaces; more and more of them are made, often quickly and without artistic care. Sometimes one even encounters typographical monstruosities, like the "gothic" font shown on Figure 10.

1.7.5 The original creations of the last few years.

There have been a few interesting font Greek creations in the last years: the Greek Font Society has created a font called "GFS Bodoni" [wSPr], after original typefaces by the Italian master (Figure 11a). This font is so refreshing that we can't resist the temptation of showing a few lines typeset with it [Roi, p. 150]:



(a) Greek Font Society Bodoni

(b) Katsoulidis' Apollonia

Figure 11: Creations of the last few years: GFS Bodoni and Katsoulidis' Apollonia.

῾Ο καιρός, λέγουσι, θεραπεύει πάσας τὰς πληγάς· ἀλλ᾽ οὐχί, νομίζω, τὸν ἔρωτα καὶ τὴν πεῖνα· ἀπ᾽ ἐναντίας ὅσῳ περισσότερον μένῃ τις σώφρων ἢ νῆστις, τοσούτῳ ἡ ὄρεξις αὐτοῦ αὐξάνει, μέχρις οὗ καταντήσῃ νὰ φάγῃ τὰ ὑποδήματά του, ὡς οἱ στρατιῶται τοῦ Ναπολέοντος ἐν Ρωσσίᾳ, ἢ ν᾽ ἀγαπήσῃ τὰς αἶγας του, ὡς οἱ ποιμένες τῶν Πυρηναίων.

A Greek artist, Takis Katsoulidis, has created two interesting typefaces: "Katsoulidis" and "Apollonia" (Figure 11b), which he describes in [Kat]; recently a Greek version of Palatino has been designed for Microsoft [wRus]. Let us hope that creative innovations like these will continue, for the sake of Greek typography.

This concludes our short description of the fonts available for typesetting Greek text. It should be noted, though, that when it comes to high quality typography of **A**, **K** or **πΔ**, there is no simple solution: the Monotype fonts are excellent in design, but they are incomplete and have no kerning pairs, so that the professional typesetter has a lot of work to do after purchasing them to really make them work (this is what the author has done, see [Har$_3$]); on the other hand, there are many freeware or commercial "scholarly" fonts around, which have a more-or-less complete set of glyphs, but rather poor design (and, unfortunately, there are many scholarly editions using precisely those fonts...).

1.7.6 Samples

At the end of this paper, we present five sample pages:

- on Figure 14 the reader can see a page from the *Oxford Classical Editions*. It is typeset in Porson. Only the lunate sigma (§1.2.3 (6)) is used.
- Figure 15 is a page from a *Belles Lettres* edition [Hér]. The Greek text is typeset in the special font of the *Association Guillaume Budé*. This font is closely related to Monotype Greek Sans 486 (Figure 8e). The critical apparatus uses the *aplá* typeface (indeed, the font of the main body text would be hard to read at lower sizes).
- Figure 16: this page, in **πΔ**, is from a book [Nte] printed in Greece in 1990. It has been typeset by one of the only remaining traditional Monotype typesetting offices in Greece, the one of Palivogiannis Bros. The typeface used is *aplá*; the Latin insertions are typeset in Didot.
- in Figure 17 we see a typical children book [Var] of the middle sixties, written in **πΔ**. We have chosen to show this page, because it uses two "scholarly" fonts: New Hellenic for the main text, and Porson for the quoted verses, and captions of figures. Underneath, and on the right of the figure caption, we see the photograph copyright, typeset in *aplá*.
- finally, in Figure 18 we see a page from a contemporary, computer-typeset magazine, in **μΔ**: ΗΥ-ΦΕΝ [Mas]. The typeface used is Helvetica.

2 Mathematics

The Greek alphabet is part of the standard mathematical notation. Perhaps the best known Greek letter is π, precisely because of that magic number 3.14... The letter π was first used as a symbol for the ratio, for example Hérigone [Caj, §254] writes: *hg* π *ga* 2|2 *hb* π *bd*, meaning $\frac{hg}{ga} = \frac{hb}{bd}$ (where 2|2 signifies equality). The first occurence of π for 3.14... [Caj, §396] was in 1706, by William Jones (before that William Oughtred wrote often $\frac{\pi}{\delta}$, where π stood for periphery, and δ for diameter).

The letter $\sum$ for "sum," was first used by Euler [Caj, §438], in 1755: *summam indicabimus signo* Σ; it was also used by Lagrange, but otherwise received little attention during the 18th century. It reappeared in 1822, in Fourier's *Theory of Heat* and has remained ever since a standard mathematical symbol.

The letter $\prod$ for "product" was introduced by another great mathematician, Gauß, in 1812. It was first used as a function: $\Pi(k,z) = \frac{1\cdot 2\cdot 3\cdots k}{(z+1)(z+2)(z+3)\cdots(z+k)}k^z$ and later as $\Pi z = 1\cdot 2\cdot 3\cdots z$ (the factorial of z). Jacobi used $\prod$ as it is used today, in 1881.

The symbol Δ for finite differences was first used by Euler [Caj, §640], in 1755, together with letter $\sum$. Lagrange had already used it in 1772. In 1808, a certain Kramp [Caj, §641] proposed the Fraktur letters $\mathfrak{D}$ and $\mathfrak{S}$ as substitutes for Δ and $\sum$ (in a book written in French !); this proposal did not meet with wide acceptance.

The symbol ∇ was first used by Hamilton in 1853. Heaviside called it "nabla" (for reasons unknown to the author) while at the same time others were calling it "atled" (the word "delta," reversed).

In this century almost all Greek letters have been used as mathematical symbols (except omicron, which is indistinguishable with Latin *o*; and upsilon, which, depending on the typeface, is often confused with Latin *v*). As we will see, even the digamma is provided for mathematical typesetting !

2.1 Greek Letters and Mathematical Typography

Let us start with three examples. Figure 12a is an excerpt from a British book [Hrd], typeset in Cambridge in 1908. We have chosen that particular excerpt because in it we see letters a and α in the same formula: the lower limit of the first integral on line 6 is $(a-\beta)/\alpha$ ("a minus beta, divided by alpha"). Greek letters are slanted, in Porson style. Latin letters as mathematical symbols are typeset in italics.

The second example (Figure 12b) is a case of traditional French typography: it is from a book printed by Hermann (the publisher of Bourbaki), in 1959. Only lowercase Latin letters are in italics. Greek letters are typeset in an upright *aplá* typeface. It is astonishing how small they are, compared to the surrounding Latin letters (typeset in Baskerville): see, for example, the expression $S\theta(M)$ in the displayed equation, or the last words on the last line: "applications φ et θ," or the upper limit of the sum: $i = \pi$ where the upper part of letter pi seems to be lower than the upper stroke of the equality sign ! This anomaly comes from the fact that the ratio between the heights of lower- and uppercase letters is much smaller in the *aplá* typeface than in most Latin ones. On the other hand, the summation symbol $\sum$ is very big. The global result is quite pleasant, both for the eye of the typographer and of the mathematician.

The third example (Figure 12c) is taken from a Russian book, printed by publisher Mir, in the Soviet days (in 1971). The text is typeset in the beautiful Russian "Antiqua" font. Latin letters, as mathematical symbols, are typeset in italics, whether they are in lower- or upper case. Greek letters are typeset in an adaptation of the Greek Times font, in upright style. Contrarily to normal size Greek letters, the symbols $\sum$ and $\prod$ (sum and product) are in *aplá* style (very thin strokes, completely flat serifs). Note that in Russian mathematics, Cyrillic letters are *never* used as mathematical symbols.[6]

To be used in a mathematical context, Greek letters have to respect two, often contradictory, rules:

[6]The only Cyrillic letter the author has ever seen in mathematics, was letter л, found in an American book dedicated to the great Russian mathematician Lobachevskii.

Examples LXXIV. 1. Show, by means of the substitution $x = t^z$, that if $s > 1$ and $\alpha > 0$ then

$$\int_1^\infty x^{-s}\,dx = \alpha \int_1^\infty t^{\alpha(1-s)-1}\,dt;$$

and verify the result by calculating the value of each integral directly.

2. If $\int_a^\infty \phi(x)\,dx$ is convergent then it is equal to one or other of

$$\alpha \int_{(a-\beta)/\alpha}^\infty \phi(\alpha t+\beta)\,dt, \quad -\alpha \int_{-\infty}^{(a-\beta)/\alpha} \phi(\alpha t+\beta)\,dt,$$

according as α is positive or negative.

3. If $\phi(x)$ is a positive and steadily decreasing function of x, and α and β are any positive numbers, then the convergence of the series $\Sigma\phi(n)$ implies and is implied by that of the series $\Sigma\phi(\alpha n+\beta)$. [It follows at once, on making the substitution $x = \alpha t+\beta$, that the integrals

$$\int_a^\infty \phi(x)\,dx, \quad \int_{(a-\beta)/\alpha}^\infty \phi(\alpha t+\beta)\,dt$$

converge or diverge together. Now use the integral test.]

(a) From a British book, 1908 [Hrd].

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9. *La propriété universelle des jacobiennes* J_m

LEMME 16. *L'extension canonique de* $\theta : X - S \to J_m$ *au produit symétrique* $X^{(\pi)}$ *coïncide avec l'application rationnelle* φ *de la proposition* 2.

Soit $S\theta$ l'extension canonique de θ au produit symétrique $(X - S)^{(\pi)}$; c'est une application régulière de $(X - S)^{(\pi)}$ dans J_m, et on peut donc la considérer comme une application *rationnelle* de $X^{(\pi)}$ dans J_m. Pour montrer qu'elle coïncide avec φ, il suffit de prouver que $S\theta(M) = \varphi(M)$ lorsque $M = \sum_{i=1}^{i=\pi} M_i$ est un point *générique* de $X^{(\pi)}$. Or, on a par définition :

$$S\theta(M) = \sum_{i=1}^{i=\pi} \theta(M_i) = \theta(M)$$

et le lemme 12 montre que $\theta(M) = \varphi(M)$.

Il n'y a donc finalement pas de différence à faire entre les applications φ et θ.

(b) From a French book, 1959 [Ser].

$E+\varepsilon A$ (с учетом кратностей) равны $1+\varepsilon\lambda_i$, где λ_i — собственные числа A. Поэтому

$$\det(E+\varepsilon A) = \prod_{i=1}^{n}(1+\varepsilon\lambda_i) = 1+\varepsilon\sum_{i=1}^{n}\lambda_i + O(\varepsilon^2),$$

что и требовалось доказать.

Р е ш е н и е. Уравнение движения можно записать в виде $\ddot{x} = (\omega^2 \pm \alpha^2)\,x$ (знак меняется через время τ), где $\omega^2 = g/l$, $\alpha^2 = c/l$.

Если колебания подвеса достаточно быстры, то $\alpha^2 > \omega^2$ $(\alpha^2 = 8a/(l\tau^2))$.

Аналогично предыдущей задаче, $A = A_2A_1$, где

$$A_1 = \begin{pmatrix} \operatorname{ch}\tau & \frac{1}{k}\operatorname{sh}k\tau \\ k\operatorname{sh}k\tau & \operatorname{ch}k\tau \end{pmatrix}, \quad A_2 = \begin{pmatrix} \cos\Omega\tau & \frac{1}{\Omega}\sin\Omega\tau \\ -\Omega\sin\Omega\tau & \cos\Omega\tau \end{pmatrix},$$

$$k^2 = \alpha^2+\omega^2, \qquad \Omega^2 = \alpha^2-\omega^2.$$

Условие устойчивости $|\operatorname{Tr} A| < 2$ имеет поэтому вид

$$\left|2\operatorname{ch}k\tau\cos\Omega\tau + \left(\frac{k}{\Omega}-\frac{\Omega}{k}\right)\operatorname{sh}k\tau\sin\Omega\tau\right| < 2. \qquad (7)$$

(c) From a Russian book, 1971 [Arn].

Figure 12: Samples of British, French and Russian mathematical typography (scaled to 80% of original size).

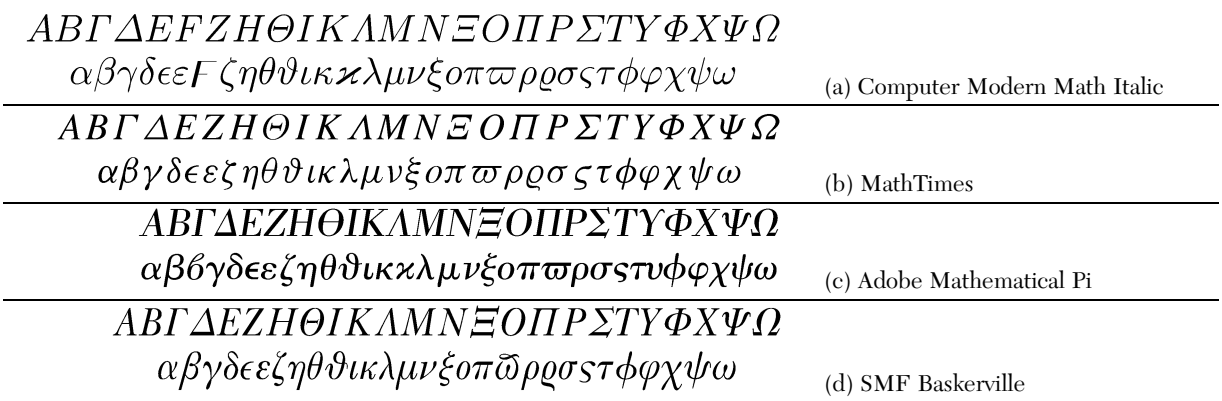

Figure 13: Greek symbols in some mathematical typefaces.

1. they have to be immediately identifiable as Greek letters. In a Greek text context, if you write $\alpha\gamma\omega\nu\alpha\varsigma$, even without the accents and breathings it is clear that the first and fifth letter is an alpha, and not a Latin italic *a*. This is not the case in mathematics, where Latin and Greek letters can be arbitrarily mixed. The letter alpha must have a special design, distinguishing it from Latin *a*, so that an expression like $a\alpha a'\alpha'$ (a, alpha, a prime, alpha prime) is immediately clear;
2. their design must fit with the surrounding Latin letters and other mathematical symbols.

In Figure 13 the reader can see three very common mathematical Greek typefaces: Computer Modern Math Italic, Y&Y MathTimes and Adobe Mathematical Pi, as well as a typeface designed by the author for the Société Mathématique de France to fit with the Baskerville text style. These fonts (with the exception of Adobe Mathematical Pi) have been designed for TEX, therefore their spacing is not the one of textual Greek fonts (see for example the pair ΓΔ in any of these fonts).

The differences between these fonts are less obvious than those between the different textual typefaces. In Figure 13(a,b,d) the letters A, B, E, F, Z, H, I, K, M, N, O, P, T, X, Y, Z and o have been taken from the corresponding Latin typeface: Computer Modern Roman, Times, ITC New Baskerville. Once again, Adobe Mathematical Pi is an exception: it already contains the complete Greek alphabet.

Computer Modern Math Italic [Knu$_2$] has the following characteristics: the lowercase alpha is larger than in other fonts, the lowercase gamma is very asymmetric, the lambda has a junction between the two strokes lower than the height of lowercase letters without ascenders, the zeta has a very small upper curly stroke, the kappa is quite curly. The delta has the smallest upper stroke. The digamma and variant kappa (which is too large) do not belong to the original font designed by Donald Knuth: they have been added by the American Mathematical Society in the MS[AB]M fonts; the author has never seen the digamma used in mathematics.[7] The uppercase phi has a round part smaller than in other fonts, almost the same size as the one of the lowercase phi. There are two epsilons, two thetas, two kappas, two pis, two rhos, two sigmas, two phis: the complete set of variants. This font has been used by hundreds of thousands of mathematicians throughout the world; it looks very nice when in a text typeset in Computer Modern; on the other hand, it is hard to fit with other fonts (like Times) because it has thinner strokes.

MathTimes [wY&Y] was designed by Michael Spivak. Its design has some flaws (the lower stroke of ζ ξ and ς is not very succesful, nor is the upper part of the open theta, etc.) but it fits very well with Latin

[7] Following a logic similar to the one that proves the existence of extraterrestrial life by the large number of possible planets that may have climatic conditions similar to Earth, we can say that, given the large number of mathematicians using TEX and hence having the digamma symbol at their disposal, there must be at least one, that has already used that symbol. The author would be very interested to hear about it.

text typeset in Times. Unfortunately it does not fit very well with text typeset in Monotype Greek Times: the ratio between thin (horizontal) and thick strokes for letters Π and Σ is 0.62 and 0.52 for MathTimes, and only 0.4 for Monotype Greek Times. It has all the necessary variant characters (except for the variant kappa). It has been used less than Computer Modern Math Italic, mainly because it is not freeware like TEX and also because it was once hard to obtain. It is often appreciated for phototypesetting because the overall result is darker than when typeset in Computer Modern.

Adobe Mathematical Pi, [wAdo] was not designed with TEX in mind. In the example in Figure 13 it has been slanted by the author (except letter ε which was already slanted), so that it can be better compared with the other fonts. The lowercase letters reflect American traditions of mathematical typesetting. It has all the variant characters (except the curly rho); it is interesting to note that there is even a variant beta (the medial form of beta in Greek text), which is indeed hard to distinguish from a Latin script b. The uppercase letters are more "oldstyle" than those of other fonts: the xi has big diagonal serifs, the upsilon is curly. Notice also that the horizontal bar of the capital theta is as thin as the one of eta; this happens in this font only.

SMF Baskerville is an attempt to make Greek letters matching Latin italic Baskerville ones. Many letters have been inspired by the design of the Porson Greek typeface. The variant pi is drawn as the author learned it in primary school: with a big curly stroke, instead of the horizontal bar found in other typefaces. The capital letters have been inspired by Adobe Mathematical Pi. As these lines are being written, the font is not yet finalized.

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This article has been typeset at the Atelier Fluxus Virus [wAte] using the Ω system (by John Plaice and the author) [wOme] on a Red Hat Linux system. The fonts used are Adobe New Caledonia for the Latin text, Aries Antiqua for the Cyrillic text, Monotype Naskh for the Arabic text, Computer Modern for the mathematical formulas, and Monotype Greek 90, 91 and 92 (with some glyphs added by the author) for the Greek text.

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ΑΙCΧΥΛΟΥ

Αγγ. θαρcεῖτε, παῖδεc μητέρων τεθραμμέναι·
πόλιc πέφευγεν ἥδε δούλιον ζυγόν.
πέπτωκεν ἀνδρῶν ὀβρίμων κομπάcματα,
πόλιc δ' ἐν εὐδίαι τε καὶ κλυδωνίου
πολλαῖcι πληγαῖc ἄντλον οὐκ ἐδέξατο.
cτέγει δὲ πύργοc, καὶ πύλαc φερεγγύοιc
ἐφαρξάμεcθα μονομάχοιcι προcτάταιc.
καλῶc ἔχει τὰ πλεῖcτ' ἐν ἓξ πυλώμαcιν,
τὰc δ' ἑβδόμαc ὁ cεμνὸc ἑβδομαγέταc
ἄναξ Ἀπόλλων εἵλετ', Οἰδίπου γένει
κραίνων παλαιὰc Λαΐου δυcβουλίαc.
Χο. τί δ' ἐcτὶ πρᾶγοc νεόκοτον πόλει πλέον;
Αγγ. ἄνδρεc τεθνᾶcιν ἐκ χερῶν αὐτοκτόνων.
Χο. τίνεc; τί δ' εἶπαc; παραφρονῶ φόβωι λόγου.
Αγγ. φρονοῦcα νῦν ἄκουcον· Οἰδίπου γένοc
Χο. οἲ 'γὼ τάλαινα, μάντιc εἰμὶ τῶν κακῶν.
Αγγ. οὐδ' ἀμφιλέκτωc μὴν κατεcποδημένοι
Χο. ἐκεῖθι κεῖcθον; βαρέα δ' οὖν ὅμωc φράcον.
Αγγ. αὐτοὺc ἀδελφαῖc χερcὶν ἠναίρονθ' ἅμα.
πόλιc cέcωται, βαcιλέωιν δ' ὁμοcπόροιν [820]
πέπωκεν αἷμα γαῖ' ὑπ' ἀλλήλων φόνωι· [821]
οὕτωc ὁ δαίμων κοινὸc ἦν ἀμφοῖν ἄγαν, [812]
αὐτὸc δ' ἀναλοῖ δῆτα δύcποτμον γένοc. [813]
τοιαῦτα χαίρειν καὶ δακρύεcθαι πάρα, [814]

793 δούλιον HK: -λειον rell. 794 πέπτωκεν δ' M; πέπτωκε δ' Burgard 798 ἐφραξ- codd. -μεcθα LhGPTr: -μεθα rell. 799 καλῶc δ' M^{s}CLcGPQ 800 -γέτηc Δ Lh^{sscr}; -γενήc Burton ex M^{Σ} (ἑβδόμηι γὰρ ἐγεννήθη Ἀπόλλων) 803 πρᾶγοc HaLcPQGFTr: πρᾶγμα rell. πλέον MAB^{ac}CHΔYYaP^{γρ}HaLcTr: παρόν B^{2γρ}H^{2γρ} rell. post h.v. πόλιc cέcωcται βαcιλεῖc δ' ὁμόcποροι (sic fere codd.; cf. 812) habent omnes; del. Porson 810 ἐκεῖθι = ἐκεῖ (Hom. *Il.* 3. 402, *Od.* 17. 10) κεῖcθον M: κῆλθον M^{s} rell. 811 αὐτοὺc Hartung: οὕτωc codd. ἅμα Nauck: ἄγαν codd.; cf. 814 812–13 post 821 habent codd.; alii aliter disponunt 812 βαcιλέων, -είων, -έοιν, -είοιν fere codd. 813 πέπωκεν MAXDYaB^{1}FTr et γρ. OPK: πέπτωκεν rell. 814 ἄγαν Nauck: ἅμα codd.; cf. 811 815 δὴ τὸ Heimsoeth; cf. Denniston *GP* 277 816 δακρύεcθαι MILhPK QTr: δακρύcεcθαι (M^{s}) vel -cacθαι rell.

Figure 14: A sample page from the *Oxford Classical Editions*.

40 ΚΑΛΛΙΟΠΗ IX 42

Σιγώντων δὲ τῶν ἐπικλήτων, τῶν μὲν οὐκ εἰδότων τοὺς χρησμούς, τῶν δὲ εἰδότων μέν, ἐν ἀδείῃ δὲ οὐ ποιευμένων τὸ λέγειν, αὐτὸς [τε] Μαρδόνιος ἔλεγε· « Ἐπεὶ τοίνυν ὑμεῖς ἢ ἴστε οὐδὲν ἢ οὐ τολμᾶτε λέγειν, ἀλλ᾽ ἐγὼ ἐρέω ὡς εὖ ἐπιστάμενος. Ἔστι λόγιον ὡς χρεόν ἐστι Πέρσας ἀπικομένους ἐς τὴν Ἑλλάδα διαρπάσαι τὸ ἱρὸν τὸ ἐν Δελφοῖσι, μετὰ δὲ τὴν διαρπαγὴν ἀπολέσθαι πάντας. Ἡμεῖς τοίνυν αὐτὸ τοῦτο ἐπιστάμενοι οὔτε ἴμεν ἐπὶ τὸ ἱρὸν τοῦτο οὔτε ἐπιχειρήσομεν διαρπάζειν, ταύτης τε εἵνεκα τῆς αἰτίης οὐκ ἀπολεόμεθα. Ὥστε ὑμέων ὅσοι τυγχάνουσι εὔνοοι ἐόντες Πέρσῃσι, ἤδεσθε τοῦδε εἵνεκα, ὡς περιεσομένους ἡμέας Ἑλλήνων. » Ταῦτά σφι εἴπας δεύτερα ἐσήμηνε παραρτέεσθαί τε πάντα καὶ εὐκρινέα ποιέεσθαι ὡς ἅμα ἡμέρῃ τῇ ἐπιούσῃ συμβολῆς ἐσομένης.

Τοῦτον δ᾽ ἔγωγε τὸν χρησμόν, τὸν Μαρδόνιος εἶπε ἐς Πέρσας ἔχειν, ἐς Ἰλλυριούς τε καὶ τὸν Ἐγχελέων στρατὸν οἶδα πεποιημένον, ἀλλ᾽ οὐκ ἐς Πέρσας. Ἀλλὰ τὰ μὲν Βάκιδι ἐς ταύτην τὴν μάχην ἐστὶ πεποιημένα,

« τὴν δ᾽ ἐπὶ Θερμώδοντι καὶ Ἀσωπῷ λεχεποίῃ
Ἑλλήνων σύνοδον καὶ βαρβαρόφωνον ἰυγήν,
τῇ πολλοὶ πεσέονται ὑπὲρ λάχεσίν τε μόρον τε
τοξοφόρων Μήδων, ὅταν αἴσιμον ἦμαρ ἐπέλθῃ »,

42 §8 ἀδείῃ codd. pl.: ἀδείᾳ P || 9 τε DRSV om. ABCP: γε coniecit Gomperz || 9-10 Ἐπεὶ... ἴστε codd. pl.: Ἀλλ'... ἐπιστάμενος, ἐπεὶ ὑμεῖς ἢ ἴστε S || 11 χρεόν codd. pl.: -εών CP Aldus || ἐστι ABCPD: τι RSV || 13 διαρπαγὴν ABCP: ἁρπαγὴν DRSV || 14 τοῦτο (post ἱρόν) om. DRSV || 15 ταύτης codd. pl.: -τῃ C || 17-18 περιεσομένους ABCPD: περισο- R περιεζο- SV || 18-19 ἐσήμηνε DSV: -μενε R -μαινε ABCP || 19 εὐκρινέα codd. pl.: εὔκρινα S εὐρικρενέα B || 20 συμβολῆς codd. pl.: -βουλῆς R.

43 2 Ἰλλυριούς codd. pl.: -ρίους RV || τὸν ABCP: τῶν DRSV || Ἐγχελέων DV: -έλεων ACPS -έλεον B R inc. || 3 τὰ ABCP: τάδε DRSV || 5 Θερμώδοντι codd. pl.: -μόδοτον R || 7 πολλοὶ ABCPD: -λῃ RSV || λάχεσίν codd. pl.: -σί RV || 8 αἴσιμον codd. pl.: ἔσ- B.

Figure 15: A sample page from the *Belles Lettres* series (*Association Guillaume Budé*).

ἀποπέμπει αὐτὸ τὸ πρόβλημα ἔξω ἀπὸ τὸ πεδίο τῆς δομικῆς καὶ καθαυτὸ γλωσσολογικῆς ἔρευνας:

> «Ἐξάλλου, ποτὲ δὲν ξέρουμε μὲ πλήρη βεβαιότητα τὸ παράγωγο καὶ τὸ μὴ παράγωγο· δὲν πρέπει νὰ ξεχνᾶμε ὅτι ἡ ἀνακάλυψη τῆς ἀλφαβητικῆς γραφῆς χάνεται μέσα στὴν προϊστορία (ὁ B. Russell ἔχει πέρα γιὰ πέρα δίκιο ὅταν ἐπισύρει τὴν προσοχή μας στὸ γεγονὸς ὅτι δὲν διαθέτουμε κανένα μέσο γιὰ νὰ ἀποφασίσουμε ἂν ἡ ἀρχαιότερη μορφὴ τῆς ἀνθρώπινης ἔκφρασης εἶναι ἡ γραφὴ ἢ ἡ ὁμιλία), παρότι ὁ ἰσχυρισμός, σύμφωνα μὲ τὸν ὁποῖο ἐδράζεται σὲ μιὰ φωνητικὴ ἀνάλυση, δὲν συνιστᾶ παρὰ μιὰν ἀπὸ τὶς διαχρονικὲς ὑποθέσεις· θὰ μποροῦσε καὶ νὰ ἐδράζεται σὲ μιὰ τυπικὴ ἀνάλυση τῆς γλωσσολογικῆς δομῆς. Ἀλλὰ ἐν πάσῃ περιπτώσει, ὅπως ἀναγνωρίζει ἡ σύγχρονη γλωσσολογία, οἱ διαχρονικὲς θεωρήσεις δὲν ἔχουν καίρια σημασία γιὰ τὴν συγχρονικὴ περιγραφὴ» (σσ. 104-105).

Ὅτι αὐτὴ ἡ γλωσσηματικὴ κριτικὴ διενεργήθηκε χάρη στὸν Saussure καὶ ἐνάντια σὲ αὐτόν· ὅτι, ὅπως λέγαμε παραπάνω, ὁ ἰδιάζων χῶρος τῆς γραμματολογίας εἶναι ἀνοιχτὸς καὶ συνάμα κλειστὸς ἀπὸ τὰ *Μαθήματα γενικῆς γλωσσολογίας* — αὐτὰ μᾶς τὰ λέει πολὺ ὡραῖα ὁ H. J. Uldall. Γιὰ νὰ δείξει ὅτι ὁ Saussure δὲν ἀνέπτυξε «ὅλες τὶς θεωρητικὲς συνέπειες τῆς ἀνακάλυψής του», γράφει:

> «Αὐτὸ εἶναι ἀκόμα πιὸ περίεργο ὅταν ἀναλογιζόμαστε ὅτι οἱ πρακτικὲς συνέπειες καταδείχτηκαν διεξοδικά, καὶ μάλιστα χιλιάδες χρόνια πρὶν ἀπὸ τὸν Saussure, γιατὶ μόνο χάρη στὴν ἔννοια τῆς διαφορᾶς ἀνάμεσα στὴν μορφὴ καὶ στὴν ὑπόσταση μποροῦμε νὰ ἐξηγήσουμε τὴν δυνατότητα τῆς γλώσσας καὶ τῆς γραφῆς νὰ ὑπάρχουν ταυτόχρονα ὡς ἐκφράσεις μιᾶς καὶ τῆς ἴδιας γλώσσας. Ἂν μιὰ ἀπὸ αὐτὲς τὶς ὑποστάσεις, τὸ ρεῦμα τῆς πνοῆς ἢ ἡ ροὴ τῆς μελάνης (the stream of air or the stream of ink) ἦταν ἀκέραιο τμῆμα τῆς ἴδιας τῆς γλώσσας, δὲν θὰ ἦταν δυνατὸ νὰ περάσουμε ἀπὸ τὸ ἕνα στὸ ἄλλο χωρὶς νὰ ἀλλάξουμε τὴν γλώσσα».[24]

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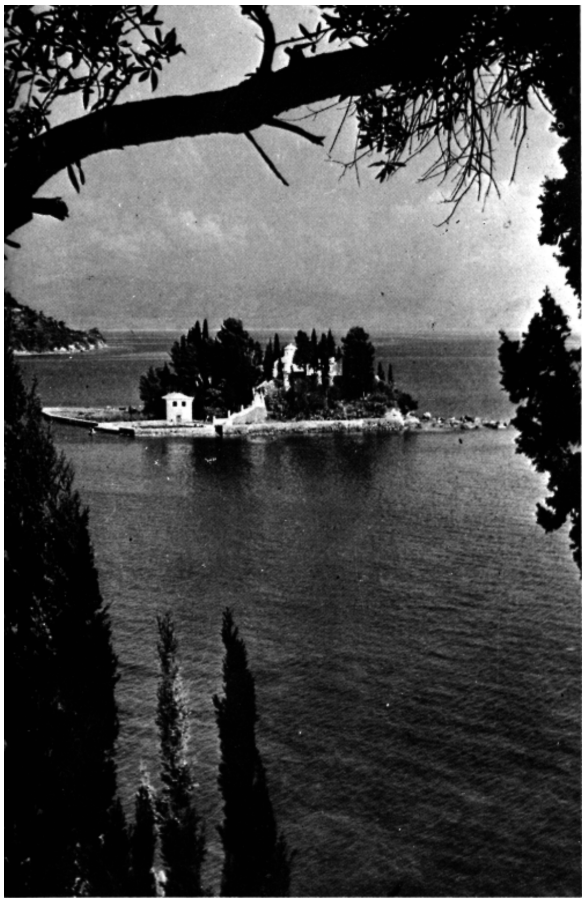
24. 'Speech and writing' (1938), *Acta linguistica*, IV (1944), σ. 11 κέ. Ὁ Uldall παραπέμπει ἐπίσης σὲ μιὰ μελέτη τοῦ D. Joseph Vachek, 'Zum Problem der geschriebenen Sprache' (*Travaux du Cercle linguistique de Prague*, VIII, 1939) γιὰ νὰ ὑποδείξει «τὴν διαφορὰ ἀνάμεσα στὸ φωνολογικὸ καὶ στὸ γλωσσηματικὸ κριτήριο». Βλ. ἐπίσης Eli Fischer-Jorgensen, 'Remarques sur les principes de l'analyse phonémique', *Recherches Structurales*, 1949 (*Travaux du Cercle linguistique de Prague*, τ. V, σ. 231 κέ.)·

Figure 16: A sample Greek book page, typeset in 1990 by Palivogiannis Bros.



Τὸ ὡραιότατο Ποντικονήσι.
Φωτ. Σπ. Μελετζῆ

σεις καὶ παρακαλοῦσαν. Πόσο τὸν ἀγαπᾶνε τὸν Ἅγιό τους οἱ Κερκυραῖοι!

Στὴ Σπιανάδα, τὴν πιὸ μεγάλη πλατεία ποὺ ἔχει ὁλόκληρη ἡ Ἑλλάδα καὶ ποὺ εἶναι τὸ καμάρι τῶν Κερκυραίων, εἴδαμε τὸ ἄγαλμα τοῦ Καποδίστρια τοῦ πρώτου κυβερνήτη τῆς Ἑλλάδας ποὺ καταγόταν ἀπὸ τὴν Κέρκυρα.

Τὸ βράδυ ἡ Σπιανάδα ἦταν φωταγωγημένη μὲ χιλιάδες λαμπιόνια. Κόσμος πολύς. Βιολιὰ καὶ μουσικές. Οἱ κοπελιὲς φοροῦσαν τὶς πλισεδένιες φοῦστες τους καὶ τὰ στρογγυλὰ περίεργα καπέλλα μὲ τὶς νταντέλλες. Χόρευαν λυγίζοντας τὸ σῶμα μὲ χάρη, τὸν τοπικό τους χορό.

Δῶ σ' αὐτὴ τὴ γειτονιὰ τὴν παραπάνω
ρούγα
τὴ φωλιά της ἔκτισε μιὰ πέρδικα μικρούλα
Πῶς ἤθελα πολὺ νὰ τὴν παινέψω
μὲ λουλούδια τοῦ Μαγιοῦ στεφάνια νὰ
τῆς πλέξω...

Πήραμε ἕνα ἀμαξάκι, ἐγκαταλείψαμε τὴ φασαρία τῆς Σπιανάδας καὶ κάναμε ἕνα νυχτερινὸ περίπατο στοὺς δρόμους τῆς Κέρκυρας. Ὁ ἀμαξὰς σιγοψιθύριζε τὴν ἄρια τοῦ Δούκα ἀπὸ τὸν «Ριγολέττο»:

Φτερὸ στὸν ἄνεμο, γυναίκας μοιάζει...

Ποῦ καὶ ποῦ μᾶς μελαγχολοῦσε μὲ τὴν παρουσία του κάποιο μισογκρεμισμένο σπίτι. Θυμηθήκαμε τὶ τράβηξε ἡ Κέρκυρα μὲ τοὺς βομβαρδισμοὺς τὸ 1940 καὶ τὸ 1943 τὸν καιρὸ τοῦ πολέμου, καὶ τὸ μετάλλειο ποὺ τῆς δόθηκε γιὰ τὴν ἡρωϊκὴ ἀντοχὴ τῶν κατοίκων της. Σὲ κείνους τοὺς βομβαρδισμοὺς χάθηκε καὶ τὸ σπίτι τοῦ Διονυσίου Σολωμοῦ.

Τὸ φεγγάρι καὶ τ' ἀστέρια λὲς κι εἶχαν κατεβῆ πιὸ χαμηλά. Ἡ ἐλαφριὰ ὑγρασία ἔκανε τὰ δέντρα καὶ τὰ πλακόστρωτα τῶν δρόμων νὰ γυαλίζουν. Μιὰ εὐγενικὴ ἠρεμία πλανιόταν πάνω στὴν ἥσυχη πόλη. Τούτη ἡ νύχτα εἶχε κάτι ἀλλοιώτικο. Τὰ πράγματα δὲν ἦταν ὅμορφα ἕνα ἕνα χωριστά. Ὅλα μαζί, ἡ νύχτα, ἡ πόλη, τὸ πνεῦμα καὶ ἡ ἱστορία τοῦ νησιοῦ βρίσκονταν ταιριασμένα σὲ μιὰ τέτοια ἁρμονία, ὥστε νὰ φτάνη μέχρι τὰ βάθη τῆς ψυχῆς καὶ νὰ τὴν γαληνεύη.

***

Τὴν ἄλλη μέρα ὁ δρόμος μας μᾶς ἔφερε στὸ λιμάνι ποὺ συναγωνίζεται σὲ κίνηση καὶ τουρισμὸ τὸ λιμάνι τῆς Ρόδου. Στὰ δυὸ πέλαγα, τὸ Ἰόνιο καὶ τὸ Αἰγαῖο, κρατᾶνε τὰ σκῆπτρα τῆς ὁμορφιᾶς. Κόσμος πολὺς ἀνεβοκατέβαινε καὶ οἱ μικροπωλητὲς πουλοῦσαν «κοὺμ - κουὰτ» σὲ μικρὰ ξύλινα κουτάκια.

Ὁ Τάκης μιλοῦσε μὲ τὸ φίλο του τὸ Γιάννο, ποὖχει πατέρα ναυτικό.

Ξαφνικά, σὰν νὰ μονολογοῦσε, ἔβγαλε ἕνα συμπέρασμα.

—Ὄχι! Δὲν εἶναι ὅλα τὰ πλοῖα κανονικά.

—Τὶ θὲς νὰ πῆς; τὸν ρώτησε ὁ Γιάννος.

—Θέλω νὰ πῶ, τοῦ ἀποκρίθηκε, ὅτι ὅλα τὰ πλοῖα δὲν ἔχουν κανόνι!

Καὶ μιὰ καὶ θυμηθήκαμε τὸ Κανόνι, ξαναγυρίσαμε στὴ Σπιανάδα καὶ πήραμε τὸν παραλιακὸ δρόμο. Ὁ περίπατός μας μᾶς ἔφερε στὸ Μὸν-Ρεπὸ στὰ θερινὰ βασιλικὰ ἀνάκτορα καὶ μετὰ στὸ Κανόνι, μιὰ μαγευτικὴ τοποθεσία μὲ ὡραιότατο ξενοδοχεῖο. Κατεβήκαμε μέσα ἀπὸ τὸ γραφικὸ μονοπατάκι μέχρι τὸ μικρὸ θαλασσινὸ ἐκκλησάκι τῆς Παναγίας τῶν Βλαχερνῶν, καὶ ἀπὸ κεῖ πήραμε μιὰ βαρκούλα καὶ πήγαμε μέχρι τὸ Ποντηκονήσι.

Figure 17: A page from a Greek children's book of the late sixties (reduced to 80% of original size).

Το δεύτερο τεύχος του *ΗΥΦΕΝ*

Κλήμης Μαστορίδης

Το τεύχος αυτό ξεκινά με ένα άρθρο του καθηγητή Michael Twyman· ένα υποδειγματικό κείμενο για την ιστορία των "παχέων-μαύρων" τυπογραφικών στοιχείων του 19ου αιώνα. Η 30ή Σεπτεμβρίου ήταν τυπικά η τελευταία ημέρα του M. Twyman στη θέση του Professor στο τμήμα Τυπογραφίας και Γραφικής Επικοινωνίας του Πανεπιστημίου του Reading. Εμείς στην *AlterVision*, όλοι παλιοί μαθητές του, γνωρίζουμε καλά ότι για τον Michael αυτό δεν σημαίνει ξεκούραση αλλά μεγαλύτερη άνεση χρόνου για τις έρευνες και τα γραψίματά του. Το λιγότερο που μπορούμε να κάνουμε για το δάσκαλό μας είναι να τον ευχαριστήσουμε και να του αφιερώσουμε αυτό το τεύχος.

Το επόμενο άρθρο είναι των Κ. Βρύζα, επίκουρου καθηγητή στο τμήμα Νηπιαγωγών του Α.Π.Θ., και Θ. Σεμεντεριάδη, υποψήφιου διδάκτορα στο ίδιο τμήμα. Αναφέρεται στο περιεχόμενο των περιοδικών για νέους γονείς και παραθέτει σειρά από ενδιαφέροντα στοιχεία, αποτέλεσμα πρωτότυπης έρευνας στο χώρο αυτό.

Το τρίτο άρθρο υπογράφεται από τον Professor Hermann Zapf τον οποίο ευχαριστούμε για την άμεση ανταπόκριση στο κάλεσμά μας. Η δημοσίευσή του αποτελεί ξεχωριστή τιμή για το *ΗΥΦΕΝ* που εύχεται στο συγγραφέα του (το Νοέμβριο ο H.Z. γίνεται ογδόντα χρόνων) να συνεχίσει να μας τροφοδοτεί με ιδέες και να μας διδάσκει με το ίδιο πάθος, όπως κάνει εδώ και πενήντα χρόνια.

Η Νίκη Σιώκη, πτυχιούχος του τμήματος Βιβλίων και Περιοδικών Εκδόσεων του Napier University of Edinburgh και υπεύθυνη των 'Ιατρικών Εκδόσεων Σιώκης', ερευνά την εμφάνιση των πρώτων έκτυπων ελληνικών ιατρικών βιβλίων. Το άρθρο της αποτελεί κάλεσμα για συστηματική έρευνα σε έναν ιδιαιτέρως ενδιαφέροντα χώρο της ελληνικής ιστορίας της τυπογραφίας.

Το πέμπτο άρθρο του περιοδικού είναι του Professor Stephan Füssel, διευθυντή του Institut für Buchwissenschaft του Πανεπιστημίου Johannes Gutenberg στο Mainz και εκδότη του Gutenberg Jahrbuch της Gutenberg-Geselschaft. Ο συγγραφέας παρουσιάζει συνοπτικά την ιστορία της εμφάνισης της ευρωπαϊκής τυπογραφίας και συζητά το ρόλο του Γουτεμβέργιου σε αυτήν.

Το επόμενο κείμενο βασίζεται στην εισαγωγή της διδακτορικής διατριβής (Μάρτιος 1997) του γράφοντος στο τμήμα Τυπογραφίας και Γραφικής Επικοινωνίας του Πανεπιστημίου του Reading με τίτλο: Casting the Greek newspaper. A study of the morphology of the *ephemeris* from its origins until the introduction of mechanical setting.

Τέλος, το *ΗΥΦΕΝ* δημοσιεύει την επιστολή του Robin Kinross, συγγραφέα και ιδρυτή του Αγγλικού εκδοτικού οίκου Hyphen Press που κυκλοφόρησε σημαντικούς τίτλους για την τυπογραφία και την αρχιτεκτονική.

θεσσαλονίκη, οκτώβριος 1998

Figure 18: A sample page from the ΗΥΦΕΝ magazine.