πάντα ὑεῖ (EVERYTHING FLOWS):
MOTTO FOR RHEOLOGY

Antony N. Beris\(^1\) and A.J. Giacomin\(^2,3,\)*

1Department of Chemical and Biomolecular Engineering
University of Delaware, Newark, DE 19716

2Chemical Engineering Department and 3Polymers Research Group
Queen’s University, Kingston, ON K7L 3N6

This report is circulated to persons believed to have an active interest in the subject matter; it is intended to furnish rapid communication and to stimulate comment, including corrections of possible errors.

*Corresponding author (giacomin@queensu.ca)
πάντα ὅει (EVERYTHING FLOWS):
MOTTO FOR RHEOLOGY

Antony N. Beris
Department of Chemical and Biomolecular Engineering
University of Delaware, Newark, DE 19716

A. Jeffrey Giacomin*
Chemical Engineering Department
Polymers Research Group
Queen’s University
Kingston, ON K7L 3N6

Friday, August 9, 2013

ABSTRACT

This historical study deepens the rheologist’s understanding of the motto of The Society of Rheology, of its history, and of its many typographies. The motto “πάντα ὅει” is not verbatim something written or said by the ancient Greek Ionian philosopher Heraclitus, ca. 540-480 BCE. Rather it is first encountered much later, in the writings of the Roman Simplicius ca. 490-560 CE. Thus, although it is uniformly agreed by Greek scholars that it correctly and concisely distills Heraclitian philosophy, that of constant change, and although this is appropriately used as the motto of The Society of Rheology, there is little point in trying to rewrite it into another form (for example to capitalize it) in an effort to be more faithful to an ancient prototype. Rather, we suggest simply reinstating the two missing diacritical marks, and thus, to express it as “πάντα ὅει” which is the form under which the motto was introduced in 1929. This is also consistent with current typography of ancient Greek writings, in use since the ninth century CE, following the byzantine scholars. We provide Table I to facilitate accurate typesetting of The Society motto.

*Corresponding author (giacomin@queensu.ca)
CONTENTS

I. INTRODUCTION.......................................................................................................................... 4
II. GREEK GRAMMAR AND πάντα ὑεἰ ............................................................... 4
III. ANCIENT GREEK HISTORY AND PHILOSOPHY ..................................................... 6
IV. ACCENTS AND BREATHINGS....................................................................................... 15
V. EUGENE BINGHAM AND πάντα ὑεἰ ............................................................... 16
VI. MOTTO TYPOGRAPHY AND SOCIETY PUBLICATIONS ........................................ 19
VII. ALTERNATIVES TO πάντα ὑεἰ ............................................................... 28
VIII. CONCLUSION.................................................................................................................. 31
IX. APPENDIX: HISTORY OF THE SOCIETY PUBLISHING .................................... 32
X. ACKNOWLEDGMENTS ...................................................................................................... 34
XI. DEDICATION ...................................................................................................................... 35
XII. REFERENCES..................................................................................................................... 40
FIGURES

Figure 1: Logo of The Society of Rheology on first cover of Journal of Rheology with three diacritical marks in motto [see typographies (1) and (3)]. Original printing (left) and its 1979 replica (right). ................................................................. 18

Figure 2: Logo of The Society of Rheology on cover of Rheology Leaflet with three diacritical marks in this typography of the motto [see typography (1)]. ........ 20

Figure 3: Magnifications of logos of The Society of Rheology on cover of Rheology Bulletin (top, from Figure 6) and Rheology Leaflet (bottom, from Figure 1) each with three diacritical marks in motto [typography (1)]. ......................... 22

Figure 4: First appearance of typography (7) of the current motto of The Society of Rheology (left) on upper left cover of Volume XVI, No. 1 of Rheology Bulletin and (right) years later on upper right cover of Volume 21 (Issue 2) of the Transactions of The Society of Rheology. ......................................................... 22

Figure 5: Logo with typography (7) used on both items of Figure 4. This is the current typography for the motto of The Society of Rheology. .................... 23

Figure 6: Motto of The Society of Rheology cast in bas-relief on banner beneath hourglass logo on the Bingham medal [this 1948 casting [57] uses typography (8)] ........................................................................................................ 24

Figure 7: Logo of the Hellenic Society of Rheology with face of Heraclitus in faux bas-relief [using typography (9) for its motto]. ........................................... 25

Figure 8: Initial Logo of the German Society of Rheology [using typography (14) for its motto]. ........................................................................................................ 27

Figure 9: Current Logo of the German Society of Rheology [60] (using typography (1) for its motto) ................................................................. 28

Figure 10: One face of the sounding block for the gavel of The Society of Rheology ............................................................................................................ 31

TABLES

Table I: Classification Codes of Greek Small Letters for Motto Typography ..... 36
Table II: History of The Society of Rheology Motto........................................... 37
Table III: Translations of “Everything Flows” ...................................................... 38
I. INTRODUCTION

The motto of the science of rheology, and specifically of The Society of Rheology, is the ancient Greek proverb:

\[ \pi\alpha\nu\tau\alpha\;\acute{o}\epsilon\iota \]  
\[ \pi\alpha\nu\tau\alpha\;\acute{o}\epsilon\iota \iota \]  
\[ \pi\alpha\nu\tau\alpha\;\acute{o}\epsilon\acute{i} \]  

Since \( \iota \) and \( \acute{i} \) are equivalent forms, and since \( \acute{i} \) is a common writer’s variant of \( \iota \), typographies (1) through (3) are equivalent. We believe that typography (1), with three diacritical markings, one on the letter \( \rho \), another on the first letter \( \alpha \), and one last one on the letter \( \iota \), is the wisest way to type this motto. For when the motto is typed this way, it can immediately be recognized as Ancient Greek, and can then be translated unequivocally to its intended meaning, “everything flows.” This motto concisely describes the omnipresence of flow phenomena.

In this paper we explore problems with the literal translation of \( \pi\alpha\nu\tau\alpha\;\acute{o}\epsilon\iota \) (Section II), its ancient historical origins, and more importantly, its proper interpretation (Section III), and the various accents and breathings that are needed to properly type it (Section IV). We further explore Eugene Bingham’s special role in connecting \( \pi\alpha\nu\tau\alpha\;\acute{o}\epsilon\iota \) to the subject of rheology and to The Society of Rheology (Section V) and the many ways that \( \pi\alpha\nu\tau\alpha\;\acute{o}\epsilon\iota \) has been typed (Sections VI, VII and Table I and Table II), and, in Section VII, we conclude that typography (1) is the best way to type The Society motto. This comprehensive report supersedes a prior shorter version [1].

II. GREEK GRAMMAR AND \( \pi\alpha\nu\tau\alpha\;\acute{o}\epsilon\iota \)

Were we to overlook the diacritical marking on the letter \( \rho \) in typography (1) we would get:

\[ \pi\alpha\nu\tau\alpha\;\acute{o}\epsilon\acute{i} \]  

and if we then attack this phrase with a dictionary of modern Greek\(^1\), as an exercise (as many must have certainly done), we find that \( \acute{o}\epsilon\iota \) is the contracted (archaic) form of the third person singular of the verb \( \acute{o}\epsilon\omega \) which means “flow”

\(^{1}\) In this paper, we distinguish “modern Greek” from “Modern Greek” by capitalizing the “M”. Whereas “modern Greek” refers to contemporary Greek usage, “Modern Greek” refers to usage common to most of the modern period, and by modern period, we mean most of the 19th and 20th centuries. Thus, Modern Greek and modern Greek intersect, but neither is a subset of the other.
as in “I flow.” During most of the modern period, in the 19th and 20th centuries, Modern Greek has existed side-by-side in two forms: A mostly written “pure” archaic form, called “katharevousa” (καθαρεύουσα) and a mostly spoken “popular” simplified form, called “demotic” (δημοτική). The form “φεί” as the contracted form of the verb, would have appeared only in katharevousa, where, as also in the ancient Greek language from which it emanates, it coexists with its non-contracted form “φεέω.” Only the latter form appears in demotic Greek.

Greek verbs have many forms of infinitive. In Ancient Greek, there are four tenses with three voices of infinitive, and in Modern Greek, one tense with two voices. This is perhaps why grammarians classify Greek verbs by their first person present singular forms, and thus, φεί is classified under its first person present singular form φέω. By contrast, the English verb “flows” is classified under active voice infinitive “to flow” (English admits only the present tense infinitive).

Now we continue our exercise by turning our attention to the first word in typography (4), we get two different translations for πάντα (with the accent on the first α). One is an adverb meaning “always,” and the other, the nominative case of the plural form of the pronoun “πᾶς”, meaning “everything.” The full cases, genders and number forms of the pronoun “πᾶς” have been preserved only in katharevousa. In demotic Greek we only encountered certain isolated forms (always with articles) that have since become nouns with very specific meaning, such as the singular form “το παν” meaning the whole or the universe and the plural form “τα πάντα” meaning everything.

One further item to note regarding typography (1) or (4) is the lack of concordance between the form (plural) of the (pro)noun and that (singular) of the verb! This is a syntax anomaly dating from Homeric times, and is fairly common in the old Attic Greek dialect use in both poetry and prose, thus called “Attic syntax” or “αττική σύνταξη” [2]. It has only been preserved in modern Greek in certain proverbial expressions such as “τα παιδία παίζει” (the kids are playing). The concept behind its use is that of emphasizing a singular idea within the use of the plural form [2], something certainly appropriate with our particular case. Interestingly, the form of the corresponding English term “everything” appearing in the translation of “πάντα” is singular.

We might expect to remove this always-everything ambiguity existing in modern Greek by preceding the noun πάντα with an article (since an article cannot precede an adverb). Specifically, we might expect the little word τά, the nominative plural neuter form of the definite article, to precede the noun πάντα.

Indeed, the Hellenic Society of Rheology did just this for their motto (see Figure 7 and typography (11) below).
However, typography (1) differs importantly from (4) by the diacritical marking on the letter Ṿ, and we believe this makes all the difference. Called a breathing, by convention since the Hellenistic period, this typography developed to represent the breathing “h” to distinguish from the letter eta “H,” has since 1981 only been included to represent Ancient Greek [3]. Hence, the Ṿ alerts both readers and translators alike, that the Greek text is Ancient Greek, and that πάντα ὑπεί is not modern Greek. In contrast to modern Greek, in Ancient Greek, πάντα has just one meaning. Thus πάντα is translated unambiguously as “everything.”

The uninitiated might worry here about the form of Ancient Greek. Specifically, Homeric Ancient Greek (which has no definite articles) and Attic Ancient Greek (which does have definite articles). However, in either form, the word πάντα has just one meaning, and thus, translates unambiguously to “everything.” So even in the Attic form, to communicate “everything flows” unambiguously, no definite article is used.

Having completed our exercise in literal translation, we now turn our attention to the more important subject of contextual translation and to the interpretation of πάντα ὑπεί.

III. ANCIENT GREEK HISTORY AND PHILOSOPHY

The aphorism has been circulating for quite some time and it is attributed to perhaps the greatest of the Greek Ionian philosophers, Heraclitus,² ca. 540-480 BCE [4]. He lived in the ancient Ephesos at the shore of Asia Minor, by the Aegean sea, at the end of the sixth century and through the beginning of the fifth century BCE³. Ephesos eventually became the largest commercial city of Asia minor after the destruction of Miletus by the Persians in 494 BCE [5]. Heraclitus’s family was aristocratic. This influenced Heraclitus in that he was always in favor of the few, “aristoi” (the experts), as opposed to the many, “plethos” (the crowd), and he was against the “tyrants” (dictators). The key element of Heraclitus’s philosophy is that of continuous change. However, he also believed in an underlying unchanged unified rule of natural law. This

---

² In English, it is customary to use the Latin transcription of scholars’s names (Confucius, Demetrius, Democritus, Diogenes Laërtius, Epicurus, Heraclitus, Kratylos, Leucippus, Plato, Seneca). We follow this custom throughout, except when quoting others, and then, when the custom is disobeyed, we use “(sic).”

³ Before Common Era: The current convention for what the West once called BC.
contrast between the unity and constancy of the law, and the multiplicity and variability of the forms to which it applies, makes the first instance of the concept of “duality” that is now underlying so many modern physical concepts (contrast that of energy, which is conserved, and time, which constantly changes, and their dual relations in quantum theory). In its time, this was truly a revolutionary idea that thus took twenty-four centuries to be appreciated. As a consequence, many of Heraclitus’s sayings remained difficult to understand for long times, and this earned him the characterization as “skoteinos” (dark) philosopher. For instance, consider his saying [6, p. 264]:

ποτάμις τοίς αυτοῖς ἐμβαίνομεν τε καὶ οὐκ ἐμβαίνομεν, εἰμὲν τε καὶ οὐκ εἴμεν

(we enter the same rivers and we do not enter [the same rivers], we are [there] and we are not [there])

The “πάντα ὅει” aphorism, aims to concisely describe the central philosophical position of “becoming” or “change” of Heraclitus, in the form of a metaphor of “flowing” or “streaming” [7, p. 178]. However, a more careful investigation on the actual source of this aphorism [4; 7, p. 178; 8; 9, p. 135; 10, p. 209], reveals that its first report was long after Heraclitus’s time, by the Roman Simplicius, ca 490-560 CE [4; 7, p. 178; 8; 9, p. 135], who wrote (Simplicius 1313.8 [4, p. 288] extended according to reference [11, pp. 752-753]):

“τούς δὲ περὶ Ἡράκλειτον φυσιολόγους εἰς τὴν ἐνδελεχὴ τῆς γενέσεως ὰθὴν ἀφορῶντας, καὶ ὁ γινόμενα καὶ ἀπογινόμενα πάντα ἐστὶ τὰ σωματικά, «ὅντως δὲ οὐδέποτε ὄντα», ὡς καὶ ὁ Τίμαιος εἶπεν, ἐκεῖ ἐστὶ λέγειν ὅτι ἀεὶ πάντα ὅει καὶ ὅτι εἰς τὸν αὐτὸν ποταμὸν δίς οὐκ ἂν ἐμβαίνῃς.”

(The physical philosophers following Heraclitus, turning their attention to the continuous flux of becoming, {and (who considered) that all that is created and (all that) is destroyed are corporal «in reality never existing», as he has also said Timaios,} they had reason to say that naturally continuously everything flows and that in the same river you cannot enter twice).

So Simplicius includes “ἀεὶ” before “πάντα ὅει,” at a time when “πάντα” meant “everything,” and when “ἀεὶ” meant “continuously” or “always.” It is
therefore of interest that in modern Greek “πάντα” has also acquired the meaning of “always.” But the most important remark to make here is that no independent connection of “πάντα ὃει” to a more ancient source than Simplicius 1313.8 exists! This is one of many instances where something well known, attributed as a key characterization to a great person, cannot be linked to his writings!

The closest that we come to tracing the source of this aphorism to Heraclitus himself is in the writings of two others of antiquity: Plato and Diogenis Laërtius. Plato, the famous Greek philosopher, in his dialogue Kratyllos, puts in the mouth of Socrates (Crat. 402a) [4,12]:

λέγει δὲν Ἡράκλειτος ὃτι “πάντα χωρεῖ καὶ οὐδὲν μένει,” καὶ ποταμοῦ ὃη ἀπεικάξων τὰ ὄντα λέγει ὡς “δις εὖ τὸν αὐτὸν ποταμὸν οὐκ ἂν ἐμβαίης.”

(Heraclitus says, you know, that all things move and nothing remains still, and he likens the universe to the current of a river, saying that you cannot step twice into the same stream.)

Now Cratylus was a disciple of Heraclitus and also happened to teach Plato. Thus, one can place confidence in the above attribution from the dialogue Kratyllos to Heraclitus himself. However, some [8, p. 68] consider it as an expansion of Heraclitus’s teachings, going beyond what he actually believed and said. This latter is reinforced by a relative comment put forward by Aristotle in his metaphysics [4, pp. 286-287 Aristotle Metaphysics 1010a13] mentioning Kratyllos’s criticism on Heraclitus flux philosophy:

Ἡρακλείτω ἐπετίμα εἰπόντι ὅτι δὶς τῷ αὐτῷ ποταμῷ οὐκ ἔστιν ἐμβήναι αὐτὸς γὰρ ὥστε οὐδὲ ἀπαξ.

(Kratylos criticized Heraclitus because he said that one cannot enter the same river twice; since he believed himself that one cannot do it even once.)

However this last comment teaches us about the significant difference in the views held between Heraclitus and Kratylos, the last one wanting to bring the argument to the extreme (and rather unattainable position) that constant change does not allow knowledge to be built. The position that the theory of flux is not of Heraclitus therefore, has also been criticized heavily by other investigators [8, p. 69] with several independent references by other writers in antiquity having
been collected, such as Plutarch, Seneca and Simplicius. These leave little doubt about the position that the theory of flux is not of Heraclitus [4, in p. 286]. However, in this excerpt, Plato mentioned “πάντα χωρεῖ” which differs slightly from “πάντα ἥει.” Whereas “πάντα χωρεῖ” means “everything passes” (as with the passage of time), “πάντα ἥει” precisely means “everything flows.” Graham [9] translates “πάντα χωρεῖ” as “all things pass.” Nevertheless, later in the same sentence, Plato does mention flow in a river “ποταμοῦ ἥοη.”

The second source is Diogenis Laërtius, a writer who lived around 200-300 CE and to whom we owe one of the first lists of biographies of great persons in Greek antiquity [13]. In that work [13], sure enough, one finds an entry for Heraclitus from where the closest entry to “πάντα ἥει” reads as follows:

(everything occurs in opposites and everything flows like a river)

This best describes Heraclitus’s philosophy and as such the aphorism “πάντα ἥει” can also be considered as a valid statement and therefore is also very fitting to use as an emblem for rheology. This seems to be the conclusion of perhaps the most informed scholar on the work of Heraclitus, Russian-born Professor Serge Mouraviev of Université de Paris-IV, who recently detailed an accounting of Heraclitus’s fragments and all known ancient sources [10]. In the same work, Mouraviev evaluated the fragments depending on (a) their authenticity, (b) whether they represent something that Heraclitus really wrote verbatim, and (c) whether they express exactly something that he could have said or written. Regarding the particular fragment, “πάντα ἥει” (catalogued as fragment F81Bb), Mouraviev gives a perfect rating in terms of authenticity (a) and for exactitude (c), but it gives almost a failing grade (2 of 5) for whether it represents a verbatim rendition [10]. It is also instructive to note here that the above discussion corroborates with earlier thoughts on the matter offered in the Section “OUR MOTTO-πάντα ἥει,” by Markovitz in [14] in a historically oriented article that appeared in the Journal of Rheology in 1985 on the occasion of the 50th anniversary of The Society of Rheology. Nowadays, so closely do engineers attach the concept of flow to Heraclitus, that any dimensionless group comprising a ratio of fluxes has been called Heraclitian (see Section 7.3 of [15]).

Heraclitus was the first but not the only one in antiquity to embrace flow and motion as a dominant characteristic of nature. Among ancient Greek philosophers one must cite the atomists Leucippus (ca. 500–430 BCE) and
Democritus (460–370 BCE) as well as Epicurus (341–270 BCE). As an inherent component of the atomic nature of matter, all of these philosophers and their schools and followers were also fundamental in introducing its continuous motion. This is most beautifully described a few centuries later by the Roman poet Lucretius in his poem “de rerum natura” (about the nature of things)---see also relevant discussion later in Section VII. However, what is also of interest is that independent of Heraclitus and at about the same time as his, the notion of flow also appeared far away from Greece, in China with Confucius.

To Confucius (孔夫子, 551-479 BCE), a contemporary of Heraclitus, we attribute “逝者如斯夫!不舍晝夜.” [or in the simplified Chinese script, “逝者如斯夫!不舍昼夜.”] (which, for Mandarin Chinese, we Romanize using the popular Hanyu Pinyin system as “shizhérúsì! fūbūshè zhòuyè.”) the Chinese equivalent to “πάντα ῥεῖ.” This saying has been translated to “Everything flows like this, without ceasing, day and night.” (see entry 9.17. on p. 41 of [16]). Confucius is said to have spoken this on a river bank. We find this in Book IX of the most commonly studied version, the Yǔ (魯) version, of the Analects (see saying 十六章 atop p. 222 [columns 5 and 6 counted from the right] with its corresponding translation into English, numbered “CHAP. XVI.” [17,18]), compilations of Confucian sayings, mainly by students of Confucius, or by their students. Saying (論語, Book IX, CHAP. VI, Verse 4) is sometimes numbered separately and as its own chapter (論語, Book IX, CHAP. VII as in [17]), in which case the “everything flows” saying is numbered (論語, Book IX, CHAP. XVII as in [16]). Otherwise, the “everything flows” saying is numbered (論語, Book IX, CHAP. XVI) (see p. 15 of [19]). Not unlike the connection between “πάντα ῥεῖ” and Heraclitus, the connection between “πάντα ῥεῖ” and Confucius is thus indirect. Remarkably, both Confucius and Heraclitus conceived “πάντα ῥεῖ” independently and contemporaneously. Of course, the literal translation of “everything flows” into Chinese is a simpler matter, and this is done in Table III.

The present section shows that “everything flows” is a proper contextual translation and interpretation of πάντα ῥεῖ, and these are the two most important results of this work. Table III undertakes the far simpler tasks of translating “everything flows” literally into a few other languages. These translations were done by members of The Society of Rheology, and in some cases, by their colleagues (see Acknowledgments in Section X below).

We can also trace the origins of “πάντα ῥεῖ” to Oceanus (Okeanos), a continuously moving mythical river that, in early ancient Greek’s cosmogony,
was believed to flow around and over the earth [20]. In a cosmological sense, the river symbolized the eternal flow of time [20]. We can find an eloquent description of it in Homer’s Iliad on the occasion of the description of Achilles’ shield [21], a true ancient wonder allegedly made by the god of metallurgy, Hephaestus (Hefaistos), himself.

The shield is described in verses 478-608 of the Σ (XVIII) rhapsody in Homer’s Iliad [22], in a very fascinating way, not as a static object, but as it is being prepared for Achilles by Hephaestus. The representations on the outside of the shield were made in five concentric circles. The inner circle presented the image of the universe in two semicircles: the top one showed the sky with the stars with the sun and the moon on each side, and the bottom one with the earth and the sea (verses 483-489; notes in page 785 of [22]). The inner annulus of the shield depicted two towns: a) a peaceful town with two scenes, one of private (wedding) life and one of public (court trial) life and b) a town at war, also with two scenes, one depicting the exodus of civilians in an ambush and one showing the fight of civilians against enemy troops (verses 490-540; notes in pages 786-787 of [22]). The next, middle, annulus of the shield presented scenes from the farm life during the seasons of spring, summer and fall, i.e. ploughing, wheat and vine harvesting, respectively (verses 541-572; notes in page 788 of [22]). The outer annulus of the shield showed scenes from the shepherd life, one with a herd of oxen attacked by lions, and one with a flock of sheep surrounded by dancing youth (verses 573-606; notes in pages 790-791 of [22]). Finally, on the outside we have a representation of Oceanus, who the early ancient Greeks believed was a river flowing around and over the earth (and hence, the ancient connection to “everything flows”. In this way, the full of life and movement images shown in the annuli are bordered by the calmer representations of the universe (at the center) and Oceanus (at the outside) (verses 607-608; notes in page 792 of [22]).

The relevant verses where Oceanus’ appearance on the shield is described are as follows (verses 607-608 of the Σ (XVIII) rhapsody of Iliad [22]):

Ἐν δ’ ἐτίθει ποταμοῖο μέγα σθένος Ὡκεανοῖο ἄντυγα πᾶρ πυμάτην σάκεος πῦκα ποιητοῖο
This is where he placed the great strength of river Oceanus in the last circle of the beautifully made shield

This is a fitting end to the shield’s description that beautifully brings forward the power of the flowing stream of the mythical Oceanus river in tightly enclosing all aspects, in peace and war, of human life; the connections to the Heraclitian philosophy are evident and have been already pointed out in relevant literature [23].
Oceanus is mentioned many more times in Homer’s Iliad [20]. Of particular interest are verses 245-246 of rhapsody Ξ (XIV) [24]. These are part of the reply of Hypnos, the god (spirit) of sleep, to the urging of Hera (Zeus’s wife), to help make Zeus sleep so that Poseidon can be convinced to increase its protection of the Greeks against the Trojans. On that occasion, Hypnos compares that task to that of putting to rest the continuously moving waters of Oceanus to demonstrate the task’s difficulty, mentioning in particular:

καὶ ἀν ποταμοῖο ὀέθηρα Ὑκεανοῦ, ὡς περ γένεσις πάντεσσι τέκτυται·
even those streams of river Oceanus, that are the beginning (driving force) to everything

An alternate translation (offered by Lattimore [25]) of the same passage reads: “even the stream of that River Oceanus, whence is risen the seed of all the immortals”. We underline that, in connection with an ancient text, especially one coming from Homer, the issue of the proper translation is always sensitive. This can be further appreciated by supplying one more of the many passages in Iliad, where a reference to the river Oceanus is made, that of verse 5 of rhapsody Π (III) [26]:

κλαγγῇ ταί γε πέτονται ἐπ’ ὑκεανοῖο ὀράων

several translations of which can be found in [27]. The above verse is part of a longer passage describing the ferocity of the Trojan soldiers. First, a literal rendition is: “with a clamor do these wing their way towards the streams of the ocean”. Second, a classical translation by Lattimore is: “and clamorously wing their way to the streaming Ocean”. Third, Fitzgerald’s version is: “over the streams of Ocean hoarsely calling”. Fourth, Eagles’s rendition is: “flying in force, shrieking south to Ocean’s guls, speeding”. This continuous, never ending, flow of the river Oceanus is further and more appropriately described in a verse of Homer’s Odyssey (verse 65, of rhapsody Υ of Homer’s Odyssey [28]):

ἐν προχοῆς δὲ βάλοι ἀψορρόου Ὑκεανοῦ.
To throw me where the waters end of Oceanus, the river that brings its waters back

The translator’s note on this informs that [29; line 7]: “the word used by Homer “ἀψορρόου”, meaning cyclically moving or backward flowing, is a very strange one, because of the strangeness of Oceanus river itself”. As the Oceanus river
surrounds the earth, its waters never really end somewhere, instead they end up at the same points continuously moving around [28,30]. This concept of continuous movement of the waters of Oceanus is indeed extremely close to that of continuous flow expressed by “πάντα ὄει” [23].

Most interestingly, we can remark here that the word “panta” also appears in a couple places within Homer’s works. As eloquently described by Havelock [31]: “there (in Iliad) intrudes from time to time a language which briefly envisions the all as an all, a whole, a total, in an act of integration symbolized in the term panta, ‘all things’.” In particular, of closer relevance to “πάντα ὄει” is the following passage, verses 195-197 of rhapsody H (VII) [7]:

οὐδὲ βαθυρρείται μέγα σθένος Ὀκεανοίον,
ἐξ οὗ περί πάντες ποταμοί καὶ πάσα θάλασσα
και πᾶσαι κρῆναι καὶ φρεάτα μακρὰ νάουσιν:
nor even the great strength of deep-flowing Ocean
from whom indeed all the rivers and all the sea
and all springs and deep wells flow. [31]

Beyond Homer’s works, the story of the mythical river Oceanus can be further followed in the writings of many other subsequent ancient Greek and Roman authors: Hesiod, Aeschylus, Aristophanes, Herodotus, Plato, Quintus Smyrnaeus, Orphic Hymn, Ovid, and Seneca (see [20]). However, what is even more interesting is that we can trace Oceanus further back in time. In a fascinating exploration of the origins of chaos in ancient cosmogonies and myths [32] the chaos expert Ralph Abraham pairs the personification of Oceanus as the father god with Tethys as the mother god, both ocean gods, both representing a sea of fresh water surrounding everything that has been created. Those are then paralleled to the Hebrew Tehom, “the deep” [32], and Tohu, respectively, biblical entities that seemed to have been generated around the same period (about 800 BCE). Oceans seem therefore to surround also the Hebrew world [33]. However, the most interesting part of that study is the capability to trace Oceanus and Tethys to the Babylonian figures of Apsu and Tiamat (the god of watery chaos [33]) discussed in the Enuma Elish, an epic that was written circa 1800 BCE, which begins with [32]:

When above unnamed was the heaven,
And earth below by the name was uncalled,
Apsu in the beginning being their begetter,
And the flood of Tiamar the mother of them all,
Their waters were embosomed together (in one place)...
These Babylonian figures can be further traced to the cosmogonies that were discussed in the earliest literature sources that appeared in Mesopotamia in 5000 BCE [32].

This connection of flow with the earliest ancient cosmogonies can also explain the importance of water to both Homer and Thales, the first of the presocratic philosophers and forerunner of Heraclitus. In fact, Gerard Naddaf, in his recent book [34], states “that certain authors argue that for both Homer and Thales, water is equivalent to the term phusis (nature) insofar as it is the principle (archê) or the first cause (prōtē aitia) of all things, and it is the element which generated the completed realities (onta)”

These connections have been extended significantly by Seely [35] to other ancient cosmogonies, mythologies and religious beliefs. In particular, Seely [16] mentions that the concept of an earth surrounded or emerging on top of an ocean is common to many ancient cultures, from Asia (Turkic, Mongols, Tungus) to America (Navaho, Zuni, Cherokee, many other tribes---North America; Nahuas---Mexico; Chorti---Mayas of Guatemala), and from Europe (Finno-Ugrians) to Africa (Dan, Bavenda, Bathonga tribes), without considering many island people for whom, of course, it is natural to think about an earth surrounded by water (New Guinea, New Zealand, Micronesia, Polynesia and Japan). The oldest Chinese view referred to a “rim ocean” that surrounds a square earth [35]; Thai cosmology also involved a circular ocean surrounding the earth; and albeit the oldest Indian literature, the Rig-Veda, does not explicitly mention it (however, in the latest translation it “the earth was spread upon cosmic waters” does appear [33]), later writings seem to imply it and even later Vedic texts explicitly mention about an earth surrounded by water [35]. Even in ancient Egypt texts, such as the hymn victory for Thutmose III (1490-1436 BCE) we can find a reference about “the ends of lands; that which the Ocean encircles is enclosed within thy gasp” [35]. Similarly, for the Celts the next thing to the fall of the sky that they feared was that “the seas would come rushing in from all directions” [33].

However, the continuously and backwards flowing river Oceanus is without doubt most clearly described for the first time in Iliad and Odyssey. As Iliad and Odyssey were extremely popular reading in the ancient world, it is therefore a safe assumption that Thales and Heraclitus, were fully aware of them when they were developing their own philosophical theories regarding the universal role of water as source of everything [36] and the concept of continuous motion [23], respectively. Still, their contributions (and those of the other Ionian natural philosophers) were immense as they made the transition from mysticism to logical thought [37]. In particular, Thales and Heraclitus, took the dominating role of water and that of eternal flow from mythology and further developed
them as scientific principles, disentangling them from gods and superstitions [37].

IV. ACCENTS AND BREATHINGS

The ancient Greek language was tonal (pitched) in form. In the old Attic writing used by official Athens before 403 BCE [38], the letter $\text{H}$ was employed to denote the rough breathing in the beginning of a word—like the sound “h” in the word “here.” Traditionally in the ancient Greek language this rough breathing always follows the consonant “rho” when it appears in the beginning of a word, resulting in the following typography:

\[
\text{ΓΑΜΤΑΡΗΕΙ}
\]

This typography is to be contrasted with typography (1), which is easier to pronounce, and which is now used universally to represent Ancient Greek writing.

The practice of denoting the rough breathing (/h/ sound at the beginning of a word) by $\text{H}$ (called “δασὺ πνεῦμα” (dasù pneûma) in Ancient Greek, and “spiritus asper” in Latin) has been followed to our days, through the evolution of the Chalkidean alphabet (named after the city of Chalkis, about 40 miles northeast from Athens) to the Latin [38] and therefore to the English language when we express with Latin characters words of Greek origin that used to have the rough breathing (compare history, rhapsody, rhinoceros, etc.). Furthermore, although the notation of the rough breathing by $\text{H}$ dates from the earliest instances of the Greek alphabet, such as the Chalkidean [2] and the Attic alphabet used in Athens before 403 [38,39] as mentioned above, it disappeared rather quickly afterwards in the Ionian dialect [40] due to the confusion that it created with the use of the same symbol to denote the vowel “eta.” Thus, although in conversations, people continued to respect the changes that used to be indicated by $\text{H}$ (rough breathing, /h/ sound) before the initial vowels of words and after the consonant “rho,” they omitted it from the written words. As mentioned, the Ionian dialect was officially espoused by Athens in 403 BCE and eventually by most of the Greek (and through Philip and Alexander the Great) and also the Hellenistic world.
However, the written indication of the rough breathing reappeared shortly afterward, in certain Greek dialects used in south Italy, transformed though as half $\overline{\text{H}}$ to avoid the above-mentioned confusion, $\overline{\text{H}}$. At the same time, they espoused the use of its mirror symmetric symbol, $\underline{\text{H}}$, to indicate its opposite, “smooth breathing”, i.e. the absence of an /h/ sound, (called “ψιλὸν πνεῦμα” (psilôn pneûma) in Ancient Greek, and “spiritus lenis” in Latin) [41]. It is from these two notations that the modern polytonic Greek breathing symbols originated, “δασεία” (daseia) [42] and “ψιλή” (psili) [43], (‘) and (‘), respectively, along with the accents acute “οξεία” (oxeia), grave “βαρεία” (vareia) and circumflex “περισπωµέένη” (perispomeni) [38] to denote the intonation of the words. All these common forms of the polytonic version of the Greek language were developed by the turn of the 3rd to the 2nd century BCE, (but used irregularly in the beginning, primarily as a means to distinguish between words that differ only in their accents) by the Alexandrian philologist Aristophanes from Byzantium [40,44]. The accents were developed in the transition of the Ancient Greek Language to the modern “Koine” form when the tonal, pitched ancient form of pronunciation was transforming to a stressed one. However, it was not until much later, in the ninth century CE, that the small (lower case) letters were developed in Byzantium. They have been preserved to modern times in the modern Greek language, albeit since the beginning of the last century several simplifications took place, first abolishing daseia on consonants, like on the letter ρ [41,45]. In 1981, by Greek law, all breathings and accents have been abolished in the modern Greek language with the exception of the oxeia, “’” and the diacritical marks, “¨” [41,45]. Shortly afterwards it was decided though to keep them in the rendering of the ancient Greek language.

V. EUGENE BINGHAM AND πάντα ὑεῖ

According to Reiner, the American rheologist Bingham (1878-1945) chose πάντα ὑεῖ as the “motto of the subject” of rheology [46], rather than as the motto of a society. Indeed, Bingham’s fascination with πάντα ὑεῖ predated his choice of the word rheology in 1926 by at least one year (see p. 85 of [47]; [48]), and of his founding The Society of Rheology in 1929 by at least four years [49]. Consider his groundbreaking paper where he introduces the yield point and what we now call the Bingham fluid (see first equation on p. 1204 of [49]). About the plastic deformation of solids, Bingham writes “Our discussion of plasticity therefore concerns itself with the flow of solids, which is certainly broad enough to suit the most catholic taste, for the Greek philosopher Heraklitus (sic) was
literally correct when he said that ‘Everything flows’ [49].” In Bingham’s book of 1922, we find no mention of πάντα ὤεῖ, not even when discussing yield (see before and after Eq. (83) in [50]).

In 1929, typography (1) appeared on a banner beneath the hourglass on the first cover of the Journal of Rheology as shown in Figure 1 (then edited by E.C. Bingham, later renamed The Transactions of The Society of Rheology, before eventually reverting to its original name [for a detailed history, see Section IX]). In 1930, referring to the motto and still using typography (1), Bingham wrote: “The stream of knowledge in regard to the nature of flow was fairly turbulent two centuries ago, but later it seemed to become viscid, no longer exemplifying that classical dictum of Heraclitus πάντα ὤεῖ, "everything flows."” Parenthetically, Bingham credits the creation of the word “rheology” to his colleague John R. Crawford, Professor of Latin at Lafayette College (see entry for “Rheology.” in [51]), but the choice of The Society motto seems to have been Bingham’s own, and his choice for its rendering seems to have been typography (1).
Bingham founded The Society of Rheology in 1929, and shortly thereafter πάντα ὑei was regarded as The Society motto. Consider the celebrated British rheologist Scott Blair (1902–1987) writing about soil pastes in 1930 in the second volume of the Journal of Rheology: “In this suspicion we are fully justified, for not only does her infancy reach back to the days of the Greek philosophers (as the motto of our Society reminds us), but our recent efforts to apply the methods of Rheology to the investigation of the parent of all materials, the soil, reveal most clearly the truth of the old saying that ‘There is nothing new under the sun’ [52].”

In 1935, The Society and especially its motto attracted national attention when St. Clair McKelway (1905-1980), a new reporter for the The New Yorker, published an article titled “Everything Flows,” a lay person’s three-page account of the 7th Annual Meeting at the Bell Telephone Building in New York City [47]. McKelway reports that “Professor Bingham brought forth at this conference not only a word for the work of the scientists gathered there but a motto, taken from a saying of Heraclitus: ‘panta rhei,’ or ‘everything flows.’ It sounds a little gay now, but it was thought up eight years before Cole Porter decided that anything goes.” A decade later, in his unpublished history of The Society, produced one decade after this meeting, Bingham muses over McKelway’s comparison of “everything flows” with its rhyme, the theme of Cole Porter’s song. On this article, Bingham later wrote: “He, too, got the picture of the waifs in the Orphanage on Christmas morning, and he was impressed that “everything flows” is not as trivial as Cole Porter’s declaration that “everything goes”. “

In 1985, πάντα ὑei is again explicitly declared the motto of The Society of Rheology (see Section “OUR MOTTO-πάντα ὑei,” by Markovitz in [14]). Markovitz, we think wisely, observes that “This phrase is not the sole property of our Society.” This is why The Society has always encouraged other societies of rheology to use the motto as they see fit. To wit, the Hellenic Society of Rheology and the German Society of Rheology both incorporate their own versions of πάντα ὑei into their logos (see Figure 7 and Figure 8).

Table I lists all letters appearing in typographies (7)-(11) or (8) along with their English names. Table II lists the history of The Society motto, and the Appendix (Section IX) compares the complicated history of the Journal of Rheology
with that of the motto, often appearing on the journal cover. From Table II, we
learn that for twenty years (1957–1976), the Transactions of The Society of Rheology
were published without motto, though by comparing Table II to Section IX, we
see that in the subinterval 1964–1966, the motto did appear on the cover of the
Rheology Bulletin, and this with typography (7). In fact, from Table II, we can see
that typography (7) originated in 1945 on the cover of the Rheology Bulletin, then
co-edited by N.W. Taylor and T. Alfrey.

In 1941, 12 years after founding The Society of Rheology and printing its
motto on the Journal cover, we find Bingham’s first comment on the motto. In a
short complaint about how Chemical Abstracts classifies literature on rheology,
Bingham writes “Heraklitus (sic) would tell us that since everything flows, we
should have expected this confusion. Rheology cannot be classed under water or
Petroleum because it is not a substance; it cannot properly be classed under
Physical Chemistry or Metallurgy because it is neither of them. It is a distinct
branch of knowledge.” In 1945, in memorial tribute to Bingham, his
colleague Professor Kunkel spoke [53]: “His special field of scientific interest
was rather beyond the knowledge of most of us. Until he invented the term
‘rheology,’ or the science of flow, we had little idea that there was anything to
flowing than simply running. We had little idea that it mattered much where it
was possible to measure the flowing qualities of limpid fluids like alcohol an
water and thick, sticky materials like tar and the proverbial molasses in January.
But Professor Bingham’s heart was so full of rheology that from the abundance
of his heart his mouth spoke to his associates so that they soon came to realize
that the famous aphorism of Heraclitus that everything flows was a reality.”

VI. MOTTO TYPOGRAPHY AND SOCIETY PUBLICATIONS

In March 1937, The Society motto appeared below the hourglass on the first
cover of the Rheology Leaflet (No. I) just this once with the following typography:

\[ \pi\alpha\nu\tau\alpha \ \acute{\omicron} \ \epsilon \ \] \hspace{1cm} (6)

and by contrast, then again, at the top of Page 1 of the same issue, with
typography (1). We know of no other occurrence of typography (6), and thus
chalk this one up to error. Thereafter, when the Rheology Leaflet included the
motto, it adhered to typography (1)---see Figure 2. Typography (1) was therefore
that with which the motto was originally introduced and used initially---see
Figure 3. Table II lists this and each subsequent departure from or return to
Bingham’s original typography (1).
Table II shows that in 1945 the Rheology Bulletin (formerly the Rheology Leaflet), without comment from co-Editors Taylor or Alfrey, stripped away the diacritical markings from the vowels from typography (1) and introduced:

\[ \pi\alpha\tau\alpha\varphi\iota \]  

leaving just one diacritical marking, on the letter ρ (see Figure 4).

Figure 2: Logo of The Society of Rheology on cover of Rheology Leaflet with three diacritical marks in this typography of the motto [see typography (1)].

However, in 1946, to commemorate Bingham, the cover of the Rheology Bulletin reintroduced Bingham’s original typography (1), without comment from then Editor Markwood. Editor Myers reintroduced the simplified typography (7) onto the covers of the Transactions of The Society of Rheology, and he continued this onto the Journal of Rheology. This particular typography is inscribed on the bases of
the hourglass in The Society’s logo, and this now appears on the cover of both print editions of the Journal of Rheology (see Figure 45). In 1977, Editor Myers also reintroduced this logo with motto in typography (1) to the covers of the Rheology Bulletin, and this persisted on Rheology Bulletin covers till 2005.
Figure 3: Magnifications of logos of The Society of Rheology on cover of *Rheology Bulletin* (top, from Figure 6) and *Rheology Leaflet* (bottom, from Figure 1) each with three diacritical marks in motto [typography (1)].

Figure 4: First appearance of typography (7) of the current motto of The Society of Rheology (left) on upper left cover of Volume XVI, No. 1 of *Rheology Bulletin* and (right) years later on upper right cover of Volume 21 (Issue 2) of the *Transactions of The Society of Rheology*.

This makes it all the more surprising that The Society of Rheology, once having typed its motto with both accents and breathings [as typography (1)], dropped the accents but kept the breathing, and specifically, kept the breathing on the letter ρ [as typography (7)]. This is why we cannot rationalize The Society’s alteration from typography (1) to (7). This problem has been the subject of formal discussion by The Society of Rheology, at both an Executive Committee Meeting, a subsequent Business meeting [54,55] and of informal discussion at a
Figure 5: Logo with typography (7) used on both items of Figure 4. This is the current typography for the motto of The Society of Rheology.

recent presentation [56]. In 1981, the further general simplification to drop all accents, except oxeia, was adopted for typing written Greek [41,45]. Perhaps we should not overanalyze this partial extinction of the diacritical marks from the motto on the journal cover. After all, close inspection of a 1948 casting [57] of a Bingham medal uncovers yet another typography:

$$\pi\alpha\nu\tau\alpha$$

$$\acute{\rho}\acute{\epsilon}\acute{\i}$$

where the diacritical marking in the first word were dropped, but both markings retained in the second word of the motto (see Figure 6). In 2013, the casting of the second lot of Bingham medals was commissioned with typography (1).

We see great wisdom in the use of Greek script for The Society motto, rather than having Romanized it as, for example, “panta rhei”, or conforming to Reference [58], as “panta rei.” The Greek script wisely circumvents the choice of any particular Romanization system [58], and more importantly, employs
symbols with which nearly all rheologists are familiar (the last letter, iota, being the single possible exception, as it is rarely used in rheology).

Figure 6: Motto of The Society of Rheology cast in bas-relief on banner beneath hourglass logo on the Bingham medal [this 1948 casting [57] uses typography (8)].

More recently, in 1996, its longer form with typography:

\[ \piαυτος \ ρε\iota \]

was adopted as the motto of the then newly established Hellenic Society of Rheology (ΕΛΛΗΝΙΚΟΣ ΣΥΛΛΟΓΟΣ ΡΕΟΛΟΓΙΑΣ), and this motto appears below a bas-relief of the philosopher’s face (see Figure 7).
Figure 7: Logo of the Hellenic Society of Rheology with face of Heraclitus in faux bas-relief [using typography (9) for its motto].

This rendition precedes the aphorism with the article “Τὰ” (unfortunately with the wrong accent! The correct one is “vareia” as “Τὰ”), leading to:

Τὰ πάντα ὅει

(10)

As this involves the article, it is thus closer to modern Greek usage, albeit it preserving the older “polytonic” system of accents and breathings (collectively called diacritical marks): In modern Greek the accent in the article “τὰ” would not have been there, neither would the rough breathing (῾) in the word “ὦεί” also with its accent being replaced from circumflex (περισπωμένη) to acute (οξεία), the modern Greek equivalent of the aphorism being therefore:

Τὰ πάντα όεί

(11)

This is why, whereas The Society’s intended meaning was and remains “everything flows,” most Greeks would translate the word πᾶντα, unpreceded by an article, as “always.” By contrast, outside the context of Heraclitus, “everything flows” is now normally translated to “Τὰ πᾶντα ὅει.” Moreover, in
modern Greek one would have used neither the attic syntax (that pairs a plural noun with a singular verb---see relevant discussion in Section II) nor the contracted form of the verb. Therefore, the proper translation into modern Greek of the aphorism is:

\[ \text{Tά πάντα φέουν} \quad (12) \]

Yet even more typographies are possible. First, the more truthful to a possible ancient Ionian Greek rendition of the motto is:

\[ \Gamma\Sigma\text{ΤΑΡΕΙ} \quad (13) \]

This Ionian writing had been officially adopted by ancient Athens in 403 BCE [38] (although it had wide informal use before then). Typography (13) involves capital letters, no spaces between words, no accents or breathing marks. In fact, even the rules for accent positioning in Greek remain a matter of scholarly research [59].

Incidentally, although ancient Greeks only use capital letters and did not use any spaces between the words, currently and internationally all use small letters with the diacritical marks (as used in the title of this paper) for all modern typographies of the ancient Greek texts. We thus think that it makes perfect sense to use small letters to type The Society motto. After all, the ancient Greeks limited themselves to capital letters mainly because they needed letters that could be easily scalped into tablet stone, and thus, each one with a few straight marks. We thus recognize that the choice of small Greek letters to type The Society motto, flows with the natural evolution of the Greek script.

The logo of the German Society Rheology (founded in 1951) also bears the “everything flows” motto, in Greek, which was introduced specifically using its own typography (see Figure 8):

\[ \text{πάντα θεί} \quad (14) \]

where the ““ι” is the Greek small letter iota with dialytika and oxeia. However, in the website of the German Society of Rheology [60] the logo now appears with the correct typography (1), as shown in Figure 9.
Figure 8: Initial Logo of the German Society of Rheology [using typography (14) for its motto].
VII. ALTERNATIVES TO πάντα ἃει

Over the years, a few alternatives to πάντα ἃει, have been suggested. Markovitz, for instance, cites one of Bingham’s own Editorials in the *Journal of Rheology*: “If we are looking for a classical reference to rheology, it would perhaps be better to quote (as did W.H. Herschel [61]) the poet Lucretius (96-55 BCE) ... :

“We see how quickly through the colander
The wines will flow; on the other hand,
The sluggish olive-oil delays; no doubt,
Because ‘tis wrought of elements more large,
Or else more crook’d and intertangled.”

A famous alternative English translation of the same passage, due to R. Humphries [62], is:

“Wine flows more quickly through a colander
Than olive oil; the latter’s elements
Are either coarser, or so hooked, so meshed
They can’t so easily be pulled apart
And one by one ooze through in proper course.”

The original latin text (Lucretius, Book II, 391-395) reads [63]:

“et quamvis subito per colum vina videmus
perfluere, at contra tardum cunctatur olivom,
aut quia ni mirum maioribus est elementis
aut magis hamatis inter se perque plicatis,
ideo fit uti non tam diducta repente “

This excerpt from Lucretius’s poem suggests remarkable insight into the relationship between molecular structure, and specifically polymer structure, and rheology. Not nearly as concise as the πάντα ρεῖ of Heraclitus though.

One might also consider the last line of one Latin verse from the Roman poet Horace (65-8 BCE) [64]:

Vivendi recte qui rorogate horam
Rusticus expectat dum defluat amnis; at ille
Labitur et labetur in omne volubilis aevum.

which has been translated to:

He who postpones the hour of living as he ought,
is like the rustic who waits for the river to pass along (before he crosses);
but it glides on and will glide forever.

and whose last line has been interpreted as “everything flows.” Readers can find this last line of the Latin verse embedded in the first letters of each sentence of the preface of Reference [65]. Not nearly as concise, nor as catchy as Bingham’s choice of πάντα ρεῖ .

Inscribed on one face of the sounding block for the gavel of The Society of Rheology, gifts from the British Society of Rheology on the occasion of The Society of Rheology’s 50th anniversary, we find “That which is hard is with
difficulty softened” [66; 67] (see Figure 10). Less concise than πάντα ὄει, but otherwise equally appropriate for the subject of rheology. This appears to have been excerpted from an essay by Plutarch (c. 46–120 CE) [68]:

“For youth is impressionable and plastic, and while such minds are still tender lessons are infused deeply into them; but anything which has become hard is with difficulty softened. For just as seals leave their impression in soft wax, so are lessons impressed upon the minds of children while they are young.”

The original reads [69]:

“Εὐπλαστὸν γὰρ καὶ ύγρὸν ἡ νεότις, καὶ ταῖς τούτων ψυχαῖς ἀπαλαῖς ἐτὶ τὰ μαθήματα ἐντήκεται· πἀν δὲ τὸ σκληρὸν χαλεπῶς μαλάττεται. Καθάπερ γὰρ σφραγίδες τοῖς ἀπαλοῖς ἐναπομάττονται κηροῖς· ὀὕτως αἱ μαθήσεις ταῖς ἐτὶ παιδίων ψυχαῖς ἐναποτυπωσόνται.”

“That which is hard is with difficulty softened” strikes a cord with those teaching rheology, but for its broader relevance, and crispness, we find Bingham’s first choice of πάντα ὄει hard to improve upon. Those teaching rheology in foreign languages may rely upon Table III, our table of translations of “everything flows” into other languages. On the same face of the sounding block, we find the logo for The Society of Rheology with the motto using typography (7), but on the opposing face, just the first half of the motto, “παντα„, without diacritical markings.
VIII. CONCLUSION

Whereas any attempt to modify The Society of Rheology motto to be “more correct” (i.e. to be truer to the original aphorism as expressed by Heraclitus himself) is futile, due to the lack of more detailed information, it is certainly a good and appropriate motto and it does express with exactitude and authenticity the Heraclitian philosophy of ubiquitous flow and change that is so very relevant to rheology. Thus, we conclude that its diacritical marks should be restored to the original form “πάντα ψήλη” [typography (1)]. Its writer’s variant [typography (3)] was printed on the first cover of Volume 1 of the Journal of Rheology in 1929.
Typography (1) also aligns the motto with the most widely accepted and current representation of Ancient Greek text. We provide Table I to facilitate the typesetting of The Society motto. We further suggest that The Society motto "πάντα όσι" be officially added to the Constitution and Rules of The Society, and specifically with typography (1).

IX. APPENDIX: HISTORY OF THE SOCIETY PUBLISHING

The Journal of Rheology has had four distinct lifetimes:

(i) In its first lifetime, 1929-1932, Volumes 1-3 are numbered with Arabic numerals (though the covers and the header of the tables of contents of Issues 2(2) through 3(4) are numbered with the Roman numerals, the odd-page header of each page in the Issues of Volume 3 numbers these issues with Arabic numerals), as the Journal of Rheology, [whereupon The Society motto appeared on each cover with typography (1)]. In this first lifetime, Issues 1(1) through 3(2) were published by The Society of Rheology with the cooperation of The Chemical Foundation, Inc., Issues 3(3-5) were published by the American Institute of Physics under the supervision of The Society of Rheology.

(ii) In its second lifetime, 1933-1935, when the journal was subsumed [70] into the journal Physics (as discrete quarterly sections called “RHEOLOGY NUMBERS” in Volumes 4 through 7 [4(3) 87-128; 4(6) 203-236; 4(8) 265-290; 4(11) 387-408; 5(2) 39-60; 5(5) 125-146; 5(8) 193-224; 5(11) 321-362; 6(2) 53-80; 6(5) 159-178; 6(8) 257-278; 6(11) 351-366 (1933-1935)]. On their covers or on pages i of Volumes 4 through 7 (1933-1936) we find “Published for the American Physical Society and The Society of Rheology by the American Institute of Physics Incorporated.”. In this second lifetime, The Society motto is absent from the journal Physics. The second lifetime ends abruptly [71,72], with Volume 7, when the American Institute of Physics embraced the journal Physics, and renamed it Journal of Applied Physics beginning with Volume 8. Curiously, as late as 1941, Article III, Section 1 of The Society By-Laws read “Technical papers presented to the Society of Rheology which are approved by the editor of the Society shall be submitted for publication among the Contributed Papers published in the Journal of Applied Physics” [73,74]. By 1947, we find no mention of the Journal of Applied Physics in said By-Laws [75].

(iii) In the journal’s third lifetime, begun in 1947 [76], The Academic Press published one yearly issue for The Society of Rheology of papers on rheology in Volumes 2 through 7 of the Journal of Colloid Science [2(1) i-vi, 1-222; 3(2) 73-183; 4(3) 185-347; 5(3) 197-314; 6(2) 93-210; 7(3) 199-345 (1947-1952)]. In this third lifetime, The Society motto is absent from the journal Journal of Colloid Science. In
1951, when the publisher the Academic Press imposed a 100-page limit on The Society publication (see p. 25, column 1 of [77]), dropped the special issue devoted to The Society publication. Instead, members of The Society of Rheology continued to publish in the Journal of Colloid Science, which interspersed their papers with other subjects. This important journal continues to this day as the Journal of Colloid and Interface Science, published by Elsevier; the Journal of Colloid Science and its successor are thus archived together electronically.

(iv) In its fourth lifetime, 1957-present, The Society journal was initially named Transactions of The Society of Rheology, and began with Vol. I, numbered with Roman numerals through Vol. VIII, then with Arabic numerals from Vol. 9 forward [whereupon in Issues 2 through 4 of Volume 21, the motto reappeared on the covers, but with typography (7)], and was then renamed Journal of Rheology from Vol. 22 forward [whereupon the motto has continued on the journal covers with typography (7)]. Volume 1 (1929-1930) had Issue Number 1 published in 1929 and then continued in 1930 with Issue Numbers 2-5, Volumes 2-3 (1931-1932) were each published in Issue Numbers 1-4, Volumes I-VIII in single unnumbered issues, Volumes 9-10 in Parts 1-2, Volumes 11-12 as Issues 1-3, Volumes 13-21 as Issues 1-4, and since, as Issues 1-6. Whereas the header on each cover in Volume 1 just read “RHEOLOGY,” the corresponding headers on each cover in Volumes 2 through 3 was improved to “JOURNAL OF RHEOLOGY.” Although these changes were made to the covers, the odd-page running title atop each page in Volume 1 through 3 never departed from “JOURNAL OF RHEOLOGY.”

We hope that this Appendix will be useful to librarians, since librarians have great difficulty in properly cataloging The Society journal. We also hope that this Appendix will help rheologists to understand why citations to The Society journal are often uneven. The Transactions of The Society of Rheology were first published by Interscience Publishers which became a division of Wiley in 1962, and Wiley continued publishing The Society journal through to 1989, after which the cost of exceeding the Wiley page limit caused The Society to switch to the American Institute of Physics for its journal publishing.

The Society of Rheology has also relied on its Rheology Leaflet [Numbers 1-15 (1937-1940)] and on its successor, the Rheology Bulletin [Volumes XII-XVI (1941-1945), 17-present (1946-present)] for archival publication. Indeed, between lifetimes, over the periods 1936-1946 and 1953-1956, The Society relied entirely on its Rheology Leaflet and on its Rheology Bulletin. These are properly archived by the Niels Bohr Library and Archives at the American Institute of Physics in College Park, MD. See Table II to see how The Society motto is intertwined with the histories of the Rheology Leaflet and then the Rheology Bulletin.
X. ACKNOWLEDGMENTS

ANB initiated this work in his fall 2006 sabbatical and visiting professorship, in the Department of Chemical Engineering at the University of Patras, Greece; ANB acknowledges Dr. Vlasis Mavrantzas for his hospitality and for supporting this visiting professorship. AJG thanks Dean Shi-Chang Tseng (曾世昌) of the National Yunlin University of Science and Technology (國立雲林科技大學) in Douliou, Taiwan, for hosting and supporting his visiting professorship. The encouragement and help in editing an earlier version of this document by Professor R. Byron Bird of the University of Wisconsin at Madison is also warmly acknowledged. The authors also recognize Mr. Yioryos Papakonstantopoulos of the Chemical and Biological Engineering Department of the University of Wisconsin-Madison for having brought the need for this study to the attention of the Executive Committee of The Society of Rheology in the fall of 2006. The authors acknowledge the help of Ms. Lindsey Gumb, Ms. Melanie Mueller and Dr. Joe Anderson of the Niels Bohr Library and Archives at the American Institute of Physics in College Park, MD. We thank Larry Belmont of the American Institute of Physics for his help with the Appendix, and specifically with details of the earliest issues (1929-1932), sometimes called Jurassic JOR. Finally, we thank Professor Manfred H. Wagner of the Technische Universität Berlin for providing information on the history of the logo of the German Society of Rheology. The authors are also greatly appreciative of H.M. Baek (백형민) of the Mechanical Engineering Department of the University of Wisconsin at Madison, for his help with Section III. The authors also thank Professor Manos Mavrikakis of the University of Wisconsin at Madison, Professor Marianna Kontopoulou of Queen’s University at Kingston, Professor Evan Mitsoulis of the National Technical University of Athens, and Professor John Vlachopoulos of McMaster University for helpful comments. A.J. Giacomin is indebted to the Faculty of Applied Science and Engineering of Queen’s University at Kingston, for their support through a Research Initiation Grant (RIG).

We thank Professors Patrick Anderson, Corneliu Balan, Ali Berker, R. Byron Bird, Victor Breedveld, Tomas Co, Lourdes De Vargas, Luca Deseri, Shailesh Doshi, Igor Emri, Furong Gao (高福榮), David Githuku, Konstantin Golemanov (Константин Големанов), Rainer Haldenwang, Ole Hassager, Wendy Heuvel, Jae Chun Hyun (현재천), Azuraien Jafaar, Musa Kamal, Chanyut Kolitawong, Sandris Lācis, Francis Lai (賴芳雄), João Maia, Irina Masalova (Ирина Масалова), Rossana Pasquino, Nhan Phan-Thien, Seppo Syrjälä, Zehev Tadmor, Tom Lih-Sheng Turng (童立生), Bruno Vergnes, Jan Vermant, Manfred Wagner, Hiroshi Watanabe (渡辺宏), Rhodri Williams, Hyun Wook Jung (정현욱), Martin
Zatloukal, and Drs. Katie Pitts, Osman Polat and Chia Yen Tseng (曾家彥), and Mssrs. Hyung Min Baek (백형민), Tiong-Boon Seet (薛忠文), Zhanibek Yessimbekov (Жанибек Есимбеков) and Haibin Zhao (赵海滨), and Mss. Patricia Lacroix, Aryn Lesage, Li-Ping Lin (林莉娉), Samaneh Khanlari and Burcu Ugur for their contributions to Table III.

XI. DEDICATION

This paper is dedicated to Professor Emeritus R. Byron Bird of the Rheology Research Center, and of the Department of Chemical and Biological Engineering of the University of Wisconsin-Madison in celebration of his 90th birthday, February 5, 2014.
**Table I: Classification Codes of Greek Small Letters for Motto Typography**

<table>
<thead>
<tr>
<th>English for Greek small letter</th>
<th>UNICODE 6 Hexadecimal Classification Without Stacking</th>
<th>UNICODE 6 Hexadecimal Classification With Stacking</th>
<th>Extended ASCII (code page 737) [code page under MS-DOS for Greek Language]</th>
</tr>
</thead>
<tbody>
<tr>
<td>π</td>
<td>03C0</td>
<td></td>
<td>167</td>
</tr>
<tr>
<td>α</td>
<td>03B1</td>
<td></td>
<td>152</td>
</tr>
<tr>
<td>α̅</td>
<td>1F71 03B1 0301</td>
<td></td>
<td>225</td>
</tr>
<tr>
<td>ν</td>
<td>03BD</td>
<td></td>
<td>164</td>
</tr>
<tr>
<td>τ</td>
<td>03C4</td>
<td></td>
<td>171</td>
</tr>
<tr>
<td>ρ</td>
<td>03C1</td>
<td></td>
<td>168</td>
</tr>
<tr>
<td>ρ̇</td>
<td>1FE5 03C1 0314</td>
<td></td>
<td>unavailable</td>
</tr>
<tr>
<td>ε</td>
<td>03B5</td>
<td></td>
<td>156</td>
</tr>
<tr>
<td>ι</td>
<td>03B9</td>
<td></td>
<td>160</td>
</tr>
<tr>
<td>ι̅</td>
<td>1FD6 03B9 0342</td>
<td></td>
<td>unavailable</td>
</tr>
</tbody>
</table>
### Table II: History of The Society of Rheology Motto

<table>
<thead>
<tr>
<th>Period</th>
<th>Where</th>
<th>Volumes (Issues) [Numbers]</th>
<th>Initiating Editor(s) or President</th>
<th>Typography</th>
</tr>
</thead>
<tbody>
<tr>
<td>1929-1932</td>
<td>Cover, <em>Journal of Rheology</em></td>
<td>1(1-5), 2-3(1-4)</td>
<td>E.C. Bingham</td>
<td>(3)</td>
</tr>
<tr>
<td>1948</td>
<td>Castings, Bingham Medals</td>
<td></td>
<td>W.F. Fair, Jr. [57]</td>
<td>(5)</td>
</tr>
<tr>
<td>1977</td>
<td>Cover, <em>Transactions of The Society of Rheology</em></td>
<td>21(2-4)</td>
<td>R.R. Myers</td>
<td>(7)</td>
</tr>
<tr>
<td>1977-present</td>
<td>Cover, <em>Journal of Rheology</em></td>
<td>22(1)-present</td>
<td>R.R. Myers</td>
<td>(7)</td>
</tr>
<tr>
<td>1979</td>
<td>Cover, Replica, <em>Journal of Rheology</em> (distributed, 51st Annual meeting, Boston)</td>
<td>1(1)</td>
<td>E.C. Bingham</td>
<td>(3)</td>
</tr>
<tr>
<td>1985</td>
<td>Section titled “OUR MOTTO-πάντα ἡμί,” in [14]</td>
<td>29(6)</td>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>2014</td>
<td>Castings, Bingham Medals</td>
<td></td>
<td>A.J. Giacomin / G.B. McKenna</td>
<td>(1)</td>
</tr>
</tbody>
</table>
Table III: Translations of “Everything Flows”

<table>
<thead>
<tr>
<th>Language</th>
<th>Native Script</th>
<th>Romanization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afrikaans</td>
<td>Alles vloei</td>
<td></td>
</tr>
<tr>
<td>Arabic</td>
<td>يَهْوَى شُئَى إِلَل</td>
<td>kollu shai-in yajree</td>
</tr>
<tr>
<td>Bulgarian</td>
<td>Всичко тече</td>
<td>vsichko teche</td>
</tr>
<tr>
<td>Burmese, Upper</td>
<td>အရာရာစီးဆင်း</td>
<td>ah ya ya seesin</td>
</tr>
<tr>
<td>Chinese, Cantonese</td>
<td>萬物皆流</td>
<td>maan mat gaai lau</td>
</tr>
<tr>
<td>Chinese, Hakka</td>
<td>萬物皆流</td>
<td>van33 vud2 gai53 lau55</td>
</tr>
<tr>
<td>Chinese, Hokkien</td>
<td>万物皆流</td>
<td>ban bu(t) gai liu</td>
</tr>
<tr>
<td>Chinese, Mandarin (simplified)</td>
<td>万物皆流</td>
<td>wànwù jiéliú</td>
</tr>
<tr>
<td>Chinese, Mandarin (traditional)</td>
<td>万物皆流</td>
<td>wànwù jiéliú</td>
</tr>
<tr>
<td>Chinese, Taiwanese</td>
<td>萬物皆流</td>
<td>banxmir long e liutong</td>
</tr>
<tr>
<td>Cree</td>
<td>Ká-pimiciwahk</td>
<td></td>
</tr>
<tr>
<td>Czech</td>
<td>Vše teče</td>
<td></td>
</tr>
<tr>
<td>Danish</td>
<td>Alt flyder</td>
<td></td>
</tr>
<tr>
<td>Dutch</td>
<td>Alles vloeit</td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>Everything flows</td>
<td></td>
</tr>
<tr>
<td>Estonian</td>
<td>Kõik voolab</td>
<td></td>
</tr>
<tr>
<td>Farsi</td>
<td>اسْتَ جِرِيَانَ دِرْ جُيْزِ مُهِ</td>
<td>Hameh cheez dar jaryan ast</td>
</tr>
<tr>
<td>Filipino</td>
<td>Lahat ay umaagos</td>
<td></td>
</tr>
<tr>
<td>Finnish</td>
<td>kaikki virtaa</td>
<td></td>
</tr>
<tr>
<td>Flemish</td>
<td>Alles vloeit</td>
<td></td>
</tr>
<tr>
<td>French</td>
<td>Tout s’écoule</td>
<td></td>
</tr>
<tr>
<td>German</td>
<td>Alles fließt</td>
<td></td>
</tr>
<tr>
<td>Gujarati</td>
<td>બધું જવહી જાય છે</td>
<td>badhu ja vahi jaay chhe</td>
</tr>
<tr>
<td>Greek, Ancient</td>
<td>πάντα ρεί</td>
<td>panta rhei</td>
</tr>
<tr>
<td>Greek, Modern (katharevousa)</td>
<td>Τὰ πάντα ρέονυ</td>
<td>ta panta reoun</td>
</tr>
<tr>
<td>Greek, Modern (demotic)</td>
<td>Τὰ πάντα ρέονυ</td>
<td>ta panta reoun</td>
</tr>
<tr>
<td>Hebrew</td>
<td>זורח כליל</td>
<td>hakol zoreh</td>
</tr>
<tr>
<td>Hindi</td>
<td>सब कुछ बहेता है</td>
<td>sab kutchh baheta hai</td>
</tr>
<tr>
<td>Indonesian</td>
<td>Segalanya dinamis</td>
<td></td>
</tr>
<tr>
<td>Italian</td>
<td>Tutto scorrere</td>
<td></td>
</tr>
<tr>
<td>Japanese</td>
<td>万物流転</td>
<td>banbutsu ryūiten</td>
</tr>
<tr>
<td>Kazakh</td>
<td>Бәрі деп агады</td>
<td>bari de agady</td>
</tr>
<tr>
<td>Korean</td>
<td>모든 것은 흐른다</td>
<td>modeun geoseun heureunda</td>
</tr>
<tr>
<td>Language</td>
<td>Translation</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Latvian</td>
<td>viss plūst</td>
<td></td>
</tr>
<tr>
<td>Latin</td>
<td>omne influat</td>
<td></td>
</tr>
<tr>
<td>Malay</td>
<td>Segalanya dinamis</td>
<td></td>
</tr>
<tr>
<td>Ojibway</td>
<td>Kina gegoo bimijiwan</td>
<td></td>
</tr>
<tr>
<td>Persian</td>
<td>دارد چریاں چھیز مہ  hameh chiz jaryan darad</td>
<td></td>
</tr>
<tr>
<td>Portuguese</td>
<td>Tudo flui</td>
<td></td>
</tr>
<tr>
<td>Romanian</td>
<td>Totul curge</td>
<td></td>
</tr>
<tr>
<td>Russian</td>
<td>всë течет                           vsë tečet</td>
<td></td>
</tr>
<tr>
<td>Slovene</td>
<td>Vse teče</td>
<td></td>
</tr>
<tr>
<td>Spanish</td>
<td>Todo fluye</td>
<td></td>
</tr>
<tr>
<td>Swahili</td>
<td>Kila kitu inatiririka</td>
<td></td>
</tr>
<tr>
<td>Thai</td>
<td>ทุกสิ่งทุกอย่างมีการเคลื่อนไหว Tuk-Shing-Tuk-Yang-Mee-Karn-Kue Luang-Whai</td>
<td></td>
</tr>
<tr>
<td>Turkish</td>
<td>Her şey akar</td>
<td></td>
</tr>
<tr>
<td>Vietnamese</td>
<td>Văn Vật Trời Trây</td>
<td></td>
</tr>
<tr>
<td>Welsh</td>
<td>Ma’ popeth yn Ilifo</td>
<td></td>
</tr>
</tbody>
</table>
XII. REFERENCES

2. Clyde, J., Greek Syntax with a Rationale of the Constructions, Edinburgh, Sutherland 1857. Also available online at the Internet Archives of the University of Toronto libraries in: http://archive.org/details/greeksyntaxwithr00clyduoft
20 http://www.theoi.com/Kosmos/Okeanos.html
22 Πρωτόταπτας Ι.Ω. (translation/notes), Ομήρου Ἰλιᾶς Σ-Τ-Υ , Βιβλιοθήκη Παπύρου ἀριθ. 267, Τὰ ἀπαντὰ τῶν ἀρχαίων συγγραφέων, Πάπυρος, Athens, Greece (1959).
24 Πρωτόταπτας Ι.Ω. (translation/notes), Ομήρου Ἰλιᾶς Ν-Ξ-Ο , Βιβλιοθήκη Παπύρου ἀριθ. 234, Τὰ ἀπαντὰ τῶν ἀρχαίων συγγραφέων, Πάπυρος, Athens, Greece (1957).
26 http://www.sacred-texts.com/cla/homer/greek/ili03.html
28 Ζευγώλης Γ.Δ. (translation/notes), Ομήρου Ὀδύσσεια Τ-Υ-Φ , Βιβλιοθήκη Παπύρου ἀριθ. 283, Τὰ ἀπαντὰ τῶν ἀρχαίων συγγραφέων, Πάπυρος, Athens, Greece (1960).
29 http://shebiw.wordpress.com/the-sea/apsorroos/
37 Theodossiou, E. and V.N. Manimanis, The cosmology of the pre-Socratic Greek philosophers, Societa Astronomica Italiana, Memorie Supplemanti, 15:204-209 (2010).

“Bingham Memorial Award,” *Rheology Bulletin* (The Society of Rheology), 18(2) 6 (June, 1947).


http://www.drg.bam.de/index.htm


http://www.thelatinlibrary.com/lucretius/lucretius2.shtml

Horatius, Quintus (aka Horace), *Epistles*, I, 2, 41.


Inscription, Side A, sounding block to gavel of The Society of Rheology (1979). Erratum to Side A: “παντα” should be “παντα ρει”. Erratum to Side B: “the American Society of Rheology” should be “The Society of Rheology”.


ΠΛΟΥΤΑΡΧΟΥ ΤΟΜΟΣ ΤΡΙΤΟΣ, PLUTARCHI OPERUM VOLUMEN TERTIUM. Πλούταρχου τού χαιρεννεος Τα ηθικα, Volume 1, by Plutarch, Friedrich Dübner, GRÆCE ET LATINE, VOLUMEN PRIMUM, PARISIIS, EDITORE AMBROSIO FIRMIN DIDOT, INSTITUTI REGII FRANCIÆ TYPOGRAPHO, VIA JACOB, 56 MDCCCXLI (1841). ΠΛΟΥΤΑΡΧΟΥ ΠΕΡΙ ΠΙΑΙΔΩΝ ΑΓΩΓΗΣ, Page 4, lines 12-16 (DIGITIGED BY GOOGLE, GOOGLE e-Book)


Tate, J.T., Editorial, *Physics*, 7, 433 (1936).


“The Society of Rheology: Constitution and By-Laws (Fully Amended as of October 1, 1941),” *Rheology Bulletin* (The Society of Rheology), 17(1) 15-16 (May, 1946).

75 “Revision of the Constitution and By-Laws of the Society of Rheology,” *Rheology Bulletin* (The Society of Rheology), 18(2) 6 (June, 1947).
