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Mr. Adam and Mr. Monro on the Nuptial Number of Plato

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must be assigned to dates within about the first 150 years of our era.

The circle to which a Greek medical treatise appeals is not large, as is shown by the fact that so many such works are known to lie unedited in various libraries, and that even the greater authors are, for the most part, inadequately edited. Even Galen waits for the completion of Prof. Iwan von

Müller's promised *opus magnum*. But for those whom the subject interests the MS. now described, with its numerous allusions to the Greek writers on medical science, should be of considerable value, and at any rate requires fuller investigation.

F. G. KENYON.

BRITISH MUSEUM, April 1892.

MR. ADAM AND MR. MONRO ON THE NUPTIAL NUMBER OF PLATO.

MR. MONRO'S careful review of my pamphlet on the Number of Plato seems to make it incumbent on me to state how I propose to meet the arguments which he has adduced against the theory I have put forward.

After giving reasons for rejecting my interpretation of four phrases, viz. (1) *ἐκατὸν τοσαντάκις*, (2) *ἐπίτριτος πυθμὴν πεμπαδί συζυγείς*, (3) *τρίς αὐξηθείς*, (4) *τρεῖς ἀποστάσεις*, Mr. Monro adds: 'Such then are the objections to which the several parts of Mr. Adam's interpretation seem to me to be open. I have only further to point out that if any of them is valid, it is probably fatal to the theory as a whole.' These last words are not (I think) correct as regards the phrase *ἐπίτριτος πυθμὴν πεμπαδί συζυγείς*: provided this phrase means 60, it does not affect the theory as a whole whether the language is to be explained as $(3 + 4 + 5) \times 5$ or as $3 \times 4 \times 5$ or in the way which will presently be indicated. Nor again is it true that the theory as a whole falls to pieces if I am wrong in *ἐκατὸν τοσαντάκις*, provided the first *ἀρμονία* can be otherwise shown to be equal to the second, and a similar remark will apply to *ἀποστάσεις*. But it is assuredly true that unless *τρίς αὐξηθείς* means 'after being three times increased, i.e. multiplied by itself,' my whole theory is false. Mr. Monro has put the truth very clearly when he says: 'It is evident that, as soon as the separate explanations have been given, the total explanation must either follow without effort, or'—here only I disagree—'become demonstrably hopeless.' It is because this is the one point of my theory which seems to me to make the total explanation follow without effort (since 60^4 is equal to 4800×2700 , while no cube number is) that I am ready to stake the whole theory on the sentence: '60 *τρίς αὐξηθείς* is 60^4 .'

Of my explanation of 60 *τρίς αὐξηθείς* as 60 thrice multiplied by itself, i.e. raised to the fourth power, Mr. Monro says: 'Mr. Adam's contention is logical, but it is not in accordance with the *usus loquendi*, which in this and many similar cases follows the inclusive method of reckoning.' In support of this he quotes *Euclid* ix. 8 *ἐὰν ἀπὸ μονάδος ὅποσοιῶν ἀριθμοὶ ἐξῆς ἀνάλογον ὦσιν, ὁ μὲν τρίτος ἀπὸ τῆς μονάδος τετράγωνος ἔσται κ.τ.λ.* What Euclid means is this: if for instance we have the series 1, 60, 60^2 , etc., in which $1 : 60 :: 60 : 60^2$, then the third number from unity will be 60^2 . From this we can certainly infer that 60^2 was called the second number from 60, and 60^3 the third number from 60: but how does this help us? We are dealing, in *τρίς αὐξηθείς*, not with the third number, but with the third increase (*τρίτη αὔξη*). Mr. Monro seems to infer that Euclid could have called 60^3 the third increase from 60, because he would call (for example) 60^2 in the series 1, 60, 60^2 the third number from unity. But is *αὔξη* merely a synonym for *ἀριθμός*? If it is, as Mr. Monro's argument supposes, then Euclid might have called 60^2 the *τρίτη αὔξη* as well as the *τρίτος ἀριθμός* from unity; will the *usus loquendi* (not to speak of logic) bear this out? Did any Greek ever use *τρίτη αὔξη* of a square number? It is Mr. Monro, not I, who interprets *τρίς αὐξηθείς* differently from *τρίτη αὔξη*: for just as surely as 60^3 and not 60^2 is *τρίτη αὔξη* of unity, so surely is 60^4 and not 60^3 *τρίτη αὔξη* of 60 i.e. 60, *τρίς αὐξηθείς*.¹

Mr. Monro rejects Schneider's interpreta-

¹ The passage of Archimedes, to which Mr. Monro refers, is cited in Nesselmann (*Alg. d. Griechen* p. 124, note 16). It is, as Mr. Monro says, similar to the passage quoted from Euclid; and what I have said of the one will apply to the other. Nesselmann's remarks on pp. 125 and 161 (where he refers to the passage in Euclid) are entirely right and in full harmony with my theory.

tion of the passage in the *Politics* (v. 12. 1316^a), *τούτων ὧν ἐπίτριτος πυθμὴν . . . παρέχεται, λέγων ὅταν ὁ τοῦ διαγράμματος ἀριθμὸς τούτου γένηται στερεός*, in favour of a view which does not even pretend to explain the construction of *ὧν* in Aristotle nor the reference in *τούτων*. The notion that Plato's Number is demonstrably insoluble can only be defended on the assumption that this passage of the *Politics* is demonstrably insoluble too. If there is anything clear about the Number, it surely is that *ὧν* in Plato has for its antecedent *αὐξήσεις* and *ὧν* in Aristotle has for its antecedent *τούτων*, in which case *τούτων* means *αὐξήσεις* and Schneider's interpretation of Aristotle is established. Perhaps I may be allowed to say that my interpretation—essentially the same as Schneider's—of the passage in Aristotle was arrived at independently of Schneider, and also to add that Schneider had not the same temptation to go wrong as I had, because he takes the ordinary view of *τῆς αὐξηθείς*. And if *τῆς αὐξηθείς* is so simple as Mr. Monro thinks, why should Aristotle have troubled to explain it? Aristotle does not explain it, because it would be irrelevant to his purpose to do so. Would indeed that he had stopped to explain it, whether relevant or not! But Aristotle's purpose is to explain *τούτων* (i.e. *αὐξήσεων*), not *τῆς αὐξηθείς*. Mr. Monro remarks 'Aristotle must have quoted the words which he thought the most important': but he does not quote *τῆς αὐξηθείς*, which (according to Mr. Monro) he seeks to explain: further 'the comment or paraphrase which follows must refer to those words' (that is, which he quotes), but Mr. Monro makes it refer to *τῆς αὐξηθείς* which Aristotle does not quote: finally Mr. Monro, admitting that 'Aristotle indeed does not quote *τῆς αὐξηθείς*', remarks that 'the gloss' *λέγων κ.τ.λ.* 'includes them': but does not the writer even of 'a gloss' quote the words which he proposes to explain? Aristotle is not writing 'a gloss' on the words *τῆς αὐξηθείς*—which require no gloss—but a clause explanatory of the *αὐξήσεις* in Plato. He virtually quotes *αὐξήσεις* when he says *τούτων ὧν*, since the antecedent of *ὧν* in Plato is *αὐξήσεις*. I have therefore nothing to retract in my explanation of *τῆς αὐξηθείς*.

The case is different with *ἐκατὸν τοσαντάκις*, and I admit that Mr. Monro has shown that my explanation—in which I took *ἐκατὸν τοσαντάκις* as epexegetic not of *ἰσην* *ισάκις* but only of *ισάκις*—of this phrase was wrong. But the ordinary explanation of

ἐκατὸν τοσαντάκις—'a hundred taken *that* number of times, viz. 100 times'—is by no means 'unassailable.' Does this ordinary interpretation regard *ἐκατόν* as accusative or genitive? If accusative (to which its relation to *ἰσην* would on this theory point), is there any example in Plato of such a way of describing a square? Certainly throughout the *Meno* the size of a square is always expressed by means of the *genitive* case (denoting its sides), e.g. 82 C *δυοῖν δις ποδοῖν*, 83 C *τετρατάρων γὰρ (not τέτταρα) τετράκις ἐστὶν ἑκαίδεκα*, 83 E *τὸ ὅλον χωρίον τριῶν τῆς ποδῶν γίνεται*. Or is *ἐκατόν* here regarded as in the genitive case? If so, are there any cases in classical Greek of an indeclinable word like *ἐκατόν* used outside nom. acc. and voc. case without an article or other word to replace inflexion? What then is the true explanation of the phrase *ἰσην ἰσάκις, ἐκατὸν τοσαντάκις*? *τοσαντάκις* must derive its meaning from a number mentioned before, as Mr. Monro says, and why not from *ἰσην ἰσάκις*? Call *ἰσην ἰσάκις* x^2 , then *ἐκατὸν τοσαντάκις* is $100 x^2$. And if $100 x^2 = 4800 \times 2700$, x is 360 and the first *ἀρμονία* is then $360^2 \times 100$. The whole phrase is equivalent to *ἰσην ἰσάκις ἐκατοντάκις*. The one harmony is *one hundred times* a square, while the other is a rectangle whose sides are *one hundred times* 48 and *one hundred times* 27. Two further points are gained by this explanation. In the first place the side of Plato's square gives the number of days (360) which he counts in the year—whereby we can convert the days of his Great Year into years (the *magnus Platonicius annus* of 36000 years, as it was actually called in the sixteenth century), and in the second place the number 100—the natural duration in years of human life, as Plato thought—appears for the third time, making the balance *ἐκατὸν τοσαντάκις—ἐκατὸν μὲν ἀριθμῶν—ἐκατὸν δὲ κύβων* complete.

There remain *τρεῖς ἀποστάσεις* and *ὧν ἐπίτριτος πυθμὴν κ.τ.λ.* As regards the first of these I am grateful to Mr. Monro for pointing out that my explanation of the *ἀποστάσεις* in part 2 of the discussion is apparently inconsistent with my explanation in part 1. The explanation given in part 2 was the one which I had in my mind throughout, but the plan—adopted for the sake of clearness—of keeping the solution as far as possible distinct from the significance of the Number led me to insist too much on Fig. vi. on p. 34. In the middle paragraph of p. 54 I think I have reconciled the two apparently inconsistent figures (vi. and ix.). Briefly, in the third, fourth, and

fifth months the child receives increases represented by 3^3 , 4^3 , and 5^3 . The only evidence—I still think it is enough—that this was Plato's idea is the passage in Censorinus (with its confirmations in Aristides) and the precise applicability of that passage to the words of Plato. I should add that the *ὅροι* of Fig. ix. were intended to be the same as the *ὅροι* of fig. vi., to which figure two *ἀποστάσεις* might be prefixed representing the first and second months after conception. The word *ἀπόστασις* by itself surely does mean only 'distance from' and not, as Mr. Monro says, 'ratio': in the *Timaeus* 43 D the notion of ratio is given to it by τοῦ διπλασίου καὶ τριπλασίου and similarly in *Rep.* 587 D Plato means the 'distance of the king from the tyrant' in point of happiness—although the *measure* of the distance must in such a case be expressed by a numerical ratio, since one cannot say e.g. 100 miles distant in point of happiness. There seems to be nothing gained by giving to *ἀπόστασις* a secondary meaning which its derivation does not warrant nor its usage require.

Mr. Monro remarks of my discussion as to *ἐπίτριτος πυθμὴν*: 'There is nothing in the Greek to suggest adding the sides of the triangle together: there is nothing in *ἐπίτριτος πυθμὴν* to imply the hypotenuse 5: and there is no parallel to lead us to take *συζυγείς* to mean "multiplied." As for *συζυγείς*, the word in reality means only 'married to': the *ἐπίτριτος πυθμὴν* is conceived of as marrying *πεμπάς* and begetting thereout by multiplication these twain harmonies which nevertheless are one. The fancy is of course extravagant, but the image is both appropriate here and extremely common in Plato (see e.g. *Theaet.* 156 D ff.), and Aristides tells us that the number 6 was called marriage because it is the product of the first male and the first female number ($3 \times 2 = 6$). To Mr. Monro's remarks on my theory of *ἐπίτριτος πυθμὴν* I might reply that there is in the Greek *ὦν* and *πυθμὴν* as well as *ἐπίτριτος*, and that *ὦν πυθμὴν* might fairly be regarded as the *πυθμὴν* of the *αὐξήσεις*—which I took to be $3^3 + 4^3 + 5^3$, whose *πυθμὴν* it is reasonable to regard as $3 + 4 + 5$. But my account of *ὦν ἐπίτριτος πυθμὴν* is (I now think) wrong. A strenuous interpretation of the words of Plato must make *ὦν* refer to the *αὐξήσεις* of the child: now Plato speaks of 9 *αὐξήσεις*, viz. 3 in each of the three months to which he alludes—that is (starting from the *ὅροι* which separate the months), in each month a linear *αὐξήσις*, a squaring *αὐξήσις*, and an

αὐξήσις making the child solid: *βάθος γὰρ ἢ σώματος φύσις*. This may be ludicrous from the point of view of modern science (like much else in Plato), but it is precisely the way in which the Pythagoreans conceived of the generation of solids, and even Plato himself: see *Timaeus* 53 C foll. *ὦν* then means 'of nine' and what is *ἐπίτριτος πυθμὴν*? Simply 'four-thirds.' In point of fact Nicomachus (p. 134 ed. Ast) expressly calls 12 the *πυθμὴν ἐπίτριτος* of 9, as 6 is the *πυθμὴν ἡμιόλιος* of 4. I therefore regard the solution of the two parts of the Number as $3^3 + 4^3 + 5^3 = 216$ and $\left\{\left(\frac{4}{3} \text{ of } 9\right) \times 5\right\}^4 = 360^2 \times 100 = 4800 \times 2700$.

Opinions may differ as to the kind of jest which Plato meant when he wrote the Number: they ought not to differ on the question whether he is jesting or not, since he says he is. For my own part, I think it a poor joke in a work like the *Republic* to propound a problem which is demonstrably insoluble; it is a frigid jest whose only point is its insolubility. The Nuptial Number, like many other of Plato's loftiest passages, is half-serious and half-playful: Plato may have smiled at these 'Babylonian numbers' without entirely disbelieving in their results, as I think we can see from the *Timaeus*. But the Number was one of those jests which (as readers of Proclus know) came to be taken seriously: and parts of it, such as the ideas of man's relation to the *θεῖον γεννητόν* and the *ἀποκατάστασις* of all things when the *ἀριθμὸς γεωμετρικός* is fulfilled, are not wholly without parallel in modern Christian belief.

JAMES ADAM.

THE courtesy of the Editor having given me the opportunity of seeing the preceding Reply, I add the following remarks, which I have made as brief as possible.

1. Mr. Adam is doubtless right in regarding his view of *τρίς αὐξήθεις* as the most vital part of his theory. In his Reply he has not addressed himself as directly as I should have expected to the defence of the paradox (for such I must call it) that *τρίς αὐξήθεις* means 'raised to the fourth power,' while *τρίτη αὐξή* denotes the third power. His criticism of the passage which I quoted from Euclid certainly does not furnish such a defence. He accounted for *τρίτη αὐξή* by postulating a series of the form

$$1 + a + a^2 + a^3 + \&c.,$$

where a^3 is the fourth term but the third 'increase.' I noticed the want of any evi-

dence that this was the basis of the phrase *τρίτη αὔξη*, and went on to quote Euclid in order to show that if such a series had been in question the inclusive method of reckoning would have re-asserted itself. The point of course is that Euclid calls a^2 not the third number or term of the series—which would be logical—but the *third from unity*. This is surely an illogical use (since the first term is not the *first from unity*), identical in principle with the illogical use (as I understand it) of *τρίτη αὔξη* and *τρίς αὔξηθεις*. But my argument does not rest on the passage of Euclid, which is one of many examples of the *usus loquendi*, and only specially appropriate in view of Mr. Adam's series $1 + 60 + 60^2$ etc. Our own use of the term 'third power' is at least as good a parallel, especially as power itself originally meant the square. I need not say that the convention by which x is regarded as x^1 had nothing to do with establishing this usage. On the other hand Mr. Adam's whole case rests on the argument that there can be no similar want of logic in the use of the phrase *τρίς αὔξηθεις*.

2. It still seems to me certain that Aristotle's comment *λέγων κ.τ.λ.* refers to the sentence which he has just quoted, and that he includes in the reference the words *τρίς αὔξηθεις*, though his quotation stops short of them. I do not see what proof of this is needed beyond placing the two passages together. We have:—

Plato's sentence

ὃν ἐπίτριτος πυθμὴν πεμπαδί συζυγείς δύο ἀρμονίας παρέχεται τρίς αὔξηθεις.

Aristotle's quotation and comment

ὃν ἐπίτριτος πυθμὴν πεμπαδί συζυγείς δύο ἀρμονίας παρέχεται, λέγων ὅταν ὁ τοῦ διαγράμματος ἀριθμὸς τούτου γένηται στερεός.

Mr. Adam makes a great deal of the omission of *τρίς αὔξηθεις* by Aristotle; though he himself takes Aristotle's comment to refer to *αὔξεις δυνάμει κ.τ.λ.*—words which are not only not quoted by him, but are in the sentence preceding the words quoted. But Aristotle did not wish merely to explain *τρίς αὔξηθεις*. He wished to explain how, as he understood Plato, the *ἐπίτριτος πυθμὴν πεμπαδί συζυγείς* (the Pythagorean triangle) furnished two harmonies. Plato says *τρίς αὔξηθεις*, 'by being thrice increased.' Aristotle substitutes for this the more explicit 'when the number of this diagram has become solid.'

I may say here that I nowhere spoke of the phrase *τρίς αὔξηθεις* as a particularly simple one. It appears that *τρίτη αὔξη* is an

ordinary expression for cubing, since it occurs more than once in that sense. I take it that *τρίς αὔξηθεις* is a variation on *τρίτη αὔξη*, suited to the affected style of the passage. For I cannot think, as Mr. Adam does, that the Nuptial Number is couched in the ordinary mathematical language of the time.

I will not enter upon the question whether Aristotle understood Plato's Number, or thought that he did. His language seems to me very guarded. But I must point out that Mr. Adam is somewhat misinterpreting Aristotle when he says that he 'admits that the Number of Plato actually does give a correct reason for the change of constitutions in general.' Aristotle certainly says *τοῦτο μὲν οὖν αὐτὸ λέγων ἴσως οὐ κακῶς*, but this refers to the immediately preceding words *ὡς τῆς φύσεως ποτε φουούσης φαύλους καὶ κρείττους τῆς παιδείας*. This is clear from the next words, *ἐνδέχεται γὰρ εἶναι τινὰς οὓς παιδευθῆναι καὶ γενέσθαι σπουδαίους ἀδύνατον*. Thus Aristotle only admits that there may be changes because nature from time to time fails to furnish adequate material.

3. Mr. Adam has changed his view of the words *ἴσων ἰσάκεις ἑκατὸν τοσαντάκεις*, which he now takes to be equivalent to *ἴσων ἰσάκεις ἑκατοντάκεις*—a square number taken a hundred times. I cannot follow this. Surely *ἴσων ἰσάκεις* is meant to tell us that the harmony is a square, and *ἑκατὸν τοσαντάκεις* to tell us what square it is; just as with the second harmony we are first told that it is oblong, then of what factors it consists.

4. The new explanation of *ὃν ἐπίτριτος πυθμὴν* is also, in my view, untenable. Even supposing that *ὃν* can mean the number 9 because nine *αὔξεις* have been referred to, I cannot admit that 12 could be called the *ἐπίτριτος πυθμὴν* of 9. The number 12 is *ἐπίτριτος* of the number 9, and the ratio 12 : 9 is an *ἐπίτριτος λόγος*, but the only *ἐπίτριτος πυθμὴν* is the ratio in its lowest terms, viz. 4 : 3. Mr. Adam has misconstrued the passage of Nicomachus to which he refers (p. 134 Ast), as he will see on further consideration. Nicomachus is comparing the series of squares 1, 4, 9, etc., and the series of so-called oblong numbers, 2, 6, 12, etc., which are mean proportionals between successive squares. Speaking of the ratio of each oblong to the corresponding square he says *πρῶτος πρῶτον πυθμὴν πολλαπλάσιος (2 : 1), δεύτερος δὲ δευτέρου ἡμιόλιος (6 : 4), τρίτος δὲ τρίτον ἐπίτριτος (12 : 9)*, and so on. Mr. Adam supposes *πυθμὴν* to be understood with *ἡμιόλιος, ἐπίτριτος*, etc., but wrongly. These words govern a genitive in the sense of

'half as much again as,' 'four-thirds of,' etc., and this is the construction here; as is shown by another sentence a little later on the same page, where Nicomachus goes on to remark that these ratios are given in terms which increase progressively. Thus, he says, *πρῶτος μὲν πρῶτον πυθμένα πολλὰ πλάσιον ἔξει, δεύτερος δὲ δευτέρου δεύτερον ἀπὸ πυθμένος ἡμιόλιον, τρίτος δὲ τρίτου τρίτον ἀπὸ πυθμένος ἐπίτριτον, κ.τ.λ.* That is to say, 6 : 4 is the second *ἡμιόλιος λόγος* from the *πυθμὴν* (3 : 2), 12 : 9 is the third *ἐπίτριτος λόγος* from the *πυθμὴν* (4 : 3), and so on.

5. The meaning of *πεμπάδι συζυγείς* will be best considered when we are agreed about *ἐπίτριτος πυθμὴν*. I may say that I merely noticed, as one of several weak points, the want of evidence that *συζυγείς* could imply multiplication. The strength of my argument here lies in the aptness of the words *ἐπίτριτος πυθμὴν πεμπάδι συζυγείς* as a description of the triangle whose sides are 4 and 3 and hypotenuse 5.

6. Similarly with *ἀποστάσεις*—I do not say that it could not mean distance from a point to another, but only that in the two other mathematical passages in Plato where it occurs it denotes the ratio between two magnitudes. The discrepancy between fig. vi. and fig. ix. seems to me to be more than an apparent one, and to involve giving up Mr. Adam's explanation of the three *ἀποστάσεις* and four *ὄροι*. On the view represented by fig. vi. the *ἀποστάσεις* lay along a line. Mr. Adam

bade us take them up tenderly and lift them with care, when they would arrange themselves in the Pythagorean triangle (fig. vii.). He now makes them all start from the same point (fig. ix.). Under this rough usage the Pythagorean triangle becomes impossible here, and the case is proportionately strengthened for finding it in the next part of the passage.

7. Whether the Nuptial Number is a good joke or not, I would press this point. Plato does not merely warn us that it is a joke. He distinctly seems to imply that the point of the joke lies in the use of high-sounding scientific language which is nevertheless without meaning. The Muses do not give us serious mathematics in a playful manner—smiling at their Babylonian numbers, as Mr. Adam puts it. Their language is lofty and serious (*ὡς δὴ σπουδῇ λεγούσας ὑψηλολογουμένας*), but they are really jesting and trifling with us (*ὡς πρὸς παῖδας ἡμᾶς παίζουσας καὶ ἐρεσχλούσας*). I agree (as I have already said) that Plato is probably half-serious. But if he had had a clear and consistent mathematical sense to convey, he would have been wholly serious, as he is in other mathematical passages. Mr. Adam has done something to illustrate the serious side, and would probably have done more if he had not attempted to explain everything: *πλέον ἡμισυ παντός*. The significance of the Platonic Number is not dependent on the completeness of its solution.

D. B. M.

ON THE STUDY OF GREEK LYRIC METRE

THE study of Greek metre has hitherto been grievously and unreasonably neglected in this country and, for want of a better advocate, I wish to say a few words in its defence: practically, to show that a great deal of metrical knowledge might be taught with advantage even in schools, a large part of the subject being both easy and simple and likely to help the learner to a better appreciation of ancient poetry; and theoretically, to call attention to some principles which seem to me to render the study less nebulous, baseless and generally unsatisfactory than it has appeared to be in the lucubrations of some of its exponents. I take the practical question first, namely, what parts of metrical science are easily taught and worth knowing—worth knowing,

that is, for people who are neither technical musicians nor scholars by profession, but for whom classical literature is part of an ordinary liberal education.

It is, I believe, the practice in schools to ignore altogether the metre of the choric parts in Greek tragedy. Only in a few schools, and there only in the highest form, is the subject touched at all. No one can deny that there are passages and even large tracts of choric verse which are metrically very difficult, and where the difficulties are complicated by textual and grammatical questions—the whole being quite beyond the capacities of schoolboys. But is that a good reason for neglecting the metre of all? There are also large tracts and whole odes which without being hard to