# WHY DID PLATO NOT SUFFER OF COLOR BLINDNESS? AN INTERPRETATION OF THE PASSAGE ON COLOR BLENDING IN TIMAEUS

*A. VL. LEVIDES*
(Πίν. 1-2)

In 1858, Gladstone, following an examination of "Homer's perception and use of color", came to the conclusion that the Greeks of the Homeric age and after suffered from some kind of colour-blindness[1]. For some years this idea influenced classisists, archaeologists and art historians who got involved in the issue and although some answers were provided to this extreme point of view, in general, suspicion and misinterpretation of ancient Greek writers has characterized the outstanding majority of researchers involved in the study of color perception of the ancients ever since[2].

I believe that the reason for such a misinterpretation lies in our attempt to approach ancient Greek texts armed with our present conceptual tools although the contemporary historical discipline along with anthropology have indicated the methodological impasse of such an approach[3].

From the 17th century and after, the scientific discoveries in the field of physics and mainly Newton's analysis of white light into the widely known colors of the spectrum combined to the needs of the new industrial era triggered radical change in our perception of color. The economy of space does not allow the slightest comment

1. GLADSTONE 1858, 457-499. I quote certain abstracts of Gladstone's arguments leading him to the conclusion referred above because they are characteristic of the researcher's inability to go beyond the narrow borders of his cultural milieu to such an extent that some of his observations surprise us of his strong prejudice, besides their inconsistency: "We must then seek for the basis of Homer's system with respect to color in something outside our own... many of the great elements and sources of color for us presented themselves differently to him. The olive hue of the skin kept down the play of white and red. The hair tended much more uniformly, than with us to darkness. The sense of color was less exercised by the culture of flowers. The rainbow would much more rarely meet the view. The art of painting was wholly, and that of dyeing was almost, unknown etc." (ibid. 487-488). Gladstone published his opinion in an article in 19th Century 2, 1877, 366-388 called "The Color Sense". Magnus published similar views in [1877].

2. IRWIN 1974, 3-30, provides a comprehensive presentation of the research on the sense of color and the relevant terminology of ancient Greeks from Gœthe and Gladstone up to 1974. We should add here two very significant contributions by Greek authors not mentioned by Irwin. They both tried, early enough to provide scientifically based answers to Gladstone's and Magnus's theories. These are: BENAKIS 1900; IDEM, 1914; MAGINA 1909; IDEM, 1992. From the post 1974 rich bibliography on color let us mention: BRUNO 1977, where *Timaeus'* abstract on color is studied, p. 89-95, KEULS 1978, FOWLER 1984, 119-149; GAGE 1995; JAMES 1996.

3. PASTOUREAU 1990, 21-40.

on such a major issue. What we must however keep in mind is that widely approved and shared contemporary attitudes that are considered today as self evident were non existent in ancient Greece and were definitely incomprehensible and totally incompatible to the Greeks' own color perception. I am referring to attitudes such as the one that supports the existence of three primary colors, red, yellow and blue and the secondary ones orange, green and purple which occur by the combination of the primaries or the belief that black and white are not colors. Any attempt to understand or moreover to interpret ancient sources along contemporary experience leads to impasses, misinterpretations, anachronisms and false conclusions as for example the so-called inadequacy of Plato and Aristotle as far as their understanding of color is concerned.

One of the major sources that helps us to approach the ancient world of color is the abstract from Plato's *Timaeus* where the philosopher presents his color theory in forty nine verses (67c 4-68d 7). In this text the philosopher analyses the birth of color, presents it comprehensively in a methodologically consistent way and illustrates it by a series of empirical "examples" covering a wide color scale. Plato bases his philosophical approach on beliefs deriving from the ancient Greeks' empirical observation, firstly traced in Homer and later found in the Presocratic philosophers, Democritus, Plato himself and Aristotle. The same fundamental ideas dominate the Hellenistic period, the Byzantium and even the western Middle Age. Plato's text is important to the archaeologists and to the art historians alike as it is contemporary to the great revolutionary changes taking place in ancient Greek painting in the end of the 5th century B.C. and is also contemporary to the blooming of the four color-palette that, to my belief, constitutes a common feature of the style of the great classical and Hellenistic school of painting from Polygnotus to Apellis[4].

*Timaeus* is Plato's only dialogue where, like in the Presocratic philosophers, the narration of the creation of the universe is attempted. Within this framework Plato comments on colors while examining the quality of sense perceptibility (67c-68d).

Color is a flame, a stream of light that springs from the visual object and meets an inner fire, the visual stream or, as Plato calls it, the *ὄψις* that issues from the eye. According to Plato for these two flames, these two light streams to meet, one precondition is needed, there must be day light, there must exist *ἦμερον φῶς*. In earlier extracts of Timaeus Plato says: "So whenever the stream of vision is surrounded by mid-day light it flows out like unto like (45c 4-6) [...] but when the kindred fire vanishes into night the inner fire is cut off" (45d 5-6)[5].

For a color to be perceived the particles of fire that issue from the colored object must be of different size from the particles of fire of the visual stream that issues from the eye. "Those then that are equal are imperceptible and we term them transparent"

4. For the great revolutionary change in ancient Greek painting in the end of the 5th century B.C., see GOMBRICH 1989, 116-146, and LEVIDES 1994, 188-194, 296-301. For the four color-palette see BRUNO 1977, 53-61, and LEVIDES 1994, 244-250.

5. For the translated abstracts from *Timaeus* BURY's 1929 translation has been used.

(67d 5-6). When the particles are larger they compress the visual stream, they squeeze it, when they are smaller they cut into it and divide it.

*Τὸ μὲν διακριτικὸν τῆς ὄψεως λευκὸν τὸ δὲ ἐναντίον αὐτοῦ μέλαν* (67e 5-6). White (*λευκόν*) is the light that divides the visual stream, it is the *ἥμερον φῶς ὃ κάει μὲν οὐ, φῶς δὲ τοῖς ὄμμασιν παρέχει* (58c 6-7)[6] and black (*μέλαν*) is darkness that compresses the visual stream to total elimination.

As Plato proceeds with his analysis, he refers to a blinding and dazzling light, a different species of fire, that divides the visual stream and forces its way into the eye causing tears and all kinds of color. This sensation is called by Plato dazzling, *μαρμαρυγή* and what causes it is called *λαμπρόν* and *στίλβον* (68a 7)[7].

In *De Coloribus* the following definition of *στίλβον* is given: *"Εστι δὲ τὸ στίλβον οὐκ ἄλλο τι ἢ συνέχεια φωτὸς καὶ πυκνότης* (793a 13) By applying the expression *συνέχεια φωτὸς* a stronger light is implied and by using the term *πυκνότης* the high density of light. *Στίλβον* then is a light that is stronger and brighter than the diffused light, the white light. It is the light reflected by a smooth surface receiving bright sunlight or light issuing from an artificial source. *Λευκόν* and *λαμπρόν* or *στίλβον* constitute quantitative and qualitative distinctions of the same entity i.e. light and not of two distinctive entities.

Up to here, Plato has defined the two extreme poles of his color scale. One pole is *ἥμερον φῶς* in other words *λευκόν* and its brighter and shinier variation *λαμπρόν* or *στίλβον*. The other pole is darkness, in other words *μέλαν*. In-between these two poles appear the rest of the colors divided into two groups: the light ones, neighboring to white, and dark ones, leading to black. An intermediary value is needed in order to link the light and the dark poles. And this intermediary value derives from the combination of the two extremes. This middle term is, according to Plato, the color of blood, *ἐρυθρόν*. *'Ερυθρόν* derives from the blending of the white light stream[8] with the moisture existing in the eye. "The gleam of the fire through the moisture with which it blends produces *ἐρυθρόν*" (68b 3-5) [trans. Tailor 1962:112].

6. In 45a 6-d7, Plato deals with the notion of eye-sight and the *ἥμερον φῶς*. See also KALFAS 1995, 407-409, notes 211-214.

7. In Timaeus 58c5-d1 Plato mentions three genders of fire: *Μετὰ δὴ ταῦτα δεῖ νοεῖν ὅτι πυρός τε γένη πολλὰ γέγονεν, οἷον φλὸξ τό τε ἀπὸ τῆς φλογὸς ἀπιόν, ὃ κάει μὲν οὐ, φῶς δὲ τοῖς ὄμμασιν παρέχει, τό τε φλογὸς ἀποσβεσθείσης ἐν τοῖς διαπύροις καταλειπόμενον αὐτοῦ*. That *ἕτερον*, therefore, *γένος πυρός* (67e 7) that meets the optical stream (*ὄψις*) with *ὀξυτέραν φοράν* and which dilates as far as to the eyes causing the sensation of dazzling, is the *λαμπρόν* and the *στίλβον*, apparently the strongest gender of fire among the three genders mentioned by Plato. It is the one that burns and causes blindness, the flame (*φλόξ*) in other words, while *λευκόν* is the second kind of fire, the one which *παρέχει φῶς τοῖς ὄμμασιν*, that is *ἥμερον φῶς*.

8. *Τὸ δὲ τούτων αὖ μεταξὺ πυρὸς γένος* (68b 1). BURY 1929, translates: "Again, when the kind of fire which is midway between these reaches to the liquid of the eyes etc." and explains (note 3, p. 174): "i.e. between the kinds of fire which produce 'blackness' and 'brightness' ". I believe the interpretation is wrong. The kind of fire which is midway between these is not the one found between brightness and blackness but is the same with the *δεύτερο γένος πυρός* mentioned in 58c6-7, that is *ἥμερον φῶς*, and this is based on the fact that Plato makes clear that it is not *στίλβον*. This quality differentiates it from the first gender of fire, that is *στίλβον* and *λαμπρόν* (67e 6). See n. 7.

Eye moisture, water, is black (*μέλαν*) for the Presocratic philosophers as well as for Democritus and Aristotle[9]. The *αὐγὴ τοῦ πυρός* (68b 3), the ray of light, seems *ἐρυθρά* passing through the black (*μέλαν*) liquid (*νοτίς*). Aristotle (Meteor.) formulates the same principle based on empirical observation. The *λαμπρή* and *λευκή* fire flame looks red (*ἐρυθρά*) through the black (*μέλανα*) smoke (Meteor. 374a 7-9).

The *λαμπρός* and *λευκός* sun, looks red (*φοινικοῦς*) through smoke and fog (Meteor. 374a 9-10).

*Λαμπρὸν ἐν τῷ μέλανι ἢ διὰ τοῦ μέλανος χρῶμα ποιεῖν φοινικοῦν* (Meteor. 374b 10-11). This intermediary value, *ἐρυθρόν*, is blended by Plato with the bright end of the scale, in other words with *λευκόν* and *λαμπρόν* in order to produce *ξανθόν*.

*Λαμπρόν τε ἐρυθρῷ λευκῷ τε μειγνύμενον ξανθὸν γέγονεν* (68b 5). *Ξανθόν* is obviously some kind of yellow. According to Aristotle it is the yellow in the rainbow (Meteor. 375a 6). But it is also the color of the sun (*De color.* 791a 4). It is mainly, however, the bright and shiny color of gold. Democritus calls it *χρυσοειδές* and names it *κάλλιστον χρῶμα.* (Theophr. *De sens.* 76)[10].

Up to here, Plato has defined the four basic colors of his color system. The two extremes (*ἀρχές*)[11], that is white and black (*λευκόν* and *μέλαν*), an intermediary value, red (*ἐρυθρόν*), and some kind of an extra middle term *ξανθόν*. He has provided the theoretical interpretation of their creation describing them as grades on a scale of light values. Plato has formulated his four- color system in analogy to the four elements constituting the body of the universe: *πῦρ, γῆ, ὕδωρ* and *ἀήρ* to which he refers in a previous part of the same dialogue (31b-32c). In this case too the initial elements are two; fire and earth. In order to bring them into unison, however, an intermediary bond is needed. Mathematical order, moreover, requires two middle terms, since the body of the universe is solid of shape, and not plane and thus, the initial bi-polar pattern with the third intermediate factor develops into a four-element pattern by adding water and air. *Ξανθόν* is respectively added in an arbitrary way to the three-element pattern of color consisting of *λευκόν*, *ἐρυθρόν* and *μέλαν* and the four primaries, as we would call them today, are thus formed. Plato, thus, fits to his own theoretical approach the relationship between four basic elements and four basic colours, accepted by certain Presocratic philosophers[12].

9. For the Presocratic philosophers: Anaxagoras, DIEHLS, *Fragmente* 98, Empedocles: Theophr. *De sensibus* 59. For Aristotle: *Meteor.* 374a 2.

10. In 59a8-b4 of *Timaeus* Plato also says that *ξανθόν* is the color of gold: *Τούτων δὴ πάντων ὅσα χυτὰ προσείπομεν ὕδατα, τὸ μὲν ἐκ λεπτοτάτων καὶ ὁμαλωτάτων πυκνότατον γιγνόμενον, μονοειδὲς γένος, στίλβοντι καὶ ξανθῷ χρώματι κοινωθέν, τιμαλφέστατον κτῆμα χρυσὸς ἠθημένος διὰ πέτρας ἐπάγει.*

11. See Theophrastus *De sens.* 59, 9-14: *Ἐμπεδοκλῆς δὲ καὶ περὶ τῶν χρωμάτων καὶ ὅτι τὸ μὲν λευκὸν τοῦ πυρός, τὸ δὲ μέλαν τοῦ ὕδατος. Οἱ δὲ ἄλλοι τοσοῦτον μόνον, ὅτι τὸ λευκὸν καὶ τὸ μέλαν ἀρχαί, τὰ δ' ἄλλα μειγνυμένων γίνεται τούτων.*

12. For the relationship of elements to colors in the Presocratic philosophers see Stobaeus *Eclog.* I, 16. According to the Pythagoreans and Empedocles *λευκόν, μέλαν, ἐρυθρόν* and *χλωρόν* are recognized as genders of colors. *Τὰς δὲ διαφορὰς τῶν χρωμάτων παρὰ τὰς μίξεις τῶν στοιχείων.* Empedocles characterizes the four

Plato uses thirty five verses (67c 4 - 68b 5) for the theoretical foundation of the procedures that produce the four basic colors of his system. In fact he integrates in his own theoretical interpretation the belief shared by ancient writers, poets and philosophers that colors are born by the interaction of light and darkness, that is white (*λευκόν*) and black (*μέλαν*). In the two following verses (68b 6-8) Plato warns that what he has already mentioned in verses 67c 4 - 68b 5 constitute a non-measurable and non-applicable theoretical interpretation. In the next seven verses (68b 8-15) Plato presents eight different color blending recipes based on the mixture of his four primary colors. The briefness of his statements and the lack of theoretical support give the impression that Plato is dealing with recipes of an empirical nature.

I personally believe that in these eight verses, Plato sites empirical recipes practiced by painters of his time in their workshops. Indeed, by replacing the four basic Platonic colors, that is *λευκόν, μέλαν, ἐρυθρόν* and *ξανθόν* which share the double nature of being colors and light values at the same time, with the basic colors of the ancient four-color palette, that is white, black, red ochre and yellow ochre (Fig. 1), one finds out that Plato's recipes are totally applicable. The samples which I have produced along this line of thinking constitute a color scale familiar to those who deal with ancient painting, the Fayum portraits or Byzantine painting.

Let us now look into the recipes:

*First recipe: Ἐρυθρὸν δὲ δὴ μέλανι λευκῷ τε κραθὲν ἁλουργόν* (68b 8 - c1). When red color is blended with black and white, *ἁλουργόν* is produced (Fig. 3A, B). The etymology of *ἁλουργόν* implies murex purple[13].

It is known that during the various stages of the production of purple dye manufactured from murex a variety of colors occurs ranging from red (*φοινικοῦν*) to purple (*ἁλουργόν*)[14].

In (*De sens.* 77) Theophrastus attributes Democritus a recipe identical to Plato's for the preparation of *ἁλουργόν* (which corresponds to Democritus's *πορφυροῦν*): *Τὸ δὲ πορφυροῦν ἐκ λευκοῦ καὶ μέλανος καὶ ἐρυθροῦ, πλείστην μὲν μοίραν ἔχοντος τοῦ ἐρυθροῦ, μακρὰν δὲ τοῦ μέλανος, μέσην δὲ τοῦ λευκοῦ...* Democritus provides the following explanation concerning the existence of white color in the mixture *Ὅτι μὲν οὖν τὸ μέλαν καὶ τὸ ἐρυθρὸν αὐτῷ ἐνυπάρχει φανερὸν εἶναι τῇ ὄψει, διότι δὲ τὸ λευκόν, τὸ λαμπρὸν καὶ διαυγὲς σημαίνειν.* White, in the sense of light, exists in the recipe in order to render the sheen, the radiance (*διαυγές*) highly admired by

colors as *στοιχείοις ἰσάριθμα*. In *De sensibus* Theophrastus says: *Ἐμπεδοκλῆς δὲ καὶ περὶ τῶν χρωμάτων καὶ ὅτι τὸ μὲν λευκὸν τοῦ πυρός, τὸ δὲ μέλαν τοῦ ὕδατος* (59, 9-11). From 73 onwards Theophrastus refers to Democritus's theory on color. Democritus also considers *ἁπλά* the well known four colors: *λευκόν, μέλαν, ἐρυθρὸν* and *χλωρόν*. It is interesting to note that, according to Theophrastus's criticism of Democritus's views (82, 1-11) although *λευκόν* is the opposite of *μέλαν* and *ἐρυθρόν* is their complementary color, the fourth one, *χλωρόν*, in Democritus, as applies to Plato, is added in a somewhat arbitrary way without theoretical support.

13. Etymol.: *ἁλουργόν = ἅλς, ἁλός+ἔργον*, purple derived from the sea. See Souidas: *ἁλουργά = θαλασσοπόρφυρα*.

14. On murex purple see MOATSOS 1932, 97 ff, and LEVIDES 1994, 221-224.

ancient Greeks in purple dyed tissues[15]. Indeed, in the color sample, the addition of a small quantity of white gives the dark and muddy mixture of red and black the beautiful purple hue.

According to Plato's *second recipe ὄρφινον* is produced by the same blending as above only applying a greater proportion of black and following some burning (68c 1-2). I believe that the reference to burning methods constitutes strong evidence that Plato is referring to painter workshops' recipes. *Ὄρφινον* is a darker version of *ἀλουργόν*[16] (Fig. 3C). In order to produce it a larger proportion of black must be applied in the blending but mainly a burnt earth red must be used, apparently red ochre. The burning of earth colors like ochre and red ochre as well as *ψιμύθιον* (white lead) for the production of various hues of red was well known in antiquity. Pliny dates the invention of such a method at the beginning of the 4th century B.C. This may be true for the burning of *ψιμύθιον* from which red minium derives but as far as earth colors were concerned, the method must have been invented much earlier[17].

The preparation of purple by blending red, black and white is opposite to the post-Newtonian color perception according to which purple is a mixed color deriving from the blending of two primaries, that is blue and red. Ancient Greeks did certainly not ignore this reality and this is illustrated by the fact that when they wanted to produce a cheaper substitute of murex purple they used to apply a combination of woad, a blue dye and madder, a red dye[18].

The reason why such a solution was not undertaken in Greek painting is related on the one hand to the ancient Greeks' firm belief that colors are born by the combination of white (light) and black (darkness) and, on the other, to the new illusionistic painting technique, the *σκιαγραφία*, which combines color theory and color practice. As Pliny says (*nat.* 35-29), in late 5th and early 4th century B.C. painting matured and became an autonomous form of art, discovering light, shade and contrast. During this maturing process painting tended to seek the best result by applying minimal means. Painters rejected the application of luxurious means like gold, were not thrilled by the multiplicity of color and the richness of materials found in nature and attempted to describe these by using a restricted color scale. An abstract

15. On the lustre of purple tissues and the relevant references in ancient Greek texts see Gage [1978: 109]. The lustre of dark surfaces, that feeling of inner shine, is particularly admired by the ancient Greeks. See also *Timaeus* 60a 5-8 where Plato speaks of the *λαμπρόν* and the *στίλβον* existing in the greasy and oily substances such as pitch and oil: *Τὸ δὲ λεῖον καὶ διακριτικὸν ὄψεως διὰ ταῦτα τε εἰδεῖν λαμπρὸν καὶ στίλβον λιπαρόν τε φανταζόμενον ἐλαιηρὸν εἶδος πίττα καὶ κίκι καὶ ἔλαιον αὐτὸ ὅσα τ' ἄλλα τῆς αὐτῆς δυνάμεως.*

16. In *De coloribus*, attributed to Aristotle (792a 24-27) the darkened *ἁλουργόν* is characterized as *ὄρφινον: Πρὸς γὰρ τὸν ταύτης κλισμὸν ἀσθενεῖς αἱ τοῦ ἡλίου αὐγαὶ προσβάλλουσαι ποιοῦσι φαίνεσθαι τὸ χρῶμα ἁλουργὲς ὃ καὶ ἐπί τῶν πτερωμάτων θεωρεῖται γιγνόμενον. Ἐντεινόμεναι γὰρ πως πρὸς τὸ φῶς ἁλουργὲς ἔχει τὸ χρῶμα. Ἐλάττωνος δὲ τοῦ φωτὸς προσβάλλοντος ζοφερόν, ὃ καλοῦσιν ὄρφινον.*

17. On burned ochre see Theophrastus *On stones* 53 and Pliny 35,35 and LEVIDES 1994, 207. On *usta* (*minium*, red lead) see Pliny 35,38 and LEVIDES 1994, 214. The same "recipe" is also found in KONTOGLOU 1960, I, 13: "Burnt umber is a dark red color, that blended with a small quantity of white lead gives a very nice purple".

18. On the imitation of murex purple by *ἴσατι* (woad) and *ἐρυθρόδανο* (madder) see LEVIDES 1994, 223. On *ἐρυθρόδανο* (madder), LEVIDES 1994, 225-227. On *ἴσατι* (woad, in latin: *vitrum*) see LEVIDES 1994, 238-239].

at the end of the second book of Alberti's "Treatise on painting" is characteristic of this attitude. It was written in the beginning of the Italian Renaissance, an era that can be compared to the one we are studying as far as the invention of new forms in painting is concerned. Alberti says, thus, that there is more admiration and praise for the painter who imitates the rays of gold with colors than for the one who applies real and expensive gold in order to achieve the same effect since real gold shines where it ought to be dark and is dark where it ought to be light. This observation leads us straight to the practice of painting. In the painting of *σκιαγραφία*[19] that was heading towards maturity in the end of the 5th century, gold as well as other bright and valuable colors, such as murex purple, lost their aesthetic value shared in earlier times. What was more important in the new painting attitude was the description of space and volume by the alternative application of light and dark tones as well as of subtle warm and cold hues. Bright colors flatten the three-dimensional effect achieved by chiaroscuro and match with a two-dimensional form of painting like the one practiced in the archaic period. The austere four-color palette was suitable for the achievement of chiaroscuro required by the new style.

But let us close these brackets and go back to the text.

The *third recipe* refers to the production of *πυρρόν*: *Πυρρὸν δὲ ξανθοῦ τε καὶ φαιοῦ κράσει γίγνεται* (68c 3). *Πυρρόν* then is the blending of *ξανθόν* with *φαιόν* which, as we will see in the next recipe, is a mixture of white and black. When *ξανθόν* and *φαιόν* are blended the brilliant and shining quality of *ξανθόν*, its reflected brightness in other words, seems to be cancelled. What is left is a rather warm yellow, a humble yellow, as Kontoglou would call it. Bruno, with persuasive arguments, comes to the conclusion that by *πυρρόν*, ochre is implied[20]

In his *fourth recipe*, Plato describes *φαιόν* as the outcome of the blending of white (*λευκόν*) and black (*μέλαν*). Like *ἐρυθρόν*, *φαιόν* is also an intermediary value in between the two poles. *Φαιότης (ἐστί) τὸ μέσον λευκοῦ καὶ μέλανος ἐν χρώματι*, says the author of *De coloribus* (828b 23)[21].

19. On *σκιαγραφία* see POLLITT 1974, 217-224.

20. See BRUNO 1977, 81-95, chapter 10, Color blending in Plato's *Timaeus*, 81-95. In *De Coloribus* (796a 1-4) the change of color of dark fruit is related to its ripening. Thus *...ἐκ τοῦ ποώδους μεταβάλλοντες μικρὸν ἐπιφοινικίζουσι καὶ γίνονται πυρροί. Ποῶδες* is the green color of the unripe fruit (*De color.* 796b 6) that is a green that contains yellow and a small quantity of white. When it turns slightly red (*ἐπιφοινικίζει*) it becomes *πυρρόν*. When a slight quantity of red is added to a yellowish green a yellow ochre is obtained. Contemporary color theory informs us (ITTEN, The Elements of Color, 1970, 20) that neutral gray may result from the blending of two complementary colors and white, for example red and green. We also know that any pair of complementary colors contain all three primaries, e.g. red-green = red-blue+yellow. Yellow ochre may also result from the blending of the three primaries with white by increasing the proportion of yellow (*ξανθόν*). In other words we come back to the fact that *ξανθόν+φαιόν* = *πυρρόν* = yellow ochre. We must note that ancient Greek color terminology does not comply with the contemporary perception of hue. It always implies a number of factors and is therefore imprecise according to our perception. The term *πυρρόν*, for example, may cover a scale of hues ranging from yellow ochre to brown going through certain hues of red ochre.

21. See Souidas: *Φαιόν: ὅτι τῶν χρωμάτων τὰ μὲν ἁπλὰ ἐστὶ τὰ ἐναντία ὅς τὸ λευκὸν καὶ τὸ μέλαν, τὰ δὲ σύνθετα, οἷον τὰ μεταξὺ τούτων. Καὶ γὰρ ταῦτα τῇ ποίᾳ μίξει πρὸς ἄλληλα τῶν ἐναντίων ἀποτελοῦνται. Καὶ*

The *fifth recipe* refers to *ὠχρόν* which derives from the blending of *ξανθόν* with *λευκόν* (white). *Τὸ δὲ ὠχρὸν [γίγνεται] λευκοῦ ξανθῷ μειγνυμένου* (68c 4). Since *ξανθόν* is the outcome of the blending of *ἐρυθρόν* with *λευκόν* and *λαμπρόν*, it is implied that *ὠχρόν*, that derives from the adding of more *λευκόν* to *ξανθόν*, is a light yellow with a diminished proportion of red in it[22]. Indeed, the modern Greek meaning of *ὠχρόν*, pale in other words, does not seem to differ from the ancient one. We are concerned with a yellow that, as we would say today, lies on the border of green.

In four color-palette painting, *λαμπρόν, ξανθόν, πυρρόν* and finally *ὠχρόν* are rendered by means of plain ochre or with the addition of a smaller or greater quantity of white[23] (Fig. 2). The difference between them consists of difference in brightness, texture and "temperature" of color as well as recognition of color within the particular iconographic context. All the above have very little relation to the concept of hue as this has developed in our contemporary perception. For example *ὠχρόν* is colder, not brighter than *ξανθόν*. In the ancient four-color palette, by using the term "colder" referring to a scale where blue and green of the spectrum the by- definition cold colors replace the comas with dushes are missing, a warm color is implied which is colder in relation to some other warm color. As contemporary Greek painter Tsarouchis sites: "color means finding the cold colors that interpret warm ones and those warm ones interpreting cold ones" or, as Anaxagoras says: *τὴν χρόαν τὴν κρατοῦσαν μᾶλλον εἰς τὴν ἑταῖραν ἐμφαίνεσθαι* (Theophr. *De sens.* 27) In other words, the dominant color can be better seen in contrast to its opposite[24].

The *sixth recipe* refers to blue (*κυανοῦν*). *Λαμπρῷ δὲ λευκὸν συνελθὸν καὶ εἰς μέλαν κατακορὲς ἐμπεσὸν κυανοῦν χρῶμα ἀποτελεῖται* (68c 5-6) (Fig. 4A). *Κυανοῦν* seems to have a nearly identical meaning to that of *μέλαν* (black) in ancient poetic texts. They are both mainly used in order to identify the dark side of the color scale and are less used as definitions of color or hue in today's context. However, *κυανοῦν* is diversified as a brighter version of black as well as a hue since it signifies the sky at night, the sea or deep-colored lustrous surfaces such as the dolphin's skin or the kingfisher's and the swallow's wings[25]. The expression *νῦξ κυαναυγὴς* (*Orf.*

*ἔστιν αὐτῶν τὰ μὲν ἐγγυτέρω τοῦ λευκοῦ, ὡς τὸ ξανθόν, τὰ δὲ ἐγγυτέρω τοῦ μέλανος, ὡς τὸ κυανοῦν, τὰ δὲ λοιπὰ μεταξὺ τούτων, οἷον τὸ φαιόν, τὸ ἐρυθρόν.*

22. The verb *ὠχραίνω* in the passive voice has the opposite meaning to the verb *ἐρυθραίνομαι* [Liddel and Scott].

23. In the ancient Greek texts *ὠχρόν, ξανθόν* and *χλωρόν* are terms that seem to cover various hues of yellow or, in a general way, the color yellow. In fact, the natural pigment yellow ochre (the term ochre is ancient Greek, see e.g. Aristotle *Meteor.* 378a 24, Theophr. *On stones* 40, Diosc. V, 108) is found in nature in various hues grading from very light (nearly *ὠχρό*) yellow to certain tones of brown. See also Pliny 33, 158-159 where he mentions that the attic and gaulic ochre (*lucidum*) is used in painting in order to render the highlights and a dark variety of ochre from the island of Scyros (*sciricum*) is used for shading. See also LEVIDES 1994, 208-209.

24. See also Pliny 35, 29: *Tandem se ars ipsa distinxit et invenit lumen atque umbras, differentia colorum alterna vice sese excitante. Postea deinde adiectus est splendor, alius hic quam lumen. Quod inter hec et umbras esset, appelarunt tonon, commissuras vero colorum et transitus harmogen.*

25. On the relationship between blue and black and the gradual differentiation of the terms see BENAKIS 1914, IRWIN 1974, 79-108.

*hymn.* 3.3) that gives the picture of the sky dome at night as if it were illuminated by an inner lustre coming out of the heart of darkness is even closer to the Platonic perception of that particular blending. This absolute darkness is the *κατακορὲς μέλαν* which is illuminated by *λαμπρόν* in order to give *κυανοῦν*. And we see here that the production of *κυανοῦν* by the blending of black and white which in fact applies to the practice of ancient four-color palette seems to derive mimetically from the observation of a natural phenomenon, that is the interplay of light and dark, like in the case of *ἐρυθρὸν* and *ἀλουργόν*.

The *seventh recipe* produces *γλαυκόν* that is, the bright version of *κυανοῦν*. *Κυανοῦ δὲ λευκῷ κερανυμένου γλαυκὸν [γίγνεται]* (68c 6-7) (Fig. 4B). *Γλαυκὸν* is the colour of the clear sky, the calm sea and the bright blue eyes. *Γλαυκὸν* is what is called *γαλανὸ* in modern Greek and this term also includes the meaning of brightness exactly like the ancient one[26].

The *eighth and last recipe* refers to the production of *πράσιον*, green in other words. *Πυρροῦ δὲ μέλανι [κερανυμένου] πράσιον [γίγνεται]* (68c 7). This is a blending that has caused a lot of trouble to modern researchers[27]. If we consider *πυρρόν* as ochre, its blending with black does in fact produce a green which is indeed different from the green of the spectrum but is still some sort of green often used in ancient and Byzantine painting[28] (Fig. 5A, B). It is the green color of the ancient four color-palette and we must take into consideration here that ancient painting and

26. For an extended discussion of the term *γλαυκός* see BENAKIS 1914, 58-76.

27. Attempts to interpret the abstract of Timaeus have caused general embarassment and have led to the formulation of various comments by the scholars. We refer to some of them: PLATNAUER 1921, refers to the abstract from *Timaeus* without attempting an interpretation and he comes to the general conclusion that: "Either the Greeks were definitely color blind... or they felt little interest in the qualitative differences of decomposed and partially absorbed light". TAILOR 1928, strongly declares: "This particular section of the dialogue is perhaps the one above all others we must never expect to understand fully". SCHUHL 1952, believes that Plato had a knowledge of the art of painting but the blending recipes he proposes in *Timaeus* were selected "de façon quelque peu fantaisiste". BRUNO 1977, studies Plato's recipes with a penetrating eye, recognizes the relationship of yellow ochre to *πυρρόν* and solves the problem of *πράσιον* (leek green) by interpreting it as a blending of yellow ochre and black (*μέλαν*). He stops, however, at that point and does not proceed to a research of the double folded character of the ancient Greek terms (light value-hue) as well as of Plato's theory. KEULS 1978, comments on the abstract at stake: "Even allowing for the instability of Greek color terminology and our imperfect understanding of that vocabulary it is not possible to make any sense out of Plato's scheme of mixtures nor is it clear whether it is based on observation of the additive or of the subtractive color scheme", providing thus a monumental example of an anachronistic approach to the text. JAMES 1996, finally, accuses Bruno of reading Plato's abstract with an emphasis on the painterly, practical nature of the passage while she personally touches upon the other extreme by declaring that "Plato's statements can be perceived as both comprehensible and sensible [...] only when the equivalence of color and hue is ignored in favor of one of color and brightness". Her analysis of the Platonic perception of colors as light values and the classification of colors to a light scale, according to the Platonic blending recipes, is extremely interesting. However she is wrong, I believe, in replacing *ξανθόν* with *λαμπρόν* in Plato's fundamental four color pattern. *Λαμπρόν* is no more than a climax of white and this is the very fact that stops her from seeing the parallel correspondence of the scale of light values to the color scale.

28. See Kontoglou 1960, I, 14: "Εὰν θέλῃς νὰ κάμῃς πράσινον ταπεινὸν καὶ κατανυκτικὸν βάλε μαῦρον, ὤχραν χρυσὴν καὶ ὀλίγον ἄσπρον". Kontoglou, besides his knowledge of Byzantine painting, had also studied ancient Greek painting (his copies of frescoes from late antiquity tombs, found in Sparta, can be seen in the quarters of the Archaeological Society in Athens) as well as the Fayum portraits.

*μεγαλογραφία* in particular was not generally interested in depicting landscapes. Green field and leafy forest images haunting European researchers' imagination constitute an exception for the Greek landscape and Greek light. Consecutively Greek painting made little use of the bright greens of the spectrum, and this was also the case for western painting up to Impressionism.

We enter now the last part of the abstract. Plato says: "As to the rest, it is fairly clear from these examples what are the mixtures with which we ought to identify them if we would preserve probability (*τὸν εἰκότα μύθο*) in our account. But should any inquirer make an experimental test of these facts he would evince his ignorance of the difference between man's nature and God's –how that, whereas God is sufficiently wise and powerful to blend the many into one and to dissolve again the one into many, there exists not now, nor ever will exist hereafter, a child of man sufficient for either of these tasks" (68d 1-8). This abstract is usually considered by researchers as Plato's evasion and as a disguised confession of ignorance as far as colors are concerned. I do not believe this is true.

Plato here clearly declares that the color combinations he has just mentioned constitute examples aiming at making us understand in an empirical way the mechanism of color blending in nature. They constitute some kind of patterns or, in order to avoid the anachronism, they are *μιμήματα* of the blending of the light streams of the fire particles varying in size which, in their combination, produce various colors. The "mimetic" procedure is in fact even more persuasive in the ancient language since Greek color terms almost always imply the notion of light. For example the constituting parts of *ἁλουργόν* i.e. *ἐρυθρόν, λευκόν* and *μέλαν* can be understood either as light values or as colors, or hues, in the contemporary use of the term, or in both meanings at the same time which, I believe, is how ancient Greeks percieved them. Plato considers the painters' blending recipes as imitations of natural procedures. Aristotle's belief that *μιμεῖται γὰρ ἡ τέχνη τὴν φύσιν* (*Meteor.* 381b 8) is widely rooted in Greek thought[29]. For Plato, the painters' attempt to imitate the colors of nature is a reduction of the activity of the creator to an inferior level[30]. Plato's remark in *Phaedo* (110b-c) is typical in this sense. He says that colors used by painters are but samples of colors of nature. Plato, therefore, does not question the correctness of the blending recipes he borrows from the painters' workshops neither do we, I believe, have the right to question Plato's or even Democritus's know how in the particular field. Democritus's recipes mentioned by Theophrastus are nearly identical to Plato's and refer to the same color scale. A careful reading of *De coloribus* would indicate that they all

29. See also Teophrastus, *On Stones* 60: *Μιμεῖται τὴν φύσιν ἡ τέχνη...* For a bibliography on relevant references in other ancient Greek texts see HALLEUX 1981, 76, n. 1.

30. Plato's statement in Timaeus 80b proposing that the harmony of sounds is the imitation (*μίμησις*) of divine harmony manifested in mortal motions is characteristic of that mode of thought. *"Οθεν ἡδονὴν μὲν τοῖς ἄφροσιν, εὐφροσύνην δὲ τοῖς ἔμφροσιν διὰ τὴν τῆς θείας ἁρμονίας μίμησιν ἐν θνηταῖς γενομένην φοραῖς παρέσχον.*

share the same attitude towards color[31]. When, therefore, Plato speaks of the finite quality of human nature he refers to the impotency of the human mind in penetrating the multiplicity of natural procedures which God the creator only masters and not to his own inefficiency in mastering the practice and theory of the painter's profession.

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31. According to later ancient biographers of Plato, he had practiced painting or, according to others, he had studied painting before dedicating himself to philosophy and, in any case, he had acquainted with painters. This piece of information is obviously not verifiable. SCHUHL 1952, partly accepts it (see p. 88 where he also provides a relevant bibliography on ancient sources). KEULS 1978, based on what she considers to be Plato's ignorance of color blending recipes rejects the information as groundless (see p. 69). Plato's contemporary, Xenophon, gives us the information that Socrates used to discuss with Parrasios. (Xen. *Mem.* II3.10.3). Before him, both Democritus and Anaxagoras, based on the painter Agatharchus's dissertation on *σκηνογραφία* (perspective), studied the issue. (Vitruvius 7 pref. 10). Among Democritus's writings the texts *Περὶ χροῶν* and *Περὶ ζωγραφίης* (Diog. Laertius 9,46-49) can be noted. The painters themselves compose dissertations on their art. Euphranor on symmetria and color (Plin. *nat.* 35, 129), Pamphillos *Περὶ γραφικῆς καὶ ζωγράφων ἐνδόξων* (Souidas), Apellis on symmetria and proportion (*mensuris*) (Plin. *nat.* 35, 79, 80, 107 and POLLITT 1974, 23). The sculptor Xenocrates writes a history of art with an emphasis on issues of technique and style, Aristotle discusses with Protogenes (Plin. *nat.* 35, 106). It is an era where the artistic personality is established, painters, sculptors and philosophers alike realize that revolutionary changes are taking place in the realm of the visual arts and they try to find the theoretical foundation of these changes. In such periods the borders between disciplines collapse and the reciprocity of theory and practice signifies the major changes and conquests in the history of art.

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## ΠΛΑΤΩΝ, ΤΙΜΑΙΟΣ, 67c4-68d7

*Τέταρτον δὴ λοιπὸν ἔτι γένος ἡμῖν αἰσθητικόν, ὃ διε-*
*λέσθαι δεῖ συχνὰ ἐν ἑαυτῷ ποικίλματα κεκτημένον, ἃ σύμ-*
*παντα μὲν χρόας ἐκαλέσαμεν, φλόγα τῶν σωμάτων ἑκάστων*
*ἀπορρέουσαν, ὄψει σύμμετρα μόρια ἔχουσαν πρὸς αἴσθησιν·*
*ὄψεως δ' ἐν τοῖς πρόσθεν αὐτὸ περὶ τῶν αἰτίων τῆς γενέ-*
d *σεως ἐρρήθη. τῇδ' οὖν τῶν χρωμάτων πέρι μάλιστα εἰκὸς*
*πρέποι τ' ἂν ἐπιεικεῖ λόγῳ διεξελθεῖν· τὰ φερόμενα ἀπὸ τῶν*
*ἄλλων μόρια ἐμπίπτοντά τε εἰς τὴν ὄψιν τὰ μὲν ἐλάττω,*
*τὰ δὲ μείζω, τὰ δ' ἴσα τοῖς αὐτῆς τῆς ὄψεως μέρεσιν εἶναι·*
*τὰ μὲν οὖν ἴσα ἀναίσθητα, ἃ δὴ καὶ διαφανῆ λέγομεν, τὰ*
*δὲ μείζω καὶ ἐλάττω, τὰ μὲν συγκρίνοντα, τὰ δὲ διακρίνοντα*
*αὐτήν, τοῖς περὶ τὴν σάρκα θερμοῖς καὶ ψυχροῖς καὶ τοῖς*
e *περὶ τὴν γλῶτταν στρυφνοῖς, καὶ ὅσα θερμαντικὰ ὄντα δριμέα*
*ἐκαλέσαμεν, ἀδελφὰ εἶναι, τά τε λευκὰ καὶ τὰ μέλανα, ἐκεί-*
*νων παθήματα γεγονότα ἐν ἄλλῳ γένει τὰ αὐτά, φαντα-*
*ζόμενα δὲ ἄλλα διὰ ταύτας τὰς αἰτίας. οὕτως οὖν αὐτὰ*
*προσρητέον· τὸ μὲν διακριτικὸν τῆς ὄψεως λευκόν, τὸ δ'*
*ἐναντίον αὐτοῦ μέλαν, τὴν δὲ ὀξυτέραν φορὰν καὶ γένους*
*πυρὸς ἑτέρου προσπίπτουσαν καὶ διακρίνουσαν τὴν ὄψιν*
*μέχρι τῶν ὀμμάτων, αὐτάς τε τῶν ὀφθαλμῶν τὰς διεξόδους*
68a *βίᾳ διωθοῦσαν καὶ τήκουσαν, πῦρ μὲν ἁθρόον καὶ ὕδωρ,*
*ὃ δάκρυον καλοῦμεν, ἐκεῖθεν ἐκχέουσαν, αὐτὴν δὲ οὖσαν*
*πῦρ ἐξ ἐναντίας ἁπαντῶσαν, καὶ τοῦ μὲν ἐκπηδῶντος πυρὸς*
*οἷον ἀπ' ἀστραπῆς, τοῦ δ' εἰσιόντος καὶ περὶ τὸ νοτερὸν*
*κατασβεννυμένου, παντοδαπῶν ἐν τῇ κυκήσει ταύτῃ γιγνο-*
*μένων χρωμάτων, μαρμαρυγὰς μὲν τὸ πάθος προσείπομεν,*
*τὸ δὲ τοῦτο ἀπεργαζόμενον λαμπρόν τε καὶ στίλβον ἐπωνο-*
b *μάσαμεν, τὸ δὲ τούτων αὖ μεταξὺ πυρὸς γένος, πρὸς μὲν*
*τὸ τῶν ὀμμάτων ὑγρὸν ἀφικνούμενον καὶ κεραννύμενον αὐτῷ,*
*στίλβον δὲ οὔ· τῇ δὲ διὰ τῆς νοτίδος αὐγῇ τοῦ πυρὸς μει-*
*γνυμένου χρῶμα ἔναιμον παρασχομένῃ, τοὔνομα ἐρυθρὸν*
*λέγομεν. λαμπρόν τε ἐρυθρῷ λευκῷ τε μειγνύμενον ξανθὸν*

*γέγονεν· τὸ δὲ ὅσον μέτρον ὅσοις, οὐδ' εἴ τις εἰδείη, νοῦν*
*ἔχει τὸ λέγειν, ὧν μήτε τινὰ ἀνάγκην μήτε τὸν εἰκότα λόγον*
*καὶ μετρίως ἄν τις εἰπεῖν εἴη δυνατός, ἐρυθρὸν δὲ δὴ*
c *μέλανι λευκῷ τε κραθὲν ἀλουργόν· ὄρφνινον δέ, ὅταν τού-*
*τοις μεμειγμένοις καυθεῖσίν τε μᾶλλον συγκραθῇ μέλαν.*
*πυρρὸν δὲ ξανθοῦ τε καὶ φαιοῦ κράσει γίγνεται, φαιὸν δὲ*
*λευκοῦ τε καὶ μέλανος, τὸ δὲ ὠχρὸν λευκοῦ ξανθῷ μειγνυ-*
*μένου. λαμπρῷ δὲ λευκὸν συνελθὸν καὶ εἰς μέλαν κατα-*
*κορὲς ἐμπεσὸν κυανοῦν χρῶμα ἀποτελεῖται, κυανοῦ δὲ λευκῷ*
*κεραννυμένου γλαυκόν, πυρροῦ δὲ μέλανι πράσιον. τὰ δὲ*
d *ἄλλα ἀπὸ τούτων σχεδὸν δῆλα αἷς ἂν ἀφομοιούμενα μεί-*
*ξεσιν διασῴζοι τὸν εἰκότα μῦθον. εἰ δέ τις τούτων ἔργῳ*
*σκοπούμενος βάσανον λαμβάνοι, τὸ τῆς ἀνθρωπίνης καὶ*
*θείας φύσεως ἠγνοηκὼς ἂν εἴη διάφορον, ὅτι θεὸς μὲν τὰ πολλὰ*
*εἰς ἓν συγκεραννύναι καὶ πάλιν ἐξ ἑνὸς εἰς πολλὰ διαλύειν*
*ἱκανῶς ἐπιστάμενος ἅμα καὶ δυνατός, ἀνθρώπων δὲ οὐδεὶς*
*οὐδέτερα τούτων ἱκανὸς οὔτε ἔστι νῦν οὔτε εἰς αὖθίς ποτε ἔσται.*