

Tyrian Purple: Its Evolution and Reinterpretation as Social Status Symbol during the Roman
Empire in the West

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ABSTRACT

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A thesis presented to the Graduate Program of Ancient Greek and Roman Studies

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The premise of this paper is to investigate the evolutionary and physiological origins of human emotional responses to color, particularly the most sought after color in antiquity, Tyrian purple; in an effort to understand why Tyrian purple gained the traction it did as the preferred symbol of the elite classes, specifically within the ancient state of the Roman Empire. The Roman Empire has the largest extant corpus of legally defined distinctions according to Meyer Reinhold's *History of Purple as a Status Symbol in Antiquity*, regarding how Tyrian purple was to be worn, displayed, who was allowed to do so, and what it visually communicated about the individual wearing it to the viewer. Investigating how colored vision influenced patterned emotional responses towards specific portions of the visible spectrum opens up new avenues to understanding why and how cultural secondary symbolic meaning was attached to specific colors in the ancient world. In addition, extrapolating how cyclical relationship between specific natural colors and patterned emotional responses inform each other, presents a possibly new explanation for why secondary symbolic meaning can be reinterpreted between differing geographical regions. A circumstance addressed by the case study of a Roman –Gallic burial, excavated in 2006 by Devière et. al.

Table of Contents

Acknowledgments.....	ii
ABSTRACT.....	iii
Table of Contents.....	iv
Chapter I. Introduction.....	1
Chapter II: Roman Expression of Tyrian Purple	5
Chapter III: The Gallic Reinterpretation of Tyrian Purple	20
Chapter IV: Conclusions.....	27
Appendix.....	31
Image Appendix.....	43
Bibliography	47

Chapter I. Introduction

Colors are an intrinsic part of every facet of the natural world. Sir Isaac Newton's analysis moved color theory from the realms of philosophy and painting to that of quantifiable science. Demonstrating that color was not an inherent property of objects, but rather an illusion produced by how the human eye interprets light and reflections.¹ The resultant portions of the visible spectrum(see Figure 1 in Image Appendix) are present in differing ratios amongst various natural habitats, providing an array of visual information necessary for survival within that habitat.

The influx of visual information from the environment is constantly repeated and reassessed within the neuropathways attached to the retina, until a patterned response is created. The patterned response to various visual input, when repurposed for use within the cultural infrastructure of complex states, creates a new layer to the visual dialogue between viewer and viewed object that has less to do with biology and more with social competition. Color, when stripped of its biological imperative, but still is attached to a physical object, becomes a social status symbol. The exact message embedded in the aesthetics of the social symbol often differ between groups of people or geographical areas, but in some cases, like with Tyrian purple dye, the message is more universal. To fully unpack the secondary meanings attached to social status symbols, like Tyrian purple, it is necessary to first understand how they became visually preeminent from a purely biological level. Only after extrapolating the mechanisms underlying human brain's emotional reactions towards certain portions of the visible spectrum, are the

¹ Finlay, Robert. "Weaving the Rainbow: Visions of Color in World History." *Journal of World History* 18, no. 4 (2007): p.384

nuanced expressions of their secondary meanings within different cultural parameters more accessible.

Despite Sir Isaac Newton's claims that color's power is illusory in nature, "reducing the world to a grey ball, revolving in space," as Goethe put it.² His mathematically defined visible spectrum is significant for understanding how colors evolve different levels of importance within cultural frameworks, because it provides a fixed, quantified definition of color perception that is universal to all human retinas. Regardless of geographical location, language categories, or ethnicity the colors that can be perceived by the human eye are the same; discounting of course genetic abnormalities like color blindness. The relative abundance of specific portions of the spectrum, in comparison with others within natural environments, however is what contributes the greatest amount of influence towards the establishment of color hierarchies.

Dyes in antiquity, like Tyrian purple occupy a subcategory within the color spectrum that inspires the chromophilia reaction. Dyes, in contrast with other naturally occurring pigments, are soluble complex organics and cannot be used on their own to impart color to paints. A binding agent is required to hold the colorant in a solution. The dye is also a colorant rather than a colored particle. Though they are natural in origin, dyes have very little direct impact on a human's, or any other organism's, ability to survive the pressures of natural selection. Often because they are a secondary product used only for aesthetic purposes.

A patterned emotional response of visual attraction is still likely to evolve, due to the low relative abundance of the dye's particular optical reflection, but the reason for doing so has less to do with the need to survive and more to do with being attracted to the color for its own sake. Unlike humans, the brains of animals like primates, birds, or other vertebrates do not attach any

² Finlay, Robert. "Weaving the Rainbow: Visions of Color in World History." p. 385

further significance to color beyond what is required to enable the greatest percentage of survival. The unique correlation human brains make between colors and emotions, such as purple for prestige, is derived from the evolution of a direct link between the visual sense and the neocortex portion of the brain in early primates. The neocortex is the portion of the brain where consciousness and understanding are located and where information from the outside world is processed; this link between color and this set of neurons contributed to the eventual human employment of symbols and language.

The relationship that the human brain has with color is unlike any other evolutionary connection it makes with the natural environment. Color even without the benefit of a physical form attached to it, still exists in a symbiotic symbolic relationship, simultaneously informing and being informed by specific meanings that have been affixed to them. As a result, the visual processing of color becomes an integral part of the intricate system of rules and symbols utilized by different artificial human social constructs. Allowing colors like Tyrian purple to become the visual definition of constructs like social hierarchies both within social groups of humans and between competing social groups of humans.

Symbolic meanings of color, however, require more than the proper equipment for visual perception or even the processing power of the neocortex of a single individual to have any kind of hegemony. An additional mechanism, which coordinates the visual processing of the same color between several groups or individuals and facilitates an agreement about the exact symbolic nature of a color becomes necessary. The agreed upon meaning then passes onto succeeding generations for as long as the agreement remains intact.

Otherwise the endowed symbolic meaning loses its power within the span of a single generation. The application of this process is impossible without the apparatuses of a complex

cultural state such an urban/agricultural dichotomy, characterized by a social hierarchy, an economic differentiation and specialization, a wealth disparity between different levels of the social hierarchy that influences how decisions are made for the group, and some measure of literacy.³ Social stratification based on economic parameters allows for certain commercial objects to develop an associated sense of desirability or undesirability relative to economic wealth. The resulting message is an individual, visually marked within a given social context because the ownership of certain objects, or more specifically colors, convey that particular social distinction visibly. Without social stratification the desire to reinforce a specific conception of the self with visible symbols does not exist.

Color symbolism, despite its paradoxical nature of being both transient and permanently unchanging, does not pop into existence fully formed from nothing. Similar to the retina's ability to see color, it takes time, exposure to new circumstances, and modification to create a system of color symbolism that has a widespread application. Complex cultural states are the perfect matrices for the development of color symbolism. The Roman Empire, which was able to achieve the greatest geographical expanse of the ancient Mediterranean states, provides a good example to demonstrate that diachronic development. Over the span of several centuries, the Romans consistently had to readjust their patterned reactions to color, as military conquest brought the Roman populace in contact with new environments, with different color ratios than what existed in central Italy. Information about how to survive in these new environments had to be recalibrated within the baseline Roman understanding of the natural world, expanding how the spectrum was understood and interpreted.

³ Finlay, Robert. "Weaving the Rainbow: Visions of Color in World History." *Journal of World History* p. 397

Chapter II: Roman Expression of Tyrian Purple

The exact details of Tyrian purple's technological process remained a mystery until Pliny the Elder revealed it in his *Natural History* in the first century CE,⁴ a process that Michel and McGovern have corroborated as a description of vat dyeing through modern experimentation based on Pliny's instructions.⁵ Vat dyeing is a labor intensive process requiring not only the raw material for the dye, in this case murex mollusks, but several chemical reducing agents, technical expertise, and a large labor force that had to be fed, housed, and clothed, which of course is to say nothing of the transportation costs for the finished product. All factors that contributed to a high starting price for a Phoenician textile dyed in Tyrian purple, a price that only increased to maintain profit margins, as the product traveled further and further away from its domestic node of production. By the time Pliny the Elder was writing about Tyrian Purple production in the first century CE, Tyrian purple had developed from a local commodity, exemplified by the evidence from Sarepta, to a form of market exchange governed by international exchange institutions (e.g. long distance merchants, administered trade and ports of trade).⁶

The channeling of foreign trade to peripheral, coastal towns as a result of the new Iron Age economy allowed the Phoenicians to capitalize on their long-distance sailing skills to make

⁴ A full translated description is provided by Ziderman, in Ziderman, I. Irving. "' BA" Guide to Artifacts: Seashells and Ancient Purple Dyeing." p. 99

⁵ For a full summary of their methodology and conclusions refer to Michel, R. H., and P. E. McGovern. "The chemical processing of Royal purple dye: ancient descriptions as elucidated by modern science, part II." *Archeomaterials* 4 (1990): 97.

⁶ Smith, Michael E. "The archaeology of ancient state economies." *Annual Review of Anthropology* (2004). p. 85

contact with local trading systems, where the sail was probably not widely in use.⁷ Establishing footholds along the Bosphorus, in Southern Italy, in Sicily, and on the Spanish and North African Coasts, the distribution of textiles dyed with Tyrian Purple followed an ever increasing arc from East to West, eventually stretching from the Levant to the Strait of Gibraltar.⁸ Of course the further the market for Phoenician Tyrian purple expanded from its central production node in Tyre, the technology had to follow in order to maintain the supply chains. Secondary nodes of production helped to impede the depletion of murex populations in Tyre, and also provided safe havens for Phoenician sailors to store their cargo and replenish their supplies. The necessity for proximity to natural habitats able to sustain murex populations and harbor ships helps to explain the distribution of archaeological sites attributed to the Phoenicians (for a map of attributed Phoenician trading ports see figure 5).⁹ This international network of markets, distribution and production centers spread across the Mediterranean basin, along with several centuries of established tradition surrounding Tyrian purple use, was what the Romans eventually inherited when their Empire became the predominant political and economic power of the ancient world.

From the origin of civilized societies, conceptual color coding was a universal phenomenon, used for identifying political status, social ranks, moral virtues, and venerated symbols.”¹⁰ Tyrian purple as a rare, bright color falls under the purview of Reinhold’s definition¹¹, however codification of ancient purple will express different forms of control from contemporary color codification: while certain controls and codices on purple in the ancient

⁷ Sherratt, Susan, and Sherratt, Andrew. "The Growth of the Mediterranean Economy in the Early First Millennium BC." P.369.

⁸ Herm, Gerhard. *The Phoenicians : The Purple Empire of the Ancient World*. P. 14

⁹ Joshua J. Mark. "Tyre," *Ancient History Encyclopedia*. Last modified September 02, 2009. <http://www.ancient.eu/Tyre/>.

¹⁰ *Ibid.* p. 398

¹¹ Reinhold, Meyer. *History of Purple as a Status Symbol in Antiquity*. Collection Latomus, v. 116. Bruxelles: Latomus, R. Colonel Chaltin 60;1970.

world are literal, its trade marking is understood in a metaphorical sense.¹² The metaphor that underlay the trade marking of Tyrian purple varied from region to region, subject to different social stratifications and visual hierarchies. By using Reinhold's chronology to trace Tyrian purple use as it moved from East to West as an economic product, the nuances of codification become more apparent. Steadily increasing in rigidity and shades of meaning, until ultimately ending up as the highly regulated symbol for imperial power amongst the Romans.

Rome was a latecomer to the social exercise of displaying Tyrian purple as a status symbol. While the Phoenicians were spreading their product and industrial infrastructure around the Mediterranean basin in the early half of the first millennium BCE, Rome was an insignificant town on the Tiber. Slowly and surely getting bigger, Rome however, had only overpowered its Etruscan allies in the fifth century and which in 400 BCE only ruled a territory reaching approximately from present-day Cerveteri to Monte Circeo in the south and Avezzano in the east. Even still it could not be compared with the Greek city-states of southern Italy or Sicily.¹³ The social definition of Tyrian purple's use and display, already had almost a millennium to develop before intermingling with the social matrix of Rome.

Beginning with Ugarit in the 14th century BCE, textiles dyed with Tyrian purple passed from Mesopotamia to the Hittite empire, to the Assyrian Empire, to Persia, Media, Lydia, and Neo-Babylonia as forms of tribute and military prizes.¹⁴ Circulating to Ancient Greece by 800-700 BCE, the esteem of purple was heralded through the Homeric epics and associated "only with persons of the highest social status."¹⁵ While this history provides a larger contextual picture of the tradition surrounding Tyrian purple's social evolution into a status symbol, it

¹² Elliott, Charlene. "Purple pasts: color codification in the ancient world." *Law & Social Inquiry* 33, no. 1 (2008). p. 178

¹³ Herm, Gerhard. *The Phoenicians : The Purple Empire of the Ancient World*. p. 283

¹⁴ Reinhold, Meyer. *History of Purple as a Status Symbol in Antiquity*. Collection Latomus. p. 9, 10, 11, 14, 16

¹⁵ Reinhold, Meyer. *History of Purple as a Status Symbol in Antiquity*. Collection Latomus. p. 11

remains unconnected to color codification or color trade marking, for purple's secondary meaning is ephemeral at best and ownership has yet to even crystallize into a question.¹⁶

By the sixth century BCE, Tyrian purple's power symbolic power origin begins to be channeled in a specific direction. In the Persian institutionalization of purple for status purposes legalized restrictions on the ceremonial use of purple are encountered for the first time, within the limits of the available data.¹⁷ Here, as with contemporary color trademark cases, color becomes a legal issue: the king claimed the white striped purple tunic of the royal costume as his "exclusive royal symbol" and used legal restrictions to solidify its meaning.¹⁸ From this point on to the end of antiquity, the use of purple as official insignia only grows and flourishes. From Greece the use of Tyrian purple spread to Rome, and by the time it did Tyrian purple had amassed several shades of meaning that grew more entrenched. The challenge that Rome faced was to create a unique Roman symbolism for Tyrian purple that not only encompassed all the trade mark meanings that had developed previously, but could also be integrated seamlessly with a social and political structure that had evolved for centuries without it.

Far removed from the natural habits of the murex mollusks needed to produce Tyrian purple, Rome had no local access to the color for majority of its early history. Etruria and Magna Graecia might have provided some indirect access to the color due to their points of contact with the Phoenician trading network. "There is no doubt that the widespread employment of purple among the Romans, both for official and rank symbols, and for private display of affluence, began in the early 3rd Century BCE, with the enormous influx of booty and

¹⁶ Elliott, Charlene. "Purple pasts: color codification in the ancient world." *Law & Social Inquiry* 33, no. 1 (2008): p. 179

¹⁷ Reinhold, Meyer. *History of Purple as a Status Symbol in Antiquity*. Collection Latomus. p 18

¹⁸ Elliott, Charlene. "Purple pasts: color codification in the ancient world." p. 180

other sources of wealth into Rome from the Hellenistic world.”¹⁹ The lateness of the intersection between Tyrian purple and the Roman visual spectrum, considering how long Tyrian purple had been utilized as a status symbol, left the Roman neocortex particularly vulnerable to the chromophilia response Tyrian purple’s reflective properties inspire. So much so, that during the latter part of the 3rd century BCE, in the course of the Hannibalic War, the first wartime sumptuary measures were enacted, restricting luxury consumption, forbade Roman women to wear gold ornament or purple garments, the principle insignia of economic status and official rank in Roman society of the time.²⁰ This first instance of sumptuary law, called the *Lex Oppia*, was the first of many legal measures employed by the Roman ruling body to regulate the overwhelming obsession Romans had with purple, but instead had the opposite effect.

“Consequently, it is worthwhile to pause for a moment and speculate why. The answer very likely resides in the "fundamental contradiction of sumptuary regulation"; the simple fact that restricting something to a select few will actually raise both its prestige and the general desire to possess that item. "If some economic or cultural asset is restricted to some groups or classes it becomes a potential object of aspiration for others," and the aspiration is intensified "where that asset is associated with a claim to social superiority.”²¹ “Indeed in the period from the 3rd century BCE to the end of the Republic, when Roman affluence introduced widespread, unfettered use of purple as a status color, four forces battled with one another: the omnipresent vogue of purple as a status color to display social rank and economic status; the use of purple for various badges of official positions in the Roman state, both political and priestly; a growing moralizing, nationalistic anti-Oriental invective against unrestrained luxury spending particularly on purple; and sporadic, though limited and ineffectual, to institutionalize some uses for purple

¹⁹ Reinhold, Meyer. *History of Purple as a Status Symbol in Antiquity*. p. 40

²⁰ Ibid. p. 41

²¹ Elliott, Charlene. "Purple pasts: color codification in the ancient world." p. 186

for status roles in Roman officialdom.”²² As a result of this four-way tug-of-war between different social implications, Tyrian purple remained embroiled in an ongoing ethical and philosophical debate on the relationship between vision and knowledge, and that the Roman body was one of the most important and controversial sites for this debate.²³

The Roman body was defined by its association with Roman toga, the toga was the first visual delineation between Romanness and non-Romanness; a way to express how the Romans perceived or defined themselves as looking.²⁴ The term *togati* was synonymous with *Romani*, to be one, demanded being the other: it defined them as a nation separate from the Greeks or *palliatii*, from the trousered Gauls and the rest of the world.²⁵ Based on Diocletian’s *Edict of Maximum Prices* the amount of cloth required to create this garment would have been 3/5 of a man’s yearly net worth, far beyond the means of most of the Roman population and still the toga remained the baseline item through which the one’s inclusion into the Roman cultural sphere was measured.²⁶ The reason for the utilization of the toga, as opposed to any other visual symbol of Romanness, is because cloth is "easily invested with meaning" and the economics of the cloth relegated its use and manipulation to the social strata that already exercised internal dominance within the Roman social infrastructure. Making it a key symbol and ideal for communicating identity. In the specific case of purple cloth, after attracting attention and creating a clear "visual hierarchy," color can transcend the cloth and become a significant symbol in and of itself.²⁷

The addition of purple to the essential foundation of Roman identity represented by the toga was necessary, particularly at the end of the Republic to reinforce the division between

²² Reinhold, Meyer. *History of Purple as a Status Symbol in Antiquity*. p. 48

²³ Bradley, Mark. *Colour and Meaning in Ancient Rome*. Cambridge Classical Studies. Cambridge: Cambridge University Press, 2009. p. 210

²⁴ Vout, Caroline. "The Myth of the Toga: Understanding the History of Roman Dress *." *Greece and Rome* 43, no. 2 (1996). p.206

²⁵ Vout, Caroline. "The Myth of the Toga: Understanding the History of Roman Dress *." *Greece and Rome*. p. 213

²⁶ Vout, Caroline. "The Myth of the Toga: Understanding the History of Roman Dress *." *Greece and Rome*. pg. 213

²⁷ Elliott, Charlene. "Purple pasts: color codification in the ancient world." p. 187

Roman and non-Roman social strata. With the expansion of Roman society to include increasingly more diverse populations, that had access to textiles that far exceeded the economic worth of the toga; the toga had to be requisitely changed to reflect increased social complexity of the Roman state, as the well as the influx of new raw materials and capital. The toga began to incorporate the use of dyes that already served as status badges from the areas that the Romans conquered. The victorious Romans could not live in less luxury than the nations they had conquered²⁸ by the time the Romans conquered the original Phoenician source of Tyrian purple in 96 BCE, the Roman toga and definition it carried about Roman identity had been fundamentally changed.

The most basic form of the *toga pura* or *toga virilis* worn by Roman citizens, was an undecorated, natural colored woolen garment.²⁹ Candidates for public office dressed in *toga candida*, which was bleached as white as ancient chemistry could make it. The whiteness, particularly of the candidates' toga, represented a separation from the indispensable physical labor for maintaining life in Rome, and contained the potential to be imbued with political power, that resulted from the people's electoral decision. By including an extravagance like Tyrian purple's aesthetics into the Roman costume, the economics of the toga were further removed from the majority of the population creating a widening divide not only between Roman and non-Roman, but rich Roman and poor Roman. Further, by tying the quantities of purple's display to social classes already divided along economic lines through the legal system, political power was visually circumscribed to only those who could pay for the privilege. A distinct break from the representative nature of the ideal Roman Republic.

²⁸ Elliott, Charlene. "Purple pasts: color codification in the ancient world." p. 213

²⁹ "Toga." Fashion, Costume, and Culture: Clothing, Headwear, Body Decorations, and Footwear through the Ages. 2004. *Encyclopedia.com*. (April 18, 2016). <http://www.encyclopedia.com/doc/1G2-3425500108.html>

Adding purple, not just Tyrian purple, to the Roman costume created such a moralistic controversy, because on one hand it embodied high political and religious authority that celebrated the expanding dominance of the Roman identity. Yet, at the same time purple was a tell-tale attribute of tyranny and eastern decadence, associated with the imperial rule of kings that the Republic prided itself on expunging from the Roman social infrastructure in 509 BCE.³⁰ Despite *purpura*³¹ developing into a standard symptom of *luxuria*³² and contemporary moral and ethical decline, by the first century it had become a “must-have” for Roman social climbers.³³ Lucretius playfully comments upon the irreversibility of Tyrian purple’s absorption into Roman material culture: the purple dye that comes from the sea binds itself irreversibly with Roman wool, and cannot be reunited with the sea no matter how many attempts are made to cleanse it from the textile.³⁴

Purple, it seems, could not be removed from the Roman toga, not as long as Rome ruled over territory where the use of purple already had a long-standing tradition as a status symbol, nor while the toga provided conquering Rome with an easily mobile method through which to proclaim its dominance in terms the conquered could understand. In fact, purple became so embedded in Roman politics that there is some evidence that the trained eye could decipher ones political character from the shade *purpura* one chose to wear on the senatorial *toga praetexta*.³⁵ This resulted in this color developing a very cogent symbolism and epistemology of its own.³⁶ Purple then could be used to the advantage to those in power, providing both an internal and external standard through which to measure their power relative to each other and the rest of the

³⁰ Bradley, Mark. *Colour and Meaning in Ancient Rome*. Cambridge Classical Studies. p. 209

³¹ Latin word for visual aesthetics that correspond with the 450-380^{nm} range of Newton’s visible spectrum.

³² The moral vice of material excess and decadence that contradicted the Roman idea of a citizens *virtus* that was based on hard work, frugality, and dedication to the state, which was a core characteristic of the Roman Republic

³³ Bradley, Mark. *Colour and Meaning in Ancient Rome*. Cambridge Classical Studies. p. 201

³⁴ *Ibid* p. 192

³⁵ Bradley, Mark. *Colour and Meaning in Ancient Rome*. Cambridge Classical Studies. p. 197

³⁶ Bradley, Mark. *Colour and Meaning in Ancient Rome*. Cambridge Classical Studies. p. 198

Roman world. Social distinctions that resulted from this symbolic system had to be persevered by language, custom and law, since the raw materials needed to maintain the symbol itself resided far from central node of Roman culture and could easily be usurped.

The result was a plethora of statues that defined categories of togas, each with its own meaning, and penalty for usurpation that would have been unthinkable in the early Republic. Senators, as mentioned previously, wore the *toga praetexta*, a white wollen toga with red sleeves and a purple hem. For other upper strata of Roman society, purple reigned: victorious generals donned the *toga picta*, a purple and gold embroidered toga. Military officers wore the *paludamentum*, a purple cloak, while the soldiers followed in the same style of cloak in red. The Roman Emperor alone wore the *tunica palmata* made of rich purple silk and embroidered in gold. Romans viewed clothing as a distinguished costume draped with meaning: it symbolized the distinctive character of an individual, a country, an epoch and a civilization, and these costumes would hold fast, for four hundred years.³⁷

By the reign of Augustus, Rome was beginning to welcome exotic, particularly eastern ideas like the incorporation of Tyrian purple, into the Roman costume.³⁸ As the political landscape of Rome changed, the reaction and use of Tyrian purple changed accordingly. The Roman eye was changed politically, philosophically, and linguistically to connect this dye with the body of the emperor.³⁹ A literary reflection of the power of the association between purple and the absolute power of the Roman world comes from several passages in Vergil's *Aeneid*, particularly in Books 1 and 4.⁴⁰ Written in the time of the early Principate, 29-19 BCE, the presence of Tyrian purple in the epic is facilitated by Dido, the Carthaginian queen who is

³⁷ Elliott, Charlene. "Purple pasts: color codification in the ancient world." p. 181

³⁸ Herm, Gerhard. *The Phoenicians : The Purple Empire of the Ancient World*. p. 265

³⁹ Bradley, Mark. *Colour and Meaning in Ancient Rome*. p. 207

⁴⁰ *The Aeneid of Virgil*. Bantam Classics, 2003. Book 1 Lines 973-989, Book 4 Lines 177-190, 348-357

originally from Tyre. The color is associated primarily with the two characters that have the greatest amount of social power, Dido and Aeneas. Dido is the representative of both the historical source of the highly valued textiles, of which Carthage was originally a colony. She also represents the weakening force of decadence that infused older traditions surrounding the use of Tyrian purple in the East. Through the association of Tyrian purple with the body of Aeneas, Vergil transforms the color into a symbol of Rome's ascendancy over the East and the divinely supported manifest destiny of the Roman Empire.

In Book 1 lines 973-980 of the *Aeneid*, Dido, the queen of Carthage, extends hospitality to Aeneas and his men in an effort to establish peaceful relations between her people and the uprooted Trojans by adhering to the Greek cultural ideal of *xenia*.⁴¹ As part of the *xenia* hospitality ritual, a meal is offered and Vergil describes the scenic backdrop to this meal as follows,

*As he [Anchises] arrives, /
He finds that the banqueting begun, the queen/
Already settled on her couch of gold/
Beneath resplendent awnings, at the center. /
Father Aeneas and the Trojan warriors/
Now gather; they recline on purple covers. /
The servants pour out water for their hands/
And promptly offer bread from baskets*⁴²

The color purple from this description, is meant to draw on the Homeric association between purple garments and those of the highest class, namely kings; retroactively setting up a link between the color purple and the first forefather of Rome, as a natural precedent in Roman history. Effectively removing some of the association with tyranny. Vergil also physically and visually restricts the association to specific elite male members within the social

⁴¹ The Greek term for the Laws of Hospitality. The custom in classical Greece and other ancient cultures that, if a traveler comes to a strange town, he can ask for food, shelter, and gifts to help him on his journey. In Greek tradition, the host was considered responsible for his guest's comfort and safety, and a breach of those laws of hospitality was thought to anger Zeus (Roman Jupiter), the king of the gods. Literary terms and definitions: X https://web.cn.edu/kwheeler/lit_terms_X.html

⁴² "Book 1" *The Aeneid of Virgil*. Bantam Classics, 2003. Lines 973-980.

context to the exclusion of everyone else. Though Dido crafted the purple coverlets and extended their use as a kindness to establish social equality between herself and the leaders of the Trojans, Vergil is careful to reflect Roman patriarchy and the traditional power of the *paterfamilias* in this scene. Dido, herself, is visually associated primarily with a gold couch. Gold serving as an obvious correlation between her economic affluence and the definitive superiority Dido holds over Aeneas at this point in his journey, is also, however, a power that a woman can only derive from her husband or father in many ancient cultures, not just a Roman context. Despite the overwhelming economic superiority Dido has over Aeneas, through exclusion of her person from the purple association in Book 1 Vergil hints that she is not his true equal. Her wealth would easily revert to the power of her husband if she ever married again whereas Aeneas would have to be physically overpowered or killed to have his prestige wrested from him. In the larger overall context when this epic was written, this scene is meant to remind the audience of the actual historical supremacy that Rome, as the empire of Aeneas, achieved over Carthage by virtue of Roman qualities such as frugality and hardwork, despite Carthage's overwhelming economic superiority

Dido, however does not remain excluded from purple throughout her entire encounter with Aeneas. In Book 4⁴³ her hunting costume is almost excessively draped in purple and gold, while the purple in Aeneas' own costume⁴⁴ is restricted to his cloak and quite subdued in comparison. Even here when Aeneas and Dido are visually portrayed as social equals, Dido is still represented as the antithesis of Roman ideals. Her depicted use of Tyrian purple is one of extreme excess, her royal status was displayed too overtly triggering a culturally embedded distaste for autocratic rulers, as the enemies of the Roman way of life. Aeneas understated use

⁴³ "Book 4" *The Aeneid of Virgil*. Bantam Classics, 2003. Lines 177-189

⁴⁴ "Book 4" *The Aeneid of Virgil*. Bantam Classics, 2003. Lines 348-352

on the other hand, goes nearly unmarked in comparison. His association with Tyrian purple is purposeful and calculated to demonstrate how foreign symbols can bolster the superiority of Roman culture, the purple associated with the power of the East is now subservient to Roman agency and will. Without drawing attention to the fact that Aeneas will become an autocratic ruler. A parallel circumstance that characterized Augustus' rule as he attempted to maintain the appearance of a Republic, while laying the foundation for a dynastic rule. His symbols of power, including his use of purple, were only displayed in calculated amounts to prevent the public from establishing any connection between his social position with that of the autocratic ruler he defeated at Actium.

The rest of the Julio-Claudian years were characterized by political legislation implemented over time by several emperors to restrict the use of *purpura* to certain individuals over time.⁴⁵ The most famous being Nero's attempt to delimit the use of purple to some degree. According to Suetonius, Nero sternly interdicted the sale and general use of the two highest qualities of purple – *amethystina* and *Tyria* – so as to reserve it, no doubt for the imperial court and other official purposes.⁴⁶ While not easily enforced the penalty was quite steep, Suetonius also mentions that “A lady wearing this illegal color at one of his recitals was dragged off and not only stripped of her clothes, but of her entire property.”⁴⁷ Nero's decree is the first instance the quality of purple, rather than the quantity of purple taking precedence within the visual hierarchy of the Roman empire. As purple garments became more and more available across the Roman world, their use became less and less exclusive, as production became easier due to improved technology and cheap additives producing a comparative visual effect to the highest

⁴⁵ Bradley, Mark. *Colour and Meaning in Ancient Rome*. p. 200

⁴⁶ Reinhold, Meyer. *History of Purple as a Status Symbol in Antiquity*. p. 50

⁴⁷ Jensen, Lloyd B. "Royal purple of Tyre." *Journal of Near Eastern Studies* 22, no. 2 (1963). p. 113

quality purples: Tyrian purple became a *sine qua non* for imperial power and there was considerable pressure for it to be seen and recognized.⁴⁸

The increasing association of purple with the person of the Emperor and his court continued to increase, reaching a turning point under the absolutism of Diocletian, with its heightened use of more Oriental symbols of royal status.⁴⁹ The new importance of purple as imperial symbol is attested also by the institution of the ceremonial of *adoratio purpurae* or "kissing the purple" as a mark of distinction and imperial favor to those granted imperial audiences. While this rite is not clearly attested until the middle of the 4th century, there is merit to view that the ceremony was first introduced by Diocletian.⁵⁰ The rite of kissing the purple was performed in the following manner: the individual admitted to the presence of the emperor fell before him in the usual attitude of obeisance, took the hem or corner of the emperor's purple robe in hand, and raising it to his lips kissed it.⁵¹ The dignitaries kissed the purple in a fixed order determined by the rank which each held in the official hierarchy.⁵² The *adoratio purpurae* ceremony allowed the emperor to rearrange the highest ranks of his political hierarchy at the slightest whim, resulting in quick, inconsistent shifts of power that left Rome unstable at its highest political level. A situation that was reflected in the rapid succession of emperors in the later centuries of the Empire. With the political infrastructure of Rome growing more unstable as the absolute power symbolized by Tyrian purple became solidified, a flurry of highly punitive sumptuary legislation was enacted to restrict the use and display of the specific Tyrian purple dye solely for imperial use.

⁴⁸ Bradley, Mark. *Colour and Meaning in Ancient Rome*. p. 201-202

⁴⁹ Reinhold, Meyer. *History of Purple as a Status Symbol in Antiquity*. p. 59

⁵⁰ Avery, William T. "The" Adoratio Purpurae" and the Importance of the Imperial Purple in the Fourth Century of the Christian Era." *Memoirs of the American Academy in Rome* 17 (1940). p. 69

⁵¹ Ibid. p. 69

⁵² Avery, William T. "The" Adoratio Purpurae" and the Importance of the Imperial Purple in the Fourth Century of the Christian Era." p. 68

The purple robe became the sole concrete attestation of the absolute sovereignty of the emperor and an indispensable attribute of his exalted station. Consequently, the attitude towards it became almost mystical.⁵³ So much so, that the visual relationship between power and Tyrian purple became inverted; Tyrian purple was no longer used to display the social dominance considered to be intrinsic to the Roman body, rather the Roman body drew its power from the Tyrian purple textile. By 300 CE purple workshops at Tyre in Phoenicia, producing the prime qualities of the dye, became imperial property.⁵⁴ The significance of the hallowed purple grew to so great proportions during the fourth century that anyone who thought he had support enough to seize the power advertised himself as emperor by exhibiting himself clad in that color. In the history of Ammianus are found repeated instances in which legal action is taken against individuals who are known to possess or who are merely suspected of possessing a purple robe, or something resembling one, and hence are under suspicion of plotting to elevate themselves to the dignity of an Augustus or Caesar. The charge was that of *laesa maiestas* and the prosecution was vigorous.⁵⁵

A typical case often resulted in the accused being tortured for information on possible sources of rebellion, exile, confiscation of property, and death by a variety of methods regardless of whether the accused was innocent or guilty.⁵⁶ The imperial absolutism surrounding the retaining ownership of Tyrian purple was further developed under the law codes of the Emperors Constantine, Gratian, Valentinian, and Theodosius with exceptions and nuances appearing sporadically in the legislature. Indeed the legislation of 383 CE appears however, to have

⁵³ Avery, William T. "The" Adoratio Purpurae" and the Importance of the Imperial Purple in the Fourth Century of the Christian Era." p. 75

⁵⁴ Reinhold, Meyer. *History of Purple as a Status Symbol in Antiquity*. p. 60

⁵⁵ Avery, William T. "The" Adoratio Purpurae" and the Importance of the Imperial Purple in the Fourth Century of the Christian Era." p. 76-77

⁵⁶ Reinhold, Meyer. *History of Purple as a Status Symbol in Antiquity*. p. 66-67

Cf. Avery, William T. "The" Adoratio Purpurae" and the Importance of the Imperial Purple in the Fourth Century of the Christian Era." p. 77

formalized the concept of *sacer murex* for the two deluxe qualities constituting imperial privilege, while *publicus murex* designated all other qualities - from less expensive sea purple mixtures to other animal, mineral and vegetable purple dyes. In many aspects of society, however, it is well known that the increasingly restrictive measures of the imperial government were, despite severe penalties, methodically flouted, often with impunity.⁵⁷

Sumptuary legislation is often difficult to enforce uniformly over a large geographical area, the Roman Empire was not an exception to this phenomenon. The restrictions various Emperors enacted to protect their exclusive right to use Tyrian purple as a formal expression of *Romanum Imperium*, were only easily enforced in the immediate vicinity of the emperor or within the capital cities where the emperor resided. Even Nero's early attempt to restrict Tyrian purple use resulted in only one documented instance of enforcement, when the infraction took place at Nero's own recital. The further removed from the cultural center of the Roman Empire, Tyrian purple was, the more open it became for re-appropriation and reinterpretation. A circumstance that current archaeology demonstrates occurred in the Western part of the Empire as power was increasingly concentrated in Constantinople, specifically in Gaul. Appreciation of purple was part of a fluid, subjective and interactive process of recognition and evaluation, and the interpretations themselves constructed its meaning as much as they reflected it.⁵⁸

⁵⁷ Reinhold, Meyer. *History of Purple as a Status Symbol in Antiquity*. p.66

⁵⁸ Bradley, Mark. *Colour and Meaning in Ancient Rome*. p. 211

Chapter III: The Gallic Reinterpretation of Tyrian Purple

Violet–purple residues were recently excavated and chemically investigated from a Gallo–Roman burial dating back to the second half of the third century CE, by multi-analytical methodology involving the use of Raman spectroscopy, direct exposure mass spectrometry (DE-MS) and high-performance liquid chromatography (HPLC–UV–visible).⁵⁹ The excavation took place at Naintr , a few kilometers north of Poitiers in west-central France, which unearthed two undisturbed Roman-Gallic sarcophagi containing the bodies of an adult woman and a child, around twelve years of age.⁶⁰ In particular, in the burial of the adult, an intense unusual violet color was clearly visible on and around the skull. Some violet traces were also identified at the level of hands and feet. Preliminary investigation by Fourier transform infrared spectroscopy did not show the presence of any inorganic material that could have been responsible for the violet color.⁶¹

Chemical characterization was then focused on identification of organic colorants. There are few possibilities only of obtaining the color violet from natural organic substances. It can be obtained by mixing red and blue colorants or directly from various species of lichens, for example *Rocella tinctoria* D.C. and *Rocella fuciformis* D.C. or from various mollusks for example *Bolinus brandaris* L. (originally called *Murex brandaris*), *Hexaplex trunculus*, *Purpura*

⁵⁹ Devi se, Thibaut, Erika Ribechini, Pietro Baraldi, Bernard Farago-Szekeres, Henri Duday, Martine Regert, and Maria Perla Colombini. "First chemical evidence of royal purple as a material used for funeral treatment discovered in a Gallo–Roman burial (Naintr , France, third century AD)." *Analytical and bioanalytical chemistry* 401, no. 6 (2011). p. 1739

⁶⁰ Ibid. p. 1739-1740

⁶¹ Ibid. p. 1741

haemastoma, and *Purpura lapillus*. The colorant obtained contains seven main biomolecular markers: indigotin, indirubin, 6-monobromoindigotin, 6-monobromoindirubin, 6-monobromoindirubin, 6,6'-dibromoindigotin, and 6,6'-dibromoindirubin. The brominated molecules are the specific markers of purple, because indigotin and indirubin can also be found in other materials.⁶² The location of the 6,6'-dibromoindigotin around the anterior skeleton, particularly on the skull, but not under it, sheds new light on a previously unknown use of Tyrian purple in the context of death within the time period.

Based on the distribution and deposition of the 6-6' diobromoindigotin molecule within this particular archaeological context, Devièse et.al have posited that Tyrian purple was not used as a textile dye, but rather as a funerary cosmetic. This use of Tyrian purple represents a distinct break not only with the traditional display of status that Tyrian purple had developed in the East, but also the re-codification that had developed within Roman law over the past few centuries. Naintré lies landlocked, several hundred miles north of Transalpine Gaul, east of the Bay of Biscay, and south of the English channel. Like Rome during the early part of the Iron age it was both far removed geographically from the natural habitats that supported murex populations and from any Phoenician distribution nodes. The patterned emotional response within this specific Gallic neocortex to the introduction of Tyrian purple into the cultural matrix, via Roman trade routes, would have resembled the one that took place within the Roman neocortex. While impossible to determine the exact nature of the chromophilia Tyrian purple would have inspired in this specific Gallic settlement, all other ratios of natural optical reflections being equal, it would have differed from the Roman reaction based on one criterion, the Gauls' familiarity with woad.

⁶² Devièse, Thibaut, Erika Ribechini, Pietro Baraldi, Bernard Farago-Szekeres, Henri Duday, Martine Regert, and Maria Perla Colombini. "First chemical evidence of royal purple as a material used for funeral treatment discovered in a Gallo-Roman burial (Naintré, France, third century AD)." p. 1741

Woad, or *Isatis tinctoria* L. , in French *gue`de, we`de, waide, voue`de, pastel des teinturiers, bleu de Picardie*, is a well known crop, which was cultivated to produce a blue dyestuff. A new find of *Isatis* has been encountered on the site of Roissy “Zac Demi Lune”, de´partement of Val d’Oise, north of Paris and ,more importantly, north of Naintré. This rural settlement, excavated under the direction of L. Leconte, INRAP (Institut National de Recherches Arche´ologiques Pre´ventives), is dated to the La Te`ne period (fifth–first century B.C.).⁶³ The active substance for dyeing is not directly synthesized by the plant. Woad derives from a recombination of indoxyl molecules, derived from two precursors: *isatan B* and *indican*. This form of indigo is practically insoluble in water and has to be reduced to another form which is absorbable by the fibers to be dyed.⁶⁴ So while Rome in this time would have at best had only secondary access to Tyrian purple dye either through Magna Graecia or Etruria, portions of Gaul were already acclimatized to woad, which contains indigo, dibromoindigotin’s, un-bromated cousin, and is optically similar to Tyrian purple.

Despite numerous identifications of the coloring agent through chemical analyses of archaeological textiles, occurrences of *Isatis* in archaeobotanical assemblages remain very scarce. The rare finds from French archaeological deposits are mainly the result of the use of leaves, not seeds, in the preparation process of the dyestuff. The cultivation of the plant on a large scale, however, would normally have led to the preservation of seeds in storage contexts, at least for re-sowing⁶⁵, a possible explanation for the presence of woad seeds at Roissy, but not

⁶³ Zech-Matterne, Véronique, and Luc Leconte. "New archaeobotanical finds of *Isatis tinctoria* L.(woad) from Iron Age Gaul and a discussion of the importance of woad in ancient time." *Vegetation history and archaeobotany*19, no. 2 (2010). p. 137

⁶⁴ Ibid. p. 140

⁶⁵ Ibid. p. 140

textiles in any aristocratic context. This raises the question of the dating of the beginning of local cultivation of the plant and the exact importance of this cultivated dye plant in Gaul.⁶⁶

Historical sources report the curiosity provoked among Roman authors by the use of woad by Celtic and Germanic people for body and hair painting, for prophylactic or ritual purposes (Caesar, B.G. V, 14, 2; Pliny the Elder H.N. XXII, 2, 1). This literary evidence suggested that the plant could have been used both for textile and body art. Archaeological evidence and artifacts connected with such a practice, however, are lacking.⁶⁷ In the case of the Naintré burial, the articulation of Tyrian purple on the woman's skull in this context could represent a creolization of between the visual symbols of woad and Tyrian purple. Reflecting a particular instance of how the various legal attempts by the Roman government to restrict Tyrian purple use, were flouted the further the symbol traveled from the cultural center of either Rome or Constantinople. In addition to providing a commentary about assumed homogenous nature of Romanization.

It took a century or more after the last stage of Roman Republic expansion for the notion of empire as a bounded space, protected by armies supplied by a peaceful interior, to become the main way empire was imagined. Parallel and sometime prior to this intellectual evolution, archaeologists can discern the emergence of geography of empire, a vast division of labor laid out in space, produced by the day to day exercise of imperial power.⁶⁸ "Underlying the interaction between Rome and other peoples was not a Roman civilizing mission, but rather the imperialist policies and ideology that Rome used to exert its influence and to maintain it once acquired. The Roman empire made use of a broad range of methods for imposing its hegemony.

⁶⁶ Ibid. p. 141

⁶⁷ Zech-Matterne, Véronique, and Luc Leconte. "New archaeobotanical finds of *Isatis tinctoria* L.(woad) from Iron Age Gaul and a discussion of the importance of woad in ancient times." p. 141

⁶⁸ Wells, Peter S. "Perspectives on changes in early Roman Gaul." *Archaeological dialogues* 9, no. 01 (2002). p. 2

Beyond its territorial borders, it combined military force with diplomatic control. In the pacified regions of the empire, imperial power manifested itself in a complex institutional structure, whose primary components were the political and administrative systems, the tax system and the judicial system. But Rome did not rely on coercion alone to create an imperial order; it also used the instrument of seduction. At a political level, this involved seducing the elite, both at the frontier and in pacified areas, to participate in imperial power networks.”⁶⁹

“The granting of *civitas romana* and inclusion in client networks (i.e. binding the indigenous elite to the Roman aristocracy and, ultimately, to the emperor) were an integral part of this strategy. Seduction was even more important on a cultural plane. Ideas and cultural practices, unlike institutions, are difficult to impose from above. Although Rome did have a 'civilizing ethos', it did not actually impose its culture. Instead, it preferred the path of slow seduction, in which foreign elites identified with the cultural ideology of Rome and adopted a Roman way of life. This combination of coercion and seduction held the key to the success of imperial power politics.”⁷⁰

Roman attitudes are important here because they made it possible for provincials to become Roman, not as a matter of ethnicity or even enfranchisement, but by wielding a specific cultural repertoire.⁷¹ The presence of Tyrian purple in the woman’s burial in Naintré allows scholars to posit several characteristics about her social status, and possibly even her identity within this provincial hierarchy based solely on the Roman definition of the color. She clearly was upper class, and based on the economics of Tyrian purple production and transport belonged to a family that amassed enough wealth to purchase the dye. Her social status, in turn, is narrowed even further to either the equestrian or senatorial order. While not yet subject to the

⁶⁹ Wells, Peter S. "Perspectives on changes in early Roman Gaul." *Archaeological dialogues* 9, no. 01 (2002). p. 18

⁷⁰ *Ibid.* p. 18

⁷¹ Webster, Jane. "Creolizing the Roman provinces." *American journal of archaeology* (2001). p. 210

highly punitive sumptuary legislation enacted by the Emperors Diocletian, Constantine, Valentinian, Theodosius, or even Justinian, the Roman eye had been trained for centuries to associate Tyrian purple with the body of the emperor. Implying that the woman in the tomb was connected to the apex of Roman imperial power.

The presence of Tyrian purple on the frontier, however, where power dynamics had to constantly be renegotiated implies that there was a whole other set of Gallic values visually communicated by this color. Since at least part of the audience creating the visual dialogue between the viewer and the perceived symbol had their choice, however limited, between levels of integration between their own indigenous systems of symbology and the Roman one. The Empire accumulated an unrivalled amount of symbolic power for its dealings with groups of unruly barbarians on the precipice between the Roman world and the non-Roman world. What has become clear in the various geographical and diachronic examples of Tyrian purple articulation is that we are dealing with not only one reality for how this status badge was displayed, understood, and distributed, but with several realities of Roman-non-Roman symbolic interaction.⁷²

A multi-nuanced understanding that is aided in its expression by the increasingly precise methodologies and analytical instrumentation of archaeological science. Without which the exact shade of the purple used in the Naintré burial would have remained unknown. Easily dismissed as one of the many widely available forms of imitation purple, which simulated all sorts of costly products for individuals desiring to imitate the status symbols of richer strata of the Roman population.⁷³ A status value that had even penetrated into the peoples outside the Greco-Roman culture area; Tacitus reports that German women often adorned their kerchiefs and

⁷² Pohl, Walter. *Kingdoms of the Empire : The Integration of Barbarians in Late Antiquity*. The Transformation of the Roman World, v. 1. Leiden ; New York: Brill, 1997. p. 6

⁷³ Reinhold, Meyer. *History of Purple as a Status Symbol in Antiquity* p. 53

cloaks with purple borders or stripes.⁷⁴ The analytical results from the Naintré burial have revealed a potentially new layer of meaning within Tyrian purple symbology, one based entirely on a Gallic, rather than Roman, understanding of color perception. Opening the doors to further investigation into comparing how different cultures produce color hierarchies within similar or dissimilar natural habitats.

⁷⁴ Reinhold, Meyer. *History of Purple as a Status Symbol in Antiquity* p. 55

Chapter IV: Conclusions

The type of symbiotic relationship between Tyrian purple dye and its secondary meaning as a status badge denoting social dominance, is the result of thousands of years worth of conditioning by natural selection on the neocortex portion of the brain. Various optical reflections ranging from 750-380^{nm} based on Newton's visible spectrum, served as indicators of pertinent biological information for the survival of the human organism. Repeated exposure to various ratios of these optical reflections in the natural world resulted in patterned emotional responses that persisted even after the biological aspect was lifted from the aesthetics of the optical reflection. For bright colors, or particularly low ratios of specific reflected portions of the visible spectrum, the patterned emotional response was often a dual reaction of chromophilia and chromophobia. Chromophilia is an attraction to bright colors that imbues visual aesthetics with a sense of desirability. Chromophobia is its exact opposite, which imbues color with undesirability, which can be converted emotionally to fear or disgust.

Tyrian purple dye is an optical reflection measuring from the 450-380^{nm} range with a high reflective index, and thus satisfies the environmental criteria for inspiring the dual reaction of chromophobia and chromophilia in the neocortex. As the biological pertinence was reduced through repeated exposure of the human retina near the only natural source of Tyrian purple dye, the murex mollusk, having no detrimental effects on human survival rate: the chromophobia portion of the patterned emotional response in the neocortex was subsumed under the chromophilia portion. Tyrian purple dye, once relieved of its biological function was subjected to a new set of artificial pressures in the abstract of human culture, which redefined its underlying visual message to correlate with specific desirable traits within cultural infrastructures. Danesi describes the result of this transformation as a "metaform" or the form

that is connected interpretively (semiotically) to a conceptual metaphor, as a consequence of the metaphor being distributed throughout the cultural network of meaning. The latter can be called a “distributed sign”, which is the meaning extracted of a specific conceptual metaphor that works its way into the interpretation and use of physical forms such as objects, rituals, symbols, and the like.⁷⁵

As a distributed sign, Tyrian purple began its evolution as the most sought after dye in antiquity within the cultural matrices of the Eastern Mediterranean. The various complex states that emerged in this geographical area were the ones closest to the natural habitats of murex mollusks. For several centuries the association between social status and the dye was defined by the economics of production and distribution, as well as proximity to the distribution centers. Increased proximity to the distribution centers for Tyrian purple products allowed for increased access, the dissemination of the dye within specific cultural matrices developed into traditions of association, that were still fluidly based on economics. Material wealth granted access to the color, which in turn could be related to social status. As Tyrian purple moved westward as an economic commodity into cultural matrices that had no established metaform or distributed sign, for Tyrian purple, the more its symbolic relationship was supported by cultural constructs other than economics.

The Roman Empire provides a unique historical perspective into how the economics were eventually lifted out of the Tyrian, and the color was imbued with a secondary meaning in and of itself, separate from the individual agents who wore it. Over several centuries the Romans took the established traditions that codified the meaning of Tyrian purple in the East and conflated them with symbols intrinsic to Roman identity, but backed the new symbolic definition with the force of law. Many of these legal codes remain extant in both the historical and archaeological

⁷⁵ Danesi, Marcel. "On the metaphorical connectivity of cultural sign systems." *Signs* 1, no. 1 (2013) p. 35

records, which provide a diachronic window into what Tyrian purple conveyed visually, to whom. The overall symbolic meaning conveyed by Tyrian purple was flattened and compressed, but this re-codification through written law codes provided a new universal baseline definition for Tyrian purple, wherein the individual drew his or her position within the social hierarchy from the color, rather than having his or her social position reaffirmed by visual association with the color. That baseline definition, along with the costume display, was further refined in the Eastern Mediterranean, as Roman power became increasingly concentrated in Constantinople, and the geographical areas where Tyrian purple had the longest tradition of use.

Tyrian purple remained in use and the sole prerogative of the Byzantine Emperor until the 1453 CE, when the Ottoman Turks replaced the Byzantines as the dominant cultural power, which already had its own established repertoire of visual symbols. In the West, however, the documented use of actual Tyrian purple in a cultural context outside the religious context of the emerging, centralized Catholic Church, is sparse. Mostly due to the collapse of the Roman Imperial trading network cutting off the dissemination of Tyrian purple dye from the Mediterranean into Northern Europe. The symbolic definition that developed to suit the political infrastructure of *Romanum Imperium* provides a starting point for extrapolating new layers of symbolic meaning from the presence of Tyrian purple at the fringes of Roman hegemony. The confirmed chemical presence of Tyrian purple from a Roman-Gallic burial in northwest France opens up new lines of investigation into what exactly this color conveyed visually to its audience on the periphery of Roman cultural space. Providing insight into what elements of Roman symbolism remained interconnected with the social infrastructures that characterized Western Europe in the Middle Ages and Renaissance.

Appendix

At each end of Newton's spectrum are the portions least commonly reflected by organic matter in natural habitat due to the extreme length or shortness of their wavelengths within white light. White light's range is 760-380^{nm}, and within that range between the 491-380^{nm} the human eye is able to perceive the colored reflections of blue and violet. Nature, on average, tends to favor the reflections from the middle portions of the spectrum, between 585-491^{nm}, which reflect as the yellow and green portions of the spectrum accounting. Instances of the blue/violet optical reflection appear in stark contrast to the natural environment, often evoking strong emotional responses to that instance of optical reflection. What form that patterned emotional response takes is best explained by the theoretical framework of ecological optics.⁷⁶

For humans and other organisms that can see the visible spectrum, color must have some evolutionary purpose or contribution to survival. Otherwise, the point behind the evolution of the eye's ability to see color becomes an irrelevant occurrence, a harmless mutation that is all show, no function. The theory of ecological optics builds upon the baseline understanding about color vision perception discovered by Sir Isaac Newton. Since the 1960s scientists have been armed with an understanding of DNA and Darwin's forces of evolution. Under this movement, theories, spanning several hundred years, regarding the physical forces that define the mechanics

⁷⁶ A theory of color perception that tries to bridge the gap between Newton (the colors are in our heads) and Goethe (the colors are in the world) by emphasizing the environmental context of color vision, the ways in which the world and the brain collaborate in generating an increasing awareness of hues. Finlay, Robert. "Weaving the Rainbow: Visions of Color in World History." *Journal of World History* p. 386.

of the natural world are combined to create a model about how the human eye perceives the visible spectrum. More importantly, however, ecological optics provides insight into the underlying mechanics of emotional responses to color within the natural world.

The model is based primarily on the interaction between white light as an electromagnetic force and the physiology of the retina. The photons of white light after traveling through space are reflected back from solid surfaces at various wavelengths, the various frequencies or electromagnetic vibrations impinge on the retina; the retina then transcribes these vibrations as the different colors in the visible spectrum.⁷⁷ Rather than completely destroy the philosophical assumption that colors are in the world, the science of ecological optics rediscovered colors in the physiology of the retina and how the information provided influenced the evolution of the brain to understand the world around it. The function of colors can no longer be illusory, since science can create a theoretical model that explains how various physical forces converge to create a colored view of the world that has the potential to inform human behavior in both positive in negative ways.⁷⁸

The ascendancy of mammals as the apex predators of the diurnal cycle also had a large impact on colored vision and its relationship to individual survival.⁷⁹ In terms of competition for resources colors serve as signals to organisms of what is useful or harmful on the basis of nutrition.⁸⁰ For example, colors can indicate characteristics useful to survival, a dark green optical reflection from the 525-495^{nm} portion of the spectrum can indicate the proximity of foliage to water, or a red dermis from the 735-675^{nm} can serve as a sign of edibility and ripeness for an apple. In contrast, bright colors can also be deliberate visual warnings of danger, a sort of

⁷⁷ Finlay, Robert. "Weaving the Rainbow: Visions of Color in World History." *Journal of World History*. p. 388

⁷⁸ Finlay, Robert. "Weaving the Rainbow: Visions of Color in World History." *Journal of World History*. p. 389

⁷⁹ Finlay, Robert. "Weaving the Rainbow: Visions of Color in World History." *Journal of World History*. p. 390

⁸⁰ Finlay, Robert. "Weaving the Rainbow: Visions of Color in World History." *Journal of World History*. p.389

weapons technology, to visually warn off other organisms by conspicuous display.⁸¹ An effect achieved by creating a stark contrast between the larger subtly hued natural landscape and the smaller brightly hued display that the viewer is shocked into focusing visual attention on a single reflective composition. The contrast is processed simultaneously as an experience of chromophilia, an attraction to color, and chromophobia, a nearly universal aversion to bright colors.⁸² Color is a notoriously protean phenomenon, eluding every attempt to categorize it. Endlessly contested, color is the only dimension of sensory awareness that also is taken entirely for granted.⁸³

Once populous and hierarchically structured societies emerged in the Third Millennium BCE, they devised and circulated numerous extrinsic status badges. Of these status symbols the one that proved the most durable and commanded the widest international currency was the color purple, whose establishment as a token of prestige reaches back to the early centuries of the Second Millennium BCE.⁸⁴ But the mechanics of how and why purple, and the hue of Tyrian Purple specifically, came to predominate the visual landscape of status badges in the first place remains to be answered.

In terms of ecological optics Tyrian purple dye is the visually perfect color to exploit as a status badge within artificial cultural hierarchies, both the historical and archaeological records attest to the efficacy of its visual display. As an optical reflection, purple, Tyrian purple in particular, occupies one of the most rare, if not the rarest, reflected portions of Newton's visible spectrum in nature. Resulting in the dual emotional response of chromophobia and chromophilia

⁸¹ Finlay, Robert. "Weaving the Rainbow: Visions of Color in World History." *Journal of World History*. p. 389

⁸² Finlay, Robert. "Weaving the Rainbow: Visions of Color in World History." *Journal of World History*. p. 396

⁸³ Finlay, Robert. "Weaving the Rainbow: Visions of Color in World History." *Journal of World History*. p. 394

⁸⁴ Reinhold, Meyer. *History of Purple as a Status Symbol in Antiquity*. Collection Latomus, v. 116. Bruxelles: Latomus, R. Colonel Chaltin 60;1970. p. 8

that, according to ecological optic theory, accompanies the visual perceptions of rare or bright colors, to remain the conditioned patterned response to purple, regardless of whether it actually has any actual impact on survival. In a world that predates the pervasion of synthetic dyes, any occurrence of a rare optical reflection, like purple, is most likely to be interpreted by the human brain as embedded with important biological information pertinent to the survival of individuals or groups of organisms. Due to the limited exposure of the human retina to the purple optical reflection the neocortex is prevented from becoming desensitized to any occurrence from the 480-391^{nm} portion of the visible spectrum. The organic source of Tyrian purple dye did serve as food source for various communities that were established near its natural habitat, particularly in the Adriatic, which attests to a possible function associated with Tyrian purple as color.⁸⁵ The dye itself has no actual impact on survival outcomes based on its reflective properties.

The visual power associated with Tyrian purple's aesthetic is artificial, stemming from manipulation of the chromophilia portion of the patterned emotional response to its optical reflection. As human communities evolved into ever more complex states, gradually cultivating nature to suit chosen settlement patterns rather than rearranging settlement patterns to suit the direct impact of nature; the forces of social dynamics gained greater immediate impact on individual survival within a community. The patterned emotional responses to various visual stimuli established by natural selection over thousands of years remained present in the neocortex. The increasingly complex social dynamics, however, provided a new canvas on which that relationship could develop new visual meaning and purpose partially divorced from biology. The abstract emotional response to optical reflections, like Tyrian purple that have no

⁸⁵ In Adriatic fish markets, purple snails are sold today as a culinary delicacy, so the archaeologist who finds a dye-murex deposit can-not exclude the possibility that what has been uncovered are merely kitchen middens. Because murex are cooked whole and the snail is re-moved without breaking the shell in preparation for human consumption, a deposit of broken or crushed shells indicates a dyeing site. Ziderman, I. Irving. "" BA" Guide to Artifacts: Seashells and Ancient Purple Dyeing." p. 100

biological impact, is difficult to cultivate, let alone manipulate, without replicating nature's process of associating color with a physical object. By anchoring the emotional response to the purple portion of the visible spectrum in garments of those who dominated the upper tiers of artificial social hierarchies, the neocortex gradually evolved a new patterned response that associated visual aesthetic of Tyrian purple specifically, with social dominance and economic power. This relationship can only be defined and reinforced within artificial social structures because the relationship is not directly supported by any biological imperative in nature.

The visual and mental association between purple and social dominance still informs the interpretation of Tyrian purple today. The spread of this relationship around the Mediterranean and beyond, is due in part to the attachment of purple to textiles. Easily portable with a stable economic market and functional niche, textiles have an unparalleled ability to cross geographical boundaries due to a highly mobile artifact life cycle, while attached to the bodies of their wearers. Dyeing fabric however, was an inconstant process, because the dyes employed were rather impure and modern instruments did not control the dyeing process. As a result there was a great variation from one dye lot to another,⁸⁶ raising the question of what were the exact shades utilized for social symbols, especially one as entrenched in conveying social dominance as Tyrian purple.

On a chemical level Tyrian purple was one of the only naturally occurring dyes to reflect the 500-400^{nm} portion of the spectrum known in antiquity.⁸⁷ It belongs to the class of indigoid dyes and is chemically characterized by a mixture of indigoid compounds. Blue dye indigo is

⁸⁶ Goldman, Rachael, Roberts, Jennifer, Clayman, Dee, King, Margaret, Brennan, T., and Asirvatham, Sulochana. *Tinturae Romanorum: Social and Cultural Constructions of Color-Terms in Roman Literature*, 2011, ProQuest Dissertations and Theses. p. 2-3

⁸⁷ McGovern, Patrick E., and Rudolph H. Michel. "Royal purple dye: Its identification by complementary physicochemical techniques." *MASCA research papers in science and archaeology* 7 (1990): 69-76.

extracted principally from the leaves of *Indigofera tinctoria*; the main component is *indigotine*, and its isomer *indirubine* is also present in small percentages.⁸⁸ The 6,6'- diobromoindigotin molecule distinguishes Tyrian purple from indigo and other related compounds through the inclusion of two bromide molecules onto the indigotin structure (for chemical formulae reference Figure 2 in image appendix). The inclusion of these two atoms also gives Tyrian purple a distinct chemical property that made it the preferred symbol for social dominance as well as the most expensive dye in antiquity. Tyrian purple is colorfast, meaning that rather than fading out of textile fibers after repeated washing and exposure to the sun, it actually became brighter. Serving a very practical purpose to those who employed it as a symbol connected to their status. Tyrian purple, as a dye, provided upper social strata not only with visual distinction, but also the means for assuring the cleanliness of their status garb.⁸⁹

The chemical foundation for the colorfast property of Tyrian purple lies in the chemical reaction pathways that occur as a result of the inclusion of two bromide atoms to the indogotin base. To instigate that specific chemical reaction chain within leuco base⁹⁰ containing the chemical precursors to the dye, the leuco base must first be harvested from its only natural source, several species of marine mollusk from the family Muricidae.

According to the archaeological record three species of murex mollusk were favored for Tyrian purple dye production; *Banded dye-murex (Phyllonotus or Trunculariopsis trunculus)*, *Bolinus (Murex) brandaris*, and *Thais haemastoma*. *The banded dye-murex* lives in shallow

⁸⁸ Andreotti, Alessia, Ilaria Bonaduce, Maria Perla Colombini, and Erika Ribechini. "Characterization of natural indigo and shellfish purple by mass spectrometric techniques." *Rapid communications in mass spectrometry* 18, no. 11 (2004): 1213-1220. p. 1213

⁸⁹ Reinhold, Meyer. *History of Purple as a Status Symbol in Antiquity*. p. 11

⁹⁰ A colorless compound formed by reducing a dye so that the original dye can be regenerated by oxidation. Dictionary.com. *Collins English Dictionary - Complete & Unabridged 10th Edition*. HarperCollins Publishers. <http://www.dictionary.com/browse/leuco-base> (accessed: March 19, 2016).

shore waters around the Mediterranean Sea at depths from 1.5 to at least 12 meters (around 5 to 39 feet) on rocky bottoms or coarse sand covered with pebbles. The shell has blunt spikes arranged in a spiral band and a broad channeled beak.⁹¹ For this species the purple dye can be made in the absence of light from banded dye-murex (from no other species, however), but the hue obtained may differ from that formed in sunlight.⁹² The second predominant species, *Bolinus (Murex) brandaris*, occupies a sandy, silty, or muddy habitat at considerable depths (10 to 150 meters, around 33 to 492 feet) off the Mediterranean coast. The shells of this species are characterized by an elongated beak and prickly spikes. The archaeological deposit at Tyre is exclusively spiny dye-murex; accordingly, the red-purple manufactured there was the extolled Tyrian purple.⁹³ The last species, *Thais haemastoma*, dwells on rocks in waters less than 150 centimeters (or 5 feet) deep, both in the Mediterranean Sea and, more widely, on the Atlantic coasts of Africa, which becomes important when considering the concentrations of distributed textiles dyed with Tyrian purple in various geographical regions. Thus, *Thais haemastoma* is particularly accessible, although less abundant than the other species. This species' shells are round in shape, and the mollusk is recognizable by the striking red coloration within the large shell orifice that has a characteristically serrated outer edge.⁹⁴

In the body of each mollusk species the precursors for the leuco base for Tyrian purple are located in the hypobranchial gland. The chemical compositions of the dye precursors are all sulfate esters of substituted indoxyls and of indoxyl⁹⁵ itself. "They are converted to indigoid dyes by enzymatic hydrolysis of the sulfate ester, followed by oxidative (air) and photo-oxidative

⁹¹ For a visual of the shells for all three species refer to Figure 3 in the image appendix.

⁹² Zideman, I. Irving. "" BA" Guide to Artifacts: Seashells and Ancient Purple Dyeing." *The Biblical Archaeologist* (1990): 98-101. p. 99

⁹³ Ibid. p. 99

⁹⁴ Ibid. p. 99

⁹⁵ a crystalline compound, C₈H₇NO, that is obtained by the hydrolysis of indican and is readily oxidized to furnish indigo

processes.”⁹⁶ When the fresh biochrome bases are exposed to strong sources of light, i.e., photochemical action, a strong odor resembling "garlic-bromoform" is emitted. Enzyme fractions (purpurases) from each of snail when acting on the leuco bases of other and their own chromogens produce a complexity of color reactions in direct sunlight and in diffused light.⁹⁷ *Murex brandaris* and *Purpura haemastoma* yield mainly the 6,6'-dihromindigotin whereas *Murex trunculus* gives both the brominated and the unbrominated indigotin. At some locations, a particular species might predominate and thereby determine the type of purple dye made locally, for example, blue-purple at Sidon and Sarepta and red-purple at Tyre.

Though the color-fast property of Tyrian purple was highly desired, each mollusk produced only a few drops of the precious secretion, and as many as 10,000 animals were required to make 1 gram of the dye (See Figure 4 in Image Appendix for a single mollusk secretion).⁹⁸ The combination of the staggering amount of murex mollusks required to yield a significant amount of Tyrian purple dye, and the narrow scope of the its natural habitat strictly limits the number of origin points for the purple trade as an economic venture. Evidence from the archaeological record points to two competing locations from which Tyrian purple could be both economically exploited and exported: Middle Bronze Age Minoan Crete and Late Bronze- Early Iron Age Phoenicia, particularly the island of Tyre, which gives the color its name.

In addition to shells there are three other archaeological artifacts connected with purple dyeing: dyeing installations, colored potsherds, and dyed textiles.⁹⁹ The Minoan argument, however, lacks two explanations: the first, is an explanation for how the dye was spread around

⁹⁶ McGovern, Patrick E., and Rudolph H. Michel. "Royal Purple dye: tracing the chemical origins of the industry." *Analytical Chemistry* 57, no. 14 (1985). p. 1516 A

⁹⁷ Jensen, Lloyd B. "Royal purple of Tyre." *Journal of Near Eastern Studies* 22, no. 2 (1963). p.109

⁹⁸ Ratio cited from McGovern, Patrick E., and Rudolph H. Michel. "Royal purple dye: the chemical reconstruction of the ancient Mediterranean industry." p. 152

⁹⁹ Ziderman, I. Irving. "" BA" Guide to Artifacts: Seashells and Ancient Purple Dyeing." p. 100

the Mediterranean basin, reaching its apex of production and subsequent display under the imperial agenda of the Roman Empire. The second is any concrete archaeological evidence, which supersedes relative association, of either Minoan or Mycenaean Crete exporting the finished dye product to an international market. The strongest piece of evidence produced to answer these questions is a significant epigraphic find at Knossos (tablet KN X976), which actually contains the expression *wa-na-ka-te-ro-po -pu-re-[]* 'royal purple'.¹⁰⁰ The first written attestation of a term which in later ages became synonymous with Tyrian purple is articulated in Mycenaean Greek, signifying that the visual and mental association between Tyrian purple and the elite was extant by 1400 BCE. The content of the tablet however, is limited to only textile allocation, and Stieglitz does not elaborate whether these allocations were comprised of imports or locally made commodities.

In contrast, the Phoenician origin hypothesis has a piece of critical evidence, lacking in the Minoan hypothesis; a colored potsherd chemically determined to contain the distinctive dibromoindigotin molecule that characterizes Tyrian purple. This particular sherd was from Sarepta, a site on the coast of Lebanon, and found in relative association with an industrial dye works complex and a pile of crushed murex shells nearby, primarily *M. trunculus*.¹⁰¹ Though Stieglitz dismisses the Phoenician origin theory for the Tyrian purple trade, as the product of a popular rationalization, dating back to the Roman era.¹⁰² Their preeminent role in the Mediterranean industry has been quantifiably re-substantiated by the chemical identification of dibromoindigotin on the interiors of 13th century BCE "Canaanite" jars, utilized for storage and

¹⁰⁰ Stieglitz, Robert R. "The Minoan origin of Tyrian purple." p. 52

¹⁰¹ McGovern, Patrick E., and Rudolph H. Michel. "Royal purple dye: the chemical reconstruction of the ancient Mediterranean industry." p. 153

--Cf. McGovern, Patrick E., and Rudolph H. Michel. "Royal purple dye: Its identification by complementary physicochemical techniques." *MASCA research papers in science and archaeology* 7 (1990). p. 71

¹⁰² The Greek rhetorician Julius Pollux, in the second century BCE, related a charming tale (Onomasticon 1.45-48) of how the hound of Herakles bit into a murex fish on the shore at Tyre and thus discovered its dye. Stieglitz, Robert R. "The Minoan origin of Tyrian purple." p. 49

mercantile shipment. Chemically, the evidence from Sarepta provides the earliest attestation of the dye from anywhere in the world, and significantly, it was found in the homeland of the Phoenicians.¹⁰³ Regardless of whether the Phoenicians were the originators of the Tyrian purple production, the presence of diobromoindigotin in pottery sherds from a Canaanite jar type, which has been documented by archaeologists in other areas around the Mediterranean supports the hypothesis, that the Phoenicians were the first to move Tyrian purple dye across geographic boundaries for economic exchange.

The Phoenicians were an ethnic segment of the ancient Canaanite people, occupying several cities along the west coast of the Levant, such as Sidon, Byblos, as well as the island of Tyre. The name Phoenician and Phoenicia, however, originates linguistically from the Greek word meaning “red skinned,”¹⁰⁴ an association derived from their most lucrative product, textiles colored with color-fast “Tyrian purple dye.” Purple dye, which according to Ziderman was characterized by reddish hue when held up to sunlight, resulting from the exploitation of a murex population that consisted solely of the *Bolinus Murex brandaris* species, hence “red-skinned”.¹⁰⁵ Though the archaeological evidence from Sarepta points to an instance of locally sourced acquisition of Tyrian purple dye; the emergence of the conditions necessary to foster the widespread disbursement of this particular commodity to Greece and the wider Mediterranean would occur several centuries later.

To understand emergence of the Phoenician maritime empire along with its corresponding monopoly over Tyrian purple dye production has to be situated in a wider matrix of contemporary political and economic activity. According to Susan and Andrew Sherratt, a

¹⁰³ McGovern, Patrick E., and Rudolph H. Michel. "Royal purple dye: the chemical reconstruction of the ancient Mediterranean industry." p. 153

¹⁰⁴ “Chapter 1” Herm, Gerhard. *The Phoenicians : The Purple Empire of the Ancient World*. New York: Morrow, 1975. P. 13

¹⁰⁵ Ziderman, I. Irving. "" BA" Guide to Artifacts: Seashells and Ancient Purple Dyeing." p. 99

new pattern that would create an economic system dependent on material culture far beyond what had occurred in the Bronze Age, had already begun to form in the centuries before 1000 BC. It formed in the processes which underlay the disappearance of the Bronze Age palace centers and the new social forces which were released by their dissolution.¹⁰⁶ The pattern was characterized by active intervention and response. Local maritime exchange cycles and routes of long-distance trade were already in existence, and the centers of future growth were already evident; but what articulated them into a single interacting system was the input of capital from the east. Large sailing vessels, and the economic organization which made them possible, drew together the fortunes of communities throughout the Mediterranean. The Phoenician trading diaspora created contacts with societies at very different levels of social and economic organization; temples and sanctuaries formed important meeting points between the different economic systems of Phoenician and indigenous groups.¹⁰⁷

“The geographical pattern which emerged was a primary zone of capital- and labor-intensive manufacturing, from the Levant to the southern Aegean, surrounded first by a zone of higher value agricultural products and then by a grain-growing belt in Cyrenaica, Sicily/ southern Italy and the Black Sea. Beyond this, separate centers of manufacturing, with their own supply zones, came into existence in Etruria and Tunisia. Establishing a complex pattern of competition as the more heavily capitalized areas of the east Mediterranean tried to outflank their control of the rich hinterland of temperate Europe.”¹⁰⁸

The emergence of the East in the Iron Age as the economic powerhouse within the new evolving pattern for commodity distribution, placed Phoenicia in the ideal crucible through which to

¹⁰⁶ Sherratt, Susan, and Sherratt, Andrew. "The Growth of the Mediterranean Economy in the Early First Millennium BC." *World Archaeology* 24, no. 3 (1993). p. 361

¹⁰⁷ Sherratt, Susan, and Sherratt, Andrew. "The Growth of the Mediterranean Economy in the Early First Millennium BC." p. 275

¹⁰⁸ *Ibid.* p. 275

determine the perfect process for producing Tyrian purple dye on a mass scale and to set the price standard for the finished textile. Part of what gave Tyrian purple the predominance it had as a status symbol was its color-fast chemical properties, but more important was the price tag which reflected the labor intensive process involved in exploiting those chemical properties on a massive scale. As stated previously, 10,000 mollusks were required to make 1 gram of Tyrian purple dye, Phoenicia had the only available source of murex mollusks for exploitation in the early centuries of the first millennium BCE, in proximity to several burgeoning economies of Eastern empires. Empires that needed symbols to reinforce the divisions of their own social hierarchy and therefore could provide an influx of both demand and capital. A lack of competition in the Eastern Mediterranean after the Bronze Age collapse, allowed the Phoenicians not only to perfect their manufacturing technique, but to establish a monopoly based on that technological knowledge wherever murex habitats were available

Image Appendix

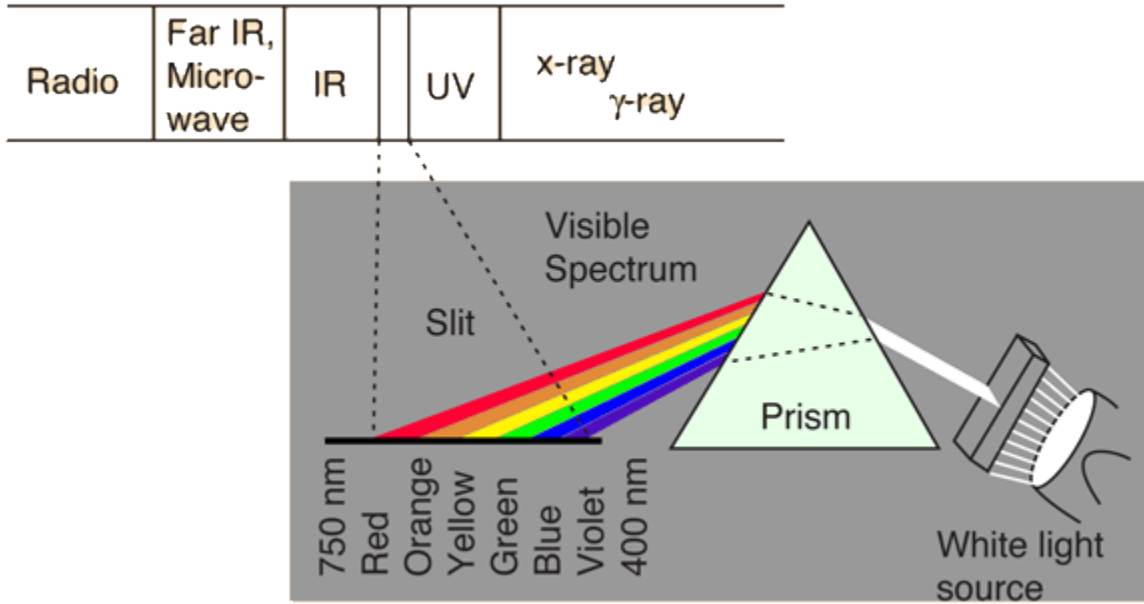


Figure 1: Newton's prism experiment from 1666 that discovered the wavelengths that compose the spectrum of colors visible to the naked eye. As displayed by the image, the visible spectrum is only a small portion of the physical wavelengths that interact with the physical universe. Image courtesy of <http://hydrogen.physik.uniwuppertal.de/hyperphysics/hyperphysics/hbase/ems3.html>.

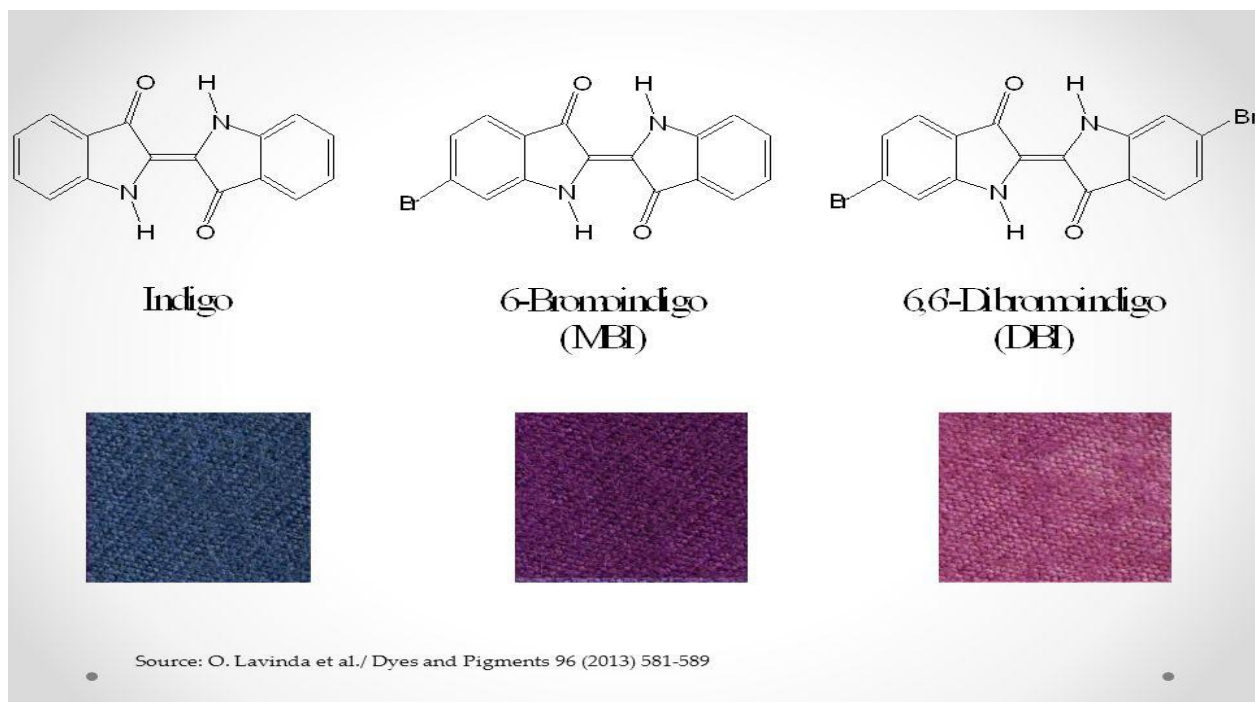


Figure 2: Chemical formulae for indigo, 6-Bromoindigo (another indigoid dye), and 6,6'-dibromoindigotin and their resultant colors. All of them occupy the 500-400 nm portion of Newton's visible spectrum. Image courtesy of Lavinda, Olga, Irina Mironova, Sasan Karimi, Federica Pozzi, Jacopo Samson, Hiroko Ajiki, Lou Massa, and Keith Ramig. "Singular thermo-chromic effects in dyeing with indigo, 6-bromoindigo, and 6, 6'-dibromoindigo." *Dyes and Pigments* 96, no. 2 (2013): 581-589.

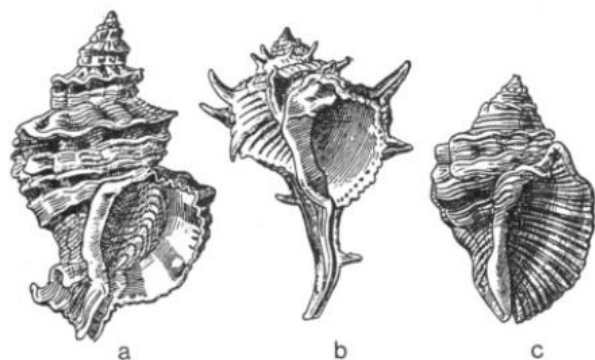


Figure 3: Intact shells for the three types of Murex mollusk, exploited for the production of Tyrian purple dye. Image courtesy of McGovern, Patrick E., and Rudolph H. Michel. "Royal purple dye: the chemical reconstruction of the ancient Mediterranean industry." *Accounts of Chemical Research* 23, no. 5 (1990): 152-158.



Figure 4: Live murex mollusk, secreting its hypobranchial fluid, containing the dibromoindigin compound onto the sand. Image courtesy of <https://smediacacheak0.pinimg.com/736x/99/04/7f/99047f84e54619a2c0837afc922e3066.jpg>.

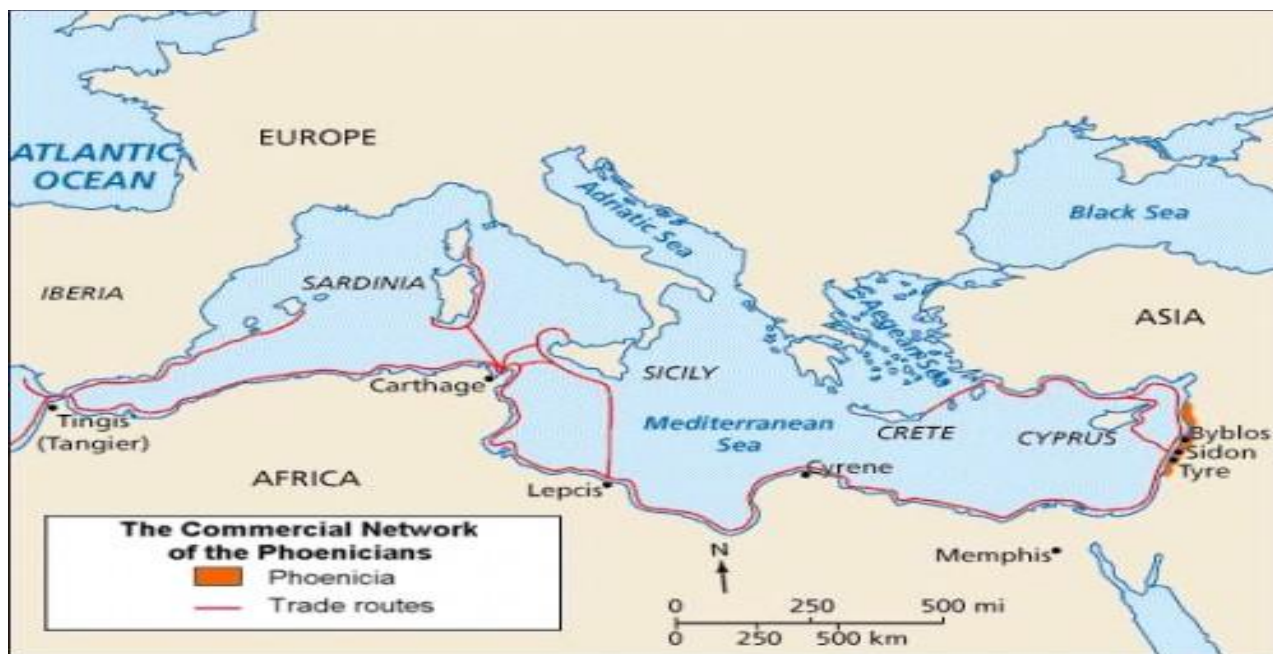


Figure 5: Reconstruction of Phoenician Settlements and Trading routes. Image courtesy of Joshua J. Mark. "Tyre," Ancient History Encyclopedia. Last modified September 02, 2009. <http://www.ancient.eu/Tyre>

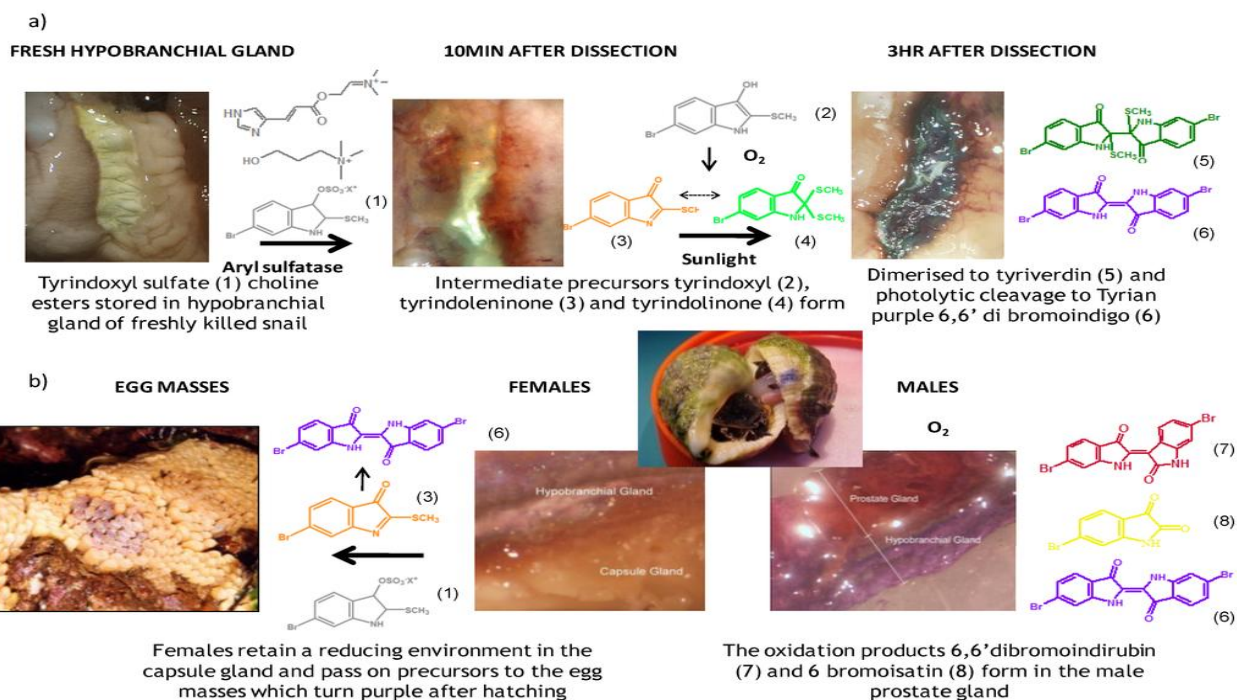


Figure 6: Diagram of the chemical reactions taking place among the Tyrian purple dye precursors in the hypobranchial glands of murex mollusks. Image courtesy of Benkendorff, Kirsten. 2013. "Natural Product Research in the Australian Marine Invertebrate *Dicathais orbita*." *Mar. Drugs* 11, no. 4: 1370-1398.

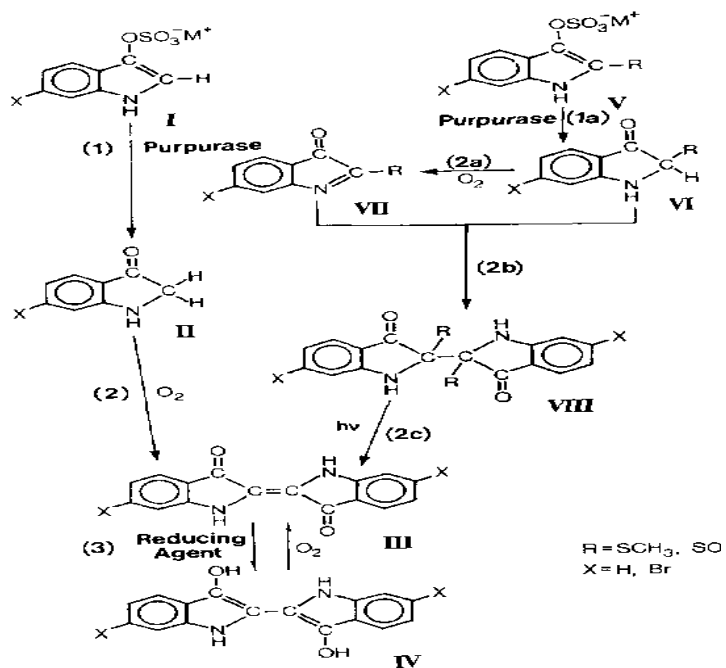


Figure 7: Another representation of the Chemical pathways and reactions caused by the exposure of Tyrian Purple dye precursors to sunlight. Image courtesy of McGovern, Patrick E., and Rudolph H. Michel. "Royal Purple dye: tracing the chemical origins of the industry." *Analytical Chemistry* 57, no. 14 (1985): 1514A-1522A.

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