# The Roman "Frantic Passion for Purple" (Pliny 9.66):

## A Geographic Analysis of the *Murex* Dye Industry from the late Roman Republican Period to Late Empire

A thesis submitted by

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*Abstract*

*Murex* snails (*murex trunculus*) were popular in antiquity because they were used to create the famed "Tyrian Purple" dye. During the Roman Republic and Empire, the dye was expensive and employed to display social status among the ruling elites. This thesis focuses on the archaeological evidence of Roman murex production, distribution, and consumption, and includes a provisional gazetteer of murex producing sites. Analysis of the data suggests that around the mid 3rd century B.C.E., there was an expansion of *murex* dye production sites which subsequently contracted during the later Empire. Sites also cluster on the coast of North Africa, and in this region, have the longest period of usage. This thesis argues that the expansion of *murex* dye sites can be attributed to the influx of agricultural and luxury goods being imported into Rome during the late Republican and early Empire period. During this period, North Africa was also exporting olive oil, fish products, and textiles to Rome. Because the coastal North African cities were already exporting many products to Rome, had the labor and production facilities necessary to create the dye, and also clearly had access to abundant *murex* snail population, it made sense that North African cities would also add *murex* dyed textiles to the exports sent to Rome. During the Empire, *murex* dye continued to grow in popularity, which in fact influenced the contraction of dye sites shown in the gazetteer. This contraction occurred in the 3rd century C.E., during the "Imperial Crisis". The elite were fearful of their status symbol losing its meaning and value because of the increased consumption. As a result, Roman emperors then placed restrictions on the consumption of purple dye, thereby decreasing the number of dye sites needed to supply the Empire.

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## I. Introduction

*Murex* snails (*murex trunculus*) were used throughout antiquity to produce a coveted purple dye, which symbolized status, power, and wealth. The production and demand for *murex* is discussed in a number of ancient texts, all suggesting that, though the appeal of *murex* was not shared by all, the majority of Romans recognized it as a means to display social status and luxury, as well as political power. The textual evidence is complemented by an expanding body of archaeological evidence, which indicates that the industry was most important during the late Republican and early imperial periods, when there was an influx of agricultural and luxury goods in Rome. Because *murex* snail habitats were not limited to any particular area of the Mediterranean, and were one of many snails used to make dye, various types of dye installations have been identified. However, to date there has been no systematic study of these facilities for the purposes of establishing a working typology. In fact, there are a large number of archaeological sites which have been inaccurately identified as belonging to the *murex* industry, thereby skewing analyses of the production, distribution, and consumption of purple dye in antiquity.

As a contribution to addressing this problem, the purpose of this thesis, therefore, is twofold. I present a provisional typology, gazetteer, and Geographic Information System (GIS) dataset of murex production sites active in the Roman period (1$^{st}$ c. B.C.E. - 5$^{th}$ c. C.E.). Then, I situate the *murex* industry within the larger Roman economy. Roman period dye sites will be specifically focused on first, because of the inherent value of the dye to the Romans, second, because dye production is linked to many other modes of production, and finally, because there is a clear relationship between the manufacture

and usage of the dye to the economic climate of the period. It is hoped that this thesis will stimulate a series of refinements in the field, to properly identify *murex* dye manufacture, so that all sites in the future might be identified in this way.

From these analyses, it shall become clear that the *murex industry* experienced an expansion and contraction, with a substantial clustering of dye installation sites in North Africa. I argue that the growth of *murex* dye production sites in North Africa beginning in the late Republic formed part of the larger agricultural export economy which developed in the African provinces under the empire, chiefly intended for Rome and Italy. The eventual contraction of sites in the late Roman period is perhaps a consequence of growing security concerns on the part of the Roman government to control purple dye accessibility as the latter became an important symbol of imperial power as manifested in the emperor himself. The restrictions placed on dye consumption eliminated the need for a large number of *murex* dye production sites, which therefore explains the expansion and contraction in number of dye sites from the late Republic to Empire.

## II. Ancient References to *Murex* Dye

Our understanding of *murex* dye emerges from the ancient sources. Among the countless references to purple dye, and *murex* specifically, Pliny is the most valuable account because of the amount of information he provides. His *Natural History* describes the dyeing process, the value of purple dye, and price fluctuations over the course of the Roman period. From Pliny, we understand that the carnivorous snails were caught via baited baskets.

Figure 1: Snails are believed to have been caught via baiting a wicker basket and dropping it in the ocean; the carnivorous snails would then have latched on to get the bait.[1]

The shells were removed so that the hypobranchial vein could be harvested. This vein was then soaked in salt for three days at most. Pliny cautioned that the dye would be more vibrant when the glands were fresh, and thus salting the veins, though necessary,

[1] Nira Karmon, and Ehud Spanier, "Archaeological Evidence of the Purple Dye Industry from Israel," In *The Royal Purple and the Biblical Blue: Argaman and Tekhelet,* Ehud Spanier, eds. (Jerusalem: Keter Publishing House, Ltd. 1987), 148.

needed to be done in moderation. Boiling proceeded in lead vessels[2] over moderate heat: "for which purpose the vessel is placed at the end of a long funnel, which communicates with the furnace."[3] After a maximum of ten days (or until the color of the dye had reached a satisfactory shade), wool or other cloth was dipped into the dye. The cloth had to be soaked for five days at least, the length of time dependent on the type of mixtures used with the *murex.* The dyed cloth would then be exposed to sunlight to trigger the dyeing color.

Pliny also discussed the varying hues of purple that could result from dyeing, and the value (in monetary and social terms) of each; a dark "blood" purple, usually from Tyre, is the most valued. The dyes would alter in color from a variety of factors: how long the dye was boiled, how long the dyed cloth was exposed to sunlight, as well as the use of additives such as kermes or urine. This process was perfected before the Romans, by either the Minoans or Tyrians (a topic of much debate).[4] Regardless of origin, the fact that the dye continued being used from the Bronze Age onwards is an indication of its value. The Romans drew a longstanding association between the dye and their cultural

[2]This translation is often debated (see proceeding commentary on Doumet). The phrase "fervere in plumbo" [Pliny the Elder, *Natural History*, John Bostock, eds. (London: Taylor and Francis, 1855), 9.70] translates as "boiled in lead," and it is generally acknowledged that a metal vessel would alter the color of the dye. However, Pliny has been noted for using "plumbo" to signify "tin" (see translation of section 9.70 in Bostock). The proceeding discussion of Doumet and Koren's dyeing methodology explains the outcome of such discrepancies.

[3] All Latin translations in this thesis are my own. Pliny 9.70: ac modico vapore torreri et ideo longinquae fornacis cuniculo.

[4] Some rely on the evidence of evidence of *murex* usage being on Crete dating to 1500 B.C.E. to attribute the invention of *murex* dye to the Greeks. However, the Phoenicians have long held the title of being the earliest users of *murex* dye. According to Lord B. Jensen: "Phoenician trading posts in pre-Hellenistic Greece and islands like Salamis and other Semitic names sites, tincture the picture deeply in favor of a [Phoenician origin]" [Lord B. Jensen, "Royal Purple of Tyre," *Journal of Near Eastern Studies* 22, no. 2 (April 1963): 105-6]. According to the Greek origin supports, the misidentification of the Tyrians as the originators of *murex* dye was a result of their having the highest quality dye [Gerhard Forstenpointer, et al,"Purple-Dye Production in Lycia-Results of an Archaeological Field Survey in Andriake (South-West Turkey)," *Oxford Journal of Archaeology* 26, no. 2 (2007): 206].

origins. According to Pliny, the first usage of purple in Rome dated to Romulus' use of it. This usage instigated popularity amongst other influential members of Roman society:

> I see the use of purple always had been at Rome, but Romulus (was) in a mantle with purple stripes. For by means of a toga praetexta and with a wide stripe, the enemy having been carried, it is agreed the first use was by the king, the Etruscans having been sufficiently defeated. Nepos Cornelius, who by means of the divine Augustan rule, left behind: "Me," he said, "with youth the vigorous purple thrived.[5]

It is uncertain whether or not the wearers of *murex* dye actually liked the shade that the snails produced. Regardless, they held a strong appreciation for the dye because of its value, which was universally acknowledged in Rome. Pliny helps us understand:

> To these, the bundles of rods and hatchets of Rome made the way, and the same was for the majesty of childhood and distinguished the senator from the knight, it was called for appeasing the god, and illuminating every cloth, in triumph mixed with gold.[6]

Thus, the purple shade was valued because it enabled certain ranks of society to be recognized, and because (to be discussed in a later section) of the monetary value associated with making it. The dye was a distinguishing feature of aristocratic attire, serving as a means to visually separate the elite from the lower class. The toga praetexta mentioned by Pliny was one of several distinctive garments which used the dye. It was a white wool toga with a purple hem and red sleeves, worn by the senators. The toga picta was completely purple, with gold embellishments, and meant to reference Jupiter Optimus Maximus. This toga was first worn by Julius Caesar, and then by later emperors

[5] Pliny 9.60.39: purpurae usum romae semper fuisse video, sed romulo in trabea. nam toga praetexta et latiore clavo tullum hostilium e regibus primum usum etruscis devictis satis constat. nepos cornelius, qui Divi Augusti principatu obiit: "me," inquit, "iuvene violacea purpura vigebat.

[6] *Ibid* 9.60.4-10: fasces huic securesque romanae viam faciunt, idemque pro maiestate pueritiae est, distinguit ab equite curiam, dis advocatur placandis omnemque vestem inluminat, in triumphali miscetur auro.

but only on certain occasions.[7] Not only in clothing related directly to the governmental and religious appointments was the dye used. "Influential groups often were permitted to wear a few stripes as the Empire aged and declined."[8] These changes will be discussed more in detail later, the main point being that the actual color of the dye had nothing to do with its popularity, beyond it being a way to recognize the social and monetary value of the dyed cloth. The Romans were not in fact passionate for their color purple, only the symbolism connected to it.

Other ancient authors reference the dye. Strabo, in his *Geography* states that purple dye was available as far as Sicily,[9] and discusses specifically the quality of Tyre's dye:

> The shell-fish are caught near the coast; and the other things requisite for dyeing are easily got; and although the great number of dye-works makes the city unpleasant to live in, yet makes the city rich through superior skill of its inhabitants.[10]

According to Vitruvius, the differing shades of purple mentioned by Pliny derived from the region which created the dye. Eastern and western regions of the Mediterranean show the purplest hues, while the south has reddish quality:

> However that was removed out of the marine (spiral) mollusk, from which purple is made, that there are not less of marvels than the others of nature for the people considering, because it has not in all places, at which it is born, tempered naturally by the course of the sun. Therefore because it was chosen in the Pontis and at Gallia, because these regions are closest to the north, it is very dark. By those going forth between the north and the west, a blueish purple was found. However because that which is collected for those going towards the east and west orient, is found with a violet color; that which is snatched up from the southern regions and is created with red potency, and to such an extent was

[7] Jensen 115.
[8] Jensen 115.
[9] Strabo, *Geography of Strabo*, ed. H. L. Jones, (Cambridge: Harvard University Press, 1924), 6.10.
[10] *Ibid* 16.2.23.

> created at the island of Rhodes furthermore and at other regions of this type which are closest to the path of the sun.[11]

Thus, the works of Pliny, Strabo, and Vitruvius demonstrate that the variety of hues *murex* snails could create were linked to status in Roman society, and these dyes were used since the founding of Rome. The importance of this dye to Roman society is then clear, and worth investigation.

[11] Vitruvius Pollio, *De Architectura*, F. Khron, eds. (Teubner, 1912), 7.13.2-3: id autem excipitur e conchylio marino, e quo purpura efficitur, cuius non minores sunt quam ceterarum <rerum> naturae considerantibus admirationes, quod habet non in omnibus locis, quibus nascitur, unius generis colorem, sed solis cursu naturaliter temperatur. Itaque quod legitur Ponto et Gallia, quod hae regiones sunt proximae ad septentrionem, est atrum; progredientibus inter septentrionem et occidentem invenitur lividum; quod autem legitur ad aequinoctialem orientem et occidentem, invenitur violaceo colore; quod vero meridianis regionibus excipitur, rubra procreatur potestate, et ideo hoc Rhodo etiam insula creatur ceterisque eiusmodi regionibus, quae proximae sunt solis cursui.

## III. Historiography

Our knowledge of purple dye production and distribution in antiquity is substantial, thanks to the research which has focused on ancient texts. Earlier scholarship on dye production focused on the origins of the dye,[12] but more recently attention has taken an interdisciplinary focus, leaning towards scientific and economic methodology.[13] This interdisciplinary focus, and the works of a few noted scholars, has led to three major areas of research in the field: dye production methodologies, the geographic spread of *murex* related evidence, and the economic implications of the dyeing industry. The latter two are the newest and least developed.

Researchers focusing on recreating *murex* dye have most often used Pliny's descriptions as a standard recipe. In part, understanding Pliny's methodology is difficult because of the array of *murex* dye he discusses. *Murex* could be mixed with a variety of substances, and as a result, Pliny has offered three separate methods. Besides the one previously discussed, he states:

> Thus meat having been spit out afterwards, which was necessary to adhere to the veins, by the tenth day nearly, fleece having been tub washed is submerged for experiment and, when there was enough of hope, the liquid is boiled. The red color is worse than being black.[14] Five hours at a time the wool drinks and having been carded again it is submerged, until it drinks all the red colored remnants. Buccinium is condemned through itself, because it remits dyes. In measure it is bound to Pellagio and it gives that saturation (darkness) and brightness of scarlet which is sought. Thus the strengths having been mixed one is excited by the other

[12] See Gleba and Jensen.
[13] See Baker, Doumet, Edens, Gleba, Karmon and Spanier, Koren, Reese 2010, Ruscillo 2000, Ruscillo 2006, Sagona, Wilson 1999, Wilson 2002a, and Wilson 2002b in bibliography. It is rare though, that all of these topics are considered in one discussion. Scholarly focus has been engaged with the Bronze Age production of *murex* dye, primarily with the debate as to whether the manufacture first occurred in Crete or in Tyre. They focus on the subsequent control that the Tyrians had over the industry because of their strong connections to trade and ability to establish settlements outside of their own region to harvest snails for dye (Jensen 107). The appearance of a new periodical, *Dyes in History and Archaeology*, has done much to contribute to an interdisciplinary focus on dye manufacture, and especially, *murex* dye (Wild 25).
[14] Meaning that a darker, blacker, shade is desired as opposed to a red shade.

> or the one is restrained by the other, the sum of the mixed substances towards pounds of fleeces 200 bucinni and from the Pelagium 111. Thus that one, the famed color was of amethyst. But Tyrian (dye) was first saturated with Pelagio but with the remnants being unripe and green, soon it is transformed in (a vat of) Buccinium. The highest color has to that in the color of congealed blood, being dark in respect to appearance and also flashing in regards to close inspection. From where blood is said to be purple in Homer.[15]

Z.C. Koren claims to have achieved the first "all natural" dye since antiquity, because he managed to correctly follow Pliny's recipe.[16] He determined that seven snails and 70 g of sodium carbonate are required to dye fully one gram of wool. To achieve the lightest shade, three snails are sufficient.[17] Building on Koren, Deborah Ruscillo determined that without baited baskets, hand collection would reduce the collection rate of 100 snails per hour by 70%.[18] According to her study, Pliny's instructions to steep fabric for 12 days in fact over processed the dye. The result was fabric dyed a dull purple-gray color. After

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[15] "Ita despumatis subinde carnibus, quas adhaesisse venis necesse est, decimo ferme die liquata cortina vellus el*u*triatum mergitur in experimentum et, donec spei satis fiat, uritur liquor. rubens color nigrante deterior. quinis lana potat horis rursusque mergitur carminata, donec omnem ebibat saniem. bucinum per se damnatur, quoniam fucum remittit: pelagio ad modum alligatur nimiaeque eius nigritiae dat austeritatem illam nitoremque qui quaeritur cocci. ita permixtis viribus alterum altero excitatur aut adstringitur. summa medicaminum in libras * * * vellerum bucini ducenae *e*t e pela*g*io cxi.. ita fit amethysti colos eximius ille. At tyrius pelagio primum satiatur inmatura viridique cortina, mox permutatur in bucino. Laus ei summa in colore sanguinis concreti, nigricans aspectu idemque suspectu refulgens. unde et homero purpureus dicitur" (Pliny 9.60.38-40).

[16] Joseph Doumet performed a similar study in 1980. It is one of the earliest scientific attempts at recreating the dye. His study yielded three plausible methods of dyeing. The first, and most simple, is to immerse crushed shells into seawater, and then steep the fabric immediately in the bath; if the dye is not used immediately it will quickly precipitate. The second method used a metal pot, tin specifically, at a low temperature. The third method was the most similar to Pliny's method, involving steeping the fabric in vats for several days [Joseph Doumet, *A Study on Ancient Purple* (Beirut: Imprimere Catholique, 1980), 47]. Doumet claims that Pliny's reference to "fervere in plumbo" calls for boiling in a tin pot, which he used in his experiment. He believed that this tin is what acted as a reducing agent in the process. Koren explains Doumet's perspective: "Pliny stipulated that the purple dyeing should be performed in a 'leaden pot'… Doumet inferred that 'lead' may not have referred to the lead metal itself, but to 'white lead', a Roman term for tin." Koren then determines that the issue of metal being required by Doumet to activate the dye can be resolved elsewhere. In his method, he uses a clay vessel, *murex* shells, heat, and then an alkaline material mixed in (such as sodium carbonate, plant or wood ash, or lime). The usage of this alkaline material is the additive necessary to create the same reaction as does a metal vat [Z. C. Koren, "The First Optimal All-Murex All-Natural Purple Dyeing in the Eastern Mediterranean in a Millennium and a Half," in *Dyes in History and Archaeology* (London: Archetype Publications, 2005), 139-142].

[17] Koren 145, 142.

[18] Deborah Ruscillo, "Faunal Remains and *Murex* Dye Production" in *Kommos V: The Monumental Minoan Buildings at Kommos* edited by Joseph W. Shaw and Maria C Shaw (Princeton: Princeton University Press, 2006), 811-12.

many attempts, she found that steeping for more than three days was unnecessary. Additionally, the color of the dye was more vibrant when urine was mixed into the dye. Using wool instead of silk or cotton achieved the same result.[19] Ruscillo also calculated that 125 cm of wool required 200 *murex* snails. From this number, she projected that dyeing an entire cloak would require 5000 snails.[20]

M*urex* scholarship has also focused on the identification of dye production facilities.[21] Ehud Spanier and Nira Karmon, working on Bronze Age sites in Israel, argued that the number of *murex* shells needed to create dye should be reflected in the number of *murex* shells found at a site where dyeing took place. If thousands of shells were needed to dye a small amount of cloth, any dye industry site would likely have several thousands of crushed shells. Spanier and Koren work thus challenged the assumption that the presence of *murex* shells at a site (either whole or crushed) is indicative of dye manufacture, even in a small number.[22] Their conclusions are extremely helpful because of the fact that this area of *murex* study is problematic. All too often, dye sites have been misidentified because other scholars have not considered the fact that a small amount of shells could not be indicative of dye manufacture occurring.

David Reese has compiled data on hundreds of sites in the Near East with evidence of *murex* usage extending down through the Roman period. His work has been quite helpful for this research because he identifies sites with usage, which can then later

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[19] *Ibid* 2006, 813-815.
[20] *Ibid* 2006, 815.
[21] See David Reese "Marine Shells," in *Tel Mor: the Moshe Dothan Excavations: 1959-1960* edited by Tristan J. Barako, (Cambridge: The Shelby White-Leon Levy Program for Archaeological Publications, 2007), 233-238 and David Reese, "Shells from Sarepta (Lebanon) and East Mediterranean Purple Dye Production," *Mediterranean Archaeology and Archaeometry* 10 no. 1 (2010): 113-141. These discussions demonstrate how research will occasionally list sites with *murex* evidence of any nature, without any assertions as to whether the evidence implies there was dye production.
[22] Karmon and Spanier 171-191.

be investigated further to understand the nature of the usage. Margarita Gleba's work on the textile manufacturing system in Italy also provides useful insights into the production of dye, dyeing techniques, fulling, as well as distribution of weaving tools. Though her focus is primarily on Italian production, she emphasizes trade relationships with other regions, Gleba contends that dye production and cloth production occurred in the same facilities.[23] Such a relationship suggests that textile evidence should be considered alongside dye production evidence.

More recently Andrew Wilson has attempted to determine the most accurate way of identifying Hellenistic and Roman period murex production sites chiefly in North Africa. [24] He discusses about 15 sites which were involved in fish-salting, garum, lime, and dye, and points out the similarities between these industrial facilities. As a result, Wilson is able to identify sites which have been misinterpreted as dye production sites,[25] and sites which are in his eyes sites that produced *murex* dye. His research is also helpful from an economic standpoint. [26] He makes clear connections between *murex* dye

[23] Margarita Gleba, *Textile Production in Pre-Roman Italy* (Oxford: Oxbow Books, 2008), 197-199.
[24] See Andrew Wilson, "Commerce and Industry in Roman Sabratha," *The Annual Report of the Society for Libyan Studies* 30 (1999): 29-52; Andrew Wilson, "Timgad and Textile Production" in *Economies Beyond Agriculture in the Classical World* eds. David J. Mattingly and John Salmon (London: Routledge Press, 2001); Andrew Wilson, "Urban Production in the Roman World: The View from North Africa," *Papers of the British School at Rome* 70 (2002): 231-273; and Andrew Wilson, "Archaeological Evidence for Textile Production and Dyeing in Roman North Africa," in *Purpurae Vestes*: *I Symposium Internacional Sobre Textiles y Tintes del Mediterraneao en Epoca Romana,* C Alfaro, J.P Wild, B Costa, eds., (Valencia: University of Valencia) 2002.
[25] Cuicul, a site which has certain features believed to be indicative of *murex* dye production (heating facilities, vats, etc.). Though no *murex* shells were found, excavators decided it was a dyeing site because of the presence of a yellow liquid deposit in the mortar, which appeared similar to the liquid secretions of *murex* shells before the dye is processed. Wilson points out the lack of *murex* dye evidence: the deposit was never analyzed, and the "dyeing facilities" found in an altered bath house, though they could have been for dyeing, had no indications that *murex* specific dyeing took place. He points instead to the possibility of the town having dye facilities with plant related material, because he recognizes that the vats were for dyeing (Wilson 2002b 158).
[26] See Wilson 2002a.

production and other modes of production, so it is understood that *murex* dye production was clearly linked to other modes of production in these North African towns.

Wilson and Gleba's discussions have initiated the economic analysis of *murex* dye production. Gleba's emphasis on understanding how Italian specific textile production can be linked to the greater Mediterranean in conjunction with Wilson's focus of how several industries are linked to *murex* dye production indicates the direction which the field needs to go towards. *Murex* dye production needs to be assessed on two scales: how the industry affected the single town in was produced in, and how it was linked to the greater Roman economy.

## IV. The Archeological Evidence of *Murex* Production in the Roman Period

### i. Typology

The *murex* sector of the ancient economy reached its peak in terms of structure, production, distribution, and consumption under the Roman Empire. This is apparent not only in the textual record, but increasingly through archaeology, as many new Roman period *murex* production sites have been identified in recent decades. That being said, we are still in the early stages of understanding how this industry functioned under the Empire.

I have identified seventeen sites to have significant *murex* related evidence pointing towards an involvement in the dyeing industry. To better understand and interpret these sites I have developed a provisional typology. This typology is based on the evidence of the sites themselves, and our current understanding of *murex* dye production. Establishing such a typology is difficult for several reasons. Many sites have been mistakenly identified by archaeologists as having definitive *murex* dye production evidence. These sites have been misidentified because the *murex* related evidence found was not related to dye production. *Murex* snails were also eaten, and the shells could also be used as decoration. *Murex* snails could be used as additives to create cheaper dye. However, the evidence of such usage would not manifest itself in piles of thousands of shells, as indicated Karmon and Ruscillo's ratios.[27] All of these different types of usages

[27] Reese's discussion on Capernaum, Israel is a good example of the many ways that *murex* usage can be misinterpreted. He claims the site was involved in dye production. The *murex* finds consisted of 65 whole (uncrushed) *murex* snails on the floor of a Byzantine house. He then relates these whole *murex* to a dump of mixed shells, *murex* among them, about half a kilometer away from the tell. He claims that there must have been dyeing facilities near the Byzantine house, and that the crushed remnants were moved outside to the dump after dyeing (Reese 2010, 121). There are many issues with this conclusion. First, the only concentrated *murex* shells found were located in a house. This would mean that the whole snails were stored inside the city, moved to dyeing facilities, and then afterwards the crushed shells would be carried

have been confused by archaeologists as being evidence for *murex* dye manufacture. To further confuse the situation, archaeological reports will often state that dye manufacture occurred at a particular site without actually discussing the evidence for this conclusion.

Thus, establishing a typology necessitates the very difficult task of sifting through many misinterpretations of sites to understand what usages of *murex* indicate *murex* specific dye production occurred. Further, after the various probable production centers were identified, common attributes had to be decided upon, and they needed to be arranged in a comprehensible and usable manner. One of the goals of the gazetteer was for it to be usable in future study. Thus, the organization of site types needs to clearly demonstrate the relationships between sites of types. Ultimately it is my hope that the gazetteer has been implemented in such a way that: 1) the sites in the gazetteer could easily be moved into a different category and 2) the categories could be used as a starting point for future analyses.

The following is a provisional typology of murex sites active in the Roman period:

*Type 1: Murex Dye Production Sites*

Sites in the Type 1 category have a large enough concentration of *murex* shells to indicate that dye production was entirely plausible at the site. These shells are found in context with architectural features understood to have been necessary for *murex* dye

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outside the tell to a dump. This is illogical, because the abrasive smell of dying snails would have been in the house. Further, the effort taken to first bring the shells into the city, store them in a house, and then move them to a dyeing facilities would be unnecessary, when there was obviously space outside the tell to store crushed shells. Thus, the dyeing facilities would more likely have been located near the dump. Second, the large midden of snails outside of the city consists of a mixture of species, meaning any dye being made consisted of a mixture of ingredients. It is more likely that these snails inside the house, because of their small number, were going to be eaten, and that the pile of snails outside of the tell was a dump for shells of snails that had been eaten. Still, the number of shells in the dump suggests dyeing manufacture could have occurred, but it was definitely not *murex* specific.

production, such as vats, cisterns, or holding tanks. [28] Because of the records left by Pliny, as well as the work by Koren and Ruscillo (among others) sites in this category also must have evidence of having a heating source in context with the dyeing facilities, because we now understand heat was necessary for creating the dye.

*Type 2: Sites with Evidence for Dye Production (Probable Sites)*

Sites in Type 2 have evidence of *murex* usage which suggests probable *murex* dye production. This includes the presence of shell middens, and other features noted below. For this reason I have established four separate subcategories determined by the evidence available. Type 2 sites should be investigated further to make sense of the available evidence, so that they may be moved to the Type 1 category, or eliminated from the gazetteer.

The following subcategories are listed. Type 2A sites arguably having the strongest evidence for *murex* dye production, Type 2D the least.

*Type 2A*:

Sites which have large concentrations of *murex* shells in context with architectural features (vats, cisterns, possible holding tanks, etc.). These sites are considered "probable" because no heating source has been found. They are also placed in this category if the installation evidence suggests the possibility that the facilities were used

[28] Ruscillo argues that Pliny and Columella's works indicate holding tanks are also plausible evidence for dyeing facilities. She claims these holding tanks would have been used to keep the snails alive until harvesting, using the statement "[*murex*] when taken will live as long as 50 days on their saliva," (Pliny 9.60.36: alioqui captae et diebus quinquagenis vivunt saliva sua). Ruscillo then suggests that the Romans were using tanks to keep fish alive. The descendents of Romulus and Numa "For what reason not only they had constructed fish ponds which they themselves constructed, but also the lake filled with natural things, they were replenishing with spawn having been collected from the sea" (Columella, *De Re Rustica*, G.P Goold, eds., Edinburgh: St. Edmundsbury Press, 1941, 8.16.2: quamobrem non solum piscinas quas ipsi construxerant frequentabant, sed etiam quos rerum natura lacus fecerat convectis marinis seminibus replebant). Because of these accounts, Ruscillo comments that holding tanks could have occurred on site with dye facilities, but most likely at locations which did not have direct access to the sea (Ruscillo 2006, 102).

for some other industry. Regardless, these sites are considered "probable" because they do have large amounts of *murex* shells concentrated in one particular area with possible dye manufacture facilities.

*Type 2B:*

Sites which have large deposits of *murex* shells.[29] These sites are considered "probable" because of the fact that there is indeed enough *murex* shells found at the site to indicate a sizeable dye manufacture facility could have been nearby. These sites simply lack the architectural features and equipment that were required for creating dye.

*Type 2C:*

Sites which have large amounts of *murex* shells incorporated into the mortar and construction materials of the Roman buildings. These sites are "probable" because though the *murex* shells are not found in a pile, and no dyeing facilities have been found, it is highly improbable that *murex* snails would be collected in such massive quantities specifically to be used for construction material. Thus, large amounts of shells which

[29]Archaeologists have often noticed that *murex* shells found in middens can have a small hole. Some archaeologists interpret this hole as definitive evidence for dye manufacture, because it could have been a method of extracting the hypobranchial vein without actually crushing the shell: "a hole was picked through a body whorl through which the hypobranchial glad was extracted and then macerated for several days in a vat of salted water to release the dye precursors" [Christopher Edens, "Khor Ile-Sud Qatar: The Archaeology of Late Bronze Age Purple-Dye Production in the Late Bronze Age Arabian Gulf," *Iraq* 61 (1999): 83]. This hole was found in shells at Sabratha as well, and has been commented on by Ruscillo as a plausible method for dye extraction (Ruscillo 2000, 103). However, one must also consider the fact that *murex* snails are carnivorous by nature. Their method of feeding involves drilling a small hole into other mollusks via their radula, after which they push their proboscis (a long stalk-like mouth) through the hole to feed on flesh [Marian Armstrong, ed., "Slug and Snail," in *Encyclopedia of the Aquatic World* (Tarrytown: Marshall Cavendish 2004), 1250]. Therefore, it is arguable that the holes on the shells are evidence of the snails being collected and left in a pile or holding tank for a period of time, so long that they began feeding one on another. Of course, the *murex* could have been collected in holding tanks or a pile before they were harvested for dye. They could also have been collected into piles for food consumption. Thus, the hole should not be considered as definitive evidence for dye manufacture because it can indicate either an alternative extraction method, or feeding. Sites which have these holes are mentioned in the gazetteer.

have been incorporated into mortar suggest the possibility that dye production occurred there, or at a settlement nearby.

*Type 2D:*

Sites which have textual evidence stating that *murex* dye manufacture occurred there during the Roman period.

### ii. Gazetteer

TYPE 1 SITES

1.1 Apollonia Arsuf, Israel (32.17364, 34.803485)
Mid 5th c. B.C.E. - late 1st c. B.C.E. (RO[30]: mid - late 1st c. B.C.E.)

Evidence for *murex* dye manufacture in the ancient urban city, is concentrated in the areas H and D, during the 4th -1st century BCE. Roman occupation indicates that Loci 1514, 1515, and 1517 were areas of dye manufacture. Crushed shells were found in context with burnt ash and other burnt organic materials, as well as pottery sherds. Large pits were also found near the shells in these areas.[31]

1.2 Tel Dor, Israel (32.64131, 34.918620)
Late 4th c. B.C.E. - mid 1st c. C.E. (RO: mid 1st c. B.C.E. - mid 1st c. C.E.)

Thick layers of *murex* shells were used as construction fill dated to the late 1st century B.C.E. A pit was found in Area A, filled completely with crushed *murex* shells (Figure 2), and was lined around the top with stones.

[30] Some sites have evidence of *murex* production prior to Roman occupation. In these cases, the first dates listed will encompass the earliest known usage to the latest known usage, and the dates in parentheses labeled with RO shall indicate dates of *murex* usage specific to Roman occupation.
[31] Karmon 278.

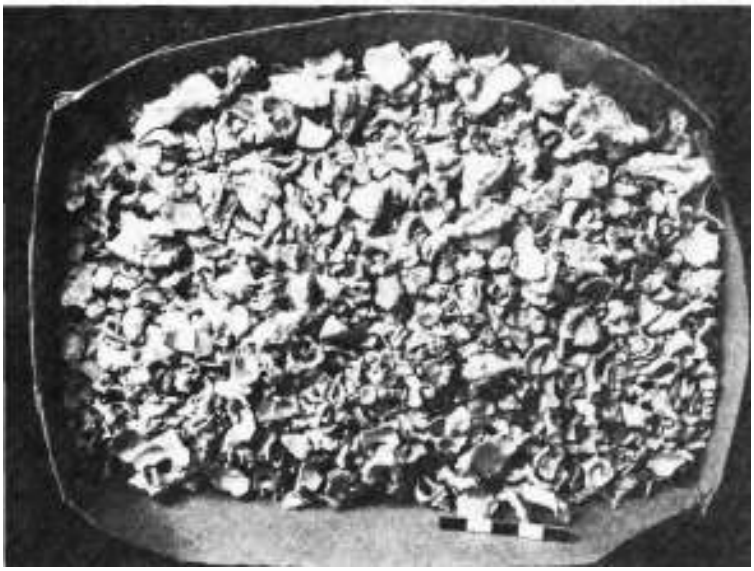

Figure 2: Sample of crushed *murex* shells from Tel Dor.[32]

It connected to another pit via a two meter long channel. This second pit was located near a third, as well as a small, square, plaster and stone lined basin. Purple material was found in the channel, the basin, and the second pit, as was the surrounding soil. Evidence of burning was also found in the area.[33]

TYPE 2 SITES

*Type 2A*

2A.1 Tel Akko, Israel (32.91154, 35.053753)
Late 2nd c. B.C.E. - mid 1st c. C.E. (RO: mid 1st c. B.C.E. - mid 1st c. C.E.)

Large amounts of crushed *murex* were found in context with waterproofed, thickened wall vessels. These vessels, dating to the 13th - early 12th century B.C.E., are only found with *murex* crushed shells and their residues, and are therefore believed to have been used to create the dye.[34] Later occupation layers

[32] Karmon and Spanier 157.
[33] David S. Reese, "Shells from Sarepta (Lebanon) and East Mediterranean Purple-Dye Production," *Mediterranean Archaeology and Archaeometry* 10, no. 1 (2010): 134-135.
[34] Karmon and Spanier 151.

are thick in mixture with ash and shells, possible evidence for heating dye. The definitive evidence for Roman period *murex* shell usage, however, does not have evidence for heating. Roman period evidence is limited to large amounts of crushed *murex* shells in area H (Figure 3) and a plastered basin.[35]

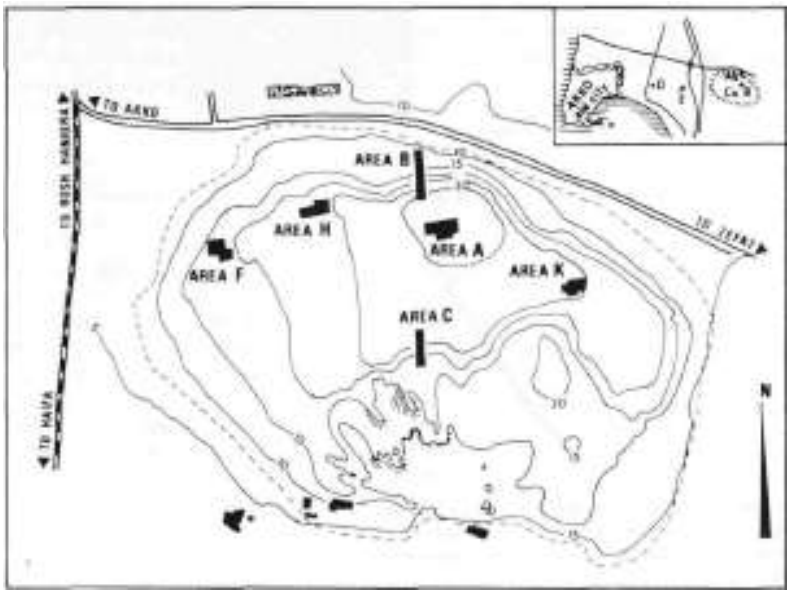


Figure 3: Excavation areas at Tel Akko; Area H being where Roman period dye manufacture evidence is located.[36]

Karmon and Spanier comment that the lack of decorative pottery in this area could be evidence of industrial work occurring here.[37]

2A.2 Tel Mevorakh, Israel (32.53381, 34.926831)
Late 4th/early 3rd c. B.C.E. - (RO: Mid 1st c. B.C.E - )

Along with large middens, a 4th-3rd century B.C.E. vat made from a hollowed out block of limestone is assumed to be evidence for dyeing installations. The vat has a chiseled groove running along approximately two thirds of its rim. Three holes are evenly spaced between the groove and the inner basin. This vat parallels the

[35] David S. Reese, "Shells from Sarepta (Lebanon) and East Mediterranean Purple-Dye Production," *Mediterranean Archaeology and Archaeometry* 10, no. 1 (2010): 121.
[36] Karmon and Spanier 150.
[37] *Ibid* 153.

design of vats found at definitive dye production sites elsewhere: Judah, Tell Beit Mirsim, Ain Shems, Tell en-Nasbeh, Bethel and Gezer. However, these earlier vats are closed at the top.[38]

2A.3 Aperlae, Turkey (36.15861, 29.783611)
Late 3rd/Early 4th c. C.E. -

The industrial town possesses large middens of crushed *murex* shells covering a total area of 1600 $m^2$. According to Holhfelder, "a conservative estimate of their number would be in the hundreds of thousands."[39] Possible holding tanks are also present, likely for keeping the snails alive before they were harvested for dye. The holding tanks were quite clearly Roman in construction, as bricks, hydraulic mortar enclosing a ceramic tile floor, and cobble stones date to the 4th century AD.[40]

2A.4 Sabratha, Libya (32.79194, 12.484722)
Mid 2nd c. B.C.E. - Early 4th c. C.E.

The town has several large buildings, with floors covered in *murex* shells, dating to the 2nd-3rd century C.E. These buildings include the House of Leda, the House of the Swan, the floor near the Seaward Baths, and the floor north of the theater.

[38] Ephraim Stern, *Excavations at Tel Mevorakh (1973-1976) Part One: From the Iron Age to the Roman Period,* Jerusalem: The Institute of Archaeology, 1978: 24.
[39] Robert L. Hohlfelder, "Cabotage at Aperlae in Ancient Lycia," *The International Journal of Nautical Archaeology* 29 no. 1 (2000): 132.
[40] *Ibid* 132.

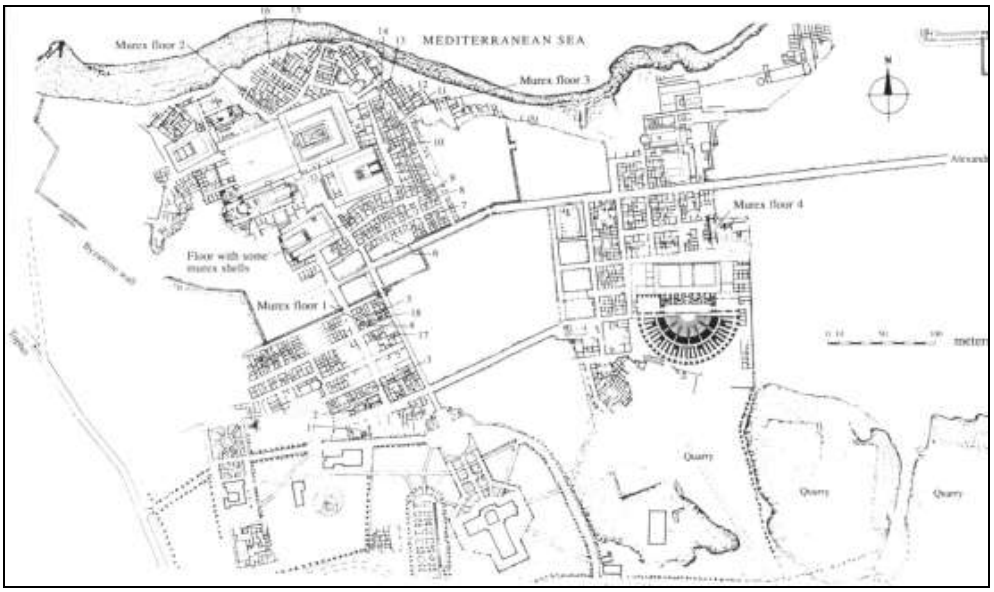


Figure 4: The numbers indicate the areas with *murex* at site, either as mortar or on the floor.[41]

The middens in the buildings could indicate the shells were recycled, and that dye production took place elsewhere. Wilson states that the dye industry ended around 300 C.E., proven by the fill in a well near Mausoleum A. A number of *murex* shells were found in the fill with artificially ridden holes on them. [42] A series of problematic vats have been found at the site. The larger vats have been identified for fish salting, however, smaller circular vats have been found that are in fact waterproof. Wilson suggests these may be for garum production[43] or, more tentatively, for *murex* dye:

> The Sabratha tubs would be suited to dyeing relatively small quantities of wool (rather than cloth) at a time, which might imply an expensive dyestuff or colour not normally used for dyeing whole garments, and the evidence for *Murex* dyeing at the site makes this an attractive possibility, but in the absence of further excavation data or residue analysis this suggestion must remain hypothetical.[44]

[41] Wilson 2002b, 243.
[42] Wilson 1999, 42-44. Please refer to note 25 for a discussion about shells with holes.
[43] Wilson 2002a, 242.
[44] Wilson 1999, 46.

*Type 2B*

2B.1 Mogador [Cerne], Morocco (31.512501, -9.770005)
Late 1st c. B.C.E. - early 1st c. C.E.

The settlement on the island was believed to have been created for purple dye manufacture. Many large middens near Essaouira have been found at the site with *murex* shells, as well as with *purpura haemostoma* (a species used to mix with *murex* dye to create cheaper imitations).[45] There was a mixture of crushed and whole shells. Many of the whole shells have a small hole.[46]

2B.2 Thamusida, Morocco (34.21854, -6.592132)
Mid 1st c. C.E. - mid 3rd c. C.E.

Magnetometer surveys reveal furnace/hearth areas beneath a ground covered with *murex* shells.[47] Wilson notes the interest in this site because of its distance from the sea; he believes that the shells had to be carried for processing into the castrum, because they would not have been able to survive in the nearby fresh water river source.[48]

2B.3 Dar Essafi, Tunisia: (36.39439, 10.621752)
Mid 2nd c. B.C.E. - late 2nd c. B.C.E.

Several large crushed *murex* middens were located near the town's small harbor.[49] There are also nearby sites which have earlier evidence of the industry, suggesting possible *murex* production. Tas-Silg, two kilometers away, has mass quantities of crushed shells.[50]

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**45** R.W. Stillwell, L. MacDonald, and M. H McAllister (eds)., "Mogador," in *The Princeton Encyclopedia of Classical Sites* (Princeton: Princeton University Press).
46 Edens 83. The fact that these shells are whole, not crushed, and have the hole suggests that the theory of dye extraction via piercing through the shell is plausible. See note 25.
47 Wilson 2002a, 253.
48 Wilson 2002b, 162.
49 There were also a series of vats found near the *murex* middens, which were hollowed out of the rock. However, these vats have not been dated and thus cannot be connected to the middens.
50 Sagona 33.

2B.4 Meninx, [Jerba] Tunisia (33.68582, 10.922214)
Early 5th c. B.C.E. – late 1st/early 2nd c. C.E. (RO: mid 2nd c. B.C.E. - late 1st/ early 2nd c. C.E.)

This site is comprised of a large midden measuring 540 m long, 340 m wide, and 3 m high, with later evidence of quarrying for lime mortar.[51]

Figure 5: The surface depicted consists of a large *murex* dump from Roman and late Roman production in Meninx. The rounded holes are evidence of quarrying for lime production.[52]

Mau wine vessels dated to the 1st-2nd centuries C.E. were found broken in the midden. Late antique dyeing installations have been found. In addition, evidence suggesting the possibility for Roman period dye production has been found, specifically the mixture of crushed *murex* and large ash dumps.[53] Previous research has mistakenly identified cisterns near the ash dumps as evidence.[54] Wilson claims these are no different from cisterns elsewhere on site or in the

[51] Wilson 2002b, 161.
[52] Wilson 2002a, 252.
[53] Wilson 2002b, 161.
[54] Wilson 2002a, 249.

general region, and thus cannot be definitely part of the dye works. However he does note that the site has the water capacity necessary for large scale dyeing.[55]

2B.5 Rhizene, Tunisia: (33.874943, 10.926486)
Mid 2nd c. B.C.E. – late 1st/early 1st c. C.E.

*Murex* shells have been found in mass quantities at the site, near the coastline.[56]

2B.6 Berenice, Libya [Sidi Khrebish, Benghazi] (32.12485, 20.063571)
Late 4th/early 3rd c. B.C.E. - mid 5th c. C.E. (RO mid 1st c. B.C.E. - mid 5th c. C.E.)

Eusperides (the predecessor to Berenice) (32.11233, 20.068716), has over 30 large spreads (ranging from 1 x 4 to 18 x 18 meters) of crushed *murex* in the street surface layers and in middens. One such spread was excavated and dated to the 4th/3rd century B.C.E. The shells had been dumped near a hearth, possibly evidence for where the dye was actually boiled.[57] Fires were lit on the mud brick in order to heat metal vessels holding the dye. Shells were likely piled next to the fire, evident from the yellow stains next to the hearths.[58]

The evidence indicates that, if *murex* dye production did in fact occurred, it would have begun during the 3rd and 4th century C.E. Dye production would have occurred outside of the city walls, evident from the thousands of crushed shells outside the city. There is no immediate evidence for dyeing installations; architectural features which could be confused for *murex* dye production were more likely used to create lime. The fact that the crushed shells were used for this lime production makes the evidence fairly complex.

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[55] Wilson 2002b, 161.
[56] Hedi Slim, et al., *Le Littoral de la Tunisie: Etude Geoarcheologique et Historique*, CNRS Editions: Paris, 2004: 101.
[57] Wilson 2002a, 254-255.
[58] When *murex* glands are extracted before the heating process, the glands secrete yellow fluid (Wilson 2002b, 162).

Small ovens were found in association with the crushed piles inside the city. These ovens are found in Building 2 (Insula II) and Building J2 (Insula I). Building J2 had a 15 cm thick layer of shells in one of the rooms. Their small size and close proximity to homes suggest the shells and ovens inside the city were not directly associated with dye production. Further, they were crude, and the large scale of dye production suggested by the *murex* dumps leads Reese to believe that "dye installations would not have been so carelessly constructed." The large amounts of crushed shells outside the city and the limited amounts of ovens also prove that lime production was not the primary focus.[59] Both the inside and outside shell middens were closely inspected to ensure they were all *murex* species.[60]

Figure 6: One of the *murex* middens beyond the city limits, near a cistern.[61]

[59] This is open to debate. Reese claimed that Berenice was using *murex* for lime production, not for dyeing, because he only knew of the *murex* found within the city walls, and made the correct conclusion that there were not enough shells to indicate dye manufacture occurred. However, Wilson recently discovered the larger dumps near the modern lighthouse "visible as surface spreads and in section near the edge of the excavation, and as surface spreads across much of the area north of the Byzantine church." In considering these spreads too, he has demonstrated (in my opinion) that there was in fact enough *murex* shells crushed at the site to indicate that dye production occurred outside the city walls (Wilson 2002b 162). Though no probable dye installation features, such as vats, were found, I think it is safe to say that there were two usages of shells occurring: first, for dye production, and second, for lime. This is evident because of the significant difference in size of shell piles inside the city versus outside.

[60] Reese 1979, 87-90.

[61] Wilson 2002b, 262.

2B.7 Taranto [Tarentum], Italy (40.46923, 17.24000)
Late 3rd c. B.C.E. – early 4th c. C.E.

Dye workshops are believed to have been located on the coast, indicative by the large middens of *murex* shells,[62] now referred to as "Monte Testacea".[63] Similar to Marsala, Tarantian coinage designs depict shells.[64] Pliny discusses Nepos' comment, in which he confesses that, during his youth: "it went for one hundred denarii per pound, and not too much more after of Taranto. From here came the double dyed Tyrian, which was not able to be purchased in pounds for 1000 denarii."[65]

*Type 2C*

2C.1 Lepcis Magna, Libya (32.64972, 14.264444)
Late 1st/early 2nd c. C.E. – late 3rd/early 4th c. C.E.

Crushed *murex* shells have been found within the mortar of structures dating to the 2nd and 3rd centuries AD. These structures include the foundations of the cistern, near the Chalcidicum fountain, in the external mortar of the large cisterns located behind the Hadrianic bath latrines (Figure 7), and in the ground near the Arch of Tiberius.

[62] Gleba 197.
[63] Silver 254.
[64] Gleba 81.
[65] Pliny's 9.71: libra denariis centum venibat nec multo post rubra tarentina, huic succesit dibapha tyria, quae in libras denariis mille non poterat emi.

Figure 7: External face of the cisterns near the latrines at the Hadrianic baths. The crushed *murex* shells are evident in the mortar.[66]

It is assumed that the significant amount of crushed shells is direct evidence for a dyeing industry, one which recycles the byproducts for construction material. Dye installations have yet to be found.[67]

*Type 2D*

2D.1 Caesarea, Israel (32.48573, 34.34123)
Late 3rd/early 4th c. C.E. -

The *Targum Jonathan* references *murex* at Caesarea: "they shall take joy in the murex and from its blood they will dye their fabrics a purple color." The Caesarean Talmud and *Expositio* mention the industry at the city as well. Levine references that "special pools for the preparation process existed in Caesarea, and

[66] Wilson 2002a, 257.
[67] Wilson 2002b, 255.

regulations were enforced to keep them sufficiently removed from other buildings because of their stench."[68]

2D.2 Tyre, Lebanon (33.26985, 35.206942)
Late 15th/early 14th c. B.C.E. - late 1st/early 2nd c. C.E. (RO: mid 1st c. B.C.E. - late 1st/early 2nd c. C.E.)

The earliest Bronze Age dyeing is clear from the *murex* middens and round sandstone pits along the coast with crushed *murex* inside. Coinage dating to the first century C.E. from Tyre has depictions of *murex* shells, while the Edict of Diocletian has direct references to the imperial manufacture at Tyre, which had a state monopoly in 383 C.E.[69] This edict also confirms that Tyre was exporting *murex* purple and imitations of the product.[70] Other literary evidence includes Strabo's account in his *Geography*: "…the purple of Tyre was the best. The great number of dye works made the city smell unpleasant. Nevertheless, Tyre was rich and prosperous through the superior skill of its inhabitants."[71]

2D.3 Marsala, Italy (37.79908, 12.434233)
Mid 3rd c. B.C.E.

The coinage depicts *murex* on both sides, likely evidence that the area was engaged in *murex* dye industries in some way.[72] The ancient site (Hydron) was also referenced by Cassiodorus in his *Variae:* "What Tyre is for the East, Hydron is for Italy—the great cloth-factory of Courts, not keeping its old art but ever transmitting new improvements." Besides Marsala's general cloth production, there is also reference to the city having access to a substantial *murex* population:

[68] Levine, Lee I. *Studies in Late Judaism in Late Antiquity: Caesarea Under Roman Rule.* eds. Jacob Neusner Volume 7, 1975: 51-53.
[69] Reese 2007, 237.
[70] Karmon and Spanier 158.
[71] Strabo *Geography* 16.2.23 in Karmon 269.
[72] Gleba 81.

Wherefore if a diver of the Hydruntum sea had found purple fish *(murex)* properly at the ready time, that Neptunian harvest, created always of flourishing purple, it will have produced the purples, always flourishing, released with an abundance of water, (and) it would have made the princely shower (the dye) with the fiery red liquid and be decorating the thrones…For if the quality of the purple fish (*murex*) was not changed, if the one press is that of wine/oil, the blame without a doubt will be of the laborer, to which himself carried off no resources (dye).[73]

This selection from Cassiodorus implies that the *murex* industry at Hydron was so developed that complaints would arise if the dye was not made according to certain specifications.

[73] Cassiodorus, *Variae Epistulae,* Theodor Momsen, eds. (Hahnsche Buchhandlung, 1980): 1.2.2-4: Quapropter si perscrutator Hydrontini maris intusa conchylia sollemniter condidisset apto tempore, acervus ille Neptunius, generator florentis semper purpurae, ornator solii, aquarum copia resolutus imbrem aulicum flammeo liquore laxaverat…. Quod si conchyliorum qualitas non mutatur, si torcularis illius una vindemia est, culpa nimirum artificis erit, cui se copia nulla subtraxit.

## V. Spatial Analyses of the Gazetteer

### i. Distribution of Sites

Though Roman period dye sites are distributed across the Mediterranean, there are two clear areas of clustering. The first, in the Near East, is logical, because of the aforementioned Bronze Age dye market in Tyre. The second concentration is on the coast of North Africa. Figure 8 demonstrates the geographic spread of sites according to the Type 1 versus Type 2 distinction. It also shows how the sites are spread according to the subtypes listed in the gazetteer. This indicates how these sub categories of evidence can aid in the understanding of how the production of the dye was distributed across the Mediterranean.

Sites in North Africa are limited to sites with architectural features and deposits (2A), with large deposits of *murex* shells (2B), and sites with shells incorporated into the construction mortar (2C). The Near East, alternatively, has sites that are definite dye production facilities (1), sites with architectural features and deposits (2A), and sites with textual references (2D). Figure 8 demonstrates that the "problematic" evidence of Type 2 sites is likely indicative of participation in the *murex* dye industry; the entirety of evidence simply has not been found yet. I argue this using Tel Dor and Appollonia Arsuf as examples. They are both Type 1 sites, and are quite close to Tel Akko and Tel Mevorakh (both Type 2A). Why would sites with definitive evidence for dye manufacture be in close proximity to sites which also have large piles of *murex* shells, and some indication of a dye production facility? There was clearly a large population of *murex* snails in the region, and evidently, the know how to create the dye.

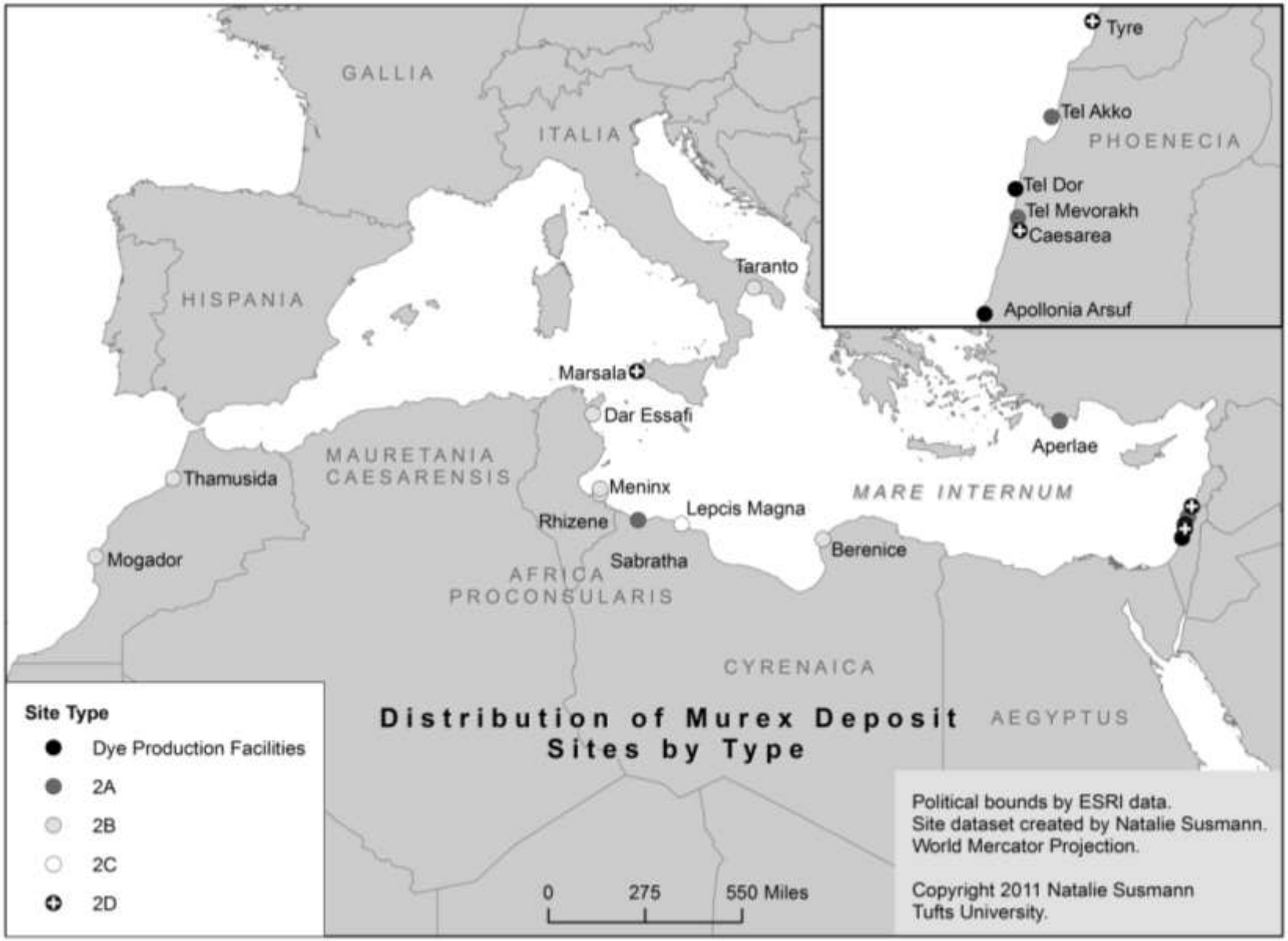


Figure 8: Distribution of sites by type.

### ii. Early Roman Sites

The sites were also symbolized chronologically, in order to show the spread of sites by their earliest known Roman occupation usage (Figure 9). The majority of the sites did not commence before the mid 3rd century B.C.E. There is also a very clear clustering in the central Italy/North Africa region of sites beginning in this period. By majority, the later Roman sites were occurring in the east, such as Aperlae, Tel Dor, Tel Mevorakh, and Caesarea. Though the sample size is small, there is a clear trend occurring in the sample. In North Africa, there is a significant number of sites with archaeological evidence suggesting *murex* were used to create dye, and were beginning in the mid 3rd century B.C.E onwards.


Figure 9: Spread of *murex* related sited by start date.

### iii. Sites by Length of Usage

A portion of sites in the gazetteer had enough evidence to isolate the period of usage of *murex* related dye evidence from the earliest to the latest date. Out of the total group of 17 sites, 13 sites had sufficient data to apply a tentative "end date" for the *murex* usage evidence. The sample size is small, and should be used as an indication of area for further study.

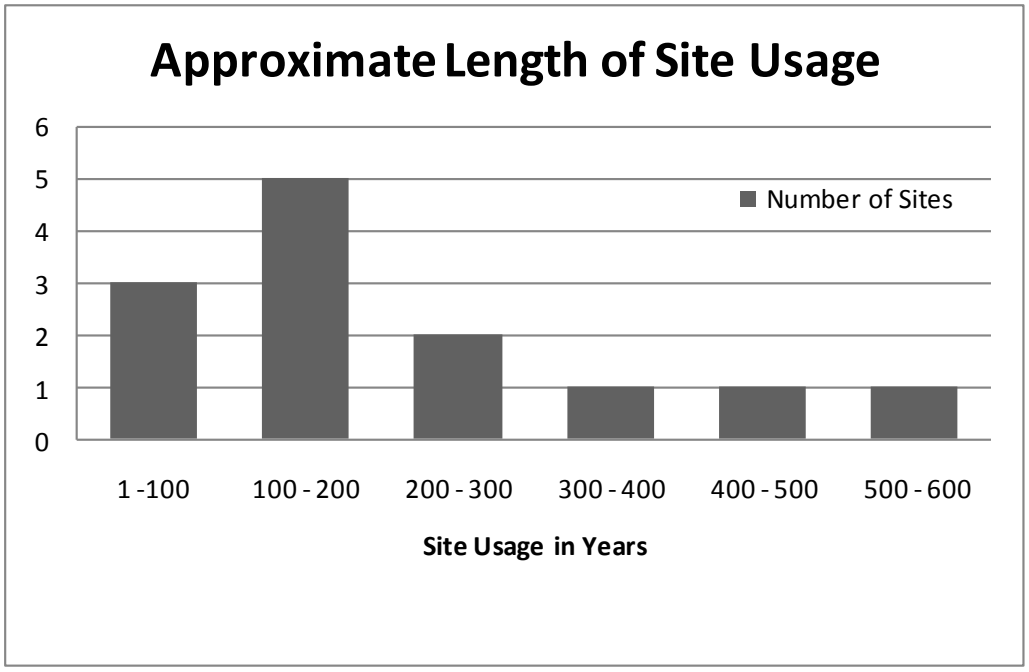


Figure 10: Numerical distribution of length of *murex* dye usage sites.

Figure 10 graphically depicts the distribution of usage. Of the thirteen sites, a total of eight were used for less than 200 years. Though the majority of the sites were used for a shorter length of time, the sites used for the 201-600 years are located in North Africa and Italy (Figure 11), whereas the sites with shorter periods of usage are located in the Near East. This trend is arguably is evidence for the greater longevity of the Roman economy. The longevity of North African dye production will become more apparent in the next section, which will relate the evidence from the gazetteer to the Roman economy from the Republican period to the late Empire.


Figure 11: Distribution of sites by length of usage.

## VI. Economic Analysis

### i. Production of *Murex* Purple Dye and its Related Markets

*Murex* snails were used extensively from the Bronze Age onwards, but during the Roman period in particular, a market emerges that spans the whole of the Mediterranean and remains in place well into Late Antiquity. The location of production sites is certainly a calculated decision, dependent on many factors. The production of *murex* dye at Near Eastern sites in the Roman period demonstrates the longevity of the industry. Many of these Roman period sites were used during the Bronze Age, and are only a small representation of the many Bronze Age-specific sites which were in the area. Purple dyed cloth, especially from Tyre, had been popular since the early Bronze Age. By the Roman period, any settlements still continuing to produce the dye were certainly not altering their economic plan.

The appearance of western Mediterranean dye sites coincide with Roman expansion. An understanding of other modes of production in these cities can help understand where production occurred. Though *murex* dye was expensive, and would yield a profit for towns able to afford dye production facilities, it is unlikely that any of these towns could have survived off of their *murex* dye profits alone. This is suggested by the fact that many of the sites in the gazetteer are linked to other modes of production: lime production, fish-salting and other marine related industries, and fulling.

The presence of a large pile of *murex* could suggest a relationship with the lime industry because *murex* shells contain calcium carbonate, a mineral that, when burned, produces lime. The process is fairly simple; when heated, mixed with water, and allowed

to sit, the mixture will thicken into putty, which can be used to create mortar or plaster.[74] The sites included in the gazetteer have evidence of their *murex* shells being harvested for lime. Meninx shows evidence of cutting into the large *murex* middens.[75] Berenice has evidence of lime actually being produced in ovens. Archaeologists believe that the crushed *murex* shells located outside the city prove that dye was created outside of the city, "much farther from the area of habitation." After the veins were extracted from the shells for dyeing, small amounts of shells were brought inside the city to make lime with the small ovens and kilns. As mentioned, the kilns and ovens were poorly constructed, and thus indicative that they were not for dye production.[76]

Fish related industries are perhaps one of the more likely markets connected to *murex* related sites. Sabratha, in addition to its large deposits of *murex* shells and (problematic) dye vats,[77] has a large body of evidence for the fishing industry as well. Large tubs have been identified as fish-salting vats:

> [the] vats are grouped in twos, threes or fours, with sides measuring between 1.0 and 2.0 m, and usually over 1.0 m deep. They have been lined with waterproof mortar, and with the internal angles founded…On the basis of size, shape, and similarity with vats at other sites, such as Lixus or Salakta, they are to be identified as fish-salting vats.[78]

The mass of the fish salting production at Sabratha is sizeable; Wilson estimates that if the Sabrathan population were to eat all of the fish that the site was able to hold, each person would have needed to consume 290 grams of salted fish per day. This number is too large, considering that game, and of course, fresh fish were available to them. The

[74] Brian Dix, "The Manufacture of Lime and its Uses in the Western Roman Provinces," *Oxford Journal of Archaeology* 1 no 3 (1982): 331.
[75] Wilson 2002b, 161.
[76] Reese 1979, 89.
[77] See Wilson 1999, 46.
[78] Wilson 2002a, 242.

salted fish must have been made largely for export. He then calculates that if salted fish were consumed once a week by everyone in the town, 86% of the fish would be exported.[79]

Because Sabratha was so focused on fish consumption, one might argue that the presence of *murex* shells was because the snails were harvested for food. However, the *murex* were concentrated, and other shellfish are absent from the record. It is unlikely that only *murex* would be harvested for food if no other shellfish are present in the record. They must have been used for dye. Sabratha then, was a town largely involved in export, specifically of marine products. Arguably there is a relationship between certain marine products (like fish-salting) to *murex* dye facilities.

Could a town be completely reliant on *murex* dye production? This is likely not possible. The final product was very expensive because it required extensive labor and materials to produce; if there was not a large enough market for the product, towns would certainly suffer a considerable economic loss. Meninx demonstrates how being engaged in other industries could make a town financially stable enough to risk participating in *murex* dye production. Besides *murex* dye production evidence, the northwest corner of the city shows evidence that fish salting occurred. It also has evidence for engagement in metalworking, suggested by the abundant waste and iron working furnaces in the southwest quarter.[80] Many towns in this study have evidence of multiple modes of production, but Meninx stands out. Unlike many of the other coastal sites, Meninx is not coastal, located several miles upriver on the Oued Sebou. Moving these *murex* snails would have increased dye costs substantially, leading one to wonder how Meninx could

[79] Wilson 2002a, 247.
[80] *Ibid* 253.

afford the extra cost. Wilson claims the answer is in the presence of other industries. He connects the metalworking production centers to the marine production centers (fish salting and *murex* dye). Having metalworking and fish salting facilities likely enabled them to engage in other modes of production, and to take the extra effort of gathering snails that were not within close proximity to the town.[81]

Production of other types of dye can certainly be linked to *murex* dye production. Some sites indicate that multiple types of dye were being created. Mogador, for example, has thousands of *murex* shell deposits, but also evidence that *purpura haemostoma* was used. This site serves as an example of how sites could be using *murex* to create two type of dye: *murex* dye, and cheaper imitations.[82] Imitation dyes were used in antiquity as a means for the lower classes to attempt in participating in the same social discourse as the elite classes, when they wore their *murex* dyed cloth. These dyes could be made by mixing *murex* with a variety of plants, such as kermes,[83] insects, berry juices or other snails, such as *purpura haeomostoma*. In some cases, only plants were used.[84]

Whether or not these *murex* dye production facilities created imitation dyes, and whether imitation dye was produced at sites nearby cannot be addressed here. To do so would involve identifying multiple modes of dye production and the accompanying archaeological remains, a task which cannot be tackled in this thesis alone. *Murex* dye can be isolated because it needed thousands of *murex* snails, and a heating source. In contrast, the textual accounts which mention imitation dye methods seem to suggest that

[81] Wilson 2002a, 253.
[82] Stillwell, "Mogador."
[83] Referred to as "Hysigic Purple." J. T. Baker, "Tyrian Purple: an ancient dye, a modern problem," *Endeavour* 33 no. 118 (1974): 14-15.
[84] Jensen 111.

thousands of shells were not needed. Further, if *murex* snails were not used at all, as Jensen suggests,[85] perhaps a heating source was not needed either. We understand, then, that imitation dye production facilities could have been entirely different from the pure dye facilities, and arguably, more difficult.

Some sites in the North African region have been identified as dye works, and could have been producing imitation *murex* dye. Carthage is one of the better examples. The supposed dye works consist of vats with a capacity, of 6-9 $m^3$, sunk 1-1.5 meters into the ground. If these facilities were in fact used for dye, they were not likely for creating *murex* dye, simply because the facilities are too large. They are more likely vats for cheaper dye, which could be created in mass quantities. A heating source was also not found. However, the possibility has been raised that Carthage could have created imitation *murex* dye, because of the fact that a small amount of *murex* shells were found near the "dyeworks".[86] It is possible that the snails could have been combined with other ingredients to make imitation dye. In this case, the method of dyeing was certainly different, meaning that the evidence for the facilities would differ from the *murex* dye facilities. However, I am tentative to believe such a conclusion at this point. To do so would mean that any site which has the presence of a few shells near large vats could indicate imitation dyes were made. More research needs to be done in this regard, in the same fashion as past *murex* dye research, to understand that if *murex* snails were used to make imitation dyes, how many snails would have been used, whether a heating source would have been needed, and the accompanying ratios of other ingredients. At this point, we can focus on identifying purely *murex* dye production sites because the thousands of

[85] *Ibid* 111.
[86] Wilson, 2002b, 160.

shells essentially guarantees dye production was occurring somewhere in the vicinity. With imitation dyes, this is not the case. Still, imitation dyes are being addressed here because, as will be discussed in a later section, imitation dyes arguably played a large role in how the pure dyes were consumed. We can thus discuss their relationship to pure *murex* dye, but cannot geographically place them in the Mediterranean. However, sites like Carthage[87] should be investigated in further detail as possible imitation dye production facilities.

The production of cloth and wool is linked to *murex* dye production as well. Once the dye was created, it needed to be transported to sites which would create cloth and dye it, or would actually dye the cloth at the same site. Understanding the locations of these sites is difficult. Physical evidence of textiles is extremely problematic in this regard. The lack of textiles present in the archaeological record disables any type of comprehensive analysis of this nature. More arid regions of the Mediterranean will have evidence of textiles, whereas the more humid regions will not. Such an issue would skew the record. Certainly we cannot assume that Egypt, for example, was more engaged in textile production simply because it is where the only three known pieces of cloth dyed with *murex* specific dyes have been found. [88]

Moreso than the textiles themselves, locating textile production sites is helpful for understanding the modes of production linked to *murex* dye. Leptiminus, for example, has evidence for a possible fullonica: a D shaped vat and a rectangular vat flanking a cistern, accompanied by floor channels, without a heating source.[89] Though Leptiminus

[87] For example, those mentioned in Reese 2007.
[88] Refer to Appendix 2.
[89] Wilson 2002b, 157.

has no evidence of *murex* dye production, it is quite close to other dye sites, such as Rhizene and Meninx. This region of North Africa was engaged in all facets of textile related production, and so a logical conclusion to be made is that dye production facilities could be nearby sites with fulleries.

Many different products are linked to the distribution of dye sites. This being said, it was unlikely for any site to be reliant on *murex* dye production alone, regardless of the high value and profit potential. Reese makes a good point in this regard. He argues that at Berenice, the lime production facilities serves as an indication that the settlement was trying to increase its revenue with lime first. Certainly, taking up *murex* dye production was risky, in a sense. The dye was intended for the elite, and though the production of the dye was certainly not an elite practice, the "social climate…would [need to be] conducive to the support of such an elite-oriented and labor-intensive industry, either for local use or export."[90]

In order to understand the production of *murex* dye in North Africa, the region's pastoral and textile production centers need to be mentioned. Timgad, for example lacked evidence for *murex* dyeing, likely because of its inland position. It does, however, indicate a large scale fulling center, as well as areas for cloth production, likely because the surrounding land was well suited for pastoralism.[91] Though the site reports are problematic and cannot be used to determine an exact number, at least twenty two fulleries were found on the site, and were concentrated in the northwest region of the

[90] Reese 1979, 89.
[91] Wilson 2002b, 241.

city.[92] And, the Numidian region was referenced in the Edict of Prices for its production of high priced cloaks.[93]

The proximity of Timgad and other pastoral regions to the North African coastal cities with evidence for *murex* dye production suggests there is an interconnectivity centered around the production of dyed textiles. Certainly the coastal cities with *murex* dye production evidence were not only producing the dye for themselves and the immediate regions; the dye was too expensive. The elite population in North Africa was not supplying the demand for *murex* dye - the elite in Rome were. This will be discussed in more detail in the next section. The number of establishments in Timgad indicates it was producing more cloth than the local town needed. Further, "given the high prices of textiles in the ancient world in the second and fourth centuries, textile production for more than immediately local consumption was a significant factor in Timgad's economy." [94] Thus, the region's production was highly interconnected, reliant on one another for the production of various raw materials which would be used to create large amounts of purple dyed cloth to be exported outside of the surrounding region.

The types of manufacture discussed in this section focused primarily on their relationship to *murex* dye production, either directly, with textiles at Timgad, or indirectly, with the fish salting vats in Sabratha. These relationships vary from site to site. However, it should be noted that the North African region generally was highly productive, manufacturing goods on a scale large enough to supply itself, the surrounding regions, and overseas. Lepcis Magna, Kasserine, and the Gebel region of coastal

[92] *Ibid* 139.
[93] *Ibid* 241.
[94] Andrew Wilson, "Timgad and Textile Production," in *Economies Beyond Agriculture in the Classical World*, eds. David J. Mattingly and John Salmon, Routledge Press: New York, 2001: 285.

Tripolitania, for example, have evidence of large scale olive oil production, indicative by the fact that a number of sites have multiple olive oil presses which were large enough to produce a significant output.[95] Thus, beginning in the Republican period, North African region was producing a wide variety of products; the amount of output suggested by the size of manufacturing facilities indicates the products were likely being exported. The types of goods being manufactured and exported varied in price; towns were not limiting themselves by producing only luxury items, and were not focused on one type of production in particular. Sabratha, for example, was producing the highly valued *murex* dye alongside salting fish for daily consumption and export to a wide range of classes.

Certain towns were choosing not to produce *murex* dye, despite the fact that there was a clear abundance of snails and knowledge of how to make the dye. Being located on the coast would certainly have its benefits in this sense. It would eliminate having to spend money on transporting the snails from the coast, as well as transporting the dye or dyed cloth to be sold. Coastal location, however, is not always necessary. Recall the discussion of modes of production in Meninx, for example. The city was not located immediately on the coast, and had to rely on river transport to get the snails. It likely relied on the fishing and metal production to finance its *murex* production.[96] The location of these dye sites being on the coast (or close to it) is of course important, however the economic state of a town was likely just as important, but no more important than a town's financial stability determining whether or not they could afford to produce *murex* dye. Larger towns with multiple modes of production and demand for their products

[95] Dennis Kehoe, "The Early Roman Empire: Production," in *The Cambridge Economic History of the Graeco Roman World*, Walter Scheidel, Ian Morris, and Richard Saller eds., (Cambridge: Cambridge University Press, 2007) 556.
[96] Wilson 2002a, 253

would have been more likely to produce *murex*. The gazetteer suggests this; the North African cities with evidence for *murex* dye manufacture are largely involved in other modes of production, and were also exporting these materials.

From this brief discussion, it is clear that North Africa, in particular the coastal cities, was a highly productive region during the Roman period. Besides *murex* dye and its related products, metals, olive oil, wine, and pottery, to name a few, were manufactured.[97] The sheer scale of production, for example in Sabratha or Lepcis Magna, demonstrates that the coastal cities were largely exporting these materials; the amount of materials produced was unlikely intended to sustain the North African population alone. This in part explains why dye production facilities would have been clustered in North Africa: it was a highly productive region with knowledge of marine products and an existing infrastructure for large scale manufacture and export. There was also an obviously well sustained population of *murex* snails in the region, or else they would not have been able to begin producing *murex* dye in the first place.

### ii. Distribution of *Murex* Purple Dye in the West

The previous discussion pointed out the large scale production which was occurring in North Africa, and how *murex* was included in the long list of products that the cities were creating. The sites indicate that the output of various products, dyes, textiles, fish, olive oil, was too large to be meant for the surrounding regions alone. The fact that *murex* dye production sites were located in the midst of a highly productive region with close proximity to Rome is not by chance, nor is the fact that dye production centers shifted from the Near East to the west went Rome's power was increasing. I argue

[97] David J. Mattingly and R. Bruce Hitchner, "Roman Africa: An Archaeological Review," *The Journal of Roman Studies* 85 (1995): 200.

that the choice to use North African cities for *murex* dye production was due to their proximity to Rome and their preexisting strong trade relationship, in which North Africa exported the aforementioned corpus of materials to Rome and the surrounding cities.[98] If the Romans were looking to North Africa for supplying them with items such as grain, olive oil, and fish products, there is certainly a case for Romans wanting to include *murex* dye in the list of imports if North Africa had as well established an industry as the gazetteer suggests.

The late Republican and early Roman Empire experienced an emergence of luxury and agricultural goods as a result of the growth of the city of Rome and those under its rule. Late Republican Roman magnates gained power and wealth by acquiring land in the provinces, and subsequent "commercial enterprises." Economic integration of the Mediterranean followed, moving around products, increasing consumption, providing wealth to the city of Rome and its elite.[99] During the early Empire, the population increased by about one third. A number of provincial cities' populations, such as Alexandria, Carthage, and Antioch measured over 100,000 people.[100] This intensive growth caused a demand of agricultural and manufactured goods by both the lower and upper class.[101] According to Jean-Paul Morel, "Rome's absolute domination of the central and western Mediterranean stimulated exchange in this area and…encouraged mass production for export."[102] Regions like North Africa were relied on to produce

[98] *Ibid* 200.
[99] William Harris, "The Late Republic," in *The Cambridge Economic History of the Graeco Roman World,* Walter Scheidel, Ian Morris, and Richard Saller eds., (Cambridge: Cambridge University Press, 2007): 514.
[100] Kehoe 543.
[101] *Ibid 543.*
[102] Jean-Paul Morel, "Early Rome and Italy," in *The Cambridge Economic History of the Graeco Roman World,* Walter Scheidel, Ian Morris, and Richard Saller eds., (Cambridge: Cambridge University Press, 2007): 504.

materials for Rome and its territories, meaning the goods they created were being exported, and increasing their own wealth. Arguably, this increase in wealth then enabled certain cities like Meninx to engage in other forms of production which had a more selective market, such as *murex* dye.

This period also experienced a rise in *murex* dye consumption by the Roman elite, explaining why so many sites in North Africa began producing dye during the late Republic. Roman elite desired *murex* dyed cloth because to them it represented status and power. Ancient sources can be referenced to understand the magnitude of *murex* dye consumption in the late Republic. Often, these accounts do not praise the usage of *murex* dye, and instead are highly critical of it. Likely, their criticism results from their feelings that *murex* purple was overtly luxurious, a concern shared by a portion of the Roman population. Grant Parker explains that writers during the late Republic and Empire believed their era was a decline from the customs of their ancestors and a more glorious Rome. "They were writing at the time when Rome had greater power over the Mediterranean than ever before, and when the supply of luxury goods was greater than ever."[103]

The late Republican accounts of Pliny are helpful in this regard. Pliny appears to have acquired distaste for the excessive luxury brought into the region, evident in the following passage regarding *murex* dye:

> He does not seek the murices in the depths untouched by anchors and by showing themselves as food for marine beasts, while the person snatches (the murex) nor does a person scrutinize so that he would find that which a married woman would be pleasing to an adulterer more easily, the corruptor could lay traps to the harm of a new bride: standing and in the dry he plucks it, by which manner (he would

[103] Grant Parker, "Ex Oriente Luxuria: Indian Commodities and the Roman Experience, *The Journal of the Economic and Social History of the Orient*, 45 no. 1 (2002): 56.

> pluck) agricultural goods. But they blamed (the fact) that it washed off from use; luxury was being able to be set out in a more flashing way in some other way, certainly in a more innocent way.[104]

In his account, Pliny suggests that other ingredients should be used to create purple dye, such as using berries and plants. His sarcasm, and preference for imitation dyes, suggests that the use of *murex* for dyeing was in fact very popular, so popular that he needed to criticize its excessive usage. Cicero is critical of Verres' lavish lifestyle because of his excessive use of purple dyes in Sicily, and his use of purple to gain power:

> The woman Segestana was very rich and noble, with a Lamian name, during a three year period, for the sake of that man of yours, there in a house full of looms she made a covering (for a bed or a wall), nothing unless dyed with a marine mollusk (a *murex*), for Attalus, a rich man at Netum, Lyso, at Libyaeum, Critolaus at Aetnae, at Syracuse, Aeschrio, Cleomenes, and Theomnastus, and Achronidas at Elorum.The day will have failed me quicker than the names- he himself was giving purple, his friends exactly this much work.[105]

Cicero and Pliny, especially, make the popularity of *murex* quite clear. Divers would have to risk their lives to retrieve thousands of shells, which were then used in a complex dyeing process and in unpleasant conditions. As a result, the dye was extremely expensive. Regardless of this fact, and the fact that there were imitation dyes, the elite were willing to pay the high prices for a product which could evidently be copied. Such dyeing methods will be discussed in more depth in subsequent chapters. These accounts demonstrate the increased consumption of *murex* caused two reactions: first, a negative

[104] Pliny 22.3: nec quaerit in profundis murices seque obiciendo escam, dum praeripit, beluis marinis intacta etiam ancoris scrutatur vada, ut inveniat per quod facilius matrona adultero placeat, corruptor insidietur nuptae: stans et in sicco carpit, quo fruge*m* modo. sed culpant ablui usu; alioqui fulgentius instrui poterat luxuria, certe innocentius. non est nunc propositum ista consectari.

[105] Cicero, *In Verrem*, Albert Clark and William Peterson, eds (Oxford, 1912), 2.59: Mulier [est] Segestana perdives et nobilis, Lamia nomine, per triennium isti plena domo telarum stragulam vestem confecit, nihil nisi conchylio tinctum, Attalus, homo pecuniosus, Neti, Lyso Lilybaei, Critolaus Aetnae, Syracusis Aeschrio, Cleomenes, Theomnastus, Helori Archonidas. Dies me citius defecerit quam nomina. Ipse dabat purpuram, tantum operam amici.

reaction by those Roman desirous of a more glorious past, and second, a continued desire to use the *murex* as a public demonstration of wealth, status, and power.

Thus, the distribution of Roman period *murex* dye sites in the Near East was simply a result of a continued usage of dye production facilities from the Bronze Age. The positioning of western dye sites, specifically those centered in North Africa, was a direct response to the increase in *murex* dye consumption by the Roman elite. North African cities were already engaged in large scale production and manufacture of goods, and were trading these goods to Rome during the late Republican and Empire. As the Roman fixation on *murex* dye increased, North African sites that had access to snails, had the capacity to engage in large scale production. Arguably, the cities had experience in textile production (referencing the previous section) saw the opportunity to engage in *murex* production as well. As a result, *murex* dye sites were distributed along the North African coast.[106]

[106] Overfishing should also be noted as a possible factor influencing the distribution of dye sites. Though no ancient authors immediately reference the overfishing of *murex*, and though the *murex* habitats were not concentrated in any particular area of the Mediterranean (Tsugio Shuto, "Larval Development and Geographical Distribution of the Indo-West Pacific *Murex*," *Bulletin of Marine Science* 33 no 3 (1983): 536), we can assume that certain settlements would have a better understanding of how to make the dye, therefore causing those coastal areas to have overworked populations of *murex*. It is possible that any settlement which was harvesting the snails could have diminished (though likely not depleted) their supply of *murex* which would have, in turn, decreased the amount of dye they were creating. The possibility of *murex* snails becoming overfished or extinct has also been suggested by archaeologists because of the decline of *murex* specific dyeing by the Medieval period. However, as Marchese points out, the idea that *murex* could have been made extinct from the ancients' dyeing production is unlikely, because of the fact that the same species is found in the Mediterranean today and has been used to recreate the dye, and because other types of *murex* species have been found in different regions, such as South America [Robert T. Marchese, *The Fabric of Life: Cultural Transformations in Turkish Society*, (New York: Binghamton University Press, 2005), 128]. Thus, the sites which indicate they stopped creating dye during the Roman period could have in part been overfished, but this possibility is a complex one and should only be raised for awareness and future biological study.

### iii. Consumption of *Murex* Purple Dye Influenced by Elite Control

The total number of dye sites expands during the Roman Republic. The number of dye sites then begins to contract, in particular around the 3rd century C.E.[107] And, in the case of sites with a known end date, North African and Italian sites have a longer period of usage than Near Eastern sites (Figures 10 and 11). This trend is a result of the fact that, by the late Roman Republic, *murex* dye products in Rome were more likely from the west than from the Near East. Though the Near East had a sizeable dye manufacturing industry during the Bronze Age which continued into Roman occupation, the number of dye sites in the Near East is lower in comparison to the west because of the location of demand. The concentrations of murex dye wearers were located closest to Rome. The longevity of North African dye sites is indicative of the popularity of the market. They were used for a longer than the Near Eastern sites because of the longevity of dye consumption in Rome, which was clearly stronger than the rest of Mediterranean.

The contraction in the number of sites which occurred during the later Empire suggests that dye manufacture was continually being concentrated into areas closest to Rome. Fewer dye sites were being created, and any new sites which were instigated did not have as long a period of usage as the North African sites. The following discussion will explain how the concentration of longstanding Roman dye manufacturing sites in North Africa can be attested to the increasing popularity of *murex* dye; as a reaction, the Roman imperial government increased its control of the market to preserve the monetary and symbolic value of the status symbol.

[107] In this case, we are considering all sites in the gazetteer to either have evidence of dye production, or the possibility of production.

Beginning in the 3rd century B.C.E., Rome was noted for its "frantic passion for purple."[108] The 3rd century B.C.E., the period of "*terramarique,*"[109] was a period of continued expansion and exposure to various luxury and exotic goods, likely to displeasure of Pliny, as mentioned.[110] The usage of *murex* dye in this period was noteworthy because it was essentially unrestricted. The only apparent restriction placed on *murex* dye at this time was its high cost, determined by the amount of materials and labor the production required. This high cost was common knowledge. Anyone wearing *murex* dye products would immediately be economically and socially superior to those not wearing it. As a result, only certain members of society could afford to purchase the dye, *murex* played a role in designating and visually representing social strata. Such a distinction influenced later years. Rome expansion continued during the 2nd century B.C.E., as did the plunder from conquests and movement of goods.[111] As a result, "purple wearing was highly evolved…Romans viewed clothing as a distinguished costume draped with meaning: it symbolized the character of an individual, a country an epoch, and a civilization."[112]

Because of their association with high status, *murex* dyed garments served as potent symbols of power in Roman society. Visually, they were distinctive costumes, and each different usage of purple on a particular garment essentially defined the status of the wearer. It is also argued that the preference for *murex* dye on particular clothing (the

[108] Pliny 9.66: quapropter excusata et purpurae sit insania. This passion is believed to have been instigated by Alexander the Great who "appropriated sixth century precedence" when he wore purple clothing after conquering the Persians. Later, Alexander's court was believed to use the color extensively. His royal court was believed to have held approximately $8 million worth of *murex* purple dyed fabric [Charlene Elliot, "Purple Past: Color Codification in the Ancient World, *Law and Society* 33 no 1 (2008): 180].
[109] Morel 498.
[110] Parker 56.
[111] Morel 504.
[112] Elliot 181.

aforementioned praetexta, picta, and paludamentum, for example) [113] was highly symbolic, due to the fact that *murex* dye was not purple, but crimson, and in the best cases, blood red.[114] The significance of the blood color has been investigated by many scholars, and is connected to possibilities of public sacrifice and triumphal processions. Fanny Dolansky writes, "shades of *purpura* were prominent during the performance of public sacrifice- in the blood of animals, but especially in the garments of the religious personnel."[115] Religiously, the usage of *murex* purple on religious garments could serve as a symbolic reference to the actions performed by the wearers of the garments. The usage of *murex* dye on the toga picta is also interesting. Because toga picta were worn by victorious generals during a triumphal procession, there is a suggestion that the garment can be connected to Jupiter Optimus Maximus.[116] It is quite possible that the desired "blood red" color can be connected with the point of the triumphal procession: to display the victory of the Romans by slaying their enemies, as well as their personification of the god. Larissa Warren states "thus, whenever Roman sources testified to the triumphator's use of the *ornatus* of Jupiter Optimus Maximus, the god's chariot, and red minium like that on the cult statue in the Capitoline temple, they implied that he was impersonating the god.[117] Though a large debate has ensued as to whether or not the Roman believed the general temporarily became the god, the connection between the color and the victory is

[113] *Ibid* 181.
[114] See page 13 for the Pliny reference.
[115] Fanny Dolansky, "Togam Virilem Sumere: Coming of Age in the Roman World," in *Roman Dress and the Fabrics of Roman Culture*, Jonathon Edmondson and Alison Keith, eds. Toronto: University of Toronto Press, 2008: 54.
[116] W. Warde Fowler, "Jupiter and the Triumphator." *The Classical Review* 30 no. 5/6 (August 1916): 154. See also Larissa Bonfante Warren, "Roman Triumphs and Etruscan Kings: The Changing Face of the Triumph," *The Journal of Roman Studies* 60 (1970): 61-62].
[117] Warren 62.

clear. The purple dye was a means to distinguish strata and to emphasize the triumph of the Roman state:

> These fasces and Roman axes make a way, and the same for which power is of noble youth, it (the purple) distinguishes the senator from the knight, it (the purple) is called for appeasing the gods and it brightens all garments, and mixes in triumph with gold.[118]

Purple was everywhere, and the symbolism associated with the color highly complex. The aforementioned "frantic passion" for purple referred to by Pliny was fueled by the public who wished to utilize the purple to make the distinctions between senators and knights, and from the upper and lower classes. The public generally wanted to involve themselves in the discourse. We see this manifested in the record in many ways.

According to the gazetteer, the majority of sites have the earliest Roman period *murex* evidence dating to the mid 2nd to late 1st century B.C.E. These sites are clustered in North Africa. They are also sites with the longest known usage (Figures 10 and 11). The evidence available at the North African sites suggests that their usage began during the Late Republic/Early Empire. As previously discussed, this period in North Africa, and all of Rome, was highly productive, showing a large influx of items being imported into Rome. A large influx of imports means there was an increase in general consumption and *murex* dye was one of the items that experienced this increase. Figures 10 and 11 demonstrate that the "frantic passion" cited by Pliny, and the "highly evolved" usage of purple can be pinned to specific archaeological sites. These sites had a well established trade relationship with Rome, and which likely continued dyeing well into the Empire (Figure 9).

[118] Pliny 9.66: fasces huic securesque romanae viam faciunt, idemque pro maiestate pueritiae est, distinguit ab equite curiam, dis advocatur placandis omnemque vestem inluminat, in triumphali miscetur auro.

Figure 9 also shows that the number of settlements beginning to dye progressively decreases over time. When considering the earliest known usage of these sites (Figure 9) with their latest known usage (Figure 11), the gazetteer suggests that the sites which began dyeing later (from the late 1st century B.C.E. to the early 2nd century C.E.) were used for a shorter period of time in comparison to the sites during the aforementioned peak (mid 2nd century B.C.E. to the late 1st century B.C.E.). Essentially, over time fewer sites were involved dye production, and those sites which were involved during the later Roman period were not engaged in the trade for very long. The sites which were used the longest during the Roman period were centered in North Africa, again indicating its important role as a highly sought after commodity.

The decrease in number of sites over time occurred because of a series of complex relationships between the upper class, the general public, the instability of the later empire, and the *murex* dye. The following discussion will explain how the decrease in sites was a reaction to the sudden popularity of *murex* dye which appeared in the late Republic. Because the dye had become a recognized status symbol, more of the population wanted to wear purple, and as a result, imitation dyes begin to penetrate Roman society. The elites opposed the imitation dyes, and as a result, restrictions were placed on the usage of *murex* dye and imitation dye by the imperial government.

To understand the contraction, imitation dyes must be discussed in further detail. As previously mentioned, imitation dye methods had been used since the Bronze Age. Their popularity increased beginning in the 4th century B.C.E., around the same time that more and more Roman elites were using *murex* as a means to visually display their status. Lower classes were able to purchase similar colored cloth at a significantly reduced price,

enabling them to project their desire to be "elite" in an affordable way.[119] The cost of *murex* dyed cloth was incredibly expensive; starting in 80 B.C.E., one pound of *murex* dyed wool cost around 100 denarii;[120] the price of dyed silk was much higher.[121] However, their cheaper cost did not eliminate their inferiority to pure *murex* dye. Imitation dyes were not color fast and were thus noted for their lower quality.[122] Additionally, a lower class citizen with an imitation *murex* streak on their cloak could certainly not fool anyone into thinking they were elite; the quality of their clothes, the shade of the purple, and their general demeanor would certainly reveal their status. Wearing imitation purple would not draw an association with those who could afford the real thing. Instead, it would elevate the imitation dye wearers into a middle status: they could not afford the real product, but they could afford to wear imitation purple. This was certainly a better choice than wearing a different color, or worse, no color at all. Thus, we see basic three divisions: elite who could afford to wear *murex* dye, those who wished to imitate the elite in wearing imitations, and those who wore plain cloth. The wearers of purple were trying to show their economic and social superiority over those below them. In the case of the elite, it was by wearing *murex* purple, and in the case of those lower than them, it was in wearing the imitation cloth. There would always be someone who could not afford even the cheapest of purple imitations.

This increase in imitation dye usage by the lower classes, as well as the increase in elites wearing both imitation and real *murex* dyes, may have inspired emperors to place

[119] Reinhold 53.
[120] It is unknown whether these prices were set with price fixing; regardless, there is still a considerable increase in price from 80 B.C.E. to the time of Dicoletian's price edit.
[121] Leadbetter 164.
[122] Reinhold 53.

restrictions on wearing *murex* dye and related imitations. Placing restrictions would have preserved the status associated with the color for themselves and members of their court. Though the amount of restriction varied depending on the emperor, the general attitude was that *murex* purple dye was meant for the truly elite.[123] Thus, an increase in consumption triggered a decrease in dye sites, likely because the emperors were gaining control of the dye installation sites, and wanted to restrict the availability of the product.

The restrictions begin before the Empire, during the reign of Julius Caesar (in other words, during the end of the peak indicated in Figure 9). Caesar's actions set the stage for his successors who limited the usage of *murex* purple dye so that it might be preserved as an imperial symbol.[124] He "instituted duties for foreign goods. Uses of a litter, likewise for purple dyed clothes and pearls he took away for certain people and certain ages and throughout certain days."[125] The reason for restricting the use of purple clothing can be linked to a longstanding debate of Caesar's political aspirations. Reinhold, A.G. Carson, amongst others, have commented on the subject. According to Carson "It has been and, indeed, still is held by many that Caesar's ultimate ambition was the monarchy; and in the context of the first century B.C.E. the monarchy which he

[123] Elliot 181.
[124] Reinhold 46.
[125] C. Suetonius Tranquillus, *Divus Julius,* Maximilian Ihn, eds., (Cambridge: Harvard University Press, 1934) Jul. 43: peregrinarum mercium portoria instituit. lecticarum usum, item conchyliatae uestis et margaritarum nisi certis personis et aetatibus perque certos dies ademit. Reinhold's point regarding the restrictions should be noted: "It merely provided that the general wearing of garments dyed with [*murex*] purple was interdicted on specified days of the year, at which time only specific persons and specific age groups wear authorized to wear them.…Unfortunately, this limited restriction of Caesar has often been misinterpreted in modern treatments as an absolute, permanent prohibition of the use of purple by the public (Reinhold 45-6).

would envisage would be that of the great Hellenistic empires."[126] An example of this intention was the deification of Caesar. Cassius Dio states:

> When he showed himself pleased with these honors also, they accordingly voted that his golden chair and his crown set with precious gems and overlaid with gold should be carried into the theatres in the same manner as those of the gods, and that on the occasion of the games in the Circus his chariot should be brought in. And finally they addressed him outright as Jupiter Julius and ordered a temple to be consecrated to him and to his Clemency.[127]

Because Hellenistic monarchy relied on the monarch being divine, Carson believes that Caesar was planning on using a Hellenistic monarchy in Rome.[128]

The restrictions that Caesar placed on *murex* purple can be possibly related to these Hellenistic aspirations. According to Reinhold, Caesar was working to disprove the accusations that he was shaping the Hellenistic monarchy hinted at in Cassius Dio's accounts. Because Romans believed that *murex* dye was a tradition handed down by the Etruscan Kings, Caesar's restrictions could be interpreted as a means to demonstrate that he appreciated "ancient" Roman ideals.[129] Carson points out that Caesar's granted rights to wear a purple robe and sit on the gilded chair during festival days was believed to have derived from Etruscan kings of Rome.[130] Regardless of whether Caesar's intentions for the monarchy are true, he was clearly restricting the usage of dye for the imperial elite, as did subsequent emperors during the Roman Empire.

Octavian continued Caesar's restrictions. According to Cassius Dio, Octavian "gave orders that no one should wear the purple dress except the senators who were

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[126] R. A. G. Carson, "Caesar and the Monarchy," *Greece and Rome* 4 no. 1 (March 1957): 47.
[127] Cassius Dio, *History of Rome (English Loebe Ediion)*, Earnest Cary, eds., (Cambridge: Harvard University Press, 1978): 43.6.2.
[128] Carson 47.
[129] Reinhold 45.
[130] Carson 51.

acting as magistrates; for some ordinary individuals were already using it."[131] The account is somewhat problematic; Cassius does not state whether the restrictions were placed only on garments entirely dyed with *murex,* or if garments with *murex* embellishments were included. If the latter option was the case, his restrictions affected a greater amount of purple wearers, because it was more likely that *murex* dye on clothing was limited to embellishments because of its price and because of the association with whole dyed garments with emperors and victorious generals.

Nero's *murex* legislations were perhaps the severest of the early emperors. He restricted usage of purple for only the imperial court and official purposes. He closed down shops selling the dye, and punished those who wore purple clothing (real or imitation) by confiscating their property, regardless of how much purple was actually on the clothes.[132] Suetonius' descriptions effectively depict the harshness of Nero's legislation:

> And when he had forbidden the use of the color Amethyst and Tyrian, and he had sent (someone) who would sell on the day of the market a few ounces, he closed the wholesalers altogether. So that also while singing and playing, he had noticed a woman dressed (in purple) in the seats, he said to his (men) and immediately she was dragged, stripped not only of her garments, but her goods (property).[133]

Alexander Severus digresses from Nero's legislation, but still restricted the public's usage of purple, as well as his own. The fact that he did not wear *murex* purple, unlike the majority of Roman emperors, is indicative of his personal taste: "He removed the gems from the shoes and clothes which Heliogabalus had used. He used white

[131] Cassius Dio 49.16.9.
[132] Elliot 183.
[133] Suetonius Nero 32.4: et cum interdixisset usum amethystini ac Tyrii coloris summisissetque qui nundinarum die pauculas uncias uenderet, praeclusit cunctos negotiatores. quin etiam inter canendum animaduersam matronam in spectaculis uetita purpura cultam demonstrasse procuratoribus suis dicitur detractamque ilico non ueste modo sed et bonis exuit.

clothing just as it was colored and not clothing having been gilded, cloaks and common togas."[134] In regards to public usage of purple, references do not seem to indicate that he pushed his own sense of moderation unto others. He allowed *murex* dye to be worn, to an extent:

> He had in his mind the thought to give to all the offices a particular garment, and to all ranks, so that they would be distinguished by means of dress, and to all slaves, so that they would be able to be recognized in the populus, lest not anyone be seditious, likewise servants not be mixed with freeborns. But it was displeasing to Ulpian and Paulus, saying there would be a great number of arguments, if men were wide open to injuries. Then, he determined that it was enough that Roman knights would be separated from senators by the quality of the stripe. He permitted that old men could use cloaks inside the city for the sake of the cold, although that type of garment had always been for travel or rain. Despite that fact, he prohibited that married women, while in the city, use the cloaks, he permitted (while on a journey).[135]

Severus was following the actions of his predecessors by restricting dye usage, but in a different way. Though he controlled how the elite could wear the dye, his main concern appears to have been focused on preventing the lower classes from wearing purple. Interpreting this restriction from an economic perspective suggests that perhaps Severus allowed *murex* dye to be used, but in monitored or pre approved quantities. He was likely aware of how the market would suffer if he prevented the Roman citizens who could afford the dye from wearing it. Perhaps Severus felt that the dye restrictions could be lifted for the sake of the economy, while restricting usage by certain classes to preserve

[134] "Severus Alexander" in *Historiae Augustae*, David Magie, eds., (Cambridge: Harvard University Press, 1993): 1.4.1-2: Gemmas de calciamentis et vestibus tulit, quibus usus fuerat Heliogabalus. veste, ut et pingitur, alba usus est nec aurata, paenulis togisque communibus.

[135] "Severus Alexander" 1.27.1-4: In animo habuit omnibus officiis genus vestium proprium dare et omnibus dignitatibus, ut a vestitu dinoscerentur, et omnibus servis, ut in populo possent agnosci, ne quis seditiosus esset, simul ne servi ingenuis miscerentur. Sed hoc Ulpiano Pauloque displicuit, dicentibus plurimum rixarum fore, si faciles essent homines ad iniurias. Tum satis esse constituit, ut equites Romani a senatoribus clavi qualitate discernerentur. Paenulis intra urbem frigoris causa ut senes uterentur permisit, cum id vestimenti genus semper itinerarium aut pluviale fuisset. matronas tamen intra urbem paenulis uti vetuit, itinere permisit.

the status symbol in society. Roman emperors who permitted non imperium dye usage were still using the purple as a source of power, in this case to trigger economic growth. The reason the number of sites during the later Empire begins to decrease is a reflection of their power. Emperors restricted the geographic availability of dye by maintaining the lower number of dye sites, but some emperors wanted to increase the revenues yielded from them, and as a result, would lift restrictions slightly.

Textual evidence referencing the 2nd century C.E. onwards demonstrates that the use of *murex* purple was increasingly associated with the emperor. The use of purple on his ceremonial garb became more complex: "In addition to the purple bordered *toga praetexta*…the triumphal costume of purple (*toga picta*) was an exclusive imperial garb, worn as gala dress on festal occasions. In particular, the general's all-purple cloak…became a symbol of imperial sovereignty."[136] The restrictions continued onwards into the 3rd century C.E. onwards, which is perhaps indicative of the political climate of the time, which was plagued by weakening borders, constantly changing emperors, and social and economic crisis.[137] It is quite possible that the reigns would have been tightened on the imperial symbol by a variety of emperors, because they wished to preserve the usage of the dye for themselves, during a time where maintaining one's seat of power was so difficult. By the reign of Diocletian, the resulting purple restrictions were inevitable. He brought the entire industry under imperial control and restricted the finest dyes to the imperial household and court. In his *Edict on Maximum Prices* he set the price of purple wool at 50,000 denarii per pound (compared to high quality undyed

[136] Reinhold 59.
[137] Christer Brun, "The Antonine plague and the 'third century crisis,'" in *Crisis and the Roman Empire,* Olivier Hekster, Gerda de Kleijn, and Daniëlle Slootjes, eds., Brill Publishers, 2007: 204.

wool, which cost 175 denarii per pound), and purple silk at 150,000 denarii per pound.[138] Thus, Diocletian's actions shows the end result: the Empire's total control of the *murex* market and related imitation dyes, in order to limit usage, preserve the power of the status symbol, and in turn the status of the highest elite. From Constantine to Justinian, the power of purple is unprecedented, referred to in texts as "imperial" or "royal" purple, with the emperors covered nearly head to toe in the color.[139] By the end of the Empire, the emperors were no longer willing to sacrifice their favored status symbol, one which had been used by their oldest kings. They needed to control the industry in any way possible.

The gazetteer suggests that over the course of the Empire, the number of dye sites begins to decrease. It also suggests that any sites which begin participating in *murex* dye production are not as long lasting as sites clustered in North Africa, which began dyeing in the late Republican period. This evidence could be interpreted as *murex* dye losing popularity over time, because fewer dye sites were needed, and new dye sites were unable to operate for long periods of time. Textual evidence indicates this is not the case. *Murex* dye consumption has a very complex connection to the Romans, in particular the elite, which can explain the sudden contraction of usage over time.

As previously discussed, the number of *murex* dye sites was at its peak during the late Republican period and early Empire because of the influx of agricultural and luxury goods being shipped from various production areas, for example from North Africa to Rome. *Murex* dye consumption and production was at its peak during this period. The

[138] *Ibid* 48.
[139] *Ibid* 62.

increase in consumption by the elites during this period influenced the lower classes. They too wished to associate themselves in the discourse of the elite, and did so by wearing imitation *murex* dye. The increased popularity of imitation dye made the elite and imperial government fearful for their status symbol, and as a result, restrictions began being placed on all forms of purple dye. Arguably, the fear was also wrought from the ensuing imperial crisis of the 3rd century C.E. Such restrictions certainly influenced the number of dye related sites that were instigated during the Empire. If the imperial government restricted who could wear the dyed products, fewer sites would be needed across the Mediterranean to fuel the demand. The restrictions did not eliminate the demand in its entirety. Instead, it became concentrated in the area most likely to be exporting the dye: North Africa. Sites in this area have the longest periods of usage, such as Sabratha (early 4th century C.E.), Lepcis Magna (early 4th century C.E.) and Berenice (mid 5th century C.E.) As previously discussed, these three sites were also engaged in other large scale forms of production during the Roman period.[140] The tentative conclusion, then, is that though the dye sites were restricted during the Empire, the sites with the lengthiest *murex* production evidence had well established trade relationships with Rome.

[140] See "Production" chapter, as well as Reese 1979, 89 for a discussion on Berenice's lime production facilities, Wilson 2002a, 242- 247 for a discussion on Sabratha's fish salting industry, and Kehoe 556 for a discussion on Lepcis Magna's olive oil industry.

## VII. Conclusions

This thesis has taken a significant digression from the aims of past *murex* related research, which has focused on understanding the early stages of Bronze Age manufacture, as well as the accuracy of Pliny's dye recipe. Despite the fact that *murex* dye had a clear impact on Roman culture, demonstrated, for example, by the large body of textual references, little work has been done to understand its role in Roman society. Few connections have been drawn between *murex* dye production sites and the greater Roman economy. This thesis has made the importance of *murex* dye within the Roman economy clear: it was a luxury good that instigated a clustering of dye production sites in North Africa, where a wide variety of exports to Rome were already being produced. Its popularity instigated a variety of imperial restrictions, as well as the increased popularity of another product: imitation dye.

The gazetteer in itself is helpful because it provides a comprehensive list of Roman period sites which demonstrate the least problematic *murex* production evidence, out of the hundreds of sites which have been identified in the past. Its division into two types: sites which have definitive production evidence, and sites which have probable production evidence, enables a clear distinction to be drawn against problematic evidence. Further, because Type 2 sites are then divided into sub categories, it enables investigations for distinguishing sites of similar characteristics, such as sites with large amounts of *murex* being incorporated into the mortar. As of yet, the evidence does not indicate whether sites with *murex* in the mortar were in fact producing *murex* dye, or were merely nearby another site which was producing the dye, and were moving the shells. Thus, the subcategories enable the distinction to be made that probable sites are

problematic in a variety of ways, and understanding their evidence should be easier if there are other sites of similar characteristic to compare them to.

The *murex* dye sites as a whole have been assessed in relation to the larger Roman economy. North African sites were emphasized in this study because of the region's large scale production centers, such as Sabratha, which was producing substantial amounts of materials with the intention of exporting the goods, most often to Rome. Because the region was so engaged in Roman trade and had established production centers, the decision to engage in *murex* production was logical. They had access to a large amount of *murex* snails and were already trading with Rome. The desire for *murex* dyed products was also common knowledge; the coastal cities of North Africa were aware of the potential economic gain.

The distribution of sites over time is reliant on many factors. The emergence of sites in North Africa during the late Republican and early Empire was likely a result of the emergence of agricultural and luxury goods from the prosperity of the period. The presence of sites in the Near East is definitely linked to the previous control of the Tyrians over *murex* during the Bronze Age. The inherent shift of political power from the Near East to the west shows that the dye installations followed in suit; the dye production centers followed to where the primary source of consumption would be: the elite in the city of Rome. Over time, the number of dye sites seems to decline. This can also be connected to the fact that sites appear to lose longevity over time; newer sites which were created in the later Empire are in existence for fewer years than sites created during the Republic and early Empire.

The contraction in number of dye sites is to the result of two factors: an increase in consumption by both the elite and lower classes, and the political crises occurring the 3rd century C.E. The elite were the main consumers of *murex* dye because of its high prices and the status associated to it. However, as the Republican period progressed, the dye increased in popularity, and the lower classes were desirous of achieving status via purple dye as well. Imitation dye methods which had been in use for some period are noted for gaining popularity during the Republican period. Possibly, the lower classes who wished to participate in the purple dye discourse were increasing consumption of imitation dye methods. Their reaction would have certainly caused an influx of purple colored clothing, and as a result, Roman elite, in particular emperors, placed restrictions on wearing purple colored clothing, *murex* or otherwise, to protect the symbol, and maintain its rarity. Thus, dye production centers decreased in number during the early and mid Empire. Regardless of their decrease in number, the clear control of the production of *murex* dye remains centered on North Africa.

A few factors should be considered in this analysis. For one, this is a small data sample, and cannot be left as the final answer. If more sites are identified with Roman period *murex* evidence, they should be incorporated into the gazetteer to test this model. This is easier said than done. From the descriptions in the gazetteer, it should be clear that *murex* dye production centers are not all cut from the same cloth. The materials vary from site to site, as does the design, likely dependent on the time they were constructed, and where. Using Pliny and the gazetteer, we can only conclude that some sort of holding tanks are necessary, as well as a mode of heating. Heating sources are difficult to retrieve in the record in a variety of instances, and in particular with these dye sites. Holding

tanks are also problematic, because in many cases they are similar to fish salting vats, garum tanks, not to mention other types of dyeing tanks. The locations of the dye production facilities within a site would vary from site to site, depending on the size of the settlement and the size of the production facilities. All of these variances complicate the ability to identify sites; in the end, the only certain indicator that *murex* dye production occurred in the vicinity is a large dump of shells.

The dates associated with the evidence for dye production are also problematic. *Murex* deposits could have been moved from one area to another, and in the cases of *murex* shells being used as mortar material, the dating is even more difficult. Broken pottery can be used to date the piles, as is the case with most of these sites, however, this becomes problematic because pottery could have been reused. Regardless of these dating issues, I stress that the location of sites ought to be investigated in relation to their dates of usage because an interesting trend is most certainly being revealed.

The presence of imitation dyeing facilities in the archaeological and historic record certainly complicates matters further. Finding these sites in the archaeological record is most difficult. Consider the discussion on Carthage. Small numbers of *murex* shells were found in relation to dye facilities, indicating that perhaps the *murex* snails had been used to make an imitation dye with other ingredients. However, the facilities could certainly have been used for a different mode of production, and perhaps, the *murex* shells found at the site are evidence for the snails having been eaten.

The evidence for imitation *murex* dyes is at the moment heavily reliant on textual sources. And, there is no definitive understanding of what imitation *murex* dye manufacturing facilities would have looked like, in particular because there were multiple

methods and ingredients which could have been used to create the dye. Though the pure *murex* dye facilities are also difficult to identify, the large dumps of *murex* shells makes it easier. We can only wonder where imitation dye sites were located, if the dye was in most cases produced in the same towns creating pure dye, and as a result, if the textual indications for when the imitation dyes grew in popularity correspond to the expansion dates of the *murex* dye industry.

Ideally, future scholarship would include finding more sites to include in the gazetteer to determine if the typologies are in fact usable. Understanding all manner of dye sites is helpful as well. Perhaps studying the largest dye manufacturing facilities, the longest used facilities, and a few Bronze Age facilities in the Near East would provide more evidence for dye facility commonalities. Such an investigation might clarify some of the limitations just stated, to understand the intricacies of dye manufacture sites and discover if, for example, Wilson's hypothesis that *murex* dye production vats would be smaller is in fact correct.

Regardless of the limitations in the evidence, the methodology presented in this thesis has hopefully opened the door to new *murex* dye methodologies and a greater understanding as to how *murex* dye manufacture fits into the greater Roman economy. I intended in this thesis to address gaps in research, mainly geographic and economic. In the end, more questions have been raised than asked. However, I have shown the value in discussing the geographic locations of dye sites, the necessity for critical analysis of dye site definitions, and the probable connections between *murex* dye and a variety of modes of production focused in the western Mediterranean.

*Appendix 1*

The gazetteer lists geographic coordinates for each *murex* site. These coordinates were located via Google Earth and the National Geospatial-Intelligence Agency Geonames server. [141] In the case that a site's coordinates could not be found, the modern city's coordinates are used. Such a choice is sufficient for the nature of this project, which focuses on large scale movement. Exact locations, then, are not necessary.
The .xls gazetteer file was then converted into the Sites.shp file, which records the information in the gazetteer in a variety of formats. Some fields are repeated for symbology purposes, with different a different field type set (i.e. long integer, string, etc.).

Table 1: A summary of fields in sites.shp

| | |
|---|---|
| Name | Name of site |
| Country | Modern country location of site |
| Alt_Name | Ancient name of site, or alternative spelling |
| Lat/Long | Decimal degrees coordinates of the site, taken via the National Geospatial-Intelligence Agency Geonames server. |
| Start_Date | Earliest known usage of the dye related evidence |
| End_Date | Last known usage of the dye related evidence |
| Site_size | Size of the dying installations or middens if known, as stated in the excavator's notes |
| Type (1-3) | Type of site (Dye installation, Midden, Textile, Construction, Textile, Lime). These fields are listed as Type, Type2, and Type3 respectively, to record instances of multiple types of evidence at one site. |

[141] National Geospatial Intelligence Agency. *GeoNet Names Server.* <http://geonames.nga.mil/ggmagaz/>.

| | |
|---|---|
| Const, Midden, Lime, Dye, Textile fields | 0 = the type of evidence is available, 1 = the type of evidence is not available. These fields are necessary for GIS coding. |
| SD1 | Lists again the start date, however B.C.E dates are indicated as negative numbers. NoData indicates that a date could not be found. |
| ED2 | Lists again the start date, however B.C.E dates are indicated as negative numbers. NoData indicates that a date could not be found. |
| Use | The period of usage based off of SD1 and ED2, listed as a number or NoData. |
| Type2 | Numerical listing of site types from the final gazetteer (1= type 1, 2A=type 2A, and so on). |

*Appendix 2*

The following sites have evidence of textiles dyed with *murex* specific dye. They were excluded from the main gazetteer because they were found out of context from any dye manufacture evidence. They do, however, indicate specific sites where dyed textiles could have been sold.

Krokodilo, Egypt (29.11897, 30.801150)
Late 4th/Early 5th century C.E.- late 6th/early 6th century C.E.

Textiles were found at Krokodilo with *murex* purple dye. They were found in trash heaps assumed to have been left by Roman garrisons. Some pieces were found also with high percentages of kermes purple, suggesting alterations were made to the mixture to produce cheaper dye.[142]

Maximianon, Egypt (30.04707, 31.234860)
Late 4th/Early 5th century C.E.- late 6th/early 6th century C.E.

Textiles were found at Maximianon with *murex* purple dye. They were found in trash heaps assumed to have been left by Roman garrisons. Some pieces were found also with high percentages of kermes purple, suggesting alterations were made to the mixture to produce cheaper dye.[143]

Philadelphia, Egypt (29.483333, 31.06667)
Late 2nd/Early 3rd century C.E. - late 3rd/early 4th century C.E.

A wool tunic dated to the 3rd or 4th century C.E. with *murex* purple dye has been identified from Philadelphia. The *murex* secretions were traced via physicochemical analysis, proving that purple *murex* dye was used to create the band's dyed color. The fabric was also decorated with linen, and a leaf motif.[144]

[142]Dominique Cardon, et al. "Dye Analyses of Selected Textiles from Maximianon, Krokodilo, and Didymoi (Egypt)," in *Purpurae Vestes,* C Alfaro, J. P. Wild, and B. Costa, eds. (Valencia: Universitat de Valencia, 2004), 153-4.
[143] Cardon, et al. 153-4.
[144] Rudolph H. Michel, et al., "Indigoid Dyes in Peruvian and Coptic Textiles of the University Museum of Archaeology and Anthropology," *Archaeomaterials* 6, no. 1 (Winter 1992): 72, 78.

*Works Cited*


Armstrong, Marian, ed. "Slug and Snail." In *Encyclopedia of the Aquatic World.* Tarrytown: Marshall Cavendish, 2004.

Aubet, Maria Eugenia. *The Phoenicians and the West.* Cambridge: Cambridge University Press, 2001.

Baker, J. T. "Tyrian Purple: an ancient dye, a modern problem." *Endeavour* 33 no. 118 (1974): 11-17.

Bradley, Mark. *Colour and Meaning in Ancient Rome.* New York: Cambridge University Press, 2009.

Brun, Christer. "The Antonine plague and the 'third century crisis.'" In *Crisis and the Roman Empire.* Olivier Hekster, Gerda de Kleijn, and Daniëlle Slootjes, eds. Brill Publishers, 2007.

C. Suetonius Tranquillus. *Divus Julius.* Maximilian Ihn, eds. Cambridge: Harvard University Press, 1934.

-------. *Nero.* Maximilian Ihn, eds. Cambridge: Harvard University Press, 1934.

Cardon, Dominique, et al. "Dye Analyses of Selected Textiles from Maximianon, Krokodilo, and Didymoi (Egypt)." *Purpurae Vestes.* C Alfaro, J. P. Wild, and B. Costa, eds. Universitat de Valencia, 2004.

Carson, R. A. G. "Caesar and the Monarchy." *Greece and Rome* 4 no. 1 (March 1957): 46-53.

Cassiodorus, *Variae Epistolae*. Thomas Hodgkins, transl. Liverpool: University Press, 1992.

Cassius Dio. *History of Rome*. Earnest Cary, eds. Cambridge: Harvard University Press, 1978.

Charles-Picard, Gilbert and Colette Picard. *The Life and Death of Carthage: A Survey of Punic History and Culture from its Birth to the Final Tragedy.* New York: Taplinger Publishing Co., 1969.

Cicero. *In Verrem.* Albert Clark and William Peterson, eds. Oxford, 1912.

Columella. *De Re Rustica.* G.P Goold, eds. Edinburgh: St. Edmundsbury Press, 1941.

Dix, Brian. "The Manufacture of Lime and its Uses in the Western Roman Provinces." *Oxford Journal of Archaeology* 1 no. 3 (1982): 331- 345.

Dolansky, Fanny. "Togam Virilem Sumere: Coming of Age in the Roman World." In *Roman Dress and the Fabrics of Roman Culture.* J.C. Edmonson and Alison Keith, eds. Toronto: University of Toronto Press, 2008: 47-71.

Doumet, Joseph. *A Study on Ancient Purple*. Beirut: Imprimere Catholique, 1980.

Edens, Christopher. "Khor Ile-Sud Qatar: The Archaeology of Late Bronze Age Purple-Dye Production in the Late Bronze Age Arabian Gulf." *Iraq* 61 (1999): 71-88.

Elliot, Charlene. "Purple Past: Color Codification in the Ancient World." *Law and Society* 33 no 1 (2008): 173-194.

Fowler, W. Warde. "Jupiter and the Triumphator." *The Classical Review* 30 no. 5/6 (August 1916): 153-157.

Forstenpointer, Gerhard, et al"Purple-Dye Production in Lycia-Results of an Archaeological Field Survey in Andriake (South-West Turkey)." *Oxford Journal of Archaeology* 26, no. 2 (2007): 201-214.

Gleba, Margarita. *Textile Production in Pre-Roman Italy.* Oxford: Oxbow Books, 2008.

Harris, William. "The Late Republic," in *The Cambridge Economic History of the Graeco Roman World.*

Hedi Slim, et al., *Le Littoral de la Tunisie: Etude Geoarcheologique et Historique,* CNRS Editions: Paris, 2004.

Hohlfelder, Robert L. "Cabotage at Aperlae in Ancient Lycia." *The International Journal of Nautical Archaeology* 29 no. 1 (2000): 126-135.

Jensen, Lord B. "Royal Purple of Tyre." *Journal of Near Eastern Studies* 22, no. 2 (April 1963): 104-118.

Johannesen, Rolf. “The Textile Industry in Roman North Africa.” *The Classical Journal* 49 no. 4 (January 1985): 157-60.

Jongman, Willem M. “The Early Roman Empire: Consumption.” In *The Cambridge Economic History of the Graeco Roman World*. Walter Scheidel, Ian Morris, and Richard Saller, eds. Cambridge: Cambridge University Press, 2007.

Karmon, Nira and Ehud Spanier. “Archaeological Evidence of the Purple Dye Industry from Israel.” In *The Royal Purple and the Biblical Blue: Argaman and Tekhelet.* Ehud Spanier, eds., 1987.

Karmon, Nira. “Muricid Shells of the Persian and Hellenistic Periods.” In *Apollonia Arsu: Final Report of the Excavations. Volume 1: The Persian and Hellenistic Periods,* Israel Roll and Oren Tal, eds. Tel Aviv: Emery and Claire Yass Publications in Archaeology of theInstitute of Archaeology, 1999.

Kehoe, Dennis. “The Early Roman Empire: Production.” In *The Cambridge Economic History of the Graeco Roman World.* Walter Scheidel, Ian Morris, and Richard Saller, eds. Cambridge: Cambridge University Press, 2007.

Koren, Z. C. “The First Optimal All-Murex All-Natural Purple Dyeing in the Eastern Mediterranean in a Millennium and a Half.” In *Dyes in History and Archaeology* 136-149. London: Archetype Publications, 2005.

Leadbetter, Bill. “Diocletian and the Purple Mile of Aperlae.” *Epigraphica Anatolica* 36 (2003): 127-136.

Levine, Lee I. *Studies in Late Judaism in Late Antiquity: Caesarea Under Roman Rule.* eds. Jacob Neusner Volume 7, 1975: 51-53.

Marchese, Robert T. *The Fabric of Life: Cultural Transformations in Turkish Society.* New York: Binghamton University Press, 2005.

Mattingly, David J. and R. Bruce Hitchner. “Roman Africa: An Archaeological Review.” *The Journal of Roman Studies* 85 (1995): 165-213.

Michel, Rudolph H. et al. “Indigoid Dyes in Peruvian and Coptic Textiles of the University Museum of Archaeology and Anthropology.” *Archaeomaterials* 6, no. 1 (Winter 1992): 69-83.

Morel, Jean Paul. “Early Rome and Italy.” In *The Cambridge Economic History of the Graeco Roman World.* Walter Scheidel, Ian Morris, and Richard Saller, eds. Cambridge: Cambridge University Press, 2007.

National Geospatial Intelligence Agency. *GeoNet Names Server.* <http://geonames.nga.mil/ggmagaz/>

Parker, Grant. “Ex Oriente Luxuria: Indian Commodities and the Roman Experience.” *The Journal of the Economic and Social History of the Orient,* 45 no. 1 (2002): 40-95.

Pinto-Guillaume, Ezequiel M. “Mollusks from the Villa of Livia at Prima Porta, Rome: The Swedish Garden Archaeological Project, 1996-1999.” *American Journal of Archaeology* 106 (2002): 37-58.

Pliny the Elder. *Natural History.* John Bostock, eds. London: Taylor and Francis, 1855.

Reinhold, Meyer. *Collection Latomus: History of Purple as a Status Symbol in Antiquity* vol 16. New York: Johnson Reprint Corporation 1970.

Reese, David S. “Industrial Exploitation of Murex Shells: Purple Dye and Lime Production at Sidi Khrebish, Benghazi (Berenice).” *The Society for Libyan Studies* 11 (1979-1980): 79-93.

-------. “Whale Bones and Shell Purple-Dye at Motya (Western Sicily, Italy).” *Oxford Journal of Archaeology* 24, no. 2 (2005): 107-114.

-------. “Marine Shells.” In *Tel Mor: the Moshe Dothan Excavations: 1959-1960* edited by Tristan J. Barako, 233-238. Cambridge: The Shelby White-Leon Levy Program for Archaeological Publications, 2007.

-------. “Shells from Sarepta (Lebanon) and East Mediterranean Purple-Dye Production.” *Mediterranean Archaeology and Archaeometry* 10, no. 1 (2010): 113-141.

Ruscillo, Deborah. “Reconstructing *Murex* Royal Purple and Biblical Blue in the Aegean” in *Archaeomalacology: Molluscs in Former Environments of Human Behavior,*Keith Dobney, Peter Rowley-Conwy, and Umberto Albarella, eds. Durham: 9th ICAZ Conference 2000: 99-106.

-------. “Faunal Remains and *Murex* Dye Production” in *Kommos V: The Monumental Minoan Buildings at Kommos* edited by Joseph W. Shaw and Maria C Shaw, Princeton: Princeton University Press, 2006.

Sagona, Claudia. “Silo or Vat? Observations on the Ancient Textile Industry in Malta and Early Phoenician Interests in the Island.” *Oxford Journal of Archaeology* 18 no. 1 (1999): 23-60.

Scheidel, Walter, Ian Morris, and Richard Saller eds. Cambridge: Cambridge University Press, 2007.

“Severus Alexander.” In *Historiae Augustae*. David Magie, eds. Cambridge: Harvard University Press, 1993.

Silver, Morris. *Taking Ancient Mythology Economically*. Leiden: E. J Brill Publishers, 1992.

Shuto Tsugio, “Larval Development and Geographical Distribution of the Indo-West Pacific *Murex*,” *Bulletin of Marine Science* 33 no 3 (1983).

Slim, Hedi, et al. *Le Littoral de la Tunisie: Etude Geoarcheologique et Historique.* Paris: CNRS Editions, 2004.

Spanier, Ehud, and Nira Karmon, “Muricid Snails and the Ancient Dye Industries,” in *The Royal Purple and the Biblical Blue* ed Isaac Herzog, Keter Publishing House Jerusalem Ltd., 1987.

Steinhert, Carol E. “Biology of the Blues: The Snails behind the Ancient Dyes.” *Journal of Chemical Education* 78 no. 11 (November 2001).

Stern, Ephraim. *Excavations at Tel Mevorakh (1973-1976) Part One: From the Iron Age to the Roman Period.* Jerusalem: The Institute of Archaeology, 1978.

Stillwell, R.W, L. MacDonald, and M. H McAllister (eds). *The Princeton Encyclopedia of Classical Sites.* Princeton: Princeton University Press.

Warren, Larissa Bonfante. “Roman Triumphs and Etruscan Kings: The Changing Face of the Triumph.” *The Journal of Roman Studies* 60 (1970): 49-66.

Wild, John Peter. “The Roman Textile Industry: Problems, but Progress” in *Purpureae Veste: I Symposium Internacional Sobre Textiles y Tintes del Mediterraneao en Epoca Romana.* C Alfaro, J.P Wild, and B. Costa eds. 2002.

Wilson, Andrew. “Commerce and Industry in Roman Sabratha.” *The Annual Report of the Society for Libyan Studies* 30 (1999): 29-52.

-------. “Timgad and Textile Production” in *Economies Beyond Agriculture in the Classical World* eds. David J. Mattingly and John Salmon. London: Routledge Press (2001).

-------. “Urban Production in the Roman World: The View from North Africa.” *Papers of the British School at Rome* 70 (2002): 231-273.

-------. “Archaeological Evidence for Textile Production and Dyeing in Roman North Africa.” In *Purpurae Vestes: I Symposium Internacional Sobre Textiles y Tintes del Mediterraneao en Epoca Romana.* C. Alfaro, J.P Wild, B. Costa, eds. 2002.

Vitruvius Pollio. *De Architectura.* F. Khron, eds., Teubner, 1912.