

THE PURPLE TIDE: MUREX DYE AND THE FORMATION OF THE MINOAN STATE

by

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Contents

LIST OF FIGURES	4
ABSTRACT	5
CHAPTER 1- INTRODUCTION	6
1.1 Introduction	6
CHAPTER 2- DEVELOPMENT OF THE MINOAN STATE	10
2.1 Theoretical Framework	10
2.2 The Mollusk and its Exploitation	14
2.3 Bronze Age Luxury Goods	20
CHAPTER 3- THE SITES	24
3.1 Petras and Kommos: EMIII to MMI	24
3.2 Eastern Crete: MMII	31
3.3 Expansion to the Islands: MMIII-LMI	37
CHAPTER 4- TEXTILES AND TRADE	42
4.1 Textiles, Trade, and the Minoan Economy	42
4.2 Costin’s Framework for the Minoan Murex Industry	47
4.3 Murex in the Post-Minoan Mediterranean	53
CHAPTER 5- CONCLUSIONS	55
5.1 Conclusions	55
BIBLIOGRAPHY	58

LIST OF FIGURES

Figure 1. 2000 year-old murex-stained wool fabric found near the Dead Sea.	7
Figure 2. The three purple-producing mollusks.	14
Figure 3. Wool on right was exposed to more sunlight, resulting in bluer shade.	15
Figure 4. Ruscillo used baited pots to catch murex snails in shallow waters	16
Figure 5. Mollusk shells pierced by cannibal snails	17
Figure 6. Fleece after being dyed begins to turn purple after about 20 seconds of oxidation.	19
Figure 7. Fresco from Thera, murex pigment used for detail	19
Figure 8. Murex production during EMIII-MMI.	24
Figure 9. Loom weights and one spindle whorl (LW 64) found in early Petras	25
Figure 10. Sample of murex debris found at Kommos.	27
Figure 11. Industrial dye area at Kommos.	28
Figure 12. Restored plan of building T.	29
Figure 13. Murex production during MMII. Square indicates detail on right.	31
Figure 14. Building Gamma 48 with drain bisecting room.	32
Figure 15. Basins with drains inside Hogarth's House I, Zakros.	35
Figure 16. Mediterranean currents during summer season.	37
Figure 17. Areas of murex production during MMIII-LMI.	39
Figure 18. The production of murex-dyed textiles gave the elites ultimate control of the product.	49
Figure 19. Costin's framework for the production of a specialized good as applied to murex textiles.	52

ABSTRACT

Though scholars have previously speculated that there was a connection between murex dye and the formation of the Minoan state, a systematic exploration of the relationship between these two factors has not been conducted. This thesis attempts to rectify that deficiency, examining the location and character of early murex production on Crete. The dye was difficult to produce and required skilled craftsmen, but the result was a colorfast dye that did not fade. I juxtapose this industry against the macro-events of the Bronze Age, which led to the increasing international connection of the island. This thesis follows the industry from its earliest origins on Crete in the Early Minoan III and Middle Minoan I, then considers the developments as dye production shifted to east Crete during the Middle Minoan II, and then focuses on the changes that arose during the Minoanization of the Aegean as the industry began to scatter to the Cyclades, the Greek mainland, and beyond.

I also investigate the potential contribution of the Minoan wool industry, which was combined with murex dye to create a prestige item. Though these prestige items involved the contribution of many members of society, ultimate control was in the hands of elites who used the textiles to gain entry to the international trade relationships which had been established by kingdoms in the east and Egypt. Though the Minoan state began as a satellite to these kingdoms, by the Middle Minoan III period they were acting as a core state to an Aegean periphery. The attributes of the production are then evaluated using Costin's framework for characterizing craft specialization (Costin 1991). This allows for a nuanced exploration of the periodic economies of murex production that manifested as the international Minoan market was developing.

CHAPTER 1- INTRODUCTION

1.1 Introduction

A powerful man nearly forty years old died in Cyprus around the year 1150 B.C. His community buried him in a shaft grave inside the village at Hala Sultan Tekke, wreathing him in a necklace with a gold-mounted faience scarab which bore a cartouche with the name of Ramses II. Other gold jewelry was peppered along the body, and many of the bronze objects bore Mycenaean characteristics. This was the richest burial of the Late Cypriote III period, with 66 separate objects included. Many of these items seemed personal in nature, items that were valued in life: game pieces and fishing tridents. The pottery inside the grave suggests that there was feasting at the gravesite, with at least one faience bowl having been ritually broken (Niklasson 1983: 171-184).

On the center of the man's chest, as if to signal a deeper and richer story, those burying him had placed a single murex shell immediately below the brilliance of the scarab. The soil, many pieces of pottery, and some beads from the jewelry had been stained a deep purple (Niklasson 1983: 172). He had been buried in a shroud dyed with the indigoid fluids of the murex mollusk, which produced a colorfast dye that outlived the crushed kermes bugs that painted the ancient world a rich vermillion, outlived the saffron gathered from the early spring crocus which tinged dresses and robes yellow, and far outlived the legacy of the man buried in its rich hues. His story was long ago lost and his name forgotten. Now all that remains of the royal brilliance of his memory is the staining of the soils where he lay. His story is emblematic of a tradition of purple textile dyeing that helped define the status and authority of many ancient elites. This tradition began centuries before, when the early Minoans began using a mollusk

which was then common in the Mediterranean for creating a dye that had far more endurance than the kingdoms it came to represent.

In the latter Early Bronze Age and early Middle Bronze Age, textiles began to circulate around the Mediterranean with a novel feature. These textiles were imbued with enduring colors that did not fade with wear or washing, and left the bearer resplendent in wine dark, rich red, and brilliant blue hues. One of the few surviving textiles from antiquity dyed with murex is 2000-year-old swatch of wool found in a cave on the western shore of the Dead Sea (Stub 2020; fig. 1). In the southern Aegean, this dye came into use during a time of growing international connections, rising wealth, and the social changes that led to the first Aegean state on the island of Crete. While this was not the first instance of the exploitation of the murex snail noted from archaeological remains, it does mark the earliest sustained period of industrial activity tied to the use of the mollusk for dye. The burial in Cyprus occurred during the tail end of the Bronze Age, when already the centers of the murex economy had jockeyed around the Mediterranean. But what was the story of the origin of the dye? How and why were workforces mobilized to tediously produce such a challenging product, but one so enduring and unique?



Figure 1. 2000 year-old murex-stained wool fabric found near the Dead Sea. Stub 2020.

Some scholars have traced the origins of murex dye and charted its progress from the earliest finds in the Mediterranean (Alberti 2008; Burke 2010). Others have detailed its production, even experimentally recreating the process (Ruscillo 2006; Koren 2005; Karapanagiotis 2019). Furthermore, there has been speculation that murex production was somehow associated with Minoan state formation. Brenden Burke wrote that “a new development in cloth production technology, which was contemporary with the early palaces of Crete and the incipient Minoan economy, was the emergence of purple-dye industries from the murex snail” (Burke 2010: 34). However, the systematic exploration of the relationship between purple dye production and the process of Minoan state formation has not been elaborated.

This thesis attempts to rectify that deficiency, examining the location and character of early murex production on Crete. I juxtapose this industry against the macro-events of the Bronze Age, which led to the increasing international connection of the island, as well as the potential contribution of the Minoan wool industry which was combined with murex dye to create a prestige item. These attributes are then evaluated using Costin’s framework for characterizing craft specialization (Costin 1991). This allows for a nuanced exploration of the periodic economies: the EMIII-MMI, MMII, and MMIII-LMII, during which the international Minoan market was developing. While Burke noted that murex was instrumental in the formation of the Minoan state, the details of this process have not been systematically considered in one study.

The chapters that follow attempt to clarify the use of Murex dye in forming the Minoan state. While the use of this dye was not the only factor at work in crystalizing these developments in Crete, it allowed the Minoan elites to create a prestige good highly useful to integrating the Minoans within the established trade traditions of the older eastern kingdoms.

Chapter 2 considers the growth of the early state and examines the theoretical framework outlining the overarching social context between elites and commoners which encouraged development. Chapter 3 presents an overview of the locations where production on Crete occurred, beginning with the earliest evidence during the EMIII and ending with the Minoanization of the Aegean during LMI. Chapter 4 introduces the Minoan wool industry and considers the relationship between wool, murex and, specialized production as well as the later trade relationship with the Cyclades. Finally, chapter 5 presents the conclusions of this thesis; while the history of murex production has been explored and the connection has been made between murex and the Minoan state, this study explores the contribution of murex dye production from its early industrial origins on Crete through the later expansion into the broader Aegean.

CHAPTER 2- DEVELOPMENT OF THE MINOAN STATE

2.1 Theoretical Framework

The social dynamics of many cultures increase in complexity over time, yet those cultures never form a state. Collective action theory supposes that it is difficult for human beings to “build and maintain stable political regimes, given the potential for disorder to be found in their rational but often selfish social actions (Blanton and Farger 2008: 5). This is largely because it is easy for conflict to arise over shared resources once a group develops the technology to exploit those resources, but to achieve statehood rulers and taxpayers must find a way to reach agreement over the assets found in their territory. A balance must be achieved that both parties find mutually agreeable, and the pathway toward this consensus might be eased if a consistent revenue stream can be maintained where either foreign trade is controlled by only a few ports, or a monopoly of highly valuable assets is maintained by the state. For example, the revenue of Tibet was gained largely through state monopolies of some trade items as well as taxes imposed on customs and transit (Carrasco 1959: 87), while in ancient Egypt the state controlled most mining operations (Grimal 1992: 247-8). A revenue stream is produced when the state can achieve consistent revenues from “specific, highly productive point sources, allowing tax administration to be carried out by a comparatively small, and, presumably, highly motivated work force and administrative staff rewarded with high social standing and a share of the state’s wealth (Blanton and Farger 2008: 112). The taxpayers contribute to this dynamic by paying taxes, often in the form of raw goods or labor, and they benefit through the construction of public goods including public infrastructure, streets, and water management projects which have a high degree of public accessibility, as well as public redistribution (Blanton and Farger 2008: 136), which might be in the form of a feasting or agricultural doles. The contributions from taxpayers

was often agricultural, and in the early Minoan state this might have included raw wool from shepherds and live murex snails from fishermen: the raw ingredients for murex textiles.

These sources can also involve highly specialized crafts that involve many workers in the polity; revenue streams are useful when the asset can be easily controlled, either through their rarity or complexity, and it is possible to have layers of production where the final goods are the result of highly skilled craftsmen, but the overall production utilizes the labor or resources of a far larger group. Among the pre-Columbian Mayan elites of Aguateca, Guatemala some of the finest objects produced were created by elite artists. Loom weights and pestles were found in an elite residence, as were stone axes used in rock carving, and it seems a princely scribe and his wife were producing the resulting textiles and carvings (Inomata 2001: 327-330). These final products were built with refined goods which utilized the labor of others in the community. Craft specialization is an important part of the development of a complex society, and is either attached, with production managed by elites, or independent with specialists producing to satisfy the demands of the general market (Costin 1991: 11). Therefore, attached specialization is not necessarily concerned with efficient production, but is very sensitive to demand. Because attached production is controlled by elites, the goods created can be used as a way for elites to control symbols of power (Costin 1991: 12-13). This control is helpful for guiding state ideology and synchronizing belief and practice, and control is enhanced if the final steps of production are done by elite craftsmen, as was the case with the Maya.

It is unlikely that elites were collecting all the resources required for their crafts, however the final products were art objects that could be circulated through gift exchange, thus nurturing diplomatic relationships with outside agents. According to Parkinson and Galaty, both the structure of local systems before and during state formation as well as the frequency and nature

of interactions between the young state and its neighbors have great significance on the direction of formation. As compared to other states, “the formal characteristics of Minoan and Mycenaean states suggest that they were most similar to secondary states that formed via long-distance interaction with larger societies that had developed complex economic and political systems hundreds- if not thousands- of years before, and that themselves had undergone several changes in state organization” (Parkinson and Galaty 2007: 113). This is contrary to the ideas of Renfrew, who believed instead that the Minoan state formed relatively independently of outside influences (Renfrew 1972). While Crete likely did experience a period of mostly internal development after the EMII disruptions that ended trading activity between Crete and the Cyclades (Manning 2008: 108), EMIII and MMI saw a resurgence in international ties that linked the nascent Minoan society to eastern states.

These ideas were an extension of Wallerstein’s model of world-systems, where powerful cores states exploit less powerful peripheries (Wallerstein 1974), but while Wallerstein designed his model to apply to modern states, Parkinson and Galaty realized the core/periphery elements could apply to ancient societies as well. They outlined a basic model of Aegean state formation based on this theory, with a shift in the nature of the core/periphery relationship creating a defining difference in the Protopalatial and Neopalatial state. According to this model, the Minoan state emerged around 2000 B.C. due to competition between tribal groups who were interacting with other outside polities Crete (Parkinson and Galaty 2007: 118). At this time, sailing ships likely increased the efficiency of exchange throughout the Aegean, Egypt, and the Near East (Cherry 1983: 36).

As the Minoan palatial system grew, it became integrated into the trade and cultural activities of the larger eastern network. This network was dominated by the original states in the

Near East and Egypt, and through these interactions the Minoans became a periphery to this older and more advanced core (Parkinson and Galaty 2007: 118). Elites began to centralize their authority through the manipulation of ritual and use of limited goods and knowledge acquired from these outside polities (Haggis 1999: 55; Cherry 1986: 27). This eventually led to the further complexity of the Neopalatial period, which lasted from 1680 to 1450 B.C. During this time, the Minoan states retained their established relationships with the Near East and Africa, but also became a core member within the Aegean, supporting a peripheral relationship with mainland Greece and the Cyclades (Parkinson and Galaty 2007: 118). These peripheries were also developing more complex social structures based on Minoan influence. During the Neopalatial period, emerging elites of the islands and mainland were interacting with the Minoan core, “actively pursuing trade to acquire low-bulk, high-value items associated with prestige and political power” (Parkinson and Galaty 2007: 121).

Therefore, the large-scale production of purple dyes and pigments from the murex snail began on Crete during a time of economic expansion and helped to strengthen trade connections between the island and the broader Mediterranean community. In addition, Crete had a rich heritage of sheep husbandry and wool production, so the textile industry combined with the emergent murex technology to produce the purple garments which would, along with other actions, allow the nascent Minoan state to develop amid this network. While many elements fused to create this state including a desire for metals (Manning 2008: 108) and an ability to navigate the Mediterranean with the use of sails (Cherry 1983: 41), early Minoan pastoralists, craftsmen, and merchants also likely contributed by combining their skills to produce a prestige good which caught the attention of eastern kingdoms. Through these networks, murex purple

helped form the Minoan state and define Minoan culture and recognizability throughout the broader Mediterranean world.

2.2 The Mollusk and its Exploitation

The mystery of murex purple lay hidden within the hypobronchial gland in the throat of the sea mollusk until some intrepid fiddler cracked open the shell of one of these animals and, probably by accident, exposed the clear liquid leaking from the gland to the air. Iulius Pollux, writing in the 2nd c A.D., insisted that the dye was discovered by Melquart, King of Tyre, when his dog bit into a murex snail and the beast's jowls were stained purple (Bruin 1966: 297). Unbeknownst to Pollux, the discovery of the dye actually predated the Phoenicians in Tyre by centuries, with the earliest sustained evidence fluorescing in EMIII Crete just before the dawn of the Minoan state. Whether the murex uses this dye as a defense mechanism, repellent, or as a growth hormone is unclear, though the production of the mucus does increase during breeding and murex eggs contain a substantial amount (Bruin 1966: 308). What is clear is that eventually someone realized that this obscure fluid from inside a snail that lives in shallow subtidal zones could open a new world of color possibilities, kingly representation, and social structuring that accompanied the growth of craft specialization on Crete.



Figure 2. The three purple-producing mollusks. Gillis 2010: 86.

Three different gastropods are used to make murex dye: *Murex trunculus*, *Murex brandaris*, and *Thais haemastoma* (fig. 2). Each subspecies hails from a slightly different geographical location and produces a slightly different color, and when combined in different ways they collectively represent a wide pallet, from pale-pink to black-purple. These colors can be tempered and varied depending on the species, amount of raw mollusk product, exposure of the dye mixture to air and sunlight (fig. 3), and type of textile used (Reese 1987: 204). The degree of variability demands an experienced dyer, and the paucity of product available from each snail demands a persistent fisherman. 12,000 individual *Murex brandaris* snails were needed to produce a paltry 1.5 grams of pure dye, enough material only to stain the trim of a single garment (Reese 1987: 205). In her experimental re-creation of the early murex industry at Kommos, Ruscillo discovered that the animals must be baited (she used dead fish), and they will congregate around an area where lure has been left over the course of a day. She left a baited pot at the Matala marina overnight and caught 48 mollusks in one pot, while more than 100 had gathered nearby (Ruscillo 2006:811-812; fig. 4). As they often accompany dead fish, it seems likely that fishermen and murex crossed paths early in the history of the Mediterranean.

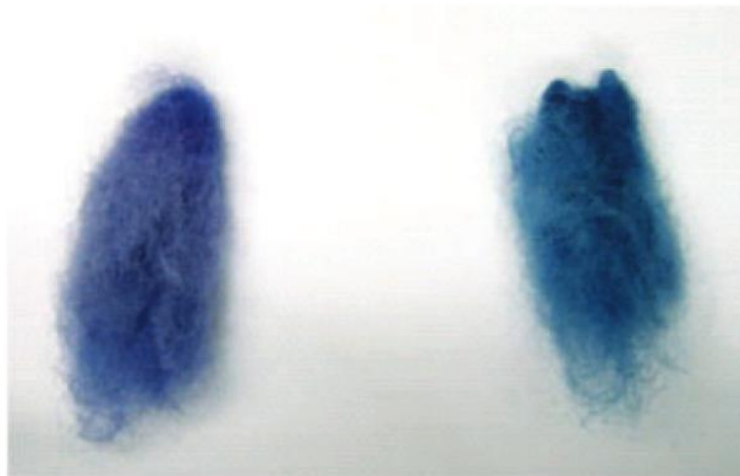


Figure 3. Wool on right was exposed to more sunlight, resulting in bluer shade. Sussman 2015: 94.



Figure 4. Ruscillo used baited pots to catch murex snails in shallow waters. Shaw and Shaw 1990: 1221.

Gas chromatography conducted on MMII sites in eastern Crete confirmed that the organic residues removed from pottery sherds contained elements of lanolin from wool fleece, madder and weld¹, and murex purple gland secretions (Koh et al. 2015: 537). Therefore, we can be confident that the murex was being used as a dye in Minoan Crete. Dye preparation was an arduous process and required prior experience and expertise. While the voracious shellfish were easy to catch with baited baskets, obtaining enough to carry out the sequence of production likely required several trips to the sea. This complicated the process because, as Pliny the Elder explained, the animals had to remain alive, or they would discharge their fluid (HN 9.62.126). Burke shares that many murex shells found by archaeologists are pierced with small holes, and while some scholars have assumed the animals were lanced during the dyeing process, Burke instead believes that they mark an actual or attempted cannibalization by a hungry snail left too long in a holding tank (Burke 2010: 36; fig. 5); however, Ruscillo is careful to note that no such tanks were found at Kommos (Ruscillo 2006: 812), and it might have been just as effective to keep them in baskets suspended in the sea.

¹ Madder and weld are both plant dyes commonly used in the Bronze Age. See Barber 1991: 227-228.

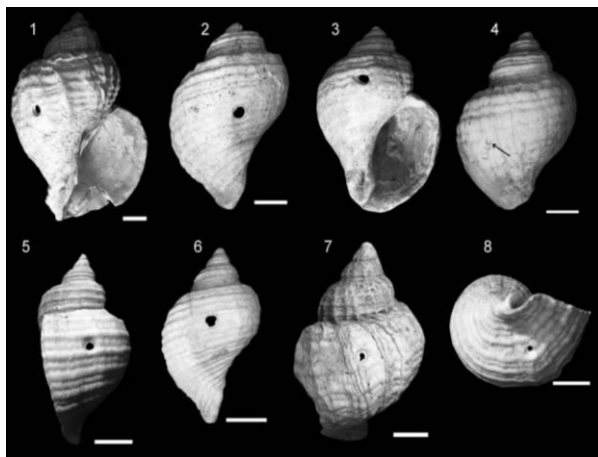


Figure 5. Mollusk shells pierced by cannibal snails. Gordillo 2013: 6.

In either method of containment, the snails still would cannibalize one another. Spanier and Karmon searched the shallow coasts of the Levant where the murex were heavily exploited for their dye during the Early Iron Age, and could find no indication of bore holes in the shells of the snails there, in their natural environment (Cited in Burke 1999: 80).

After enough mollusks were collected, Pliny said they were crushed in a way that would reveal the hypobronchial gland and release the mucus, which turns purple when exposed to oxygen and sunlight (HN 9.62.126). At this point, the slurry was mixed with salt and water and boiled for several days. While Pliny advised that it was best to steep the mixture for three days then boil for nine, in his experimental reconstruction Koren left the mixture at room temperature for three days, then heated at 144 degrees Fahrenheit for four (Koren 2005: 140-141).

While the dye was draining from the carcasses, the scum rising to the surface had to be continually removed. Reese described this material as smelling like “rotting garlic” (Reese 1980: 83), while Strabo also noted the smelly nature of the process (XVI.2.23). The activity also attracts flies and wasps, and Ruscillo found that the flies soon laid eggs in the detritus, even that

which was still warming in the pot. Her mixture was constantly swarming with maggots (Ruscillo 2006: 814).

Because the process was an olfactory nightmare and attracted many unpleasant creatures, and because the snails needed to be kept alive, the dye-production process was largely relegated to coastal areas. According to Barber, these areas provide the best location not only because the frequent breezes of the coast tend to dissipate odors, but also because the winds quickly dry processed textiles. Additionally, the coast provides easy access to a water source, which is necessary in both the manufacture of dye and the dyeing process (Barber 1991: 239). In considering the locations of early Minoan murex production, the overwhelming majority of sites associated with the manufacture of dye and dyeing activity are located on the coasts.

After the mixture was heated for several days, the textiles could then be steeped. Before being dipped in the mixture, however, the textiles themselves had to undergo processing to clean and prepare them; any debris remaining on the fleece was removed and the lanolin grease produced by the sheep was cleaned, an activity aided by warm, running water (Barber 1991: 239). Though wool textiles are referenced here, the process is not limited to fleeces; silk, linen, and other vegetable sources could also be dyed. However, of these fibers wool was the easiest to dye, as most vegetable sources require a mordant to allow the dye to chemically fix to the microstructure of the plant (Barber 1991: 235). The typical dyeing process included a kettle placed over a fire, which provided heat for the dyeing reactions. The wool or other fiber was placed in the vat once the dye solution was warm. Then the textile and dye liquor simmered together before cooling, with the fire being controlled through both fuel use and airflow (Hopkins et al 2005: 4-5).

Koren used wool in his experiment, and noticed that after the boiling process, the dye mixture was dark green in color. When the fleece was dipped in the tincture, it also turned a dark green, and remained this color for about twenty seconds before oxygen exposure turned the dyed fibers purple (fig. 6). Karapanagiotis created two different mixtures: one with 2g of salt per 30 ml of water and the second with 20g of salt per 30 ml. The extreme amount of salt in the second mixture reduced the ability of the indigoids to attach to the fibers, thus reducing the amount of purple and instead yielding a much bluer dye (Karapanagiotis 2019: 14). Like the mysteries inside a kiln which resulting in a finely fired red figure vase, the product of dyeing wool in a murex mixture was not obvious until the process was complete.

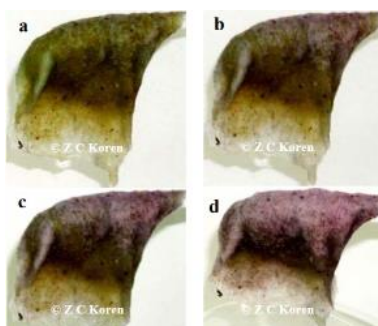


Figure 6. Fleece after being dyed begins to turn purple after about 20 seconds of oxidation. Koren 2005: 141.



Figure 7. Fresco from Thera, murex pigment used for detail (red arrow). Karapanagiotis et al. 2021: 176.

Because murex dye was precious, that which was not initially used to dye material needed to be retained, which required additional processing. The murex tincture could be saved as either a dye or a pigment, but if no attention was given to the material, it would quickly dry out. Vitruvius claimed that honey could be added to the dye to extend its longevity (DA XIII.1-3). Additionally, the substance was absorbed by a base of calcium carbonate when it was immersed in the dye bath, resulting in a pigment which could be used for painting pottery or frescoes. Two purple lumps were found at Akrotiri in Complex D, room 12 which date to the 17th century B.C. or before. This pigment matches the indigoids found in the Saffron Gatherers fresco and the Procession of Women from Akrotiri. Murex pigment was also found in the detail of the rosettes from Raos, Thera (fig. 7), while an additional lump was found at Trianda in Rhodes (Sotiropoulou et al 2021: 173-175).

2.3 Bronze Age Luxury Goods

Because of the complicated process of dye production, goods using murex products were limited, yet the rare color allowed for a symbolic product which was desirable to elites. Therefore, these dyes and pigments likely gained the attention of powerful individuals in the ancient world, as the Late Bronze Age grave from Cyprus alludes. In South America, textiles were fundamental to the maintenance of power and the political environment of Inkan societies because they were “the most valuable items in the Inka world,” and communicated social status, power, and ideology (Costin 2011 :103). It seems Bronze Age societies attached a similar function to their own textiles. In the ancient world, textiles were only outranked by metals in terms of value as a trade item, and the worth and quality of a garment signaled identity and social standing (Smith and Tzachili 2012: 141). The nature of high-level diplomatic trade can be

understood through three different sets of letters written throughout the Bronze Age. The Amarna letters came last, written during the Late Bronze Age around 1350 B.C. These letters were recovered from Amarna, and corresponding replies were found at the Hittite capital Boğhazköy as well as the city-states of Ugarit and Alalakh (Liverani 2000: 15) and they suggest that international diplomatic discourse was structured around the idea of “familial” relationships where gifts (including goods, wives, and workers) were exchanged for participation in the international community. Larger states had the upper hand, and the ultimate sanction rendered was the end of the diplomatic relationship of a weaker state (Liverani 2000: 20-22).

Much of the language and structure of these letters mirrors earlier letters. From the Middle Bronze Age, a set of documents was found at the royal palace of Mari, a kingdom destroyed by the Babylonian ruler Hammurabi in 1759 B.C. (Munn-Rankin 1956: 69). The Mari letters archive the reigns of three Mari kings who are characterized as envoys of the gods; their purpose was to enforce divine will. Therefore, the earthly treaties these letters document were “a counterpart of divine agreement” (Munn-Rankin 1956: 72).

Political relationships were discussed in terms of kinship, with a reference to brotherhood indicating that the strength of two kingdoms stood at relative parity, while a reference to sonship pointed to a vassal and overlord relationship. Because the quality of a gift was a way of indicating perceived status between polities, gifts served as a major force for diplomacy as long as rulers were on friendly terms. Gifts also helped initiate alliances and solidify international ties; the Mari letters record gifts that had been received from 30 kings, and they included cloth and clothing, gold and silver dishes, jewelry, cylinder seals, and wine (Munn-Rankin 1956: 97).

Burke believed the Minoans began actively engaging in textile trade with Egypt and

Mesopotamia by the 2nd Millennium B.C. (Burke 1999: 75) and could have been the originators of many of the gifted textiles.

Additionally, the oldest set of letters, those from Ebla dating to the Early Bronze Age (around 2350 B.C.) detail a very similar system between the Mesopotamian states (including Mari) and those further afield. These letters discuss many foreign envoys who received gifts from the palace administration, and these gifts were mostly textiles (Winters 2018: 2). Through this lineage of correspondence, a picture develops that highlights the nature of diplomacy of the state. Powerful kingdoms negotiated their capacity and dominance within the system, and symbolized the esteem granted to other territories through the quality of their gifts. Textiles played an essential role in this system, and the quality of a gift given would have served both as a marker of international prestige, but also would have provided a powerful domestic symbol to local rivals and constituents.

As Parkinson and Galaty theorized, Crete was at the periphery of this system and was dominated by the older and more powerful kingdoms of Asia and Egypt, but the integration of a few Minoan merchants and seafarers would have allowed a privileged few on Crete access to international goods and knowledge. Murex dye and textiles would have given them a status good to trade, provided them access to powerful figures overseas and increased the fame both of the island of Crete and of the individual who controlled the outside knowledge. The adoption of deep-hulled sailing vessels made trade far more efficient and made sustained trade activities possible (Wengrow 2009: 149). Therefore, an early Minoan ability to link into this network would have helped organize state formation through the mutual interest of the older and newer states, helping create the core/periphery relationship.

The following chapter details the expansion of the murex industry on Crete that was fed by these relationships. The earliest evidence points to just a few locations, namely Petras and Kommos. But by the MMII, the industry became localized in the east, where many areas had adopted the craft. Then in the MMIII and LMI periods, murex dye production expanded past Crete and into the Cyclades, mainland Greece, Asia Minor, and Egypt. Once the secret was out, the whole of the Mediterranean began to turn purple.

CHAPTER 3- THE SITES

3.1 Petras and Kommos: Early Minoan II to Middle Minoan I

The earliest evidence for the production of purple dye on Crete can be traced to the site of Petras during the EMIII period (around 2000 B.C.; fig. 8). This industrial activity began just after a population increase during the EMII, as seen from cemetery remains (Soles 1988: 51), which might have helped initiate the process of social differentiation. In addition, pottery found in a refuse pit shows evidence for ritual feasting and drinking, and one of Crete's earliest seals dates to this period. The site had been inhabited then abandoned, and this population growth and social activity accompanied the reoccupation of the area (Tsipopoulou 2012b: 50-51). The exploitation of murex, likely for dye, began soon after. Indirect evidence has been found at Petras from EMIII (Alberti 2008: 79), and a pile of nearly 200 crushed shells was found dating to MMI (Burke 2010: 37). This is the earliest evidence for the use of murex as a material for dyeing anywhere in the Mediterranean.

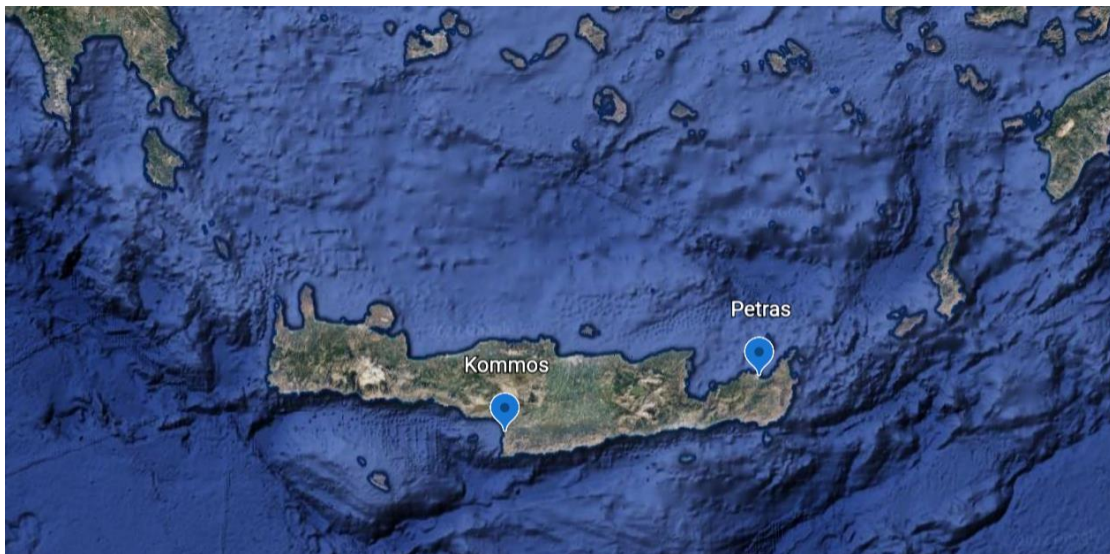


Figure 8. Murex production during EMIII-MMI.

In addition to the earliest evidence for the exploitation of these gastropods, those living in Petras also constructed the only Protopalace found and excavated in eastern Crete, a building which dates to MMIIA (Tsipopoulou 2012b: 54). Growing into at least a two-story complex from the settlement on Hill II, the building was surrounded by an early defensive wall (Tsipopoulou 2012b:54-55) and was supported by an industrial area. Cavities cut into rocks were connected to channels that drained liquid away, an arrangement that had many advantages for working with woolen textiles (Tsipopoulou 2012a: 129-130). In addition, beginning in the MMIII period, house II.1 had a large-scale industrial area on the ground floor which was likely dedicated to dyeing and weaving. Channels connected to vats were cut into the rock, and loom weights were found in the industrial center (Tsipopoulou 2012b: 49, fig. 9).

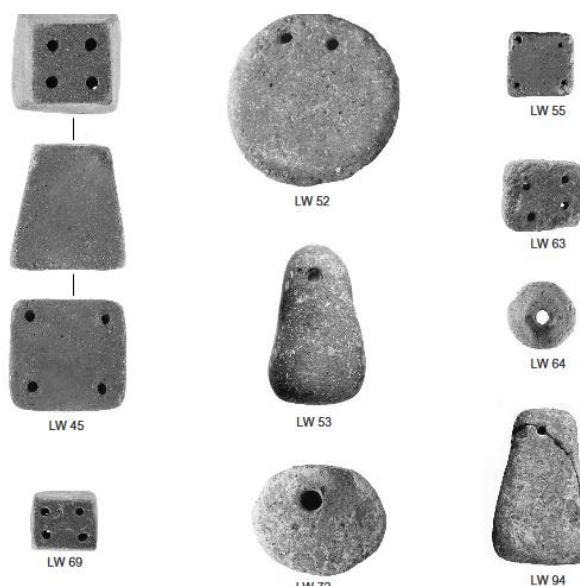


Figure 9. Loom weights and one spindle whorl (LW 64) found in early Petras. Tsipopoulou 2016: plate 34.

Thus, the area of the earliest example of murex exploitation for industrial applications also provides evidence of an increasingly complex social and technical situation. Additionally, the presence of murex dye first appeared while the population of the area was increasing, and

ritual feasting often accompanied the ostentatious displays which allow social stratification to commence. Also interesting is the presence of a wall around Hill II, which Tsipopoulou designates as defensive. This evidence suggests that just after the community began the use of murex dye, Petras had something to defend and someone to defend against. It might have been that remote exchange of goods created from the dye were allowing more stationary wealth to accrue within the community. Additionally, Petras had a level of social organization and complexity that allowed for the coordinated efforts required to erect a defensive wall.

An additional factor worth noting is the similarity between House II.1 at Petras and the elite Mayan house found in Guatemala. It has been proposed that the Mayan elites were performing the final labor to craft value-added products (Inomata 2001), and this might have also been the case at Petras. Powerful individuals could have commissioned the collection of murex mollusks from fishermen, then had skilled craftsmen produced the dye solution from these raw materials. This dye might have then been taken to the elites who made the textiles and dyed the final product, or used workers dependent on administrative control. In this way, elite Minoans would have had access to purple textiles which then could have been traded with outside polities.

While Petras was in northeastern Crete, Kommos was a harbor town on the southern central coast. The murex dye industry on Kommos dated to MMIIB and was slightly later than that from Petras, but the same general social dynamics were nevertheless occurring, and murex activities are actually much clearer. Ruscillo tackled an extensive survey of the faunal remains of Kommos and found that murex followed only the edible limpet in amount of mollusk remains recovered from the site, with 12 kg represented from the MMIB/II (Ruscillo 2006: 802). Most of these remains were fragmentary, and many of these fragmentary shells had small holes indicating that hungry contemporary snails drilled into the shells while the animals were in holding vessels

awaiting the start of the dye extraction process. Contrast these shells to the *Monodonta* mollusk, also found at Kommos but consumed as a food source. These shells were found intact with far more regularity (Ruscillo 2006: 785). Most murex shells, on the other hand, were found crushed into tiny fragments and Ruscillo believed this was in preparation for processing into lime, which would be used in the production of plaster (fig. 10). Brysbaert notes that murex shells were frequently stored for construction purposes and were useful not only for plaster, but also for tempering in pottery (Brysbaert 2007: 33).



Figure 10. Sample of murex debris found at Kommos. Shaw and Shaw 1990: 1220.

Other fragments were found underneath the central court, constructed during the MMIIB period (Ruscillo 2006: 802). While the excavation team at Kommos found only 12 kg of murex fragments, these additional clues suggest the industry was once far larger, with much of the material having been exploited for building purposes. Ruscillo characterized the dye industry at Kommos as “significant” (Ruscillo 2006: 803).

The southern area of Kommos was set aside for non-residential use, with administrative and industrial buildings concentrated in this area. Excavators found murex remains massed around two buildings, AA and T, in this southern zone where the shells were used as fill

material. Vats sitting atop a paved surface were found nearby (Ruscillo 2006: 802). The process of murex preparation required draining considerable water from the vats, which would have soaked into the earth leaving a muddy mess for the dyer. A paved surface remedied this problem, especially if channels were included to direct the water flow. Such was the case at Kommos, and the channels servicing the vats were packed with murex debris (Ruscillo 2006: 802; fig. 11). The concentration of dyeing activities at areas like Petras and Kommos prompted Burke to suggest that during the early years of palace formation, these activities began to concentrate in a few specialized locations (Burke 2010: 37).

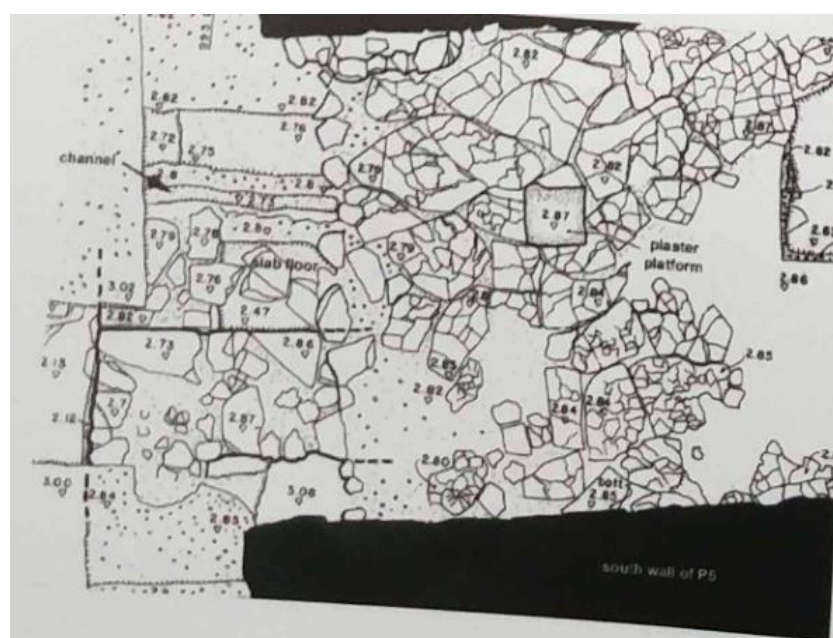


Figure 11. Industrial dye area at Kommos. The Channel where murex debris was found is labeled at the left. Shaw and Shaw 1990: 1220.

Until the MMIB period, Kommos had only a small population largely concentrated in the hills south of the later settlement, but the MMI and MMII periods ushered in a time of growth and increased prosperity that characterized the MMIII (Shaw 2006: 18). Building AA was a monumental construction erected during MMII, and at the base of the hill building T, placed at the end of a broad avenue that led to the sea, was an ambitious project to house area ships. Two

stoas flank the north and south ends of a pebble court, and to the east were rooms dedicated to food and craft production, including bronze work (Shaw 2006: 30-34; fig. 12). The activities occurring in Kommos in the EMIII and MMI period were lucrative enough to sponsor the construction of these large structures, and it seems likely that production in the area combined with shipping facilities allowed for such wealth to accrue. Kommos' ability to produce purple dye along with their shipping infrastructure were economically well-proportioned for developments taking place in the broader Aegean world during the shift from the EM to MM periods.

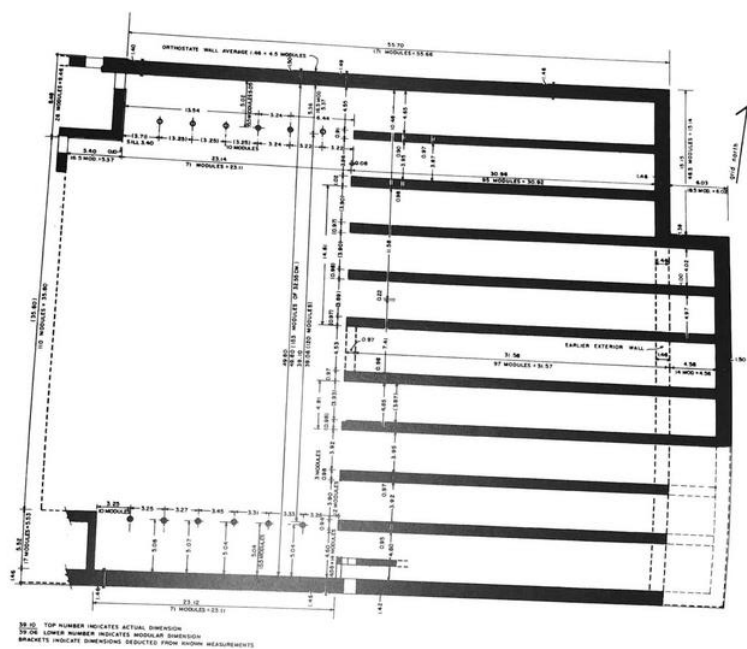


Figure 12. Restored plan of building T. Shaw and Shaw 1990: 958.

The beginning of the MM was a time of expanding international networks: the Near East, Anatolia, and Egypt all became accessible through ecological stability and the expansion of sail technology (Cherry 1983: 41). On Crete, populations grew and once again expanded into the countryside, increasing the agricultural and pastoral footprint of the island and refining ritual practices (Cherry 2009: 122), with peak sanctuaries likely serving as places of community

engagement and worship (Peatfield and Morris 2012). The MMI was a time of stability and confidence. Grave goods indicate both rising levels of wealth and individualized treatment of the dead, with the expansion of single burials in pithoi and larnakes. At the same time, specialized trades emerged; goldworkers adopted granulation from techniques observed in the east, and Minoan goldworkers began gaining a reputation for the skill and quality of their work (Cherry 2009: 123-124).

The period of Cycladic trade in the EBA may have set the tone for the broader Mediterranean world Crete found itself immersed in during the early MM, but the focus of this activity differed from region to region and was mainly divided between the more developed core states to the east and the emerging peripheral state on Crete. On the one hand, elite consumers in Egypt were interested in the material of an item; early Asian goods entering the kingdom were prestige goods typically made of precious materials like lapis lazuli. On the other hand, while nucleation was taking place in the communities of Crete, many trade goods were funneled into rural areas, and it seems the exotic nature of the goods was more compelling to the islanders than the material from which they were composed. The scarab shape was frequently replicated in local materials, with many relatively inexpensive limestone copies circulating on the island (Wengrow 2009: 148). While Egyptian rulers found it more beneficial to own and display novel substances, the fluorescing leadership on Crete realized more benefit from the control of knowledge.

Such was the situation when Petras and Kommos embarked on the manufacture of purple dye, and these ambitions fit seamlessly into the pattern of local growth and expansion combined with the intensification of international connections. The kingdoms of the east provided a ready market for purple textiles, and the industrialization of the process on Crete met that demand. The

consumption of these products abroad not only further enriched these port cities but also provided free marketing by advertising the existence of such emblazoned garments to a broader eastern consumer base. And this advertising was effective; production on the island was soon to expand and shift to the edge of the island where the markets of the east were most accessible.

3.2 Eastern Crete: Middle Minoan II

Murex production began to shift to the eastern edges of the island by MMII (fig 13). Bosanquet was the first to note the presence of a large heap of crushed murex shells during his 1901 excavations at Palaikastro (Bosanquet 1901: 305), and this large surface deposit was also later found by Steiglitz during a 1981 survey (Steiglitz 1994: 47). In addition to this pile, many shells were used as construction material in the walls of a well-built stone structure in the southeast of the town near Kastro hill, which hooks around the bay (Steiglitz 1994: 49-50). The harbor protected by this hill provided those living and trading at Palaikastro an excellent port for commerce. Nicolas Platon, famous for his work at Zakros just south of Palaikastro, said that this area was an important mercantile center and had good access to the east (Platon 1971: 50).

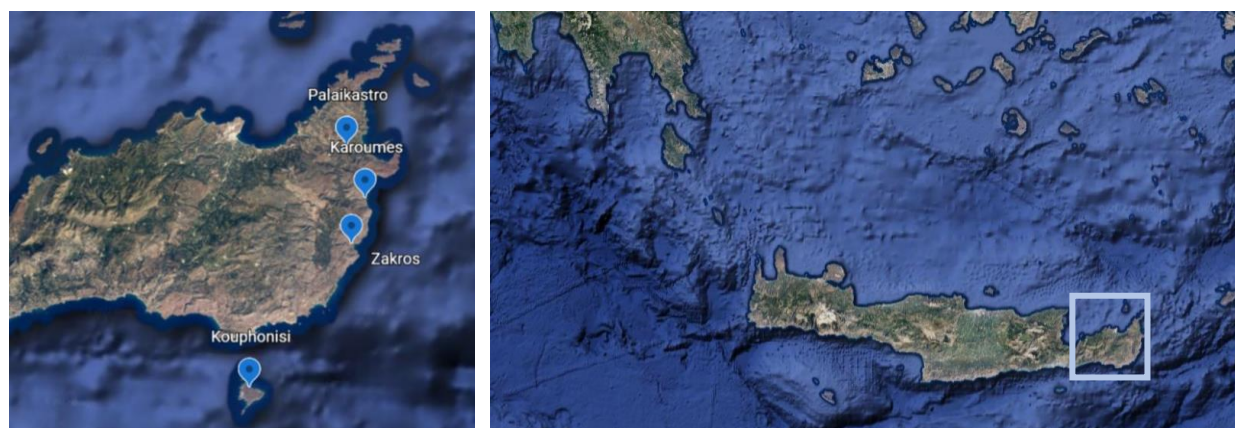


Figure 13. Murex production during MMII. Square indicates detail on right.

The area around Palaikastro, which was continuously occupied from EMIIA (around 2600 B.C.), saw the construction of a large building in EMIIIB followed by the erection of a

planned town. The main streets were long and remained in use over many generations, and well-maintained drains ensured major areas were kept dry (MacGillivray and Sackett 2012: 3). The surrounding area was devoted to agriculture, especially shepherding, and this activity along with trade from the harbor supported a thriving craft economy; many loom weights have been found throughout the area and textile activity was likely decentralized. MacGillivray and Sackett surmised that traders at Palaikastro were exporting cloth garments (MacGillivray and Sackett 2012: 6). A large murex deposit was found in building Gamma 48, and a well-constructed drain 0.20 meters wide ran through the building (Knappet et al. 2007: 164; fig. 14). Alberti said that because of the wide-spread nature of murex remains throughout the inhabited area of Palaikastro, “all the area around the Minoan town seems to have been involved in purple shells exploitation, with discarded debris, reuse, and recycling” (Alberti 2008: 77).

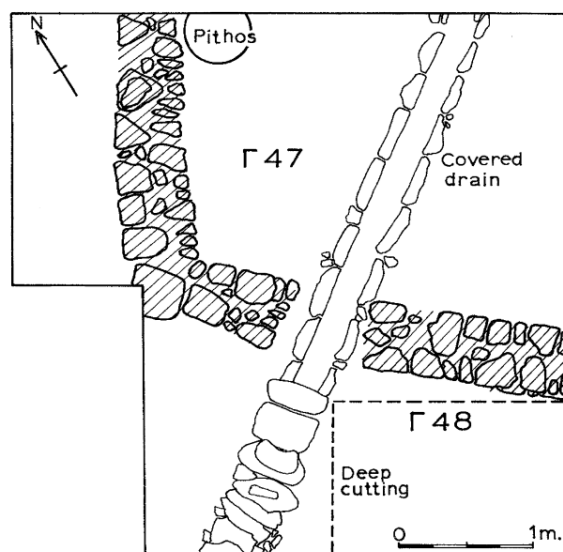


Figure 14. Building Gamma 48 with drain bisecting room. A large murex deposit was also found in this building (Knappet et al. 2007: 166).

This speculation was supported by the methods of construction used to create Building 6. Here, the floors and walls were lined with a lime plaster mixed with crushed murex shells, and large quantities of the mollusk were used as fill. These shells were also found in the fill of terrace

walls in Buildings EM and EN 88 to the north, which were dated to MMIIIB or LMIA (MacGillivray et al. 1991: 126-127). Before the palace was found at Zakros, Bosanquet believed that Palaikastro was the seat of government for the area, and that Zakros was no more than a small port (Bosanquet 1939: 66). However, there has been no evidence of palatial construction found at Palaikastro. This is not to say that there is no evidence for social differentiation. Pottery from MMI shows an increase in drinking and pouring vessels in a range of styles, which points to the potential for “competitive feasting,” as at Petras (Knappett et al. 2007: 195), and the chryselephantine kouros made with hippopotamus ivory (Moak 2000: 69) shows a potential coopting of ritual by elites.

The island of Kouphonisi, known in the classical period as Lueke, was also explored by Bosanquet over a century ago, and he noted the presence of a “bank of pounded purple-shell” there, as well (Bosanquet 1904: 321). Bosanquet associated these shells with the Middle Minoan pottery that was found amongst the crushed remains. Reese gave more details of these discoveries by noting that the associated pottery came from the sherds of a MM Kamares ware vase and a MM jug which dates the material to the MMII period, as at Palaikastro (Reese 1987:204). This island is just off the southeast coast of Crete, very close to Zakros. In the classical age, Leuke was a center for the production of “Tyrian” purple and during that time, as in the earlier Minoan period, manufacturing facilities for processing dye existed that were comprised of stone and clay vats, as well as basins and channels for handling liquid. These facilities, by necessity, were built near sources of water (Steiglitz 1994: 50).

Though there was a Roman town complete with a theater and forum on the island of Kouphonisi, there is little information from the Minoan period detailed through excavation, beyond the observations made by Bosanquet at the turn of the 20th century and a brief site survey

by Steiglitz in 1981. During his survey, Steiglitz commented that the industrial area had not yet been excavated but was exposed, making observation and commentary possible. (Steiglitz 1994: 50). Therefore, it is difficult to present a detailed account of production, however, like Palaikastro the island offers harbors and beaches, which allowed sailors and fishermen easy access to the interior. The small size of the island would have naturally limited agricultural production and population size, so it seems instead that Kouphonisi was well-suited for industrial production like that of murex dye. Its easy access to the sea and accommodating beaches allowed fishermen to exploit the mollusks, process them close to the shore, then send them off for further manufacture and broader distribution.

Kouphonisi may have served to supplement the quantity of murex available to the island community at Zakros, and connections between the two places have been suggested by Platon, who believed that upon the erection of the palace, industrial textile activity took place on the second floor while industrial dyeing took place on the island (Platon 1971: 251). Thus, the construction of the palace might have amplified activities that had already become common. On Zakros, facilities including water channels and spouted tubs were found in Hogarth's House I, a domestic area named for the original excavator, which predates the palace (Hogarth 1900: 141; Burke 2010: 37). Four tubs sit side by side and a channel drains fluids away from the area (fig. 15). These rock-cut basins were also very similar to those found in Pefka, just east of Gournia. Excavations revealed that the Pefka basins were associated with dye-work, based on gas chromatography done on pottery samples as well as cisterns that supplied running water (Apostolakou et al. 2020: 6-8). The pottery revealed that murex products were included in the dye remains (Koh et al. 2015: 537). While Hogarth speculated that perhaps the basins he found were used for wine production, Burke believed instead they were used for dyeing activities, as at

Pefka. It is plausible that the process of dye creation took place on Kouphonisi where the smaller population and ready access to windy coastal locations melded well with the unpleasant business of dye extraction, while the dyeing of the wool garments themselves took place at Zakros where the textiles were created, however little evidence of such a situation remains beyond the speculation of Platon.



Figure 15. Basins with drains inside Hogarth's House I, Zakros (Hogarth 1900: Plate V).

According to Hogarth, Zakros was the last port on the “directest sea route from the Aegean to the Cyrenaic shore” (Hogarth 1900: 121), and indeed, east Crete was in an advantageous position to exploit the growing demand for trade from the empires of the east. The bay of Zakros protects ships from the strong northwest winds that are common to the area, and the waters inside the gulf were safe for merchants and fishermen (Platon 2012: 1).

The first palaces were erected in Knossos, Malia, Phaistos, and Petras in the MMII, and the period was marked by the formalization of ritual, continued nucleation with a central polity influencing surrounding areas, and a focus on infrastructure which saw the construction and elaboration of roads, watchtowers, and ports (Manning 2008: 111-112). Nevertheless, these early palaces were relatively decentralized. While much of the architecture is now obscured by Neopalatial construction, it seems that the older palaces reserved only limited storage and space

for foodstuffs and craft production (Manning 2008: 119). Despite these advances toward centralization, Schoep also believes there were continued trends toward regionalism during the MMII. She echoes Manning in citing the lack of palatial storage; the large circular pits called koulares were once considered areas for surplus grain, but it is no longer clear that they could be used for this purpose (Schoep 2012: 2). Despite these trends, Militello found evidence that one craft was practiced at these early palaces: the creation of textiles, as will be detailed below.

This period might also highlight how murex products were becoming a revenue stream for Minoan elites, where taxpayers contributed to the production of an easily controlled good sold to outside agents. In exchange for the work of these taxpayers, elite managers improved community resources. As at Petras and Kommos, it seems reasonable that murex snails were brought ashore by fishermen and processed by experienced dye manufacturers. This dye was then given to elites, who might have produced the textiles themselves or might have procured textiles from craftspeople in the city. Because elites were responsible for the final stage of production, they also had control of this highly desirable prestige good, which was traded to outside agents. The revenue acquired by these trades was then used to improve conditions within the city which would benefit everyone living there, and the streets and drains of Palaikastro might be evidence of such improvements.

Palaikastro and Zakros were well situated for trade; the southern Mediterranean in the summer is a bit like a conveyer belt, with currents traveling in a counterclockwise direction. With a sail it was possible for Minoan merchants to travel directly from Crete to the north African coast, then on to Egypt and around the coast to Cyprus before heading back to Crete (Wengrow 2009: 145; fig. 16). The eastern areas might have enjoyed easy access to murex, and so the industry naturally gravitated toward this area, where large swaths of the community

worked toward preparation of the dye. Once the purple had been extracted and the dye was made, it could have either been used on local textiles as seems to be indicated from the dye vats at Zakros or sent west into the interior of the island to areas like Knossos, which were also controlling the production of wool material and accruing wealth from the international market. Once produced, merchants took advantage of summer weather conditions and sold the products in eastern markets, purchasing exotic goods for the return trip home. These patterns of interconnection between Crete and the outside world would only increase during the MMIII period, when Crete would once again reengage with the Cyclades as well as the Greek mainland, as the Minoanization of the Aegean came into full bloom.

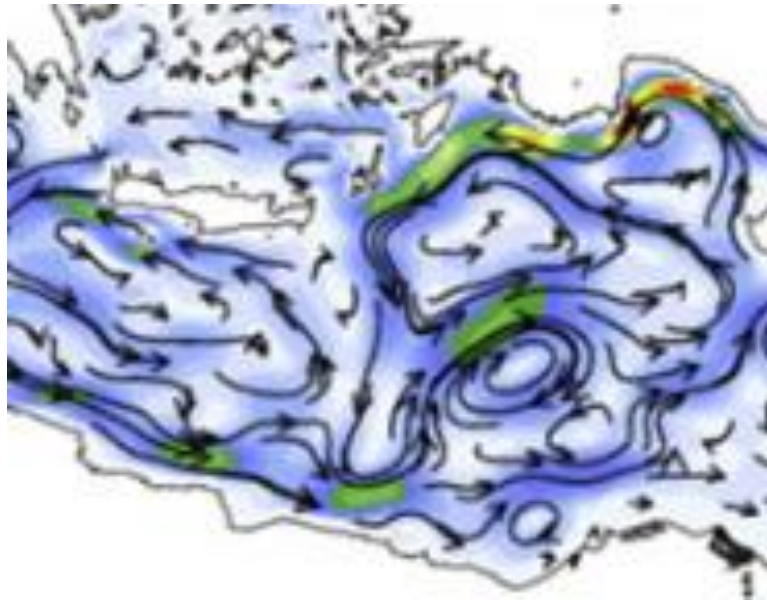


Figure 16. Mediterranean currents during summer season. Pinardi et al 2019: 1714.

3.3 Expansion to the Islands: Middle Minoan III-Late Minoan I

The island of Thera, and Knossos on Crete had a very close economic relationship until the volcano on the heart of the smaller island came alive and disrupted the whole of the Mediterranean. At the town of Akrotiri, buildings up to four stories high were built in the

Minoan style with frescoes on the walls; Linear A labeled some trade vessels; and discoid lead weights recording standard Minoan measurements were found in many numbers and sizes (Doumas 1983: 118-124). Thera lay about 70 km to the north of Crete and until the Late Bronze age began, it was densely populated and an important area for Minoan trade. The island was both importing Minoan goods and imitating the styles and patterns found to the south with wheel made pottery, rooms that reflected the Minoan polythyron style (Davis 2008: 191), and frescoes that were painted in the Minoan technique but presented themes more in line with Thera's "folk art" (Doumas 1983: 124). The discovery of murex pigments at Akrotiri has already been discussed, and their use in these frescoes confirmed. The presence of these pigments also begs the question, what was the state of murex production on Thera?

Archaeologists have been carefully excavating and studying Akrotiri since its discovery around 1860; the island of Thera was used to mine pumice for the creation of cement for the Suez Canal but was found to hold more than just dam materials (Mamet and Gorceix 1870: 183-186). Among the stunning architecture, the Bronze Age remains also revealed many different species of gastropods collected by island fishermen and utilized by the community. By far the most abundant mollusk recovered was *Murex trunculus*, while *Murex brandaris* was also found in most areas, albeit in much lower quantities (Kerali-Yannacopoulou 1990: 411). This shell debris was recorded in heaps in the settlement strata, with large quantities used to bind the wall plaster (Alberti 2008: 80). Doumas also notes that shells were used as fill to strengthen floors and in terracing (Doumas 1983: 117). While the town of Akrotiri has been well excavated, the coastal areas have inspired less investment. Thus, no dye installations have been found, however Alberti reasonably assumes that there was a purple-dye industry on the island because such extensive evidence for the processing of murex shells has been discovered (Alberti 2008: 80).

And Akrotiri was not the only Cycladic island to commence the production of murex dye during the MMIII and LMI; evidence from Kythera also shows that the exploitation of the snail was occurring. To Aristotle, Kythera was known as Porphyroussa, the purple island (HA 5.15), and large piles of discarded shell fragments were found on the coast (Alberti 2008: 83). Akrotiri and Kythera are both examples of the dispersion of practices and material cultures which accompanied the Minoanization of the Aegean, when Minoan ideas and practices began spreading through the region, and to a lesser extent, beyond it. During this time, many other locations in the Cyclades, mainland Greece, eastern Asia Minor, and even Tel el Dab'a, Egypt produced evidence for the use of murex for dyes and pigments (fig. 17).

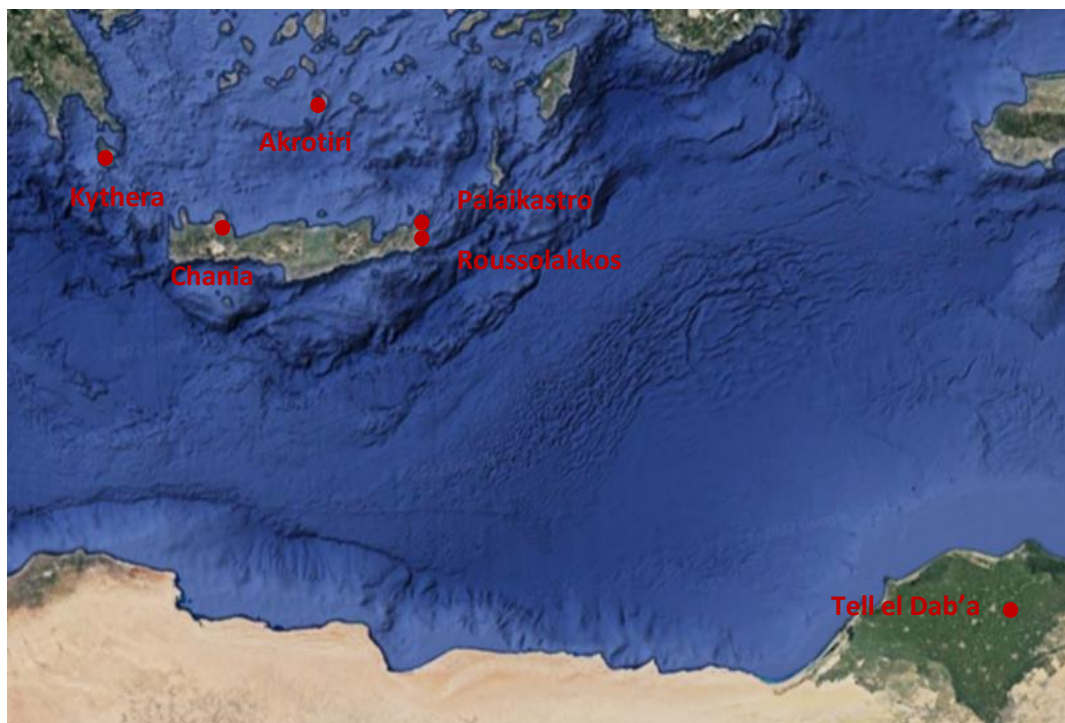


Figure 17. Areas of murex production during MMIII-LMI.

Knappett and Nikolakopoulou suggest that during the Protopalatial period the islands were more introverted, but the influence of Crete began expanding during the Neopalatial period. This expansion of Minoan merchant activities into the Cyclades helped define and solidify the organization of power structures and tightened links between influential island figures and the rising powers on Crete. Furthermore, elite conspicuous consumption helped continue to expand the demand for Minoan goods (Knappett and Nikolakopoulou 2008: 37). Indeed, Doumas believed that overseas trade was vitally important to the economy of Akrotiri (Doumas 1983: 119).

These activities were all taking place during the Neopalatial period, and the Minoan state, while still maintaining its relationship with the older Egyptian and Near Eastern states, was also becoming a core state for the Aegean periphery. Through this process, the Minoans were sponsoring the growth of social complexity, especially on the Cyclades and Greek mainland, where powerful rulers were coordinating the growing social intricacy of their areas, as the older states had once done for the Minoans. However, this process might not have been evenly distributed throughout the entirety of the Aegean. Davis believed that the focus of Cretan influence during the Middle Bronze Age was in the western Cyclades. Specifically, Thera, Melos, and Keos constituted the “western string” where contact was regular, judging from the wealth of pottery remains connecting Crete and these areas (Davis 1979: 146). Crete was likely interested in the Laurion mines, and much of this metal was processed in Ayia Irini. Other metals, especially gold, could be found at Mycenae, which encouraged this “down the line” trade (Schofield 1982: 18). Because of the desire for these metals, Crete established ports along the way and connected itself to these specific islands as a pathway to the mainland.

The production of murex dye is compelling in that it helped bind these areas in a shared technology; however, it is difficult to effectively utilize the fruits of such an industry without a vehicle for their distribution. Crete had a robust wool industry, and textiles were likely one major product that helped define Minoan culture for the broader Mediterranean community. The next chapter turns to the details of wool production on the island. Then the framework for understanding craft specialization as elucidated by Costin is applied to the three areas examined in this chapter: EMIII-MMI; MMII; MMIII-EMI. This framework will allow an analysis of the evolution of the industry and give broader context for the impact murex dye production had on the Minoan economy.

CHAPTER 4- TEXTILES AND TRADE

4.1 Textiles, Trade, and the Minoan Economy

While the Minoans were using murex products to create pigment for frescoes, it seems likely that the dye for textiles was a more desirable product. Demaree reconstructed the pigment for use in a modern painting and ironically found that the color was not retained as permanently in this form as it was when used as a dye (Demaree 2017: 8:25). This can also be seen in the fresco from Raos (fig. 7) which is barely visible today. Wool, however, was easily dyed (Barber 1991: 223), and textiles were created by elites and villagers alike. Wool dyed with purple made a desirable trade good. Below, we examine Minoan wool activities in more detail.

During the Mycenaean occupation of Knossos, Linear B tables carefully recorded information related to flocks detailing the numbers of sheep, the shepherd maintaining the herds, and any wool expected but not harvested. These tablets show that at the time the palace was destroyed there were around 100,000 sheep under palatial control which, with each textile weighing around 10 kg, allowed for the annual production of between 5,000 to 7,000 wool textiles (Killen 1964: 10). The flocks were overseen by individual shepherds, some listed by name, and those shepherds worked for the palace. The palatial management of flocks accounted for a major segment of the Mycenaean economy, and Killen remarks that “it is tempting... to ask whether the astonishing wealth of Knossos in the Late Helladic II may not have been as much derived from a trade in wool and textiles as the wealth of England in the Middle Ages” (Killen 1964: 14). The numbers certainly are impressive, but while the Mycenaean inherited much of their capabilities in ovine husbandry from their Minoan predecessors, there were also some significant differences in their management of textiles and wool production; most notably, the

Mycenaeans employed a centralized approach to sheep herding and textile production, while the Minoans were far more decentralized in both cases.

Sheep were first brought to Crete in the 7th millennium B.C. Bones were found at Knossos dating to the early Neolithic that show the animals were slaughtered at a relatively young age: between six months and two years. However, by the Early Bronze Age, bones show that the animals were living much longer, pointing to the use of wool as a secondary product (Issakidou 2006: 101). Additionally, the percentage of sheep bones in comparison to all domesticated animal bones increased during the Early Bronze Age, indicating that these animals began to dominate the preoccupations of animal husbandry on Crete. According to Sherratt, the increase in sheep and the transition to male dominated agriculture shifted women to the domestic sphere where they began to focus more heavily on spinning and weaving (Sherratt 1981: 283). Killen adds to the characterization of this period by noting that the expanded use of wool for textiles began in the urbanized centers of Mesopotamia, and thus there was a connection between the production of woolen textiles and an urbanizing society (Killen 1964: 10).

Domestication slowly changed the characteristics of the sheep, and after the Neolithic period their wool began to take on particular qualities, most notably a decrease in rough outer hair fibers and an increase in soft, fleecy wool. These patterns of domesticity continued on Crete, where careful husbandry practices led to finer fibers, a control of the molting process that allowed the collection of wool to occur in a single, seasonal episode, and the alteration of natural pigments which meant that white wools and lighter colors could be dyed more easily (Nosch 2015: 170-171). All told, careful control of sheep breeding generated wool that was more spinnable, creating a wider range of textile qualities.

Additionally, Ryder noted that in the Bronze Age, there was a difference in the production of wool between older states and those that experienced more recent development. The older states, mainly the large kingdoms like Egypt and those in the Near East, tended to produce animals whose fleeces were coarser but were also more uniform in quality. The areas that developed outside these original states, on the other hand (i.e., those comparatively less developed economically and politically like the Minoan state), tended to produce sheep with finer wool but with more variation in fleece texture. This meant that higher quality textiles could be created, but only after the wool was sorted into finer and coarser grades (Ryder 1974: 110). The garments made from these higher-quality fibers were likely to command strong demand from the older regions, where such textiles were not available domestically.

While the Linear B documents reveal the process of producing cloth for the broader Aegean market, there were some modifications to these patterns during the time of Mycenaean domination on Crete. The Myceneans controlled around 100,000 sheep a year, but the ideogram for sheep can be found in only two hieroglyphic tablets from Knossos and in half a dozen Linear A texts from Phaistos during the Protopalatial period. These numbers increased during the Neopalatial period, with 30 sheep accounted for in the tablets from Agia Triada and maybe 100 from records kept at Zakros, and while Zakros may have had a small palace flock, it is equally likely that these numbers simply reflect food consumption (Militello 2014: 38). This question may be answered more fully with careful examination of the sheep bones; castration enables the male sheep to produce a finer fleece, and these sheep live longer than those consumed as food (Nosch 2014: 1). Instead of palatial control of flocks, it seems the maintenance of sheep during Minoan times was largely decentralized, with paltry evidence remaining for the numbers once herded in individual and community-level flocks. And it seems this decentralized character was

not relegated to Crete; according to Davis, “the economy of Melos was so arranged in the Middle and early Late Bronze Ages as to produce an excess of wool- intentionally for export” (Davis 1979: 147). Gamble studied the sheep bones found on the island and determined that the Melians devoted much of the island to raising sheep to provide wool for export, centralizing human populations in urban centers to devote more area for husbandry. The product of these activities was then concentrated on Crete: evidence remains for the gathering of wool from these smaller entities at Minoan administrative centers (cited in Schofield 1982: 132).

A conflagration destroyed the site of Agia Triada at the end of the Neopalatial period, and the disaster disrupted the invoicing of fleece receipts taking place in room 27 of the southwest quarter. According to Pietro Militello, room 27 also contained a group of loom weights, and many receipt nodules were found on the windowsill that connected room 27 to a smaller room which had exterior access. Furthermore, several Linear A tablets were found at the end of the hallway which joined these two rooms to the rest of the south-west quarter. On one of these tablets the ideogram for wool can be seen, while the opposite side gives a balance which equals 45 units of wool.² It is interesting that the number of wool units recorded matches the number of nodules found on the windowsill: 45 (Militello 2014: 39). The picture this seems to paint is one of nuanced control of textiles manufacture at the end of the Neopalatial period. The wool from sheep were either taxed or traded by the administrative centers, and the raw product was then transformed into textiles either within the palace or in nearby elite areas. As at earlier areas where the manufacture of murex dye took place, this arrangement would give elites final access to the finished good. After examining the numbers from room 27, it is helpful to compare this picture with that from the Protopalaces, which display some variations to this model.

² The equivalent to around 135 grams.

While the number of loom weight found in room 27 was modest, the archaeological remains of the Protopalaces at Knossos greatly amplify these totals; 400 tongue-shaped loom weights were recovered after falling from the upper floors of the building (Evan 1935: 678-680). Such a figure would provide for about 20 looms, with two to three workers operating each loom. The same situation is found in Quarter Mu at Malia where 500 clay loom weights and 130 stone weights were discovered, and again at Phaistos where excavators uncovered 60 weights, likely allowing for 5 looms (Militello 2014: 41). All these loom weights seem to ascertain direct control of the production of textiles at the palaces, while the production of wool remained decentralized. However, the patterns of these earlier palaces differ slightly from those of their later Neopalatial heirs.

During the second period of palace construction, as has already been discussed concerning the evidence at Agia Triada, there is far less evidence for loom weights at the palaces; however, wealthy villas appear in towns near palatial areas and some of these villas do contain loom weights. Such is the case at Archanes, where two sets of loom weights were found near an administrative room housing tablet archives, and at Kommos where loom weights were found in four separate villas (Militello 2014: 42). While loom weights do occur in the palaces, their number are far reduced and it seems the palaces were mostly consumers of textiles rather than producers. Still, the evidence from villas shows that elites were continuing to manufacture fabrics. This evidence also shows a pattern where raw products become more refined the closer they get to the central administrative body. The raw wool is the purview of the independent shepherd, and it is likely that this wool was also processed into spun yarn before being sent to the villas. At the villas, this yarn was worked on the loom and transformed into textiles which were probably dyed in these same areas, or perhaps at the palace itself. For Militello, "it is probable

that specialized craftsmen simply produced what people in the palace needed for private use and for ceremonial and diplomatic activity” (Militello 2014: 44). This is similar to Blanton and Farger’s thoughts on revenue streams. The simpler procedures: spinning and mollusk procurement, were levied as a tax on the people living in palatial areas, while final procedures of weaving and dyeing took place closer to the palace, or at elite villages. At the end of the process, the symbols of power (murex dyed textiles) were held by the elites who might have also been responsible for the final stages of craft production.

It is also interesting to consider the types of looms commonly used on Crete. Ground looms were frequently found in Egypt and were useful in the dry, arid environment because they could be set up outside to take advantage of natural light. However, the width of the garment was limited to the arm length of the two people working the loom (Barber 1991: 81). The warp weighted loom solved this problem. This type of loom was in use near modern Hungary by at least the Early Neolithic and had migrated to Crete by the Middle Neolithic, as can be determined by excavated loom weights (Barber 1991: 93; 100). Not only could the warp weighted loom produce textiles that were much wider than those of a horizontal loom, but they also provided the tension needed for weaving elaborate patterns (Burke 1999: 77). The use of this type of loom gave the Minoans additional technical ability in the textile arts. At least where Egypt was concerned, those on Crete offered rare and intricate garments.

4.2 Costin’s Framework for the Minoan Murex Industry

While exchange among regions and polities is an important aspect of the economy and the activities of the state, it is invisible in the archaeological record; however, Costin points out that it is much easier to gather information for production (Costin 1991: 1). The ability to create a specialized product is dependent on the availability of raw materials and technology which, in

the case of murex dye production, can be found in the form of shells, dye vats, and channels. While production is only one aspect of the economic systems along with distribution and the ultimate consumption of a good, Costin proposed a framework which allows other scholars to consider specialized craft manufacture, or the the specific way of organizing the objects made from raw materials, which takes advantage of the overall visibility of this economic aspect (Costin 1991: 4). This section specifically considers the specialization of murex dye, though other murex products were created and used concurrently. This framework considers the context, concentration, scale, and intensity of production.

Context is best described as a continuum between attached and independent specialization, where attached specialization is sponsored and controlled by a governing body, while independent specialization is determined by supply and demand with production dependent on market forces. Such an aspect is particularly useful when determining if the goods produced are exclusive or utilitarian; this is important because it can help describe the relationship between the workers and sponsoring organization, and in this way sheds light about ultimate control of the final product. If the good is manufactured in an attached setting, restrictions can be placed on the use of the product by those creating it (Costin 1991: 11).

Even in the early history at Petras and Kommos, the creation of the dye was likely commissioned by a central power, and production can be characterized by the layers of activity involved. The creation of dyed textiles required, of course, both the dye and the textiles, so two separate efforts were eventually combined (fig. 18). On the one hand, for the dye itself the snails were the raw materials, collected by fishermen. Then high-skilled dyers used the snails in the complicated process of dye production. On the other hand, shepherd collected the raw wool, which was graded into courser and finer fibers. Then many low-skilled laborers were responsible

for spinning the wool into yarn. After this, the yarn was woven into a textile, which took place directly at the palace during the Protopalatial period, and often at villas close to the palace in the Neopalatial period. Finally, the dye and textiles were combined, likely at the palace, by elites which would have allowed them control of the final product. These sponsors of murex-dyed textiles would have then used these prestige goods in the establishment and maintenance of relationships with outside regions.

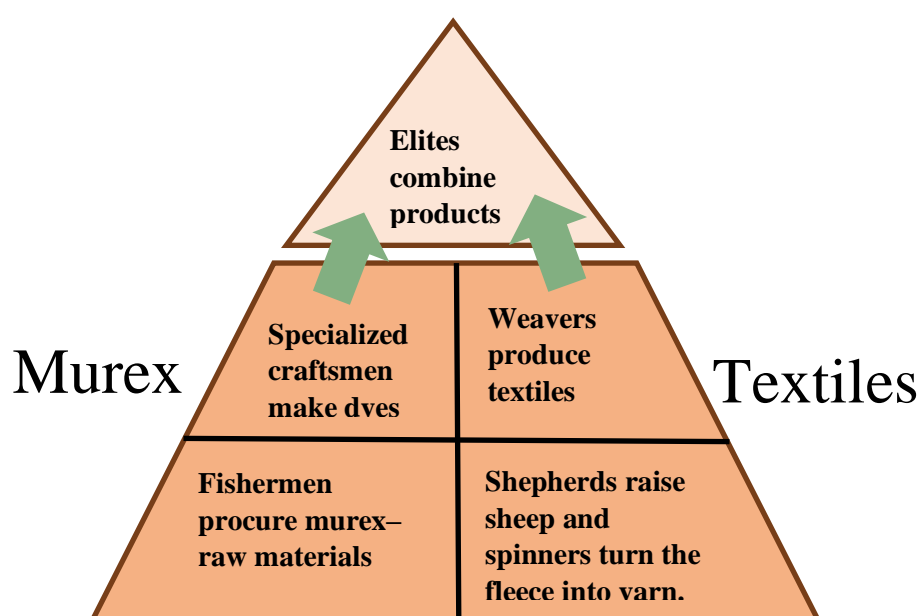


Figure 18. The production of murex-dyed textiles gave the elites ultimate control of the product.

Concentration is characterized by the geographical organization of production, and considers whether specialists are dispersed across the landscape, or nucleated in one area. Specialists often aggregate in a single area of individual communities, and the specialized products they create must be exchanged in a larger market. (Costin 1991: 13). One discernable difference in the patterns of murex industry is the spread to more dispersed regions in the Aegean as the MMIII and LM periods approached. It is unlikely that demand shrank as this technology dispersed, but rather that the communities capable of supporting an elite interested in these

products grew as trade and communication increased. This could have been a byproduct of the growing Minoan influences, which created a core territory of the island nation. The trade interests of those on Crete helped initiate the process of social differentiation in many new areas, which created more elites with a demand for prestige goods.

Transportation is another important consideration affecting the concentration of production of specialized goods. Weight, bulk, and distance of the ultimate destination all effect the dispersed or concentrated nature of this focus (Costin 1991: 14). The demand for murex-textiles would have been great enough to overcome many of these factors, however they were also mitigated naturally because textiles are lightweight, flexible (can be folded and shaped to fit the given cargo space), and are easy to transport. The initial dispersal to the Cyclades made the product available to these new areas and helped increase international connections through shared symbols of authority. Growth to these other regions also took advantage of the natural resources of these new places, as murex mollusks are located in shallow waters throughout the Mediterranean. Perhaps the dyers who learned their craft in eastern Crete had freedom of movement and were able to spread the technology to these new areas.

Scale describes both the size of the industry in terms of the number of workers, as well as labor recruitment. Small family-run units of production fall on one side of the continuum, with large factory-based units on the other (Costin 1991: 15). Because murex-dyed textiles involved layers of production, the scale of operations took place on multiple levels, which descended in number of workers involved as the production process drew to a close (detailed in Figure 16). Many workers were needed to process the raw materials, be they murex or wool, and many fishermen, shepherds, and spinners were deployed to this end. Dyeing and weaving were both skills that required knowledge and experiences, and fewer individuals were required to complete

these tasks. During the last stage, only elite representatives, or the elites themselves, were involved in combining the textile and dye and creating the finished murex-dyed fabric.

Finally, intensity characterizes the amount of an individual worker's time spent in the process of producing the good; either the work is done on a part time basis in conjunction with other activities, or production endeavors are the exclusive task of the individual (Costin 1991: 16). This also would have varied depending on the stage of production. Fishing and shepherding were full-time work, though not all a fisherman's time would have been spent collecting murex. Spinning required vast time commitments from multiple people, but is a task that can be easily interrupted, then resumed as needed. Other levels of the production process required a brief period of intense work but were dependent on the availability of raw goods to process and could not be done on a full-time basis. Dye-production is one example; the dyer could not create these hues full-time, but when enough snails were collected, they had to work quickly to process them all before the snails were cannibalized or otherwise spoiled. However, the creation of other dyes might have provided an individual dyer with more work. The pottery from Pefka showed evidence of murex byproducts as well as madder and weld (Koh et al. 2015: 537). Therefore, it is likely many colors were produced by the same dyers in the same locations.

Costin's four facets of production can be visualized on a continuum, with context falling between independent and attached, concentration between dispersed and nucleated, scale between small shops and large factory settings, and intensity between part-time and full-time work. Figure 19 represents these four factors as they related to Minoan (and later Aegean) production of murex-dyed textiles between EMIII and LMI. The context always falls firmly on the side of attached, as this complicated and demand dependent good required the sponsorship of central agents who then controlled the output of production. Concentration is also highly

nucleated, though over time the increased demand inspired by growing Aegean interconnection created a regional spread in the use of the technology. Scale and intensity varied, depending on the stage of the production process, sometimes requiring many workers or full-time work, and at other times requiring the opposite.

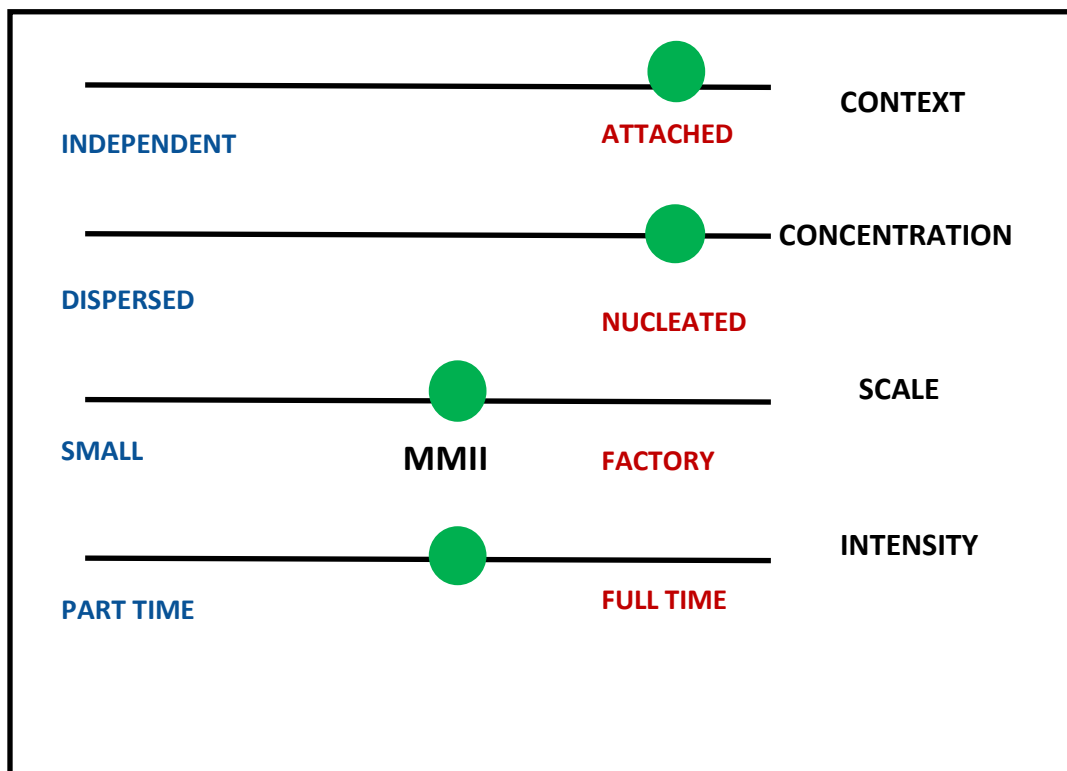


Figure 19. Costin's framework for the production of a specialized good as applied to murex-dyed textiles.

According to Costin's typology for the organization of specialized production, the creation of murex-dye textiles can be characterized as the result of individual retainers or a retainer workshop, depending on the phase in question. These areas concerned artisans working for or within the palace and describe the settings for highly specialized work (Costin 1991: 8-9). The palatial setting was the location of the final phase of production, combining the dye and textile, and this gave control of the final product to the elites. These elites might have been a part

of the production process itself; Militello noted the connection between weaving textiles and palatial settings (Militello 2014), and Inomata detailed similar activities among Mayan elite (Inomata 2001). These products could then be traded by these elites to other polities, and used to enhance their own communities, as might be seen with the investments in the streets and drainage systems of Palaikastro, a town heavily invested in the production of murex goods. Collective Action theory suggests that the collection of taxation through elites is dependent on the good will of the public being taxed (Blanton and Farger, 2008), and the income from murex was used for the benefit of the entire community.

4.3 Murex in the Post-Minoan Mediterranean

After production diffused from Crete, many territories began their own murex industry. By the time of the Amarna letters, the eastern Mediterranean had thriving centers for murex processing, giving rise to the idea of “Tyrian Purple.” Nearly eight bushels of crushed shells were found at Sarapta on the Levantine coast, and Tyre and Sidon both had competitive centers by at least 1000 B.C. (Reese 1987: 206). These trends continued into the Classical and Hellenistic periods and became more pronounced, with purple stained containers, containers with crushed murex shells, heaps of shells found near dyeing installations, and drains, stands, and coastal dyeing stations found in Sarepto, Akko, Tell Keison, and Tel Dor (Alberti 2008: 77).

The Mycenaeans also took up the trade after their Minoan predecessors. The Mycenaean palaces played a more central role in the creation of these textiles than did the Minoan palaces, and the textiles were at the disposal of the elites controlling production. Purple is one of the four colors listed in Linear B documents, and these hues seem to refer to woven bands (Barber 1991: 312). Bands were important for beginning the textile when weaving with a warp-weighted loom and purple might have been used as an accent in those bands, giving a garment a pop of royal

color; it is likely that these garments were worn in a way that emphasized those bands.

Furthermore, the L 474 linear B tablet lists 21 purple double-cloaks which were described as wa-na-ka-te-ro-po-pu-re. This vowel combination merges the royal moniker, wa-na-ka-te-ro, with po-pu-re: purple (Ventriss and Chadwick 1973: 321). Tablet Kd 573 also lists 35 cloaks suitable for guest-friends, linking the gift of textiles to international diplomacy and exchange (Ventriss and Chadwick 1973: 318). Locations where the collection of murex has been documented during the Late Bronze Age include many sites on Crete; Zakros, Rousallakos, and Chania all have evidence from LMIII, the time of Mycenaean administration of the island (Alberti 2008: 79).

CHAPTER 5- CONCLUSIONS

5.1 Conclusions

This thesis attempted to outline the use of murex dye in Crete as the Minoan state formed and expanded by considering the technical aspects of dye production, the nature of international Bronze Age diplomacy, the early sites in Crete of murex use, and the specialized craft production of murex goods. While murex dye production was far from the only factor which helped shape Minoan society, its use and spread are consistent with patterns of trade and core/peripheral developments. Though scholars have previously investigated early murex production, this thesis contributes to the existing body of research by highlighting the use of murex to trace the development of the Minoan state as it began on Crete and then later expanded to the Aegean. The exploitation of the murex mollusk for its color rich gland led to the growth of an industry and spanned its inception in the EMIII period in Crete to the eventually growth beyond the borders of the Mediterranean, where the social dynamics of the Cyclades were affected by the introduction of elite Minoan technologies. This industry initially helped organize the nascent Minoan state through the ability of elite members of Minoan society to access a prestige item that was desirable to the powerful eastern kingdoms. The diplomacy of these kingdoms centered on symbology based on gift giving, and a purple cloak made with fade-resistant dye was an excellent vehicle for conveying royal power as well as royal friendship and favor. As Minoan society matured, the capability to produce murex related goods expanded to neighboring regions, which were influenced by the healthy trade network in the western Cyclades that linked Crete with mainland Greece.

However, this dye was difficult to produce and required expertise and experience. In the earliest periods, only a few areas in Crete show evidence for the production of murex dye. Later,

the industrial core moved to the eastern end of the island, where a substantial focus of the economy of entire towns was dedicated to murex activity. The production of the dye and high-quality textiles took place at the palaces or wealthy villas near the palaces, and this gave elites access to the goods produced from the combination of murex and wool. As the power of Crete continued to grow and connections throughout the Mediterranean strengthened, the technology for producing murex goods followed. Many areas in the Cyclades, the Greek mainland, and the coast of Asia Minor left behind piles of crushed murex shells, which indicated they, too, were harvesting the snails to create dyes and pigments, and that an administration had centralized to allow for the specialized production of these materials. This diaspora of use continued even after the collapse of the Minoan state, with the Mycenaeans and areas in the Levant dominating the refinement of this technology.

The most difficult aspect of any consideration of ancient textile and dye production is the lack of evidence. Over time, the variable climate of the Aegean destroys textiles and leaves researchers with only tangential clues that they once existed. For example, the purple stain on the soil at Hala Sultan Tekke gives evidence that a cloak once wrapped the deceased. Future research may depend on the agglomeration of such secondary information, which requires excavators to have knowledge of these soil conditions. If indigoids consistent with murex dye are found in additional Bronze Age mortuary sites, it may be possible to connect these sites with known murex activities. This would strengthen our understanding of the spread and connection of the use of murex in Bronze Age diplomacy, as well as provide information about the textiles themselves. Thus, future study will benefit from an awareness of the residual signs indicating the inclusions of textiles, particularly within a funerary context.

The events of the Bronze Age and the Minoan state cast only a pale shadow over the world today, and an understanding of the zeitgeist of this society is opaque. Much material has been lost through looting, later building, or archaeological excavations that were never recorded. However, the early trajectory of murex production can allow a glimpse of the process that led to the creation and spread of influence of the Minoan state and the attenuation of this craft due to changes in the overall culture. Ultimately, the production of murex dye on Crete allows for a broader understanding of the complex and dynamic forces that pressured the mutation of the social patterns of the Bronze Age Mediterranean, and sheds light on the brief flame that was the dominance of Minoan culture in the Aegean.

The inky remnants of the period of Bronze Age purple production still stain the soils of a small grave in Cyprus, and there are likely many other plots where the soil is infused with a color not from the earth, but from the sea. The elite nature of the Cypriot burial highlights the demand from the upper echelon of the polities, who helped organize the developing societies around them into a new complexity. Many of these elites dreamed their kingdoms would last forever and might have even believed it would be true. How could they have known that the most enduring symbol of their reign came not from the longevity of their civilization, but rather from the colors rimming the trim of their cloaks.

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