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Ancient Greek Weaving, Experimental Archeology on Greek Textiles and Household GDP.

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Abstract

This paper outlines the experimental weaving project of an ancient Greek *chlamys* to investigate the weaving production capacity of a typical household and reconstruct women's contribution to household GDP in ancient Greece. While some scholars have researched finer textiles and techniques based on visual evidence, very little is known about the skills and time needed for the production of the most basic clothing form (the *chlamys*) produced in an ancient Greek domestic setting. The experiment, which involved the creation of a single heddle warp weighted loom based on archaeological and iconographic evidence, found that a team of three weavers could spin and weave this common use textile in roughly three to four weeks. Cutting extra-long warp threads made this process easier, as multiple garments can be made with one warp and then separated once they have been taken off the loom. Based on these results, it is possible to calculate the amount of money that an average household could earn in a calendar year. The author estimated that a family could sell enough textiles to make about 60-140 *drachmae* a year, while still keeping some textiles for their own use. Little is known about the exact demographics of who bought these textiles. However, there is some evidence for a market in the context of funerals as well as evidence for a large, physical fiber craft markets in Athens. As an experimental archaeology project, this research sheds light on aspects of Greek household economics, the contribution of women's household labor, and craft production skills within the domestic context.

1. Introduction

The project researches the process of creating an ancient Greek *chlamys* in order to investigate the production of an average household. The research will assist in hands on weaving, and the study of this process from setting up the warp to completion. While research has been done on some individual aspects of weaving, there is little research concerning the whole process and the final product, and even scarcer research into everyday textiles.

[1] This experiment can inform the study of the ancient world in the time required to make these garments, as well as the mathematics, skill, and physical toll required. The specific textile produced is a *chlamys*, a type common in the 5th c. BCE, although the garment itself was in use before and after this period. This knowledge can be used to better understand production and the amount of cloth that could be made in an average household, as well as what that cloth might be like.[2] The information from this project can give a better understanding of the daily life of women and the realities of textile production and trade which are absent from our view of the Greek world.

2. Loom weights and Tools Used

The loom (*histos*) is not based on a single specific classical example, but, rather, conforms to examples proposed by other scholars as well as an understanding of the properties of single heddle warp weighted looms.[3] This style of loom is a single heddle warp weighted loom, or a vertical loom using hanging ceramic weights to create tension.[4] The loom can be taken down, folded, and reassembled even with a weave in mid progress. An example of the loom used for this project, and the heddles in use can be seen in Fig. 1 and 2.[5]

Fig. 1 The loom is fully set up, and all the warp threads are measured but not tied onto their weights.

Fig. 2 shows the heddles in use, creating an open shed for the shuttle to pass through. All photos are my own, unless mentioned otherwise.

The loom weights (*laiai*) replicate various classical examples, and were fired to the temperatures of pit firing thus mimicking ancient firing techniques of loom weights and ensuring accurate replication[6]. These are diskoid loom weights, roughly 180 grams in weight, and made by hand, using a lower quality blended clay similar to the local clays that would be used.[7] Since these are handmade, there is some variety in size, thickness and weight, to replicate real weaving conditions, skills, and the range of weights rather than strict replicas (Figs. 3 and 4).

Fig. 3 shows the unfired clay weights, stacked and ready for the kiln.

Fig. 4. The bottom photo was taken after the weights were fired and placed on the loom. There were extra weights in case some broke.

The tools used for weaving are handmade wooden and bone weaving tools, though are not exact replicas as the evidence for the exact tools is too scarce to replicate. However, some parameters can be established in what tools to use as there were five main tools used in the ancient world and in this weaving experiment. The shuttle (*penion*) is a tool used to spool the weft and weave swiftly without constantly dealing with excess weft or new threads. Two shuttles were used, both wood, a larger and smaller size in order to weave with multiple colors. A weaving knife or beater (*spathe*) is another essential tool; this is a carved stick that is used to tighten and compress the weave, as well as to separate warp threads that stick together. The weaving knife used is a foot long, and while there's no direct replica there is an example of an Italian weaving knife that is from the time period.[8] This does not mean that weaving knives are exclusive to Italy, as different beaters and knives were essential Greek tools, but some of the best-preserved tools are from Italian sites.

The next tool is a wool comb (*kteis*) which is essential both for weaving and carding.[9] One of the better-preserved combs is from the same archaeological site as mentioned above, although the comb used in this experiment is a wider and more common hair comb of a similar thickness. Needles (*rhaphis*) are also essential to weaving, and physical examples are very rarely documented, so for this experiment a set of bone and horn needles was chosen; as they are easy to produce and made out of common materials.[10] The last major tool is the shear (*kouris*), which is irreplaceable for cutting threads. A standard shear design was chosen, as it shows little variation in functionality or design from the ancient world.[11] The use of tools and the creation of the loom and weights are important, as they replicate the conditions of ancient weavings from the time it takes to use and set them up, to their effects on the weave and the hand. A photo of all the tools used is provided below (Fig. 5).

Fig. 5 is an example of most of the tools used for this project. While some are anachronistic, an attempt has been made to accurately portray historical tools.

3. Experimental Archeology and Questions

This undergraduate research project looks at the creation and production of textiles in ancient Greece, specifically using a single heddle warp weighted loom and investigates the process of making a Greek *chlamys*, with intent to create a finished woolen textile. As textiles were a daily part of life, as well as an important economic factor within the household GDP and trade in general, the experiment can be used to determine the production value of an average household.[12] Though this research focuses on the 6th, 5th, and 4th centuries BCE, since this is the period of the textile reproduced, archaeological evidence dating to before this time frame is often cited as the technology did not change in any substantive way. There are a few references to technologies used after the period under investigation, when it seemed appropriate to include them. The archaeological evidence covers not only mainland Greece but also Magna Graecia and Turkey, as these areas have yielded significant archaeological finds.

While the author was not accustomed to this style of loom, he has some experience with different fibrecrafts, and all the weaving is his own. Because of his lack of experience, the final products do not exemplify the skills of ancient weavers, but rather his own intermediate technical skills and his experience with this style of loom.

3.1 Critical Questions

How many hours does it take to make a basic utilitarian garment?

What does this mean in terms of production for an average household?

How physical is the work of weaving on a warp weighted loom, what skills are required to work this style of loom?

Would increasing the warp length, in order to make two garments from one warping, make the process quicker/easier?

What is the final product, and how does it compare to the original depictions?

4. Clothing Choice, Functionality, and Common Use

A Greek *chlamys* is a cloak that is primarily associated with travelers and hunters, and was widespread throughout the Greek world[13]. The *chlamys* was chosen because it is a basic shape, requires only basic skills, and was a commonly used textile. These factors provide a good understanding of daily textiles, and they will make this easily replicable by weavers possessing a variety of skills. The dimensions are approximations based on images on red and black figure pottery from the late Archaic/early Classical period around the 5th century B.C.E.[14] This is cross-referenced against a sheet which was fitted and pinned to the author, in order to get the most accurate dimensions for his frame. The image that provided the key visual source appears on a krater in the Metropolitan Museum of Art depicting Persephone and Hermes (Fig. 6). The intended size is 30 inches x 70 inches, hanging just above the wearer's knees and providing enough length to similar to the one on the krater at the Met (Fig. 7). While other images were consulted in order to get a good understanding of the *chlamys*, this image gives an exceptional view of garment and a rare frontal depiction. The final products should fit similar to this depiction and include a stripe similar to the depiction as well.

The weave attempted is what is known as a tabby weave, that is, a weave with about the same amount of warp and weft. Stella Spantidaki has noted that these are the only identifiable weaves, and one of the most common as well.[15] The result of the experiment is a more warp-faced weave than weft-facing, although it is still a recognizable balanced tabby in certain sections. The edge itself is fringed on the first *chlamys*, as this seems to be a common enough finishing border, although sewing the ends in is also common enough.[16] Once finished, the *chlamys* required several washing and beating sessions, in order to balance some of the weaves and make it a cohesive textile.[17] These steps were taken to mimic classical weaving aesthetics and techniques, and to ensure that the experiment was as close to ancient weaving as possible.

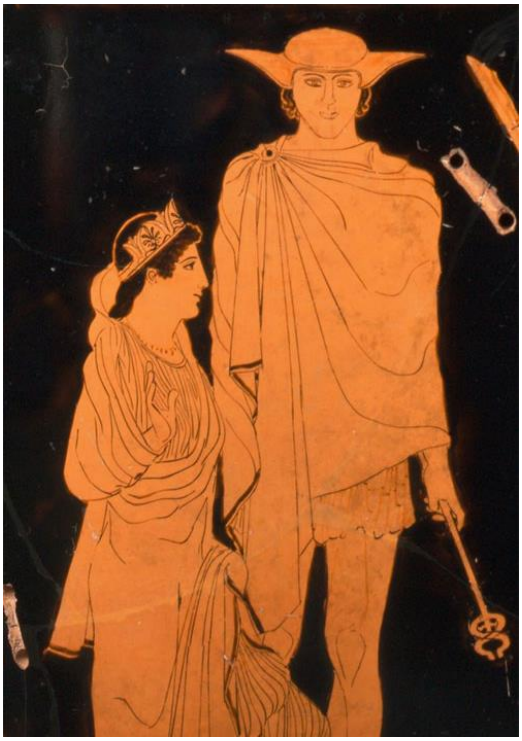

Fig. 6: Krater depicting a *Chlamys*, c, 440 BCE. Metropolitan Museum of Art, New York, K14.9.

Fig. 7: The author wearing the first experimental textile. The textile varies slightly from the image on Fig. 6.

5. Yarn used, tension, style, size

It should be noted that the yarn used is machine produced and bought in a store: however, calculations have been made to determine how many hours it would take to spin the yarn.[18] This yarn is 2-ply, which would be more improbable to see in the Greek world, but not impossible. The choice was mostly due to necessity and the ability to find large quantities; since 2-ply yarns did exist -this choice was a plausible substitution.[19] The yarn used is pure wool, and the width of yarn is based on the researcher's understanding of functional textiles as well as economic considerations. The yarn is about 1mm wide and while this is rather wide for clothing, there are textile fragments and iconography that demonstrate its use in Greek utilitarian textiles.[20] The colors used are based off of natural wool colors as well as madder root dye, a red dye used throughout European history, and specifically noted in Greek sources.[21] These trends correspond to Iron Age Italy, where there is a color convention of darker cloaks with a border, similar to what is found in the red figure depictions. The borders are often red as noted by textile specialist Margarita Gleba in her monograph *Italy: Iron Age: Textiles and Textile production in Europe.*[22] This experiment is meant to mimic classical weaving, in part through aesthetic and style, so the common style of darker cloaks with a weft-faced stripe was used, implementing minimum but bold colors (Fig. 8). The use of traditional colors also corresponds to practical pricing, as any dyed good costs more, and an outer cloak would get the brunt of the elements. Using minimum dying for the outer cloak and nicer materials for a tunic would be the most practical way to use dyes without wasting money. These mimic the depictions of *chlamys* cloaks previously noted from the Theoi Project. The steps mentioned in the past few sections are in place to ensure that the weaving experience is as close as possible to classical weaving. The experiment was set up to focus on the weaving produced in an average house, where Lakonian purple or extra house slaves would be absent. This gives a much more accurate view of textiles used by an average person, and creates the most accurate conditions to study the production of textiles.

Fig. 8. This shows the colored stripe and its contrast to the neutral color of the rest of the cloak.

6. The Weaving Experience and Costs

Time/materials for first Chlamys:

11 balls of natural yarn (each about 200 yards), plus a few dozen yards of red weft threads. One ball was wasted through various mistakes.
9 hours to measure threads
10 hours to hours to measure and tie on the warp weights, plus figuring out the initial excess materials.
6 hours to make loom weights (2 people), 8 for the firing but this was not an active firing process.
4.5 hours for 3 re-ties of the excess warp.
4 hours for untying the excess material 4 times.
3 hours for experimenting on rolling the warp, only 30 minutes to actually roll up 4 times (2 people).
4 hours for experimenting on initial weaving, cut the sections out.
1 hour for reloading the shuttle multiple times.
Roughly 15-20 minutes to weave an inch, 67 inches woven for a grand total of 17-23 hours.
1 hour to unwarp, tie off the fringes, do basic weave ins for loose threads.

Altogether, the first *chlamys* took 60-66 hours with the loom weight firing and several mistakes included, without the experimental blunders this would take about 53-60 hours. It can be assumed that a less experienced weaver would have made these mistakes, so they will be included as the author is a beginner to this particular type of loom. For every hour of warping or weaving, it is generally calculated that it would take 10 hours of spinning, although some variation occurs.[23] With this calculation added, making this *chlamys* would take 320-380 hours of labor. This would be divided among a team of women which; in an average house without a large number of slaves, would be two or three women.[24] While this project was quite labor intensive, as a utilitarian cloak, it did not require the time nor skill that a chiton or tunic would. Undoubtedly, fine cloth such as those would take exponentially longer than this, and require much more careful planning and a more diverse skill set.

Fig. 9; a picture of the second weaving experiment. This weave is in the process of being rolled up.

The experience of weaving was demanding, but it was incredibly fulfilling to work on and finish. The second weaving experiment proceeded slightly faster, although there is a limit to how much the process can be hastened (Fig. 9). The author is not an expert in weaving so the results reflect that, although this was a factor that was also present in the ancient world. As Linda Foxhall, a leading specialist in ancient Greek textiles, notes, a newly wed woman could lead and complete her first large weave at her husband's house.[25] This does not necessarily mean that girls would not be exposed to weaving before marriage, but it can be assumed that these girls would not have too much experience. In Xenaphon's *Oeconomicus*. Ischomachus talks about his wife and her weaving skills when she entered his house:

> καὶ τί ἄν, ἔφη, ὦ Σώκρατες, αὐτὴν παρέλαβον, ἢ ἔτη μὲν οὔπω πεντεκαίδεκα γεγονυῖα ἦλθε πρὸς ἐμέ, τὸν δ᾽ ἔμπροσθεν χρόνον ἔζη ὑπὸ πολλῆς ἐπιμελείας ὅπως ὡς ἐλάχιστα μὲν ὄψοιτο, ἐλάχιστα δ᾽ ἀκούσοιτο, ἐλάχιστα δ᾽ ἔροιτο; [6] οὐ γὰρ ἀγαπητόν σοι δοκεῖ εἶναι, εἰ μόνον ἦλθεν ἐπισταμένη ἔρια παραλαβοῦσα ἱμάτιον ἀποδεῖξαι, καὶ ἑωρακυῖα ὡς ἔργα ταλάσια θεραπαίναις δίδοται; Xen. *Oec*. 7:5-6.
>
> "And what knowledge could she have had, tell me, Oh Socrates; when I brought her in as my wife? She who hadn't even been born 15 years when she came to me; before that time, she was living under diligent care in a way that she might see, hear, and ask as little as possible. For is this not expected to be enough, when she came, if she only knew how to turn wool into a cloak when she was given it, and she had only seen the task of spinning given out to her slaves."[26]

This phrase provides a pertinent—if male based—view into the skill set of a young woman during this time period. Socrates has just asked if Ischomachus' wife knew all of the house duties and skills that a woman was supposed to. Though his wife is not necessarily a common girl, as he mentions her female slaves, it is clear that girls were not assumed to have a lot of experience in fiber arts. Girls were not expected to lead their own textile projects before they were married, but newlyweds would soon become skilled in this process. The casual mentions of textile slaves (specifically spinners) in Xenophon 7:6 and 7:41 confirms the economic importance of weaving and the relative normalcy of buying slaves for this purpose. In general, weaving's prominent place in this chapter (mentioned in 7:5-6, 21, 36, and 41) show's women's importance and their monetary value to a family and to a household. Such insights into ancient perceptions of weaving are rare in the textual sources; and obviously written with a strong male bias. Nonetheless it is clear that the economics of women's work are of some importance.

One aspect of weaving that must be noted is the creation of long textiles on the warp weighted loom. The ability to roll the warp is essential to weaving on almost every loom, but the process on the warp weighted loom is not fully documented. The author did not have to untie the warp weights, as he tied the excess in large knots right above the warp weights, and simply untied to release, making this process incredibly efficient and helpful. When this occurs, the tension is taken off of the textile, and the woven warp can be wound around the cloth beam, exposing the next section of warp threads to weave. Using a round cloth beam, as depicted in classical artwork, leads to the warp sliding, and the warp weights crashing onto the floor as soon as tension is reapplied.[27] It took the author several attempts to figure this out, and several more experiments before a solution to this issue came about. Since the information on warp weighted mechanics is sparse, a look into another form of ancient weaving was taken to obtain relevant information. Backstrap weaving is a form of weaving where the warp is tied around one's body and then readjusted when the weaver reaches the end of their workable warp. As the textile is tied to your body, there is a constant need to reroll of the warp, so backstrap weaving has developed an easy solution for rerolling.[28] Backstrap weaving adds an extra cloth beam and then traps the warp in between them, ensuring that the warp will not slide when it is readjusted.[29] To stop the cloth beams from moving around, they were lashed onto the loom with cordage, and then the process was repeated when the warp needed to be moved. This method was extremely effective, and allowed the author to reroll his first warp four times without issue (Fig. 10). The lack of representation on period artwork could be due to the fact that the second cloth beam is not terribly noticeable, and the cordage is already seen in some places.[30] While there could have been another way for ancient Greek weavers to achieve this, until further evidence is shown this method seems historically plausible and it follows the general way that these looms work.

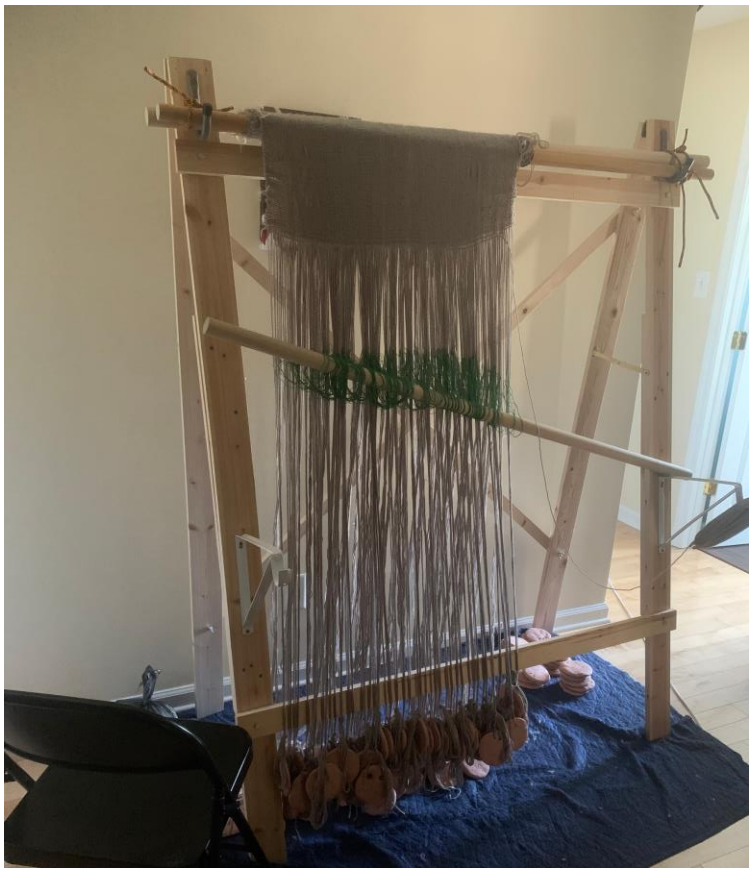

Fig. 10; The first warp rolled up on the two warp rods. These rods are lashed onto the frame and allow the weaver to continually weave. The cloth beams trap the warp between them and keep tension on the threads.

On a more physical note, the art of weaving on a warp weighted loom requires a strong dominant arm and some endurance.[31] After a few hours of continual weaving, my hands, wrists, and arms often hurt from beating the warp tight, while my muscles were sore after a full day of weaving. This could obviously be mitigated by having multiple people who could switch duties, as well as through general conditioning, but it is important to note that this particular

fiber-art is physically demanding.[32] Using a warp weighted loom still requires a second person, at the very least to roll up the warp. Overall, a team of weavers would make this process much faster, but the hours and skills required do not change. As the author repeats this experience, more data will be compiled to give the most accurate view of ancient Greek weaving.

The second experiment mimicked the first in almost every way, from the dimensions to the use of the red stripes. The times are not listed here at the moment, but they will be as more data is compiled. The most notable difference is the slight acceleration of pace. This weave had two functions, to ensure that the findings of the first experiment are repeatable and consistent, and to experiment with the idea of rolling the cloth beam in order to make multiple full-length textiles from one warp set up. In the first project the cloth beam was rolled 4 times in order to get the full length, but ensuring that the process would work for two weaves is important. This experiment saw a reduction in the weaving time by almost 20 hours, as the production process was more efficient and streamlined. For this second project, the 8-foot long warps of the first experiment were doubled to 16 feet. The final product was of a better quality and contained far fewer errors.

7. Textile Production and Sale

The lives of ancient Greek women are woefully under-documented, and that is particularly true when it comes to evaluating their labor within a monetary context. Textile prices are generally absent from the ancient textual sources, but there is some pertinent evidence found in the sumptuary laws limiting funerary costs and the maximum amounts that a family could spend. These funerary edicts mention blankets, similar in dimension and material to that of a *chlamys*, so the amounts of these blankets will be used to price the *chlamys*, which allows us to extrapolate prices. An edict from Delphi during the Classical Period allowed for the purchase of one blanket and one cushion, totaling no more than 35 *drachmae*. This is quite low compared to other similar laws where the expected cost of a single garment is close to 50 *drachmae*, and would suggest that the Delphic blanket is a plainer weave closer to the one created in this experiment.[33] Unless further evidence is gathered, for the purpose of this paper the cost will be split roughly down the middle; with the blanket costing 20 *drachmae*, as it would be more material than a cushion. One cannot assume that women were paid the same as men, and textile trade was often done under the table, but these numbers give a great starting point into understanding the economics of textile production.[34] The amount of textiles that could be produced within a calendar year could fully flesh out this analysis, and provide a theoretical amount of money which women could earn through weaving. While speculative, it may be possible to generate some predictions about the number of textiles that an average family could produce. Though this does not imply that every family produced textiles in these numbers, or that this involved the three-woman dynamic previously mentioned.

Weaving a *chlamys* is a considerable time investment, and even with a group of three women this would take several weeks. It is unknown how much time a group of women would spend weaving each day; the forty-hour work week of the modern era does not apply to the daily lives of women during the Archaic and Classical periods. Nevertheless, if one is to treat the production of textiles as a cottage industry, a minimum average of 5 hours work per person is assumed for this paper. This number allows for plenty of time to focus on other jobs that women were responsible for and the activities that were part of daily life; while giving textile production its proper place as an important contribution to household economics.[35] Using the average work mentioned above; and assuming that this weaving continues 7 days a week, a single *chlamys* such as this can go from a pile of wool to a fully finished cloak in 3-4 weeks. If the team of weavers produced two *chlamys* off of a single warp, then roughly 20 hours of work would be removed, pushing this closer to 3 weeks. This was one of the questions answered in the experiment, and it gives a better understanding on how this weaving can be streamlined.[36] Weaving with a warp of such length requires additional materials and so possibly the extra upfront cost of this means that the method should not be assumed to be the standard. It is also possible that ancient Greek weavers measured long enough threads on one warp for more than two textiles, but more experimental archeology needs to be done to see the quality and results of this. The author believes that the week of leeway is important, as this is not a wage job and one cannot assume the uniformity of production that our modern world requires.

Given these numbers and the rate of production, a team of three weavers could realistically spin and weave between 13 and 17 *chlamydes*' a year. Using a warp long enough for two cloaks would put this number firmly closer to 17 cloaks a year, although this method might not have been exclusively used. This is a significant amount of textiles to produce on such a loom, and the amount of cloaks is more than a typical family needed. This strongly suggests that women could create enough textiles both to sell and to clothe themselves and their family. Even if a family took the equivalent of 10 cloaks produced a year, either in *chlamys* and blankets, or in finer tunics, there would be 3-7 *chlamydes*' to sell.[37] This excess textile would be worth a significant amount of money, based on the price calculated

above of 60-140 *drachmae* a year. While this many textiles may not have always been produced, and regional economics would determine different prices, this baseline provides an important perspective on women's potential contribution to the domestic GDP. Assuming that families would only sell these extra textiles, this still constitutes about 9-28 weeks' worth of labor and, thus a significant amount of money for a family. The amount of extra textiles that could be made in one year, and the amount of money for which they could be sold, significantly alters prior notions of family economics. Women's contributions to family wealth were significant, and this cottage industry represents an important force in the daily lives of ancient Greeks.

The most speculative aspect of this research is a very simple question-- who would buy these textiles if many households wove their own? This is difficult to answer as textile sales were often overlooked, but there is some evidence for large textile markets in Athens.[38] This demonstrates that there was a market for fibercrafts even if it doesn't reveal the buyers or other details. The widespread enforcement of funerary laws limiting the amount families could spend on textiles is also relevant here as it indirectly reveals that a significant motivator in buying textiles for funerary usage would have been convenience. People would not always have weeks to wait for a textile to be made in house. In funerals, one would have to prepare the body immediately and in cases like this buying a pre-made shroud is far more practical.[39] There were also metics (foriegners) and bachelors to account for, i.e. people who might not have family nearby to weave their clothes. This is speculative in the absence of affirmative evidence, yet these assumptions can give a better understanding of how the textiles would be circulated throughout the population.

Other variables that make calculating a strict price for these textiles still remain. Textiles require raw material, in this case wool and if the family bought yarn that would cut into the profit margins.[40] If the family owns sheep, then those sheep require care and land, although we can assume most citizen families would own land. If a household were to buy pre-spun yarn, the process would be shortened rather significantly. Assuming all the yarn was bought already spun, an average family could produce a *chlamys* per week, although this would cut into the profits of the final product significantly. Even with these variables unknown, it is abundantly clear that these textiles could have contributed to a portion of the families' wealth, and that women's contributions to the standard of living were potentially quite substantial.

8. Improvements for Future Research

As mentioned previously, continual training on this loom is paramount to producing successful and beautiful textiles. There is a large learning curve to developing this skill and continued study will both make an improved product as well as a decrease production time. While the first textile contains a number of mistakes, the second seems to be of better quality. Nevertheless, the author is proud of both of them, and they are very warm.

Learning how to tablet weave, and how to incorporate those weavings into the warping phase will create a more even warp and will assist in future experiments.[41] At the moment the author cannot tablet weave, so both textiles were produced without the benefit of starting with this type of weaving. The next steps are to continue developing my skills as a weaver and creating more ancient Greek textiles to better understand this area of study.

9. Conclusions

The process of setting up a loom is a difficult endeavor but one which had a strong economic impact on ancient Greek society. While many of the details concerning the actual prices and trade are still uncertain, this experimental project and research contribute both to our knowledge about the quantity of textiles that an average ancient Greek family could produce and to our knowledge about the process of making a textile and what it requires to embody those skills through technical expertise. This project confirms earlier claims that textile production could have made major contributions to a family's economy.[42] Further research must be done to repeat these results, and to branch out into different textiles in order to get a clearer picture of Archaic and Classical weaving.

10. Acknowledgements

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the entire loom had to be moved mid-project; so special thanks should be given to my parents for allowing their upper hallway to be taken over by weaving and for putting it with the late night sounds of clanging weights and dropped shuttles. Another special thanks should be given to my father, Richard Palmer; for moving the loom back and forth from Asheville to Mooresville and for helping build the loom in the first place.

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12. Endnotes

1 Cadwallader and Canavan, *Fragments of Colossae*, 123.

2 Ibid. 118. Linda Foxhall, *Webs of Knowledge: Untangling Textile Production in Ancient Greece.*

3 Mårtensson, Nosch, and Strand, *Shape of Things: Understanding a Loom Weight*, 374. Foxhall, *Webs of Knowledge: Untangling Textile Production in Ancient Greece*. Carroll, *Warping the Greek Loom: A Second Method*. Margarita Gleba and Ulla Mannering, *Textiles and Textile production in Europe*, 15. There is an illustration by Eva Andersson which illustrates the principles of the warp weighted loom, and this model specifically was very influential in the production of the loom used by the author.

4 Carroll, *Warping the Greek Loom: A Second Method*. Hooper, *The Technique of Greek and Roman Weaving.*

5 While classical looms did not have that ability, it became quite useful as COVID-19 forced me to move and forced me to bring the loom to my parent’s house.

6 The loom weights are primarily based on the record and research of several authors and articles, ranging from the mycenaean period to the first and second century BCE. These authors include Linda Foxhall and Alessandro Quercia, *Loom Weights; The Chora of Metaponto 6: A Greek Settlement at Sant'Angelo Vecchio;* Francesco Meo, *New Archaeological Data for the Understanding of Weaving in Herakleia, Southern Basilicata, Italy*; and Linda Mårtensson, Nosch and Strand, *Shape of Things: Understanding a Loom Weight.*

7 Agata Ulanowska, *Experimenting with Loom weights. More Observations on the Functionality of Early Bronze Age Textile Tools*, 165.

8 Marta Bazzanella, *Italy Neolithic and Bronze Age: Textiles and Textile production in Europe*, 207. There is a photo of some Early-Middle Bronze Age artifacts which show a weaving knife and two combs. These are not the only style for these artifacts, but it is helpful for understanding their function and use.

9 Margarita Gleba and Ulla Mannering, *Textiles and Textile production in Europe,* 9. There is a visual depiction of a modern wool comb from the Caucasus. While this region is outside the investigation, it correlates to the designs of Italian models.

10 Stella Spantidaki, *Textile Production in Classical Athens,* 93. Stella has a photo of a bronze needle, but mentions that needles come in an extremely wide variety, although there is next to no documentation.

Małgorzata Siennicka, Lorenz Rahmstrof, Agata Ulanowska, *First Textiles, The Beginnings of Textile Manufacture in Europe and the Mediterranean,* 2. Bone is a natural material for textile tools, as it is easily accessible, easily worked, and quite durable.

11 Margarita Gleba and Ulla Mannering, *Textiles and Textile production in Europe,* 7. There is a shear design that looks similar to the style used by the author. Margarita Gleba also describes an Iron Age Italian shear with a very similar description in *Italy: Iron Age: Textiles and Textile production in Europe,* 234-5.

12 Linda Foxhall, *Webs of Knowledge: Untangling Textile Production in Ancient Greece.* Stella Spantidaki's *Textile Production in Classical Athens,* 11. Canavan, *Fragments of Colossae.*

13 Cadwallader and Canavan, *Fragments of Colossae,* 118-127. Much of the iconography of the *chlamys* is from pastoralist deities and figures, specifically Hermes has many depictions where he wears this cloak.

14 Atsma and the Theoi Project. This website has a good database of iconography from classical and archaic pottery.

15 Stella Spantidaki, *Textile Production in Classical Athens,* 55-56.

16 Ibid. 65.

17 Ibid. 91-92.

18 Mårtensson, Nosch, and Strand, *Shape of Things: Understanding a Loom Weight,* 393. Stella Spantidaki, *Textile Production in Classical Athens,* 67. These calculations are based on the thickness of the yarn, and for a 1mm diameter thread 40 grams of tension are needed to give proper structure.

19 Marta Bazzanella, *Italy: Neolithic and Bronze Age; Textiles and Textile production in Europe,* 207, has another example of such a thread diameter in Italy during the bronze age, of a 2 ply wool thread roughly 1.3 mm in diameter. There is another iron age example of a similar thread diameter from *Sasso di Furbara*, a wool tabby textile; *Italy: Iron Age: Textiles and Textile production in Europe* by Margarita Gleba on page 223. Unfortunately many utilitarian textiles are not preserved, as they are less common in funeral contexts; but it is important to note that these examples show that they exist both in the Bronze and Iron age.

20 Youlie Spantidaki and Christophe Moulherat, *Greece: Textiles and Textile production in Europe, 188*. There are several examples of textiles with thread sizes similar to the size used by the author, "[the textile] With the diameter of each thread surpassing 1 mm. It is probably a fragment of a simple utilitarian textile as indicated by the thread diameter and low thread count.". There is a chart on the following pages, 190-191; which confirms several other textile fragments that have similar thread diameters.

This choice was confirmed by the author's own experience , as this cloak would be for insulation on the road and in the woods, and therefore it would be utilitarian in nature. The thicker yarn allows for an incredibly warm cloak, and it does not wear too odd as outerwear tends to be thicker. If oiled, this would also provide a fair amount of waterproofing.

21 Martelli, Alchemical Textiles: Colourful Garments, Recipes and Dyeing Techniques in Graeco-Roman Egypt, 122-123. Cadwallader and Canavan, *Fragments of Colossae,* 115. These color choices influenced the author's own, alongside the research of Stella Spantidaki, *Textile Production in Classical Athens,* 63, 79, 87. She mentions the commonality of starting borders, as well as primary references to red dye, and specifically madder.

22 Margarita Gleba *Italy: Iron Age: Textiles and Textile production in Europe,* 224.

23 Stella Spantidaki, *Textile Production in Classical Athens,* 11. Stella mentions some research by Elizabeth Barber on page 11 that lays out this formula. This is a general formula, as there would be a lot of differences between thickness, material, or ply, but as a general formula it works well so the author includes it.

24 Linda Foxhall, *Temporality, Gender and Materiality in Ancient Greece,* 192-3.

25 Ibid. 195.

26 All translations done by the author.

27 Stella Spantidaki, *Textile Production in Classical Athens,* 52-53. Stella has a photo of a painting with a warp with what seems to be a very dense roll of warp upon the cloth beam. She also notes that this technology was fairly important, although she mentions that it seems to be an innovation. In this author's experience the warp weighted loom is not really whole without this technology, and it is intrinsic to the medium.

28 Backstrap weaving does not have any trace within Classical Greek sources, but that does not mean that it wasn't in use. The Backstrap loom would dissolve very quickly, and it does not drastically differ from other small loom styles which did exist in the Greek World. Stella Spantidaki, *Textile Production in Classical Athens,* 52-53.

There is some scant evidence for various backstrap and early horizontal looms during the bronze and neolithic age, Małgorzata Siennicka, Lorenz Rahmstrof, Agata Ulanowska, *First Textiles, The Beginnings of Textile Manufacture in Europe and the Mediterranean*, 3-4. It must be assumed that the classical world had several types of different fibrecrafts happening simultaneously, and that techniques would be shared between these mediums.

29 Laverne Waddinton, *Backstrap Basics*, 2009.

30 Stella Spantidaki, *Textile Production in Classical Athens,* 50.

31 Linda Foxhall, *Temporality, Gender and Materiality in Ancient Greece, 197.* This means that women would start working the loom in their mid to late teens, when they have grown up enough. The physical strain is also personally noted by the author.

32 Linda Foxhall, *Webs of Knowledge: Untangling Textile Production in Ancient Greece.* Linda Foxhall, *Temporality, Gender and Materiality in Ancient Greece, 195.* For the purposes of this project; a weaving team consists of three weavers within a household. This number is drawn from primary sources and the family dynamic in an ancient greek house. The traditional members of this team are the mother in law, the daughter in law, and a mix of either a sister in law, a daughter, or a house slave. These numbers aren't set in stone, but with the numbers given above, one can calculate their own conclusions about the production values.

In Italy there also seems to be a focus on more domestic production, although some specialization starts to occur during the iron age. Margarita Gleba mentions the importance of weaving's economic impact, "Textile production has moved to a new level, becoming one of the main economic activities and sources of wealth." in Margarita Gleba *Italy: Iron Age: Textiles and Textile production in Europe*, 237.

33 Stella Spantidaki, *Textile Production in Classical Athens,* 6. Unfortunately, the Delphic edict does not categorize the separate expenses.

34 Linda Foxhall, *Webs of Knowledge: Untangling Textile Production in Ancient Greece.*

35 Ibid. Dr Foxhall discusses that classical textiles made up to a quarter of household income during the 4th century BCE. This number is not a monolith across various cities or centuries, but one must assume that this represents the importance of weaving to local economies and households. Stella Spantidaki's *Textile Production in Classical Athens,* 11, states that poorer households would supplement their income with weaving, and a strong focus on the cottage industry of textiles.

36 Stella Spantidaki, *Textile Production in Classical Athens,* 52.

37 The amount of textiles a family would need is unknown, and would vary year to year. The author is assuming that a fine tunic would take twice as long as a thicker *chlamys*, although this assumption cannot be corroborated without additional research. The author is also assuming that a family might use 3 *chlamydes* a year, and about 3 finer tunics, although these numbers would be very difficult to calculate or average out. For the purposes of this paper, however; the assumption is that a normal family would use the majority of its textiles to clothe itself, and only sell the extras, as mentioned By Stella Spantidaki, *Textile Production in Classical Athens*, 11.

[38] Stella Spantidaki, *Textile Production in Classical Athens,* 11.

[39] Ibid. 6

40 Ibid. 11. There are references in Aristophanes to linen sellers, and a note saying that the Agora could have had substantial textile business.

41 Tablet weaving is traditional for many of the starting borders in warped weight weaving, although it is not the only way to weave. Agata Ulanowska, *Experimenting with Loom weights. More Observations on the Functionality of Early Bronze Age Textile Tools*, 170.

42 Linda Foxhall, *Webs of Knowledge: Untangling Textile Production in Ancient Greece.*