The Roman Glass Industry: An Analysis of Roman Era Glass Production and the Lives of Glassblowers

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by
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Dedication

For

Helen Rose Gransby
whose love and kindness has made a permanent impact on both my mind and heart

and

Albert Daniel Zeitzer
who held such a strong passion for education that it has and will continue to influence my family

for generations.

May their memories be a blessing.
Abstract

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Circa 20 CE the practice of glassblowing, which likely originated in either Syria or Judea, had begun to spread across the Roman Empire. Glassblowing was significantly faster than older methods of shaping glass and therefore resulted in less costly wares, affordable for even lower class Romans. Glassblowing remained in use from the first century CE through the fall of the Roman Empire in the fifth century CE during which time the Romans established glassblowing workshops in far-reaching locations such as Lyons, Putoeli, and Sardis. Despite the long life and prominence of Roman glass, limited information remains about the glass industry itself or the glassworkers.

To provide background information necessary for understanding why the invention of glassblowing this paper begins with an overview of Hellenistic and Roman glass shaping
techniques, the duration of their usage, their advantages, and the benefits glass provided to the Romans. In the second chapter, examines a passage on glass in the *Price Edict of Diocletian* in order to study glass production in the Roman Empire. Specifically, the second chapter uses evidence of Roman trade routes, passages from Pliny’s *Natural History*, evidence from the excavation at Jalame, and other scholarly research to suggest that the terms *Judean glass* and *Alexandrian Glass* refer to glass made in Judea and Alexandria rather than glass made in the style of Judea and Alexandria. The third chapter analyzes surviving glass wares, stylistic trends of glass during the Roman era (from the first century CE to the fifth century CE), and the Theodosian Codex to determine the social economic status and welfare of Western glassblowers and how that status changed over time. The third chapter also suggests that the centers of raw glass production in the Eastern Mediterranean were owned by wealthy Roman senators and equites based on comparisons to contemporary industries owned by senators. Ultimately, this paper reveals how glassblowing is a great case study for researching the immense impact that new technologies, such as glassblowing, could have on economics and social structure in the ancient Mediterranean.
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Introduction

The study of Roman glass can be overwhelming to those unacquainted with it due to the diversity of subjects within the field. These subjects include the production of raw Roman glass, the technology and advancement of Roman glass, the economics and trade of Roman glass, the art historical aspects of Roman glass, and the chemical traits of Roman glass. Currently, no sufficient scholarly source exists to provide a comprehensive overview of the various subjects within the field. The study of Roman glass should, however, be encouraged more often due to how glass is a useful case study for analyzing both the spread of technology in the ancient world and trade. In the future, I hope to create a holistic guide to introduce high school, undergraduates, and early graduate students to the various fields within the larger study of Roman glass.

This thesis, which begins my long-term endeavor, focuses on the economics of Roman glass and is divided into three chapters. The first chapter is a brief introduction to the major technological advances in glass shaping between the first century BCE and the first century CE. The background information provided by the first chapter is necessary for understanding the circumstances leading to the changing social status of glassmakers (as discussed in chapter three). The second chapter concerns the production of raw glass in Judea and Egypt around the start of the fourth century CE when Emperor Diocletian released his Price Edict. The third chapter is in two parts. The first part seeks to analyze the social status of glassblowers over time from the first century CE, when glassblowing was introduced to
Roman Italy, to the fourth century CE, when a law in the Theodosian Codex excused glassblowers from military service. This chapter also analyzes their health and their potential for success. Ultimately, this thesis will grant the reader a better understanding of the enduring social and economic changes caused by technological advances in glass shaping during the first century CE.
Chapter 1: An Overview of Roman Glass

Although both archaeologists and art historians admire Romans for their remarkable glass wares, glass production is not “native” to the Romans or Italy. The first wares which scholars might describe as “Roman glass” are dated to the first century BCE and were imports from Egypt and Syria, two nations with a long history of glassworking. The phrase “Roman glass,” however, is misleading as the term “Roman” in this context does not mean “made in Italy,” but rather “created 30 BCE - 476 CE”. The early Roman (first century BCE to early first century CE) glass products and innovations were primarily the creations of Judean and Syrian craftsmen.¹ By the end of the first century CE, glass workshops had spread across the empire. The goal of this chapter is to give general background information about Roman glass, including the predecessors of Roman glass and how they were made, the various methods of shaping glass during the Roman era, and the benefits of glass as a material. The importance of this background information is that it explains why the glass products of the first century CE were unfamiliar to the Romans and the rapid changes which occurred in the glass industry at the start of the Roman era. Understanding the novelty of glass to first century Romans is essential.

The oldest examples of glassware in Italy come from the southern part of the peninsula during the late third century BCE (figures 1 and 2).² Collectively known as the Canosa wares or Canosa group, they were found in Hellenistic funerary contexts.³ Their creation, however, was

¹ N.B. The term Judean, as used here, does not exclusively mean Jewish, but any person who lived in the kingdom or province of Judea.
² The term “glass wares” refers to useable tools such as cups, unguents, and plates as opposed to glass objects such as decorative glass beads, jewelry, or game pieces.
probably due more to Greek influence than Roman. Canosa was a Greek colony within the Hellenized region of Southern Italy referred to as Magna Graecia. The shape of the Canosa group glass wares also mimic Greek styles. Thus although glassware arrived in Italy during the middle of the Roman Republic, they existed outside Roman society and therefore the Canosa wares are not the first Roman glasses but a predecessor to Roman glass.

As late as the mid-first century, glass played a miniscule role in Roman material culture as evident by scarcity of Roman Republic era glass, and that the Latin word vitrium (glass) does not appear in Roman literature prior to Cicero’s *pro Rabirio Postumo* in 54 BC. The popularization of glass in Roman society began shortly after Augustus’ victory over Mark Anthony and Cleopatra in 31 BCE. The war annexed Egypt as a province. Shortly thereafter the production of Roman glass began. The age of Roman glass is known for technical discoveries, increased accessibility, and growth of the industry which existed around the Mediterranean as early as the 16th century BCE.

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The name Canosa group comes from the town of Canosa where archaeologists uncovered many of the Early Hellenistic glass wares.


Much of Magna Graecia region (excluding Sicily) was absorbed into the Roman Empire during the third century. Since Canosa was a relatively small city (and generally avoids mention in a list of Rome’s significant conquests), dating when precisely the Romans annexed Canosa is nearly impossible. The date when Rome establishes control over the entire Italian Peninsula is 264 BCE. Thus the Romans annexed Canosa sometime between 275 BCE (the end of the Pyrrhic War) and 264 BCE, which is well after the creation of the Canosa wares.

http://www.jstor.org/resources.library.brandeis.edu/stable/10.1525/j.ctt1ppxrv.17.

Grose defines 30 BCE - 50 CE as the early era of Roman glass.
1.1 Glass in the Hellenistic Era: A Prelude

To contextualize the impact of the glass impact that defined the Roman-era glass industry, first the glass shaping techniques of the Hellenistic era are analyzed in respect to both their strengths and weaknesses. In the middle of the first century BCE, the major glassmaking techniques in use were core forming, closed mold casting, and former molds. Core forming was the oldest of the three methods and, in the Hellenistic era, primarily used for unguents, bottles for perfumes and cosmetic oils. The technique begins by shaping an internal core, often composed of some combination of dung, clay, mud, and sand, on the end of a long rod. The artisan then would dip the core in an initial layer of glass. Atop the first layer of glass, the artist would drizzle a second, decorative layer of multiple colors in horizontal lines. Usually in the middle of the unguent, the artisan would pull the glass to create a zigzag pattern. When the glass had hardened a little, the artisan would tap the glass against a surface to destroy the internal mold and remove the glass from the rod before beginning the annealing process. The problem with core-forming is that the technique is rather tedious and requires the artisan to have good dexterity. In addition, while large core-formed amphorae exist, the combined weight of the rod, glass, and interior mold would have weighed considerably and taxed the glassmaker’s strength. As a result, core-forming was discontinued in the early first century CE, shortly after the creation of glassblowing.

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8 Grose, *Early Ancient Glass*, 122, 189, 194, 197.
11 The artisans created the composition of the interior mold so that it will break more easily than the glass around it. The interior mold has the consistency of clumpy dirt and will crumble apart fairly easily.
The second oldest method of shaping glass in the Hellenistic era was closed mold casting, which artisans used to create most of the Canosa group.\textsuperscript{12} Closed molds often consisted of a convex exterior mold and a concave interior mold. The craftsman places pieces of glass in between these two molds and heats up the mold. The artisan can create mosaic glass by arranging the glass in a specific pattern before heating (figure 3). In some cases, the artisan also used gold sandwiched between two layers of glass to create a decorative pattern (figure 4). Glassworkers used closed molds to create table wares (i.e. plates, bowls and cups) starting from the late fourth century BCE and never completely fell out of use.\textsuperscript{13}

Former molds were the latest glass-shaping innovation of the Hellenistic Era. Former molds were mostly limited to creating only bowls or cups, but they were efficient for production. The former molds method utilizes only an interior concave mold. A glass disk is placed atop the mold and, while heated in a kiln, sags down into the mold. The exterior is fire polished; the craftsman rotary polishes the interior after the annealing process.\textsuperscript{14} Often, glassmakers would beat a ribbed pattern into large glass bowls created by former molds. While artisans could create colorful mosaic glass out of former molds, former mold bowls were in the Hellenistic Era were often produced in a natural, monochrome green. Craftsmen in Syria and Judea were the primary users of former molds, which only had a lifespan of less than 200 years (first century BCE to first century CE).\textsuperscript{15}

The impact of the Hellenist invention of closed molds and later former molds is that glass shaping became a less technical skill. Before the invention of these molds, glassworkers had to

\textsuperscript{12} The Canosa wares, however, were not the first cast vessels. The Egyptians and Persians created cast vessels in the Bronze Age and Iron Age respectively. What separates the Canosa wares is their Hellenized style. Grose, \textit{Early Ancient Glass}, 46, 74.
\textsuperscript{13} Glass tablewares lost popularity in the Roman Empire during the late first century CE. Stern, \textit{Roman Mold-Blown Glass: The First through Sixth Centuries} (Rome: “L’Erma” di Bretschneider, 1995), 184.
\textsuperscript{14} Grose, \textit{Early Ancient Glass}, 32.
\textsuperscript{15} Grose, \textit{Early Ancient Glass}, 245.
shape their glass by hand near the heat of the furnace. Now, the mold did much of the work for the glassworker. From an archaeological perspective, the Hellenistic era left a visible increase in the number of glass vessels distributed in the cities of Hellenistic Mediterranean, such as Sardis, Athens, Cosa, and Canosa. Because of the Hellenistic inventions and increase in glassworkers, a golden age of glass was inevitable, with or without the Roman Empire.

1.2 The Beginning of Roman Glass

The discovery of glass blowing in the Roman Era was probably an accident. One possibility is that in the middle of the first century BCE, a glassworker saw a chunk of hot glass on the ground and tried to pick it up with a blow rod used for stoking fires. When the hot glass got stuck on the blow rod, the glassworker tried to blow it off, and thus made the first glass bubble. Regardless of whether the tale is accurate, modern scholars have a fairly strong consensus that the first glassblowers blew chunks of glass on the end of the rod rather than dipping the blow pipe into a crucible of glass as modern glassblowers do. The problem with using liquid glass is that a significant portion of the glass is lost inside the pores of the crucible; therefore, blowing glass chunks is less wasteful. The fact that glassblowing originated in either Syria or Judea is generally agreed upon. The evidence, however, is not perfect. Pliny and Strabo

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19 Stern, Roman Mold-blown Glass: The First through Sixth Centuries, 42.
both commend the Syrian city of Sidon for its skill in glasswork. Pliny even mentions that
glassblowing was one of Sidon’s main techniques. The primary evidence for this assertion comes
from a workshop in Jerusalem, dated to the middle of the first century BCE, where
archaeologists found glass-working waste with indications of experimental glass inflation.\textsuperscript{21} The
evidence, however, does not suggest that the workshop ever moved beyond experimenting to
producing blown products for consumption. And while no contemporary literary source confirms
glassblowing’s origins in the Levant, the first-century historians Strabo and Pliny both held the
glass industry of Sidon, Syria in high regard for its innovations.\textsuperscript{22} Thus while the evidence for
glassblowing originating is not beyond doubt, the case for a Judean or Syrian origin is fairly
strong.\textsuperscript{23}

In the early first century CE, glassblowing brought an end to the dying core formed
method, as glassblowing gave the artisan a similar amount of freedom in designing his ware
while also being faster and simpler than core forming.\textsuperscript{24} Glassblowing also played a role in the
decline of former molds because glass blowing was less restrictive but about as fast. The process
of glassblowing begins either with a malleable chunk of glass or melted glass. The benefit of
chunks of glass is that very little glass is lost during the shaping process and the temperature of
the glass only needs to reach 940 °C. The downside of using chunks of glass is that the artisan

\textsuperscript{21} Stern, \textit{Roman Mold-blown Glass: The First Through Sixth Centuries}, 38.
Grose, \textit{Early Ancient Glass}, 262.
Pliny writes, “Sidon was once famous for its glassworks, since, apart from other achievements, glass mirrors were
invented there.”
\textsuperscript{23} Furthermore, scholars can be fairly confident that the invention of glassblowing did not originate in Egypt, as the
Egyptians were noticeably slow to utilize glassblowing in their workshops.
Stern, “Roman Glassblowing in Cultural Contexts,” 443.
\textsuperscript{24} Recall that during the Hellenistic era, core forming was already limited primarily to creating unguents. Grose
dates the end of the major core forming glass production to 10 CE.
Grose, \textit{Early Ancient Glass}, 125.
has to estimate the amount of glass he needs to work with before beginning his process. If the artisan uses melted glass, he can add more glass to the end of the blowpipe in the middle of the shaping process.25

After preparing the glass, the shaper attaches the glass to the end of his blowpipe and begins to blow an air bubble into the glass. During this process, he must keep his pipe rotating to prevent the glass from falling off the rod.26 Once the bubble is of sufficient size, the glassmaker can shape his ware. Various tools allowed the shaper to twist, pull, and flatten the glass. At some point in time during the early years of glassblowing, the Romans invented a method of transferring the glass from the blow rod to a separate iron pipe attached to the base; this method is called the pontil technique.27 The pontil technique begins with a second glassworker heating up the second shaping rod.28 Once the second rod is about as hot as the blowpipe, the second glass worker attaches it to the bottom of the ware. Both glassmakers rotate their rods in unison to ensure the second rod is thoroughly attached. Then a small, encircling incision is made towards the end of the blowpipe.29 To remove the blowpipe, the glass is banged on a surface near the incision. Because the incision is the weakest point, the glass breaks along its lines. Once the pontil technique is completed, the glassblower can work the mouth of the glass ware. After shaping the mouth, the craftsman places the glass in an annealing chamber.30

26 The glass is, during this process, a slow moving liquid. By rotating the rod, the artisan constantly changes the angle in which the gravity pulls down the glass and can therefore ensure that the final product is equal length on all sides. For novices, the act of constantly rotating the rod is fatiguing. The author can attest to this process and the exhaustion it brings through personal experience.
27 Stern, Roman Mold-blow Glass: The First Through Sixth Centuries, 44.
28 This shaping rod is just like a blowpipe except the rod lacks a hole in the center since the rod is not used for blowing.
29 The incision is not a full, deep cut, but rather more of an indent. The idea is that making this incision is easier than trying to use muscle to cut through the glass.

Annealing is a necessary process to bring slowly the ware to room temperature without cracking. Excavations have
During the early first century CE, the Syrian craftsmen discovered mold-blown glass. Mold-blowing is a more technical skill than regular glass blowing, but the technique results in a more quickly shaped product. An estimate made by observing a modern glassblower working under primitive conditions is that a Roman glassblower could create around one hundred wares a day.\(^{31}\) The glassmaker could create his molds out of a variety of materials including clay, plaster, or wood. The molds were always composed of at least two parts to allow the glass to be removed easily at the end of the process. The mold-blowing process begins similarly to the glassblowing process. The artisan sticks some glass at the end of the blow rod, shapes the glass so that the glass is long enough for the end of the mold, and blows.\(^{32}\) The artisan then uses the pontil technique to shape and smooth the neck and mouth of the vessel before placing it into an annealing area. Blown glass wares take a large variety of shapes. Among the various shapes of Roman mold-blown glass are fruit shaped jars, head shaped jars, and vessels which bear relief carvings on their walls from the mold-blowing process. The mold-blown reliefs lack the quality of those carved into glass by stone cutters, but creating reliefs through mold-blowing glass was a quicker and less expensive process than hiring a stone cutter.\(^{33}\)

By the middle of the first century CE, several Roman authors document the low cost of glass in the Roman Empire, presumably a result of the invention of glassblowing and mold-blowing. Strabo wrote, “...in the case of glass-ware, where one can buy a glass beaker or


\(^{32}\) One common method used by modern glassblowers, and presumably ancient glassblowers as well, to lengthen the molten glass is to swing the blowpipe in a circle, causing centrifugal force to extend the length of the glass. Because the glassblower must understand the limits of the glass (i.e. how fast he has to spin his rod to reach the appropriate length and how long to blow into the mold), mold-blowing takes considerable more time to learn than regular glassblowing.

\(^{33}\) Wares with reliefs cut by stonecutters are discussed in greater depth in chapter 3.
drinking-cup for a copper.”

From a cultural perspective, however, glass was paradoxically both disposable and desirable, as Petronius remarks in his Satyricon. Petronius wrote, “‘You will forgive me if I say that personally I prefer glass [to silver]; glass at least does not smell. If it were not so breakable I should prefer it to gold; as it is, it is so cheap.’” Because of its low price, glass became a commodity for the rich and poor of the Roman Empire, and just as Petronius implies, glass products had other qualities (even beyond the lack of smell) that made it preferable over its alternative wares.

1.3 The Benefits of Glass

Glass had several advantages that could make it more desirable to the Romans than other material. The first advantage was the appearance of glass. To the Romans and earlier people, glass, on account of its translucent quality, looked similar to semiprecious stones. Pliny the Elder thought the resemblance was concerning enough that he warns his readers to be wary of glass sold as counterfeits of the semiprecious stones “callaina” and “carbunculus.”

Furthermore, Dr. Cosyns studying glass in Britain and Gaul noted that black glass was often a substitute for obsidian. A second benefit of glass’ appearance is its mutability. Though glass was typically created with a green color due to iron impurities, the Romans could add antimony and manganese to melted glass to make it clear, add cobalt make it blue, or copper oxide to

34 Strabo, Geography, 16.25.
36 In old Hebrew, the same word was used for both “fine crystal” and “glass.” Engle, Anita, eds. “3,000 Years of Glassmaking on the Phoenician Coast,” in Readings in Glass History. Jerusalem: Academon Publishing House, 1973, No. 1, 8.
37 The identity of these stones is debated among scholars. Pliny does state that carbunculus comes in a variety of colors while callaina is a pale green. Pliny, Natural History, Volume X: Books 36-37, 37.26, 37.33.
create a red color. Finally, glassmakers could easily manipulate the shape of glass so that their wares could serve a variety of purposes. While the beginning of the Roman era featured bowls, cups, and plates in traditional Greek styles, by the third century CE glassworkers also designed jars in the shapes of fruit or human heads (figures 5, 6).

The low cost of glass was another clear benefit of the material. Three factors that were responsible for the low cost of Roman glass are its low cost of production, its massive yield, and wide distribution. Glass production had a low cost because Roman glass was made of only two primary ingredients, soda and fine sand. Both are naturally occurring and rather abundant in the eastern Mediterranean. As a result, glass factories could have their own workers collect the ingredients (to reduce cost) rather than paying an outside group to send them supplies. The Romans transformed the raw ingredients inside large furnaces that produced glass by the tons; thus they should have rarely encountered a circumstance where the rate consumption drastically exceeded the rate of production. Finally, Roman sailors found it beneficial to distribute the large supply of glass because unshaped glass functioned well as ballast. The ability of glass to serve as ballast encouraged the overseas trade of glass and helped ensure that Romans all across the Mediterranean would have little trouble obtaining supply. Thus the low manufacturing cost, high yield, and wide distribution all ensured that glass remained an affordable commodity from the first century CE until the end of the Roman era.

40 The process of creating glass from raw materials is discussed in depth in chapter two.
42 Stern, “Roman Glass in Cultural Context,” 475.
1.4 Conclusion

The drastic changes in glass shaping techniques during the Roman period were not caused by the Roman conquest of the glass-producing Mediterranean, but rather a continuation of progress that had begun during the Hellenistic era, which saw the rise of closed mold castings and the invention of former molds. The invention of glassblowing and mold-blowing in the early first century CE made glass notably inexpensive. Because of the rapid changes to glass production during the Roman era, Roman glass provides scholars with an object of study that allows them to understand better both how new technology for glass production spread across the ancient world and how the ancient economy reacted to change in technology.
Chapter 2: The Dominance of Egyptian and Judean Glass Production

By the early fourth CE, glass workshops had long since spread across the Empire; excavations in Sardis, Puteoli, London, Lyons, and Tel Yoqne’am discovered evidence of several ancient workshops. Despite the widespread distribution of workshop locations, glass factories were more concentrated in two regions, Judea and Egypt.

In the year 301 CE, Emperor Diocletian issued his *Price Edict* to set limits on the maximum prices people could charge for goods and services. While the *Price Edict* was only in effect for a limited time, the edict serves as an essential guide to understanding ancient markets since so few other documents (perhaps no other contemporary document) exist recording the prices for such a wide range of goods. Based on the *Price Edict* and other ancient sources, the Eastern provinces of Egypt and Syria-Palestine continued to perform an essential role as the

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Stern, “Roman Glassblowing in Cultural Contexts,” 443.
N.B. The glass workshop in Sardis was established during the fourth century CE, possibly after Diocletian’s *Price Edict*.

44 Pliny the Elder, writing in the first century CE, mentions that during his life people had successfully created glass with the sand from the Volturno river in Italy as well as in Gaul and Hispania (although Pliny does not mention where the soda came from). Since glass production in these areas are never mentioned again during the Roman era, and since archaeologists are still searching for evidence of Roman glass production outside of Judea and Egypt, glass production in these areas was probably not economically sustainable. Pliny, *Natural History*, 36.195.


46 The *Price Edict* was only in effect for a short time because the prices were so low that people withheld goods from the market.
The text reveals three main categories of glass that were Alexandrian, Judean, and window glass.

Because of its low price, window glass is believed to have been the lowest quality of glass. The glass windows of the Roman Empire were cast made and thick, therefore more translucent than transparent. While some buildings might just leave a hole for a window, glass windows were particularly useful for bathhouses, since they provided both insulation and light.

In respect to Alexandrian and Judean glass, two main factors might account for the difference between their prices. First, in the *Price Edict*, green color is the defining feature of
Judean glass, while Alexandrian glass is colorless. Since glass received its green color usually because of the inclusion of metallic impurities, particularly iron, Judean glass was probably naturally colored while Alexandrian glass was purified glass. Second, the economics of these neighboring regions were drastically different. Judea had economic freedom. Judeans could trade with any other region, work individually or as a group, and use the standard currency of the Roman Empire. Egypt, however, was the emperor’s province and all trade within the region was strictly regulated.

Egypt had its own unique currency which was worthless anywhere else. In addition, Egyptian craftsmen often worked in guilds that protected the members’ business and limited completion. Even Roman travel to Egypt was strictly regulated. Perhaps the difficulties of overcoming Egypt’s trade regulations were another cause for Alexandrian glass’ higher price. A third possibility is that the more traditional methodology of shaping glass in Egypt meant their products were created more slowly and requiring more intense labor, resulting in higher prices without necessarily higher quality.

The *Price Edict* also demonstrates that the Roman elite, that is, Diocletian and his advisors, were practically clueless about the glassmaking industry. Dr. Stern calculated that

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51 Charlesworth, M.P., *Trade Routes and Commerce of the Roman Empire*, 17.
55 Charlesworth, M.P., *Trade Routes and Commerce of the Roman Empire*, 17. Charlesworth writes, “No Roman of rank except the emperor’s servants was allowed to set foot there without special leave; August became the ruler of Egypt and controller of all its revenues…”
56 N.B. The short lifespan of the *Price Edict* suggests that Diocletian and his advisors wrote the maximum prices without proper consideration for any industry. The Christian writer Lactantius claimed the *Price Edict* caused
based on the maximum prices ascribed to raw and shaped glass, glassblowers would find it virtually impossible to profit. Stern wrote:

“The total weight of the 1080 vessels that could be blown from 450 kg raw glass would have been ca. 270 kg, or 825 Roman pounds. The PE allows a maximum sales price of 30 denarii per pound for Alexandrian glass vessels, which translates into 24,750 denarii for the lot—significantly short of the 33,720 denarii necessary to buy 450 kg of raw glass.”56

One factor that Stern does not consider in this scenario is that the glassmaker could reduce their losses by blowing chunks of glass instead of using glass in a crucible, but the profit would still be minuscule at best. Because the margin of profit for glassworkers is so small, we can assume either that those responsible for creating the law had little to no business in the glass industry or that the Roman elite were relatively ignorant about the glass trade. The Price Edict was allegedly an altruistic attempt to stop price gouging and improve the standard of living for a large number of people. The Price Edict says, “Thus, when the pressure of high prices appear anywhere—may the gods avert such a calamity!—avarice… will be checked by the limits fixed in our stature and by the restraining curbs of the law.”57 Assuming this statement was written with honesty, Diocletian did not intend for his legislation to worsen the condition for glassworkers who sought to create mass produced-jars for distributing other materials, only stop merchants who overcharged for wares.58 Thus while the Price Edict is an essential source for understanding glass production in the late Roman Empire, scholars must also consider the Price Edict as an unreliable source for understanding the reality of the market.

people to stop selling goods on the market, resulting in higher prices than before. Lactantius may have exaggerated details of his account, however, because Diocletian persecuted Christians. Lactantius, “On the Deaths of the Persecutors,” in History of Western Civilization IV (Chicago: University of Chicago Press, 1970), 120.
56 Stern, Roman Glass Cultural Context, 103.
57 Diocletian, “Diocletian’s Edict on Maximum Prices,” translated by E. Graser, in History of Western Civilization IV, 127.
58 An alternate possibility is that the Diocletian and his advisors believed forcing glass to lower prices would be beneficial for them; perhaps because glass is a useful vessel for transporting ointments and perfumes.
Despite revealing Diocletian’s clear lack of understanding about glassmaking, the fact the \textit{Price Edict} refers to glass as either Judean or Alexandrian shows that production remained strongly connected to the south-eastern Mediterranean. Some scholars, however, debate as to whether the terms “Alexandrian” and “Judean” refer to glass made in the style of these regions or glass physically made in these regions. To draw a modern comparison, white wine, although famously associated with France, is produced worldwide; Champaign, however, is by definition produced only in France. The question is, therefore, whether the location in which the glass was produced mattered.

In 1985, Dan Barag first put forth the idea that the regional terms refer to two different styles of glass.\footnote{Barag, Dan, "Alexandrian and Judaean Glass in the Price Edict of Diocletian," \textit{Journal of Glass Studies} 47 (2005): 184-86, http://www.jstor.org/stable/24191095.} The center of his argument concerned the history of the region “Judea.” After the Jewish rebellion known as the Bar Kokhba Revolt (132-135), during which the Roman legions sustained heavy casualties, Emperor Hadrian changed the name of the province from “Judea” to “Syria-Palestine” as a punitive measure. Barag point out that after Hadrian changed the name, the region was never again referred to as “Judea.” Barag cites numerous coins and the New Testament to support this theory.

One flaw with Barag’s argument is that he only cites official sources referring to the region and does not analyze whether “Judea” remained an acceptable vernacular term during the Late Empire. Two main reasons why the term “Judea” might have survived the Bar Kokhba Revolt are as follows. First, the Jewish and early Christian people people may have continued to use the term “Judea” during their everyday life out of a sense of ethnic or religious pride as using that name for the region gives them ownership of it. This is supported by the early fifth century
texts of Jerome and the seventh century writings Isidore of Serville, both of which refer to the region as Judea.60

Second, the term “Judea” might have survived in the markets as a sort of brand name for the region’s glass. Even in modern times, some consumers prefer olive oil from Italy, cars from Germany, and fashionable clothing from France. Products from those locations have long held a reputation among consumers for being of the highest quality. If such a system of regional favoritism exists in the ancient world, the Levantine merchants might hesitate to rename their glass to “Syrian glass” so as to avoid confusing their customers looking specifically for the “Judean glass” they were accustomed to. In the Natural History, Pliny mentions several regions that are the best producers of particular goods. For example, he writes that the best soda (presumably for medicinal purposes) comes from Clitae in Macedonia, the best cyanus (a blue stone) comes from Scythia, and the best purple dye comes from Tyre.61

Perhaps the most overlooked reason as to why glass production would remain concentrated in the eastern provinces concerns the locations of the required natural resources. Pliny the Elder documented the process of creating glass from raw materials in the first century CE. He wrote,

“…[Sand] it is taken to be ground in a mortar or mill. Then it is mixed with three parts of soda, either by weight or by measure, and after being fused is taken in its molten state to other furnaces. There it forms a lump known in Greek as ‘sand-soda.’ This is again melted and forms pure glass, and is indeed a lump of clear colourless glass.”62

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Pliny, Natural History, 37.119.
62 Pliny the Elder, Natural History, 36.194.
While the procedure probably changed over the centuries, the core ingredients, fine sand and soda (sodium bicarbonate), remained constant. Finding suitable sand was the easier part. Pliny says that during his lifetime, people discovered that the Volturno River in Italy along with other locations in both Gaul and Spain had suitable sand for glass production. The more troublesome task was discovering a nearby supply of sodium bicarbonate. Pliny mentions numerous locations where people had access to a large, natural supply of soda, but all of those locations were on the eastern portion of the Mediterranean. And although, the Romans knew how to extract soda from sea water and oak trees, Pliny notes that they produced such small quantities that they would have been extremely insufficient for supplying a large industry. Thus, regardless as to whether the people of the Western Empire chose to create their own glass or shape Eastern glass, the need for imports was unavoidable.

Another reason that glass factories probably remained in the Eastern Empire is that unshaped glass is more easily shipped than soda. Soda is a powder and powder is more difficult to ship. The problems with shipping powder are that they are easily displaced (which can be problematic since weight distribution is crucial for ships carrying heavy loads) and that some product is always lost when mechanically transferred between vessels. While the loss of soda would seem miniscule at the time of transfer, it compounds over time as the substance continues to move. Glass by contrast is sturdy and does not scatter like powder. In fact, trading raw glass was actually beneficial for the balance of the ship. Because glass is both sturdy and has the

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63 Neuberg, Glass in Antiquity, 2.
64 Pliny, Natural History, 36.194
65 Pliny, Natural History, 31.104-115
Locations of naturally occurring soda (not accounting for quality or quantity) include Medes, Egypt, Lydia, Lake Ascanius, and Chalcis.
66 “But soda from burnt oak-wood was never made in large quantities, and the method has long been altogether abandoned. Alkaline water, however, is found in very many places, but the soda is not concentrated enough to solidify.” Pliny, Natural History, 31.44.107.
ability to be cut into a variety of shapes, glass was often used as ballasts for the ships that traded it. Thus the convenience of shipping glass over soda may have promoted the continuation of glass production primarily in the East.

In addition to the inconvenience of shipping a powder, glass was also more convenient to for the consumer because, unlike soda, glassblowers can shape glass as soon as they receive it. If soda was shipped, the buyer would also need to acquire suitable sand, land to build the temporary furnace, fuel for the furnace, and slaves to tend to it. Then, the buyer would need to wait until the process was complete. And at the end of the process of creating a new glass factory in the region to which the soda was shipped, the only benefit for the region is that they can claim to sell domestic glass. Because glassworkers could easily alter both the color and shape of glass, the imports would suffice.

The fourth century CE glass furnaces near Jalame, Israel also shed new light on the notion that the region remained a major glass producer during the Late Empire (figure 7). The glass discovered at the site had a light green color, matching the description of Judean glass in the Price Edict. The excavators believe the soda used in these furnaces was supplied from the el Wadi Valley, the sand was brought down from the Bay of Acre, and the fuel came from the surrounding forests of Mount Carmel. The factories were temporary structures and the archaeologists at Jalame only unearthed their foundation, a number of stones arrayed in a rectangular pattern. Observations suggest the furnace was filled with large quantities of sand and

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67 The furnaces in Israel took two weeks to convert soda into glass, but a smaller batch should theoretically require less time.
Jalame was initially excavated from 1964 to 1967. That excavation also resulted in the discovery of a single Roman glass furnace from late fourth century. In 2015, archaeologists returned to the site and found additional glass furnace from earlier in the fourth century CE. The IAA has not yet released the preliminary report for the 2015 excavation.
soda and kept at a temperature of 1100 °C for two weeks at a time. At the end of the process, the furnace was taken apart to extract the glass and the product yield measured in the tens of metric tons, enough to supply a large area for a time.\textsuperscript{69}

Of course the reasonable skeptic might question how the archaeologists determined that Jalame held a glass factory as opposed to just a glass workshop.\textsuperscript{70} The evidence comes from the remaining glass fragments. The remaining glass sherds at Jalame were large, plentiful, and in the form of unshaped chunks. The nearby archaeological site of Tel Yoqne’am, which the Romans occupied from the end of the Hellenistic era to the fourth century CE, contained a glass workshop. The archaeological site of Tel Yoqne’am held only twenty-seven sherds of glass (much fewer than the number at Jalame) in the form of small chunks, droplets, and misshapen fragments.\textsuperscript{71} Both the droplets and misshapen shards are characteristic of a glass workshop as show evidence that the ancient people attempted to manipulate the shape. Furthermore, the furnaces used to shape glass and create glass were structured differently as well. The shaping furnaces, such as those at Tel Yoqne’am, were more permanent structures, although they required annual replacements and repairs.\textsuperscript{72} Glassmaking furnaces, such as Jalame’s furnaces, were larger temporary structures that were dismantled after a single use.\textsuperscript{73} The large size meant that more fuel was needed to heat the glassmaking furnace than was necessary for a glass shaping furnace, but as a result the glassmaking furnace was able to produce large amount of product per a batch. Thus based on both the structure of the furnace and the remaining shards, the archaeologists at Jalame were rather certain they discovered an ancient glass factory.

\begin{footnotes}
\item[69] “Glass Production Furnaces,” Museum HaMizgaga. IAA reg. number: 2016-1834. This glass furnace was discovered in the 2015 excavation at Jalame.
\item[70] To reiterate from above, a glass factory creates glass from raw materials, a workshop makes products from glass.
\item[72] Stern, Roman Glassblowing in Cultural Contexts, 447.
\end{footnotes}
Another argument against the concentrated production of glass continuing in the eastern provinces is that it would require the glass to travel a long distance to a variety of ports. Barag asks those who support the notion that Judean and Alexandrian glass are region products, “Are we to assume that an imperial edict listed raw glass from a nonexistent province of Judaea that was to be traded at Pettorano sul Gizio in Italy; Delphi, Plataea, and Tegea in Greece; Knossos on Crete; and Aezani in Phrygi?”

There are three reasons to support the possibility that Judean and Alexandrian glass was so widely traded is not so as absurd as Barag claims.

First, Rome had long relied on trade with Egypt. Throughout the Imperial era (ca. 30 BCE- ca. 430 CE), Egypt became the main supplier of grain to the Roman Empire. Every year during the spring or summer, Rome would send a large number of ships to Egypt to return to Italy with large grain shipments. The grain trade effected the glass trade in two ways. First, the grain trade encouraged increased contact, both trade and otherwise, between Alexandria and Rome. For example, the grain ships often took aboard passengers from both Syria and Egypt seeking transportation to Rome. Those same ships also brought bricks to Alexandria. In addition, Alexandria’s connection to India via the Red Sea meant that the city held plenty of other exotic goods that drew Roman merchants not trading grain to the city. Second, the continuation of the grain trade shows that the Romans were capable of managing long distance supply routes for their most valuable resources.

Like grain, nearly all glass, whether Alexandrian or Judea, shipped to Rome and the western portion of the empire passed through Alexandria. While Judea had several functioning ports, such as Caesarea and Dor, none had nearly the same amount of traffic as Alexandria.

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74 Barag, "Alexandrian and Judaean Glass in the Price Edict of Diocletian," 186. These locations are places where archaeologists have recovered fragments of the Price Edict. The term “nonexistent” in Barag’s question is a reminder that the region was officially Syria-Palestine when Diocletian ruled.

75 Charlesworth, Trade Routes and Commerce of the Roman Empire, 23, 42. For a visual depiction of Roman Empire’s major sea trade routes, see figure 17.
Egypt’s commerce was largely fueled by a combination of grain production and the trade of exotic goods from East Asia via the Red Sea.\footnote{Charlesworth, Trade Routes and Commerce of the Roman Empire, 20.} Since glass was not shipped on its own, and because ships seeking the goods that they could receive exclusively through Egypt dispersed from there through the empire, the glass industry was able to utilize the city’s ports to the fullest possible extent. These ships took direct routes across the Mediterranean Sea to their destination. The speed of these trade routes is difficult to assess, but Charlesworth estimates the time necessary for travel from Rome to Alexandria to be about twenty days, while he estimates the time traveling from Alexandria to Rome to be twenty-five days.\footnote{Charlesworth, Trade Routes and Commerce of the Roman Empire, 23-24.} The reason that traveling from Rome to Alexandria is faster than the opposite is that the winds of the Mediterranean during the summer blow north to south. The time to journey from Judea by Alexandria by sea is unknown, but probably took around a day or two since the distance is relatively short and the summer winds are favorable.\footnote{Charlesworth, Trade Routes and Commerce of the Roman Empire, 24.}

Glass that shipped to other areas in the eastern Mediterranean (e.g. Rhodes, Lycia, or Athens) could travel either from Egypt or Judea.\footnote{Charlesworth, Trade Routes and Commerce of the Roman Empire, 42.} Unlike trade routes to the Western Empire, the ships traveling to Eastern cities generally kept close to the coast. Sailing along the coast had the advantage of making navigation easier and granting easier escape from rough weather. Traveling down the coast, the journey from Byzantium to Alexandria took thirty days, so the Journey from Alexandria to Byzantium probably took closer to thirty-five days.\footnote{See figure 17.}

\footnote{Titus and his army traveled from Alexandria into Judea in two weeks, but for industry moving bulk supplies of glass by ship might make more sense than by land since glass is heavy. Titus, since he was traveling to wage war, would have wanted to journey into Judea by land to avoid a sea-land battle at the harbor.}

\footnote{If the ship begins its journey in a Judean or Syrian Port, the journey would take less time since the ship starts closer to its destination.}
Unlike grain, however, glass was not traded in ships filled with only glass, but rather in ships bearing an assortment of other goods. Of the first nine Roman shipwrecks bearing glass, all of them bore additional cargo as well.\textsuperscript{81} Take for example the \textit{Julia Felix}, a third century CE ship which carried a significant quantity of colorless glass for sale.\textsuperscript{82} The cargo of the \textit{Felix Julia} was composed mainly numerous of amphorae in addition to 11,000 fragments of glass vessels.\textsuperscript{83} By weight, the glass carried by \textit{Julia Felix} is less than 1\% of its cargo.\textsuperscript{84} The recovered \textit{Julia Felix} reveals that the glass trade from the eastern provinces continued to flourish not because of specialized glass merchant boats, but because they were placed aboard ships carrying an assortment of cargo.

A third reason that the widespread trade of Judean and Alexandrian glass in the early fourth century is not such a strange concept is that the Romans were capable of recycling glass. Modern research into Roman-era glass recycling began relatively recently as there are only two well-known literary sources from the late first to early second century CE, written by Martial and Statius, referring to the subject.\textsuperscript{85} Martial writes, “What you are, the cheapjack from across Tiber is, who bartering yellow sulphur matches for broken glass…”\textsuperscript{86} Most of the glass on the \textit{Julia Felix} was broken before placed aboard the ship, collected for recycling.\textsuperscript{87} The existence of recycling during the Roman era means that a scenario in which glass desperately needed to be shipped to a

\begin{footnotes}
\item[81] Stern, “Roman Glassblowing in Cultural Contexts”, 473.
\item[82] Silvestri, \textit{The Colourless Glass of Iulia Felix}, 1.
\item[83] Presumably, at least a portion of these amphorae formerly carried liquid merchandise, but because the ship sank into the ocean, more research is necessary to determine their identity of the contents inside the amphorae.
\item[84] Silvestri, \textit{The Colourless Glass of Iulia Felix}, 1.
The estimated weight of the amphorae carried by the \textit{Julia Felix} is 22 metric tons (22,000 kg). The estimated weight of their glass is only 140 kg.
\item[87] Both Martial and Statius mention that sulfur was exchanged for the broken glass, but more research is necessary to determine why sulphur specifically was exchanged for glass.
\item[87] Silvestri, \textit{Colourless Glass of Julia Felix}, 1.
\end{footnotes}
western province was unlikely. In the event of a shortage of raw glass imports, glass makers could simply melt older broken or less fashionable wares to create new products.

The final reason that the Romans kept most glass production was in the eastern provinces during the fourth century BCE is that the demand for more raw glass was probably rather low. While the Romans probably considered most glass to be “disposable” on account of its low cost, glass vessels were still used many times before they needed to be replaced or recycled. Glass, unlike grain, does not spoil. Furthermore, each boat carried large supplies of glass per shipment (recall the *Julia Felix* held 140 kg). The need for more raw glass in any particular area, therefore, was probably kept to a low enough demand that glass shapers could work with only periodic shipments, especially considering that boats like the *Julia Felix* carried over 100 kg of glass.

Archaeologists have only discovered fragments of Diocletian’s *Price Edict* surrounding the Mediterranean.⁸⁸ Thus if the *Edict* neglected to mention any glass producing region, the most likely candidates would be the Northern provinces. Sea trade was essential to the distribution of Judean and Alexandrian glass, as ships could move could travel the sea quickly and with large cargo and hold tens of tons of cargo.⁸⁹ The *Julia Felix*, for example, held an estimated minimum of twenty-two tons of cargo. Long-distance land trade is significantly slower and more expensive, as is evident in the *Price Edict*.⁹⁰ Late imperial glass production in Germania and Gaul seems unlikely as Pliny the Elder fails to mention any sources of soda in those regions, despite his service in the military in Germania Superior and later holding public office over Narbonensis and Belgica.⁹¹ Pliny was probably less familiar with the landscape of Britannia,

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⁸⁸ Barag, *“Alexandrian and Judaean Glass in the Price Edict of Diocletian,”* 186.
⁹⁰ Stern, “Roman Glass Blowing in Cultural Contexts,” 472.
however, as Britannia was not only the frontier of the empire, but also physically separated from Europe as well. In 1998, archaeologists published evidence of primary Roman glass production in Roman York during the late second to early third century, which is at least one hundred years prior to the Price Edict. The evidence is problematic, as the Roman-era stratigraphy is mixed with a ninth to tenth century Viking layer, but the ingredients show that the occupants attempted to make soda glass (the only type of glass produced during the Roman era) rather than potash glass (which is common in during the Medieval era).

The claim that Roman Britannia produced its own glass is tempting to believe since an Alexandrian or Judean product would have to make its way up the Mediterranean through Gaul and across the English Channel. But even if scholars ignore the fact that the semi-reacted material from York excavation was in a mixed context, several other problems arise. First, scholars must identify the source of the soda. If scholars conclude that the soda was exported from Egypt to Britannia, then Roman York’s attempt at glassmaking was probably a short term experiment that failed to commercialize. Second, if the soda is from a local source, scholars have to answer why medieval glassworkers outside of Venice had to rely on Egyptian exports for soda-glass (or alternatively create potash-glass) instead of importing soda from Britannia. To rephrase this problem, if Roman Britain ever had the soda to create its own glass, why The question of what became of the British glass is the perhaps the more important one, as Judea

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94 Neuberg, Glass in Antiquity, 2.
95 Pliny mentions first century glass production in Gaul, Hispania, and Italy, but those efforts probably failed in the long term due to the lack of soda in the nearby area. Pliny, Natural History, 36.195.
96 Neuberg, Glass in Antiquity, 2.
continued to produce soda glass after the Roman era and while Egypt (as previously stated) became a supplier of soda for glassmaking.\(^\text{97}\) Third, more excavation is necessary to establish Britannia as a producer of glass, because twenty five fragments of unreacted material does not give enough information on the extent of glass allegedly produced. If production was of a minute quantity, the York glass production may have had minimal impact on the larger Roman glass industry and Roman British glass production may have been an exception rather than rule of Roman-era glass production outside of Egypt and the Levant. Ultimately, more research on Roman-era British glass would be beneficial to the fields of glass study and Roman trade, but until these problems are solved, any theories about British raw glass production are premature.

In conclusion, the concentration of soda in the East is responsible for the continued focus of glass production in Judea and Egypt at the start of the fourth century CE. The etymological argument against the term “Judean” glass is weak because it fails to consider whether the term survived in the vernacular language. In addition, archaeological evidence suggests the existence of late Roman glass factories capable of creating glass by the tens of tons and the Roman practice of glass recycling, which archaeologists have begun to investigate only recently, could curb the need for raw glass between shipments. Finally, raw glass was easy to ship because it functions well as ballast. At the current time, archaeologists have unearthed few Roman-era glass factories, none in Israel prior to the fourth century CE. While archaeologists in York found evidence of glass production is present in Britannia, more work is necessary to determine if the amount produced was of a significant quantity. Thus much remains undiscovered and unknown about the history of glass production in the Roman Empire. Ideally, archaeological sites believed to contain glass workshops and factories will receive more focus in the future since the study of the Roman glass industry is vital not only for understanding the history of glass, but also how the

people of the Roman empire managed the supply and distribution of raw material among the empire’s provinces.
Chapter 3: Owners and Workers of the Glass Industry

To this date, little is known about who the ancient glassworkers were. Nothing akin to an ancient documentary or biography exists to attest to the struggles of their daily lives. Even on the occasions where the societal elites practiced glass blowing as a hobby, no writing remains to provide an account of their experience.\textsuperscript{98} Archaeological evidence and documents concerning price, however, provide some insight into the shifting social and economic standing of glassworkers over time.\textsuperscript{99} This chapter is divided into two parts with distinct goals. The first section provides a sketch of the economic and social standing of Roman glassblowers and the second section seeks to understand who controlled the production of raw glass.

3.1 The Social Standing and Welfare of Glassblowers in the Western Empire

The evidence suggests that glassworkers had the most potential for economic success during the early first century CE when mold-blown glass was first introduced to Rome, but their economic opportunity gradually declined from the second century until the early fourth century CE. From a social perspective, glassworkers received the most attention during the first and fourth centuries CE, but for different reasons.

During the first century CE, some glassworkers produced wares bearing stamps with the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass industry. Some of these most famous stamps bear the names of people associated with the glass indus...
names Aristeas, Meges, Artas, and Ennion. These names could belong to the glassworker who made the ware, but other possibilities include the glass workshop owner or a head glassworker who created designs for his underling. Based on the relatively wide dispersal of these wares, the name does not seem to belong to the buyer; particularly in the case of Ennion’s wares, which archaeologists have uncovered in Israel, Cyprus, Italy, and other parts of Europe. Ennion does not seem to be the name of a merchant who used glass wares to sell his goods either, since many of his vessels bear the inscription “ΕΝΝΙΩΝ ΕΠΟΙΕΙ Ennion made this.”

One such vessel is a brown mold-blown vase currently held in the Corning Museum of Glass (figure 8). The vase is rather large (23.8 cm tall), blown in three or four parts (foot, one or two for the body, and the neck), and contains four distinct decorative patterns. The shape is also elegant and, although the vase’s elongated body is reminiscent of traditional Greek amphora, unique since the overhanging handle, relief pattern, and base are all features that potters would find difficult to replicate in clay. The Ertz Israel Museum in Tel Aviv has a second glass jug identical in every way except that the glass is a blue color, allegedly discovered in Jerusalem (figure 9). Ennion was also famous for his two-handled cups, a number of which survive with today. The MET Museum, the Corning Museum of Glass, Museo Archaeologico Nazionale di Adria each hold a cup of Ennion’s that bear identical wall designs to the other two (figures 10, 11, 12). Careful analysis suggests that the walls of these cups one mold may have created all

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100 Lightfoot, Christopher S, *Ennion: Master of Roman Glass* (New Haven. Yale University Press, 2014), 28, 32, 42, 44. These are all people names, not location names.
102 Lightfoot, *Ennion*, 144.
three cups, although the mold used for the base varied. Compared to Ennion’s jugs, these cups are much simpler (probably consisting of only two mold parts to three or four jug mold parts) and smaller (averaging about 6.2 cm high to about 21.5 cm high). These pieces alone are not representative of Ennion’s entire repertoire, but their drastic differences show that Ennion did not specialize in one type of ware but proudly created a variety of shapes both simple and complex.

Many scholars believe that Ennion began his business near Sidon before moving to Rome. One likely explanation for Ennion’s move (if he, indeed, had moved) is that Italy provided him with better business opportunity. One reason that Italy provided Ennion, and those like him, with better business opportunities is that he probably faced less competition for high quality mold-blown wares. Since the practice of mold-blowing began in the east, the practice almost certainly spread across multiple workshops before the glassblowers already living in Italy had properly learned how to utilize the new technique.

The second reason Italy may have held better business opportunity for Ennion is that the Italians would place more value on his wares because they were exotic to them. To the first-century Roman’s mind, Ennion’s products may have been more than ordinary glass wares.

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The bases of the Corning Museum of Glass and Museo Archeologico Nazionale di Adria cups are also identical, but the base on the MET museum’s Ennion cup is a little more rounded.

106 N.B. Simple here does not imply that these cups were of low quality. On the contrary, Ennion’s the reliefs on Ennion’s cups remain notably clear despite the passage of time. Simple does not necessarily mean inexpensive either, as, for a short time after the introduction of glassblowing to Rome, even some cups were highly valued. Strabo, for example, wrote that Nero paid 6000 sesterces for two moderately sized glass cups. Pliny the Elder, *Natural History*, 36.195.


Lightfoot discusses the theories about Ennion’s life developed by other authors, not his own. Dan Barag and Michele De Bellis are two scholars who proposed the possibility that Ennion moved from Syria to Italy.

108 Generally speaking, no reputable scholar has seriously believed that Ennion may have come to Rome as a slave. No evidence exists to support that notion and his wares have a certain degree of artistic freedom (seals that say “Ennion made this,” for instance) that suggests he ran his own business.

Perhaps they were a masterwork from the east made by latest technology and a foreign master (or at least the seller might have said as much).  

Finally, if Ennion’s wares were marketed as more expensive products and marketed towards societal elites, then Italy provided a larger market for him than the nations of the Levant. As the Seleucid Empire waned towards the end of the Hellenistic era, the Romans took over their former territories. Constant internal struggle and war with Ptolemies had drained the empire’s wealth and power. The civilian population also suffered due to the high taxes the Seleucids needed to fund their constant wars. By 63 BCE Judea was a tributary to Rome and Syria was a province. While the region was not poor, the economy was relatively stagnant in the early first century compared to Rome. Rome, unlike Judea and Syria had largely profited through wars. As a result, Rome had a number of citizens with excessive wealth who were willing to buy premium glass wares. The annexation of new territories to the Roman Empire had benefitted private business by supplying them with more natural resources to exploit, thus potentially expanding the size of the upper class. Thus the greater opportunity of the Roman market may have played a significant role in some glassblowers’, such as Ennion, move away from the Levant.

As an alternative to the possibility that Ennion moved from the Levant to Rome, some scholars propose that Ennion spent his life remaining at one workshop while he traded copies of

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110 Ancient merchants were not above giving grandiose details to up the price of their products. Ancient writers have documented some of the most absurd tales. For example, Roman merchants claimed that cinnamon came from the phoenix nests, which were dangerous to approach, and those who gathered cinnamon had to wait until it fell down. While scholars cannot judge how much the Romans believed this tale, they do know that cinnamon maintained a high price from the first to fourth centuries CE. Thus, the probability that Ennion (or whoever sold his wares) played up the exotic quality of his wares in the marketplace is rather high. Faas, Around the Roman Table (Chicago: University of Chicago Press, 1994), 163.


112 Wars did not necessarily bring immediate profit to the Romans, but could also bring profit down the line since victory brought them new territories to tax with more resources to exploit. By this reasoning, the Romans would have ultimately found profit from the first two Punic Wars (Sicily, Sardinia, Corsica, Carthage, et al. First Punic War was 264-241 BCE and the Second Punic War was 218-202), the Gallic Wars (58-50 BCE), and even the War between Octavius and Antony (32-30 BCE, annexed Egypt).

113 See page 44.
his glass molds to other workshops. Some of alternate theories even suggest that Ennion always worked in Italy, which, although not an impossibility, seems less likely since his Semitic roots are tied to his identity as a craftsman. During the second century CE the city of Lyons, France recruited a skilled glassblower from Carthage by the name Julius Alexander to lead their workshop. Regardless of whether Ennion traveled, because he attached to his name to his products, scholars can to use Ennion as a case study for the potential success and fame a glassworker could achieve in the early first century CE.

The story of Ennion, however, is representative of the exceptional rather than ordinary glassworker. Most were, undoubtedly, mass producing wares without leaving a trace of their own name or origin. In some circumstances, glassworkers seem to produce their wares mainly for the use and distribution of other businesses, functioning like a subcontractor.

One piece of evidence supporting this possibility is found in the city of Pompeii. Pompeii’s House of the Vetti has a section of a wall painting frieze depicting numerous cupids performing human labors related to the creation of perfume (figure 13). Although archaeologists cannot speak with certainty as to why the house owner commissioned this work for their wall, one reasonable possibility is that he owned a perfume business. The wall painting does not focus purely on the act of making perfume, but also includes the ancillary tasks as well.

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The scholars Jennifer Price and Genevieve Sennequier both proposed that Ennion was a mold maker in Italy who sold his molds.
Aside from this famous glassblower, the only other currently known person named Ennion was a third century architect from Damascus. As a result, scholars struggle to identify this glassblower’s ethnicity, but scholars generally agree that the name “Ennion” is a Hellenized version of a name originating from the Levant (possibly Phoenician). In addition, a number of Ennion’s cups include the inscription “ΜΝΗΘΗ ΟΑδΟΡΑ Ζνω,” which translates either to “may he remember” or “may he be remembered.” The word for remember, “ΜΝΗΘΗ” might be the creator’s way of translating a phrase common to Semitic prayers into Greek.
117 Other portions of the frieze depict the cupids as goldsmiths, garland makers, and fullers.
For example, the third cupid from the left appears to be blowing glass. That cupid is holding a long pipe up to his face, which seems to get wider towards the end (which might be the spot where the pipe ends and the glass begins). In addition, the third shelf of the cabinet on the left side of the image has a vessel with a bulb shape typical of blown wares. Overall, the scene lacks details; the crucible lacks a heat source and the cupid does not have a furnace nearby. Because the painting focuses so minutely on the glass working cupid, we can assume that glass working was ancillary to the owner’s business; the inclusion of the cupid, however, means he very much considered glassworkers to be a part of the business as opposed to a separate entity supplying him with vessels.¹¹⁸

The early glass workshops of the Roman Empire were probably formed with one central leader, or master craftsman, with a multitude of less skilled workers assisting him and completing simpler works under his direction. Such an organization would explain why the city of Lyon had sought out Julius Alexander from Carthage.¹¹⁹ In many cases, the glass workshop owner was separate from the master craftsman. Workshops with separate owners and masters were probably most common in the early first century CE when many of the Western glassworkers were immigrants from the East, as opening a new glass workshop would be particularly difficult for them due to the typical difficulties of moving to a new location, i.e. finances and language.

¹¹⁸ Archaeologists also study the inscriptions on glass bottles to determine whether the names on the inscriptions refer to glassblowers or the producers of the contents. Because the base of glass bottles are formed by a different piece of the mold than the walls, Stern speculates that the glassblowers would have little trouble switching out the base molds to an identically shaped mold carrying a different inscription so as to serve their different clients with ease. This author disagrees with Stern’s claim in the article that an inscription with a name followed by the word “fecit mades this” is suggestive that the preceding name refers to the glassblower. A subject can “fecit” either the perfume or the bottle and no words follow to suggest the inscription must refer to one or the other.
Stern, Roman Glassblowing in Cultural Context, 468.

¹¹⁹ Stern, Roman Glassblowing in Cultural Context, 458.
Also see:
Charlesworth, Trade Routes and Commerce of the Roman Empire, 200.
To open up a glass workshop, at bare minimum, a Roman would need a workspace with a furnace, a large crucible, a blowpipe, fuel for the furnace, and enough glass to work with.\textsuperscript{120} To create quality wares and be competitive in the middle of the first century (as mold-blowing became popular), they would also need clay to create their molds, additional tools for shaping, and potentially some assistants.\textsuperscript{121} If a glassblower were move from Syria or Judea to the western portion of the Empire, he would be able to take his personal tools with him, and maybe a small quantity of glass to work with, but the larger and more expensive items (i.e. the crucible, fuel, and furnace) he would have to purchase anew. To cover the cost of their initial business expenses and living expenses while they set up their business, the first glassblowers of Italy probably had to find rich sponsors to help them begin their business.

The need for glassblowers to find a wealthy sponsor, however, probably declined over time for several reasons. First, veteran glassblowers could (and probably did) work together to reduce the initial investment in establishing their workshops.\textsuperscript{122} While the first generation of Western glassblowers probably consisted mostly of immigrants, the second generation of glassblowers (which certainly included many of the children of the first generation) was more likely to work in their native land. As a result, the second generation of glassblowers did not face the challenges that result from moving to a new area, such as unfamiliar dialects, leaving behind possessions in order to travel overseas, and a lack of social connections. Second, after the first

\textsuperscript{120} Stern, “Roman Glassblowing in Cultural Contexts,” 463. Based on later documents from the 10\textsuperscript{th}-13\textsuperscript{th} centuries, Stern estimates that 1405 pounds of glass was necessary to open a new glass workshop. Based on the prices of Diocletian’s \textit{Price Edict}, she calculates the 1405 pounds of glass was an initial investment of 33,720 denarii if the glassworker only used Alexandrian glass or 18,265 denarii for only Judean glass.

\textsuperscript{121} Glassworkers can perform glassblowing on their own, but towards the end of the process (i.e. when grinding, smoothing, the pontil technique, flattening the base and/or shaping the neck) becomes tedious as one arm has to hold the glass by the metal rod the whole time.

\textsuperscript{122} Stern, “Roman Glassblowing in Cultural Context,” 460. Due to a lack of any documents concerning partnerships between Roman glassblowers, Stern instead examines a series of 10\textsuperscript{th}-13\textsuperscript{th} century documents, known as the Geniza documents, from a synagogue in Cairo that document contemporary cases of partnerships between glassblowers.
generation of Roman glassblowers, Italy would have some glass workshops and glass working tools that the younger generation could purchase instead of creating their own (which some would do regardless). Furthermore, the Theodosian Codex seems to suggest that families often passed down their glass working tools and practices from generation to generation.\textsuperscript{123} Third, later generations of glassblowers had better technology to work with, which improved the efficiency of their business, thus saving the craftsmen money. The first generation blew glass with clay pipes, which were cheaper but less durable than the lead pipes used by later glassblowers.\textsuperscript{124} Thus the craftsmen needed to replace the clay pipes more often. The invention of the closed furnace by 70 CE also made the manipulation of glass easier and thus reduced the amount of waste.\textsuperscript{125} In addition, the first generation of glassblowers did not realize that glass could be recycled.\textsuperscript{126} The discovery of glass recycling during the second half of the first century CE was another way later generations were able to save money and increase profits.\textsuperscript{127}


\textsuperscript{124} Stern, \textit{Early Mold-blown Glass: The First through Sixth Centuries}, 447.

\textsuperscript{125} Stern, “Roman Glassblowing in Cultural Contexts,” 447.

\textsuperscript{126} The author makes this claim based upon a passage from Pliny. Pliny writes, “Pieces of broken glass can, when heated to a moderate temperature, be stuck together, but that is all. They can never again be completely melted except into globules separate from each other.” Pliny, \textit{Natural History}, 36.199.

Based on how Pliny describes the issue, the closed furnace may have been the key component for Romans to begin recycling glass since the improved heating would aid in the fusing of the glass. Just sixteen years after Pliny wrote the majority of his \textit{Natural History}, Martial wrote the first literary reference to traders collecting glass for recycling. Stern notes that although that information seems to date the start of glass recycling between 70 and 86 CE, another distinct possibility is that glass recycling had started on a small scale during Pliny’s lifetime and he was simply ignorant of it.


\textsuperscript{127} For more on glass recycling, see page 25.
While the passage of time brought glassblowers greater independence, time also may have reduced their chances of obtaining fame through the crafts. Production of blown glass tablewares in the Western Empire ceased shortly after the reign of Titus (79-81 CE). Presumably, the Romans became somewhat jaded towards the glass that had only gained widespread attention in Rome about 150 years prior. Production in the Western Empire after Titus was mostly focused on bottles and small containers. Some of these vessels were relatively plain, such as prismatic bottles, while others were more decorated, like head jars (figure 5), but they served the same utilitarian function; because they were mold-blown, they required similar levels of skill to create. The desire for more transparent glass may have also decreased the potential for a glassblower to earn success and fame.

One flaw of mold-blown glass is that the technique created less transparent products, which, according to Pliny the Elder, became less fashionable towards the end of the first century CE. Pliny writes, “…The most highly valued glass is colourless and transparent, as closely as possible resembling rock-crystal.” Two techniques were employed to increase transparency. The earlier option was to send glass with a thick wall to a stonecutter for shaping and decoration. The stonecutter could then carve high-relief decorations into the wall of the glass. The process was laborious and expensive, and even in the modern era the Roman glass wares cut by stone are among the most treasured glass pieces in museum collections. Two of the British Museum’s most famous Roman glass objects, the Lycurgus cup (from the fourth century CE) and the Portland Vase (early first century CE), were clearly the work of stonecutters (figures 14 and

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128 Stern, Roman Mold-Blown Glass: The First through Sixth Centuries, 184.
129 Stern, Roman Mold-Blown Glass: The First through Sixth Centuries, 184.
130 Pliny, Natural History, 36.198.
Both of these cups depict mythological scenes in relatively high relief. The Portland vase, while invoking the appearance of flawless white marble figures over a blue sapphire base, seems to depict the marriage of Peleus to Thetis. The Lycurgus cup features the tale of King Lycurgus in dichroic glass, one of only about a dozen known samples of Roman dichroic glass in the modern era.

The second technique employed was facet cutting (figure 16), a method more famous for its use in modern jewelry, which glassmakers began to use in the second half of the first century CE. Facet cuts come in a variety of shapes, but one major commonality is that they featured a repeating shape pattern, or face, surrounding the entirety of the ware’s body. These shapes could be a diamond, hexagon, or oval pattern. Like most Roman glass shaping techniques, the practice of facet cutting appears to have originated from the Eastern Empire, based on Greek inscriptions found on some of the earliest facet-cut wares. Facet cutting is less laborious than stone cutting because the cutter only needs to employ the same pattern repeatedly, which was generally a series of straight cuts, rather than the more precise and varied cuts required to engrave people or vines. As a result, facet-cut glass was probably less expensive than glass with reliefs carved in by stoncutters.

N.B. These pieces are mentioned here for their fame and recognizably, not because they are the most typical examples of relief carved glass wares.


At a later point in time, a flat, cameo base with the face of Paris was also added. Scholars, however, cannot be certain whether that addition was made in antiquity or not.


Lycurgus insulted Dionysus banning his cult and chasing away (or imprisoning) his followers. In retaliation, Dionysus drove him mad, causing him to attack his wife and son (depicted in front of the king) before he got eaten by a panther (which is depicted alongside Dionysus behind Lycurgus).


Oliver, “Early Roman Faceted Glass,” 40.
Neither relief carvings by stone cutters nor facet cutting replaced mold-blowing glass, but these techniques shifted the design process (and therefore a lot of the more skillful labor) away from the glassblowers. As a result, whoever managed glass workshops, whether the blowers themselves or an employer of glassblowers, would need to pay a stonecutter to work any wares that they wished to stylize, increasing their expenses. Alternately, the consumer may have been able to bring some newly purchased wares to the stonecutters themselves to stylize. For facet cuts, the former approach is more probable since the initial investment in facet cut wares is relatively low. Relief carved glassware, however, was probably commissioned ad hoc by the consumer, due to the high expense and therefore smaller market. If a glassworker was unable to sell relief carved glass wares, which he himself designed for sale, he would be at a much greater loss than if those same wares were facet cut.

Glassblowers could not work every day. A problem with primitive glass furnaces found in modern developing countries is that they become damaged if used on consecutive days, as they need sufficient time to cool off.\textsuperscript{136} Roman furnaces would have faced the same problem. Even though the usage of these furnaces was limited to every other day, scholars believe that they would have required near-annual repairs.\textsuperscript{137} For this reason, in addition to avoid the troubles of limited space that arise when blowers share a single furnace, every Roman glass factory that archaeologists have discovered has contained multiple furnaces.\textsuperscript{138}

General estimates as to how many days an ancient glassblower worked per year vary between 220 to 290 days for those working in temperate climates such as Rome to just 110 days.

\textsuperscript{136} Stern, “Roman Glassblowing in Cultural Contexts,” 455.
\textsuperscript{137} Stern, “Roman Glassblowing in Cultural Contexts,” 455.
\textsuperscript{138} The need to repair furnaces after continuous use might also explain why the Roman glass factories were scrapped after creating a single batch. The prolonged exposure to heat probably damaged the building so severely that the workers found it easier to build a new factory furnace than to repair the old one.

Glassblowers often have to reheat the glass several times during the process. Because the single door of the furnace is narrow (wider or additional doors would reduce insulation), Stern imagines glassblowers would find their job both more difficult and inconvenient if they had to share their furnace with other workers.
for glassblowers in the southeastern regions of Egypt and the Levant. Heat was a problem which limited the work of all glassworkers, especially those in Egypt and Levant. Even in modern glass workshops, despite having the advantages of space fans and central air conditioning, glassblowers can feel uncomfortably hot. Without those modern advantages, ancient glass workers had to plan their work schedule around the seasons. For most of the empire, craftsmen would cease their production of glass wares during the summer; while Egypt and the Levant glassworkers may have only worked in the winter (hence the reason scholars believed they only worked about 110 days).

Even during the winter when the heat of the workshop was most bearable, the heat remained a health hazard for the workers. As glass only reaches a molten state at temperatures over 1000 °C, glassblowers could receive a burn or heat rash just from prolonged exposure to the heat radiating from the molten glass. Dehydration was another heat-related concern the glassblowers faced. These problems were easily preventable if the glassblower remained vigilant of his own symptoms; respiratory problems, however, were practically unavoidable. At the basic level, constant fires meant that the workers constantly inhaled smoke. In addition, continuous exposure to gaseous silica will also negatively affect respiratory health. Modern glassworkers minimize this risk by insuring their workshop has proper ventilation, but ancient glassworkers were probably ignorant to the damage this caused.

An additional health hazard that ancient glassblowers faced stems from the physical side of the craft. The use of heavy iron rods meant that the glassblower was constantly doing a bit of

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139 Stern, “Roman Glassblowing in Cultural Context,” 456. Stern mentions that these work calendars assume that each glassworker took one out of every eight days off.


141 Ancient glass workshops may have been well ventilated regardless of whether the workers were concerned about poisonous gas, since they needed to manage the heat of their workspace without the aid of modern technology.
heavy lifting, putting strain on the same muscles for prolonged hours. While modern science informs today’s glassblowers of the proper stretches, postures, and messeges to ease the pain the work brings, the ancient workers largely lacked that knowledge. Perhaps, the muscular problems would have plagued the glassblower the worst of all. Unlike the respiratory and heat related problems, muscle fatigue was rather unavoidable by the nature of the job and had both long and short term consequences. But, most of the health hazards glassblowers faced were avoidable if they vigilantly paid attention to their condition and thus took breaks, cooled off, and drank water when they needed to. While glassblowers would face long term consequences from the physical labor and gasses, the damage did not prevent them from living long lives. The glassblower Julius Alexander in Lyons, for example, lived to the age of 75.

During the late Roman Empire, under the rule of Constantine, the prestige of glassblowers was elevated to a formal zenith under the Roman Empire. According to the Theodosian Codex, Constantine established a law that placed them in an equal rank to goldsmiths and artists. Craftsmen of this rank were excluded from military service, so that they might teach their skills to their children who were expected to take over the craft one day. Constantine also removed a tax on glassmakers which had crippled the Italian glassblowing industry, as the tax made Roman glassworkers struggle to compete with their Egyptian counterparts for nearly a century. The goal of Constantine’s laws is clear; he desired to halt a decline in skilled laborers among the Roman people. The success of this law as a means to the desired end, particularly in the West, is difficult to assess, as the Roman Empire officially fell just 150 years later. The law, nevertheless, serves as evidence to the modern scholar that

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142 Short-term problems include stiffness and soreness. Long term problems could include wrist arthritis and disfiguration of the back.
144 Theodosius, “IMPERATORI THEODOSIANI CODEX LIBER TERTIUS DECIMUS,” 13.4.2.
glassblowing remained a vital service to the Roman people from the craft’s inception until nearly the time of the Empire’s collapse.

Due to a lack of contemporary writing on the subject, piecing together the various aspects of a Roman glassblower’s life is a difficult task, but through examination of archaeological evidence, texts concerning glass, and modern glassblowers working under primitive conditions scholars can create a rough sketch of the glassblowers’ lives. Early glassblowers seem to have had the highest ceiling for success, as their products were new and exciting to Roman consumers. Thus the early glassblowers could sell their high quality wares at a high price. The glassblowers of the late empire, however, had the highest de jure social status as the Theodosian Codex placed glassblowers in the same category as goldsmiths and exempted them from military service.

When all the details are considered, perhaps the most significant point about Roman glassblowers is that, from the inception of the Roman glassblowing ca. 20 CE until the empire’s decline in the fifth century, glassblowers could live a comfortable life. For not only were glassblower’s products in regular demand due to their affordability and the skill required to shape glass, but also the job would not have a serious negative impact on their health so long as the glassblowers were mindful of their conditions. Furthermore, unlike sailors and soldiers, glassblowers could spend their whole career working near their hometown, in the vicinity of their friends and family.¹⁴⁵ Wellbeing is a difficult metric to measure, as the term is defined by more than just financial success, but glassblowers had an opportunity to achieve it.

¹⁴⁵ Theodosius, “IMPERATORI THEODOSIANI CODEX LIBER TERTIUS DECIMUS,” 13.4.2. The Theodosian codex actually implies in its wording “per singulas civitates through individual communities” that glassblowers were strongly connected to their community.
3.2 Glass Owners

If archaeologists were to uncover the early Empire’s glass factories, they might find that wealthy Romans, especially those of the senatorial class, held a big share in that business. Literary sources concerning the business of senators are not plentiful, as one scholar notes, “Since it was a part of upper-class etiquette for a rich man to pretend that he was not really well-to-do, the character and degree of senators’ involvement in money-making ventures usually resist precise documentation.”

Despite the Roman senators’ resistance to document their business practices, enough evidence has remained for historians to have discovered that the Nonii Asprentates established a mining industry in Hispania under Augustus, T. Statilius Taurus exported lumber from Dyrrachium (modern day Durrës, Albania) to Rome, and Cn. Domitius Afer ran a brick manufacturing industry which produced most of Italy’s bricks starting in the middle of the first century CE.

These examples show that Roman elite could control large, multi-provincial industries. More significantly, Roman elite often target essential industries producing raw/building materials (metal, wood, bricks) rather than final products (such as weapons or tools for cooking). The goal is not to state that the Roman elite never owned businesses that sold finished products, Statilius Taurus had many freedmen work in the construction industry (presumably to encourage the use of his wood), but rather to stress the desirability of investing in raw materials. The raw material industry is/was desirable since control over their distribution grants not only profit, but also power since slowing down their distribution to any particular person or area slows down their production of essential finished products. Since glass was utilized in every province of the

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147 D’Arms, *Commerce and Social Standing in Ancient Rome*, 155-156.
empire, but produced in only a few locations, glass production was probably a desirable industry for a Roman senator or eques to invest in.

This potential for profit is, perhaps, best found in the documentation and archaeological evidence of the money spent on the purchase of architectural glass (i.e. glass for windows and mosaics) because architectural glass often went towards public works, which are both in many cases better documented and often well preserved for modern study. For the construction of a public bathhouse in the small Egyptian town of Oxyrhyncus, Egypt 1320 talents were spent on windows for the warm baths and Rome’s Baths of Caracalla included 16,900 m² worth of glass mosaic pieces. Architectural glass was not necessarily a more profitable industry than glass manufactured for glassblowers to create wares; however, architectural glass is better suited for understanding the potential profit made by glass factory owners for two reasons. First, a shipment of glass made for blowing does not remain in one place after the craftsman works it; rather the craftsman sells it to his various consumers. Architectural glass, however, is designed to remain in its place and should remain there unless moved by natural disaster or looting/vandalism. Second, architectural glass is more commonly used for government projects than glass for creating wares. Therefore the receipts were sometimes public record, as in the case


The cost of mosaic tiles is impossible to accurately assess for two reasons. 1) The precise weight, a necessary value since glass was sold by weight, of the glass is unobtainable without knowing the volume. 2) The price of glass mosaic tiles, and whether the different colors had different prices, is unknown. Possibly, the price of mosaic tiles was similar to the price of window glass since neither type of glass needed to be perfectly transparent and they could both sold as sheets and then cut to size by the consumer. The main differences in how they are sold would probably come from thickness and color. If the assumption is made that the average mosaic tile was 1 cm, that the glass had an approximate density of 2.5 g/cm³ (this value is a little more than the density of modern soda lime glass to accommodate for the impurity of Roman glass), that one Roman pound is 329 g and the price of mosaic glass was equivalent to the price of second quality windowed glass as mentioned in the Price Edict, the cost of the mosaic glass used in the Baths of Caracalla is approximately 7,710,000 denarii.


“Physical Properties,” University of Delaware Department of Chemistry and Biochemistry, accessed March 7, 2018, https://www1.udel.edu/chem/GlassShop/PhysicalProperties.htm#SodaLime
of Oxyrhyncus. Third, these projects are examples of when large quantities of glass were bought at once, which is easier to assess for estimating a profit than compiling multiple purchases from a single year. Ultimately, public projects which utilized architectural glass (particularly bathhouses), reveal that glass manufacturing held a great potential for profit during the second and third centuries CE. While the manufacturing of glass for wares must have also been profitable (otherwise the factories would have died out after a short time), archaeologists find it difficult to measure just how profitable the manufacturing of glass for wares was since this was used on a multitude of small projects rather than a few large ones.

One problem the Romans of the equites and senatorial classes needed to overcome to invest in glass production was the emperor’s laws regarding Egypt. Egypt was the emperor’s personal province, meaning all the taxes went directly to him, no senator could create a business in the area, and many were not allowed into the province without his permission. Not only do the laws of Egypt mean that legally Alexandrian glass had to run independently of any Roman senator, but the laws regarding Egypt also would have created trouble for a Roman running a Judean glass factory too. Because Judean glass factories got their soda from Egypt, any Roman that controlled a Judean glass factory would have needed a third party to fetch the soda. For the Roman elite the laws restricting their access to Egypt would probably have been more of a minor nuisance than a major hurdle. Roman senators, whose wealth was somewhat restricted by law, often employed their freed slaves to run certain businesses in their stead. The relationship was such that the freedman could enjoy much of the wealth the business provided with the knowledge that his status was still tied to his former master. And since these freedmen were not

149 Charlesworth, M.P., Trade Routes and Commerce of the Roman Empire, 17.
150 D’Arms, Commerce and Social Standing, 42-46.
One of the most famous restrictions placed on Roman senators, which the freedmen avoided, was a limitation on the number of ships senators could own.
considered socially elite, they avoided many of the regulations that their benefactor would face. Through such means, the Roman senators could avoid the regulations placed upon (such as travel to Egypt) them and create additional investments through their dependents.\(^{151}\)

A major problem that archaeologists face when investigating the possibility of Roman ownership of a Judean glass is a lack of seals. When no literary sources are available, archaeologists have attempted to track the businesses of Roman elites by examining seals found on certain artifacts such as anchors, metal bars, and bricks.\(^{152}\) The problem is that archaeologists are unlikely to find any raw glass products with seals on them. The owner of a metal refinery might place a seal on his metal bars to give his assurance of weight and/or purity, artists may have put seals on their glassware to assure artistic authenticity, and a seal on a ship’s anchor could either be an assurance of functionality or a declaration of ownership. Because raw glass was often cut up to redistribute weight aboard a ship, glass manufactures had no motivation to market their products in bars of standard weight. Furthermore, the translucent nature of glass would make many impurities apparent and any seal guaranteeing functionality would disappear upon its first use. As a result, barring the discovery of an ancient receipt, archaeologist will probably never discover who owned the glass factories.

\(^{151}\) D’Arms, *Commerce and Social Standing*, 44. D’Arms notes that numerous freedmen were in port cities (vital for business due to Roman industries’ reliance on sea trade) such as Capua, Puteoli, Delos, and Ostia, but does not mention freedmen running businesses in locations that forbade their former masters’ from entering. But the usage of freedmen by their former masters as a means of circumventing the restriction on trade ships suggests that Roman senators could have sent their freedmen to Egypt.

\(^{152}\) D’Arms, *Commerce and Social Standing in Ancient Rome*, 155-156.
Conclusion

Through the study of Roman glass, we may better understand the impact of new technology on the ancient world. Shortly after Judean and/or Syrian artisans introduced glassblowing to the Roman Empire ca. 20 CE, the Romans gained access to low cost glass wares. As a result, glass became a major part of Roman material culture starting in the early half of the first century CE through the fifth century CE. The introduction of glass into Roman material culture resulted in the creation of several new economic opportunities. Glassblowers established workshops in a variety of locations, stonecutters could find additional work by creating luxury glass wares, and workers in Egypt and Judea created factories that supplied the entire Empire with glass produced in bulk. 153

The invention of mold-blown glass in the middle of the first century CE reveals the long and short term changes that new technology causes in the social structure as well. In the short term, the more skilled artisans, such as Ennion, earned renown for themselves. Over time, however, the desire for more transparent glass than was possible through the mold blown method led to a preference towards openly worked glass wares. The exemption from military service Constantine gave to glassblowers in the fourth century CE suggests that society eventually recognized glassblowers as respectable and valued community members. 154 Thus the study of glassblowing with a mold suggests that those who were skilled at utilizing new technologies found the greatest success in the short term, but found better formal recognition in the long term.

153 Some of those workshop locations were in modern day Sardis, Puteoli, London, Lyons, and Tel Yoqne’am.
154 Theodosius, Theodosian Codex. 13.4.2.
While my research has made in-roads into this discussion, the study of the impact of other inventions in the ancient world, however, is necessary before making a larger conclusion.

Through the study of Roman glass and glassblowing we can obtain a better understanding of the full impact that new technology had on ancient society, both socially and economically. Furthermore, the lessons learned concerning the impact on glass in ancient society can help shape the way we think about those other aspects of society. For example, the change in the social standing of glassblowers over time suggests that Roman social status had a degree of fluidity even for workers.

By contrast, the empire’s continued reliance on Judea and Egypt for most of the glass production is an example of a static aspect of Roman society, but the analysis of why the glass factories remained in Judea and Egypt reveals that tradition was not what restricted factories to this region, but that the decision was strategic as establishing glass factories in other locations would face numerous obstacles. A future study could examine the earliest finds of blown glass in the provinces of the Western Mediterranean and compare their approximate dates and quantity to the earliest blown glass in Italy to gain a better understanding of how Rome traded and communicated with its Eastern provinces.

If the dates of the earliest blown glass wares in major ancient Roman cities of the Western Empire are even, the data would suggest that Judea and Syria traded generally traded directly with Rome’s Western territories. If the early, blown wares of Rome, however, are generally found to be earlier and in larger quantity than the earliest wares of Gaul, Germania, or Hispania, then the data suggests that the Judeans and Syrians traded their wares primarily with Italy, who then moved their products throughout the Western Empire. Thus scholars must
continue to study Roman glass holistically not just for the sake of understanding Roman glass, but to also as a means to test and examine theories on other aspects of Roman life.
Figures

Figure 1: Canosa Skyphos from the Louvre


This skyphos (a type of traditional Greek cup) is one of several pieces that make up the Canosa group of Hellenistic glass wares.

A collection of wares from the Canosa group held in a private collection. On the left is a colorless plate with gilded decorations, the center is a light green, footed bowl, and the left is a light green dish with painted decorations.


http://library.artstor.org.resources.library.brandeis.edu/asset/SS7731421_7731421_11656264.

[Link to the original image](http://library.artstor.org/resources.library.brandeis.edu/asset/ARTSTOR_103_41822003764006).
Figure 7: Jalame's Glass Production Furnace

Glass Production Furnaces, Museum HaMizgaga, Tel Dor, Israel. IAA reg. number: 2016-1834.

The author is responsible for taking this photo.
Figure 9: Eretz Yisrael Museum’s Glass Jug Signed by Ennion

Figure 10: MET Museum's Cup Signed by Ennion


http://library.artstor.org.resources.library.brandeis.edu/asset/MMA_IAP_10311978497.
Figure 11: Corning Museum’s Cup Signed by Ennion

Figure 12: Museo Archeologico Nazionale di Adria's Cup Signed by Ennion

Ennion. c. 1-50 CE. *Two-Handled Cup Signed by Ennion*. glass. Place: Museo Archeologico Nazionale di Adria, Adria, Italy.

http://library.artstor.org.resources.library.brandeis.edu/asset/SCALA_ARCHIVES_10310474785
A wall painting of cupids performing various Roman crafts from the House of the Vetti. The glass blower is third cupid from the left. Located in Vetti VI 15, 1.27 inside the north wall of a triclinium.

Photo Credit: Dr. Ann Koloski-Ostrow
Figure 14: Lycurgus Cup


Figure 14 shows two pictures of the Lycurgus Cup to demonstrate its dichroic nature. The image on the left shows the cup reflecting light and the image on the right shows the cup in translucent light. N.B. These images are not identically scaled.
Figure 15: Portland Vase

1-25 CE. *Portland Vase*. Place: British Museum. 1945,0927.1

http://www.britishmuseum.org/research/collection_online/collection_object_details.aspx?objectId=466190&partId=1
Beaker with Faceted Decoration. 75-125 CE. Place: Corning Museum of Glass. 59.1.129.

http://library.artstor.org.resources.library.brandeis.edu/asset/AWSS35953_35953_39620503.
Map of sea trade routes in the Roman Empire. Of particular importance to this report are the twenty day journey from Rome to Alexandria and the thirty day journey from Byzantium to Alexandria.

From: Charlesworth, *Trade Routes and Commerce of the Roman Empire*, i-ii.


Charlesworth, M. P. *Trade Routes and Commerce of the Roman Empire*. Chicago: Ares Publishers Inc. 1926.


“Glass Production Furnaces.” Tel Dor. HaMizgaga Museum. IAA reg. number: 2016-1834.


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Selected Additional Works Consulted


