Detail from a relief of the Battle of Actium (31 BC). The ships have been rendered both with accurate and fanciful, perhaps symbolic, details.

RECREATING AN ANCIENT NAVAL RAM

BEESWAX TO BRONZE

By Stephen DeCasien

The naval ram, in its three-bladed form, was the predominant weapon of ancient navies used throughout the Mediterranean to break, breach, or destroy enemy warships for almost a thousand years. This type of ram has only been attested archaeologically in the last few decades, and the majority were found far more recently. But how exactly were these complex bronze-cast rams made?

The Greek term *embolos*, referring to a ram, was first mentioned by the Greek poet Hipponax in the mid- to late-sixth century BC (Hipponax, fr. 29). Its use in naval combat was first described by Herodotus at the Battle of Alalia, off Corsica, around 540–535 (Herodotus, 1.166). It is unclear if both Hipponax and Herodotus are referring to the ram in its three-bladed form. Textual, iconographical, and archaeological evidence, however, indicates that the this style of ram became the standard during the Greco-Persian Wars and into the early years of the Peloponnesian War. The last author to directly mention the use of rams was Procopius at the Battle of Sena Gallica in AD 551 (*De bello Gothico* 8.23.31–39).

Egadi Ram 8, with helmet decoration and a Latin inscription on the cowl: *L QVINCTIO C F QVAISTOR PROBAVET* (approved by the quaestor L. Quinctius son of Caius).
© Dan Diffendale / Flickr

The complex nature of naval ram construction and the process of casting rams has been a matter of scholarly debate since the discovery of the Athlit ram off the coast of Israel in the 1980s. Subsequent archaeological discoveries and reexaminations of ancient texts have only added to the question of how the ancients built such intricate and superb weapons. To better understand this significant naval weapon, I proposed an experimental archaeology project to recreate a trireme-sized three-bladed waterline ram using ancient methods. From 2021 to 2023, Dr. Christopher Dostal, Glenn Grieco, and I conducted the Ancient Naval Ram Casting Project at Texas A&M University. The project's steps consisted of building the front of a trireme warship, crafting a ram model in beeswax, and then direct lost-wax casting the model in bronze. This is the first bronze ram cast in over 1500 years and the only ram housed outside the Mediterranean basin. This reconstruction has provided information on the time, manpower, and materials needed to create ancient naval rams as well as the socioeconomic implications of building ancient navies.

A short history of naval rams

In essence, a naval ram was a penetrating weapon, placed at the bow of an ancient warship near the waterline. They were used to strike other warships in both offensive and de-

fensive naval manoeuvres causing damage that could lead to an enemy's warship being sunk, swamped, or destroyed. The ram developed from an extension of the timbers that made up the bow of a warship in combination with a metal covering. The development of the ram likely had its origins in the earliest bow projections in the eastern Mediterranean followed by a few hundred years of various ram innovations or so-called "proto-rams". This proto-ram period dating from roughly 850 to 540 BC, saw the invention of ram-like projections at the warship's bow, such as bronze coverings, sheathing, boar's heads, and various ram-like structures lacking three blades.
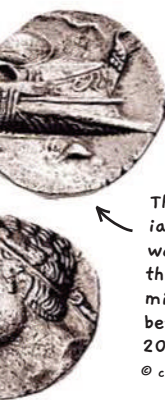
By the mid-sixth to early fifth centuries BC, the ram had developed to its so-called "final" form, referred to in modern terms as the three-bladed waterline ram, characterized by its three-finned profile. The ram's three-bladed design could penetrate the hull while separating the planks of an enemy's warship along the horizontal axis. Three-bladed waterline rams, like those built during the Hellenistic and later Roman Republican eras, were used to break through harbor siege defenses and even ram enemy warships head-on, striking the frontal face of a warship or directly ram to ram. The ram was not immediately adopted by all navies in the Mediterranean when it was invented. It became standard on nearly every warship following the Peloponnesian War, however. The ram was used by most navies in the Classical Greek, Hellenistic, Roman Republic, and Roman Imperial periods.

The decline of the naval ram began at the Battle of Actium in 31 BC, fought by Octavian and Marcus Agrippa against the combined fleet of Mark Antony and Cleopatra. This engagement was the last great naval battle of antiquity which saw the use of ramming tactics, the deployment of massive warships, and the use of large Hellenistic style naval rams. After the Battle of Actium, the Romans controlled the entire Mediterranean basin with no direct naval competitors left to contest their control of the sea. As the Roman

navy changed its purpose from fighting other navies to protecting grain ships and patrolling the Rhine and Danube rivers, the use for naval rams steadily declined. By the third and into the fifth centuries AD, the Roman navy ceased to exist with only the eastern part of the Roman Empire fielding a semi-effective fleet. Ultimately, building naval rams and warships became costly, time-consuming, and the techniques of building ships changed.

The archaeology of naval rams

Despite the thousands of warships that were built and hundreds of battles fought in antiquity, no single ramming warship has ever been discovered intact. The only physical evidence directly related to ancient warships that is

(Top) Assyrian gypsum wall-panel relief of a Phoenician ship with proto-ram (apparently lashed to the hull — if the incisions represent rope). Now in the British Museum.
© Livius.org

(Bottom) A monument to a naval victory in the agora of Cyrene, Libya. Built by the Ptolemies in the third century BC with the prow of a trireme mounted by Victory.
© MM / Wikimedia Commons

The Piraeus Ram, probably dated to the fourth century BC — now in the Piraeus Archaeological Museum, Greece.
© Stephen DeCasien

available to archaeologists is the ram. Today, approximately thirty-six ram-like artifacts have been found. Of these, thirty-one are considered three-bladed waterline rams. The first three-bladed waterline ram to be discovered was the Athlit ram, found off the coast of Athlit, Israel in the 1980s. This was the first ram to be studied and published by archaeologists and historians. The bronze Athlit ram with its intact bow timbers indicated that, by the Hellenistic period, the ram served as a central part in the warship's construction. Further examination of this ram also suggested that it was cast in bronze to the highest standards using the sand casting or lost-wax casting method.

Since the recovery of the ram from Athlit, numerous rams have been discovered on the seafloor. Each subsequent discovery has helped scholars gain deeper insight into naval ram production and naval warfare from the Classical Greek to early Roman Imperial period. Of the thirty-one three-bladed waterline rams in the archaeological record, twenty-six have been recovered at the Battle of the Egadi Islands site off the coast of western Sicily. The Battle of the Egadi Islands, which occurred on March 10, 241 BC, between the Mediterranean naval powers of Rome and Carthage, is the only known ancient naval battle site ever discovered. According to the ancient historian Polybius, the Carthaginian warships and crewmen that fought in the battle were inferior to the well-trained Roman fleet that faced them (Polybius, 1.61). The engagement that took place was decisive, with the Romans destroying so many warships that the Carthaginians had to make peace, ending the First Punic War.

Other waterline rams recovered include those in Bremerhaven (Germany),

Roman relief of a ship with clearly depicted three-bladed ram from the Augustan era. Now in the Palatine Museum, Rome.
© Sailko / Wikimedia Commons

Piraeus (Greece), Acqualadroni (Italy), Follonica (Italy), and a supposed Mithridatic forefoot ram discovered in the Black Sea. Proembolia, or 'subsidiary,' rams like those in Belgammel (Libya) and Turin (Italy) and an unpublished Imperial Roman era subsidiary ram have also been found. Lastly, there is the Kanellopoulos (Greece) ram which has no accurate date but might be a highly stylistic boar's head ram. There is also important indirect archaeological evidence for rams at Nikopolis, Greece where Octavian constructed two naval monuments to commemorate his victory in the Actian War. At these monuments, Octavian displayed the captured naval spoils of Antony and Cleopatra's fleet from the Battle of Actium in 31 BC. Of the naval spoils, around 33 to 35 naval rams were placed in the retaining wall of the main victory monument. These rams came from polyreme warships varying in classification from a *penteres* (or 'five') to a *dekeres* (or 'ten'). Although none of these rams have survived, their existence is evidenced by the rock cuttings, or sockets, through which they were once attached to the retaining wall of the monument. These sockets indicate the possible range and sizes of the largest rams built in antiquity.

## The ancient naval ram casting project

Centering on the archaeological evidence, the project to cast a full-scale trireme-sized ram using ancient methods started with an analysis of all known rams. By examining archaeologically attested rams like the Athlit, Acqualadroni, and Egadi rams, it can be concluded that no two rams were identical in size, weight, and dimensions even within rams of the same warship class. This was due to the complex nature of how the ancients produced these weapons and the warships they were placed on. Of course, many rams had a common overall structure that included three main sections: cowl (top), driving center with a three-blade design (middle), and bottom plate (bottom).

Prior scholarship argued that rams might have been cast in the sand or lost-wax casting methods. These methods differ in the cast they produce, and each has their own complex processes that are unknown in relation to the production of naval rams. However, it is known that the ancients used the lost-wax casting method
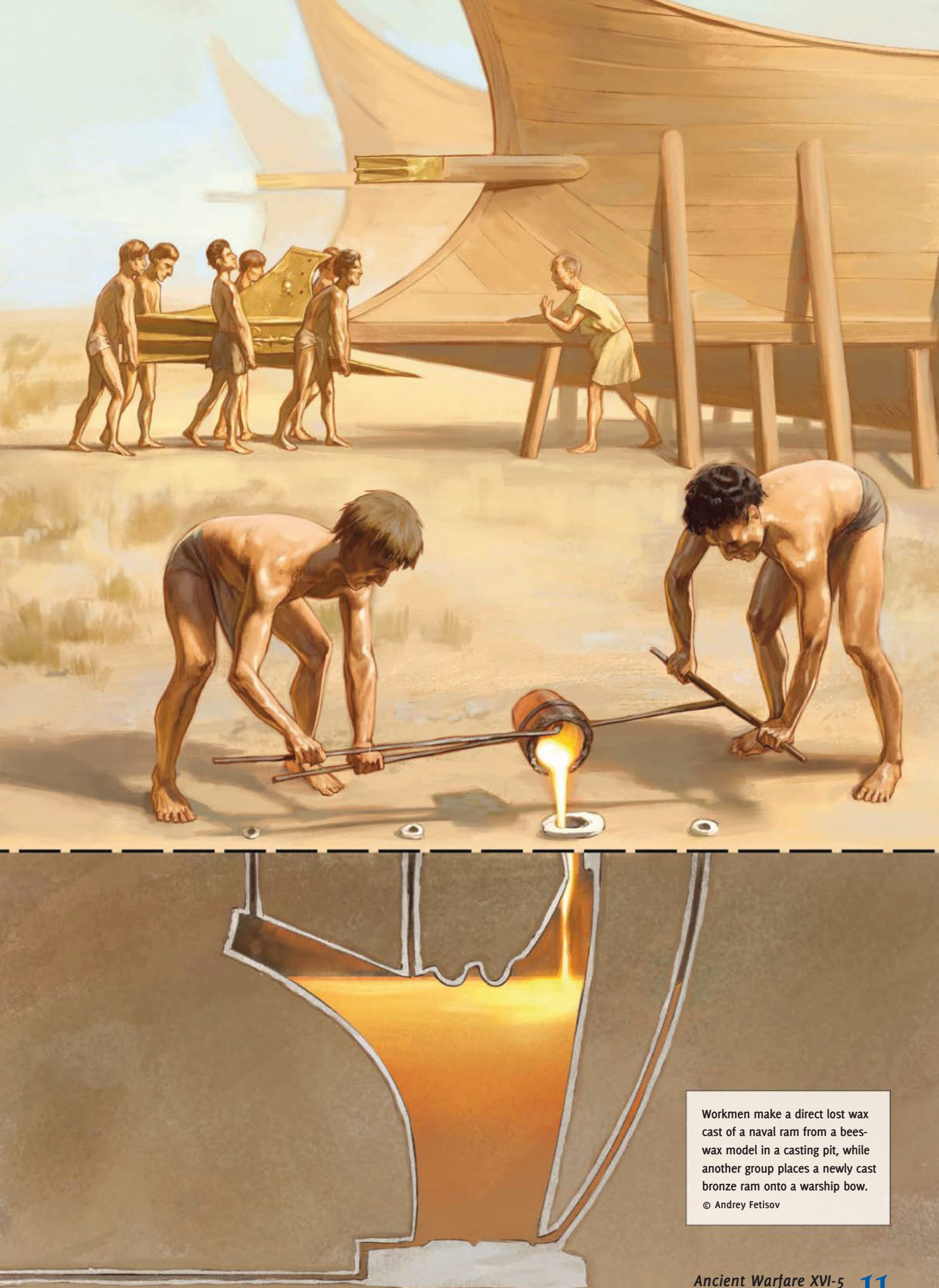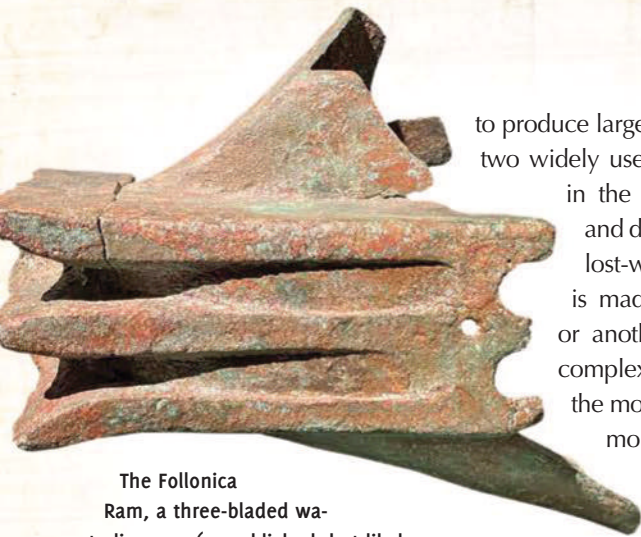
Workmen make a direct lost wax cast of a naval ram from a beeswax model in a casting pit, while another group places a newly cast bronze ram onto a warship bow.
© Andrey Fetisov

The Follonica Ram, a three-bladed waterline ram (unpublished, but likely Roman). Currently housed at the Museum of the Ship in Pisa, Italy.
© Stephen DeCasien

to produce large bronze objects. There were two widely used lost-wax casting methods in the ancient world, the indirect and direct methods. In the indirect lost-wax casting method, a model is made of beeswax, wood, clay, or another appropriate material. A complex mold is then built around the model and left to dry. Once the mold is dry, it is opened to release the model. The mold is then reconstructed and filled with beeswax to create an accurate replica of the original model. This secondary model is then invested and cast in bronze.

In the direct lost-wax casting method, a model is made of beeswax and then invested directly in a clay mold. This mold is then baked in a casting pit to harden the mold and melt the beeswax. Bronze is then poured into the empty space left in the mold. In this method the original wax model is lost along with its mold and therefore only one bronze cast can be created from this process. The direct-lost wax method was likely used to cast ancient naval rams as it provided greater flexibility in the construction of the model and design of the ram itself onto the warship bow and explains the difference of ram dimensions within the same warship class.

Based on this information, the project to recreate a trireme-sized naval ram consisted of three major steps to replicate the process: false bow construction, beeswax model creation, and direct lost-wax casting. The first step of the project was to construct a trireme-sized ramming bow to serve as the beeswax model's core. The bow was based on a culmination of archaeologically attested ramming bows such as those found inside the Acqualadroni, Athlit, and Egadi rams. The bow consisted of six major timbers: the ramming timber, port and starboard wales, keel, chock, and stem. The second step of the project involved the use of beeswax to fashion a model of a trireme-sized ram onto the false bow. The beeswax model was made using various ancient methods including coating the bow in pitch to hold the beeswax to the surface of the bow; melting the beeswax into blocks, sheets, and semi-hot "half-blocks"; using pre-made molds and handmade sheets for constructing the ram's body; and sculpting raised and incised inscriptions using metal tools.

The last step was to cast the beeswax model which took place at the Pyrology Foundry and Studio in Bastrop, Texas. The foundry used a similar method to the one used in antiquity to cast the model. Several sprues and channels were added to the beeswax model to allow the molten bronze to be poured in for casting. The model was then placed in a casting slurry which created a protective shell around the model. This shell was then heated to melt the beeswax out of the model, leaving the shell empty with the sprues and channels still intact. The molten bronze was then poured in the shell, filling the areas where beeswax once was. The bronze was then allowed to cool and then the shell was broken open leaving an exact replica of the beeswax model in bronze behind. Overall, the experimental ram weighs 160 kilograms with a maximum height of 67 cm, its narrowest section at 38 cm, and a total length of around 73 cm.

What have we learned?

This experimental archaeology project informs us that all ancient naval rams were made using the direct lost-wax casting method as opposed to the indirect lost-wax or sand-casting methods. Based on these findings concerning casting, it is now clear that

Top left — the false ramming bow; top right — a beeswax ram model; bottom left — casting the ram in bronze. Bottom right — Ancient Naval Ram Casting team members (left to right Dr. Christopher Dostal, Stephen DeCasien, Glenn Grieco)
© Stephen DeCasien

This small fragment of bronze is all that survives of the actual rams that once adorned the monument to the Battle of Actium in Nicopolis.
© Dan Diffendale / Flickr
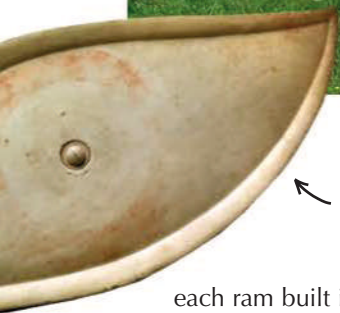
A marble eye ornament probably meant to decorate the prow of a trireme as an apotropaic device to ward off evil.
© Mark Cartwright / ancient.eu

each ram built in antiquity was uniquely built for each warship. No two rams were identical, and rams were never reused for another warship. In terms of material, we can now safely assume that a trireme-sized naval ram required an average of 30 to 50 pounds (13.5-25kg) of beeswax to create a model for casting, meaning that any ancient civilization that wanted to build a fleet required an extensive amount, access, and trade in beeswax as well as bronze, pitch, and wood.

It would take as many as three to four skilled craftsmen one to four working days to build one beeswax model, depending on its size and complexity, indicating that ancient navies and rams could be built relatively quickly and efficiently if the materials and manpower were accessible. This suggests that rams were likely only used by organized ancient states.

The entire reconstruction process confirmed that rams must have been expensive, time consuming to build, and crafted to the highest standards in antiquity. The process also reaffirmed the idea that rams were part of an "industrialized" weapon system which included the warship and ram itself. Future research may include testing the ram to understand its ramming capabilities and strength against replica ancient warships. For now, the so-called "DeCasien" naval ram, resides in the Conservation Laboratory in the Anthropology Department on Texas A&M University Campus in College Station, Texas. ᴀᴡ

Stephen DeCasien is a PhD candidate studying Nautical Archaeology at Texas A&M University with a special focus on Greek and Roman naval warfare, warships, and naval rams.

FURTHER READING

- DeCasien, S. (2023). 'Ancient Naval Ram Casting Project (2021-present)' *CMAC News and Reports* 6: 4-6.
- Murray, W.M. (2012). *The Age of Titans: The Rise and Fall of the Great Hellenistic Navies*. Oxford: Oxford University Press.
- Oron, A. (2006). 'The Athlit Ram Bronze Casting Reconsidered: Scientific and Technical Re-examination' *Journal of Archaeological Science* 33: 63-76.

Remains of the Victory Monument to Actium in Nicopolis, Greece. At this site, thirty-six rams from captured ships were set into the base of the monument in order of size. Other than a single fragment, the rams do not survive, but their precisely cut mountings give an excellent indication of ram measurements.
© Vassiliki Feidopoulou / Wikimedia Commons

A marble relief ram from Ostia Antiqua, Italy. The three-bladed ram is depicted in detailed manner, taking 'blade' quite literally.
© Stephen DeCasien