2

Frontal Ramming

STRUCTURAL CONSIDERATIONS

The Evidence of the Athlit Ram

On November 11, 1980, Yehoshua Ramon spotted the exposed corner of a large bronze warship ram while snorkeling near Athlit castle, just south of Haifa, after a storm. Although he suspected his find was important, Ramon could not foresee how important his discovery would become. In time, the Athlit ram would teach us how ancient galleys functioned as ramming machines. Two weeks after its discovery, however, when the ram was finally pulled from the sea, the main concerns were more pragmatic and focused on issues like the artifact's protection and conservation. It would be some time before the secrets of the Athlit ram were fully revealed.

Now, some three decades later, it is far easier to see how much we have learned. For example, symbols on the weapon suggest that it was cast on Cyprus for the Ptolemaic fleet at the end of the third century or during the first generation of the second century.[1] The ram, which is completely intact, measures 2.26 m. in length, 95 cm. in height, and 76 cm. in width from starboard to port trough ear (for the terms, see Fig. 2.1). It weighs 465 kg. and is made of resilient, high grade bronze with a copper to tin ratio of roughly 9:1.[2] Although it was initially thought to belong to a heavy galley, much larger

1. For a full discussion of the Athlit ram, see Casson and Steffy 1991. Coin evidence suggests the ram was cast on Cyprus at Kition or Paphos between 204 and 164 BCE, that is, during the reign of Ptolemy V Epiphanes or Ptolemy VI Philometor; see Murray 1991.

2. According to Oron 2006, 69, the alloy exhibits "a major element distribution with mean values of 90.4% copper and 9.78% tin, with virtually no lead." A 9:1 copper to tin ratio is most suitable for a weapon like a warship ram due to the alloy's high resistance to wear, high hardness, and moderate strength; see Eisenberg 1991, 41.

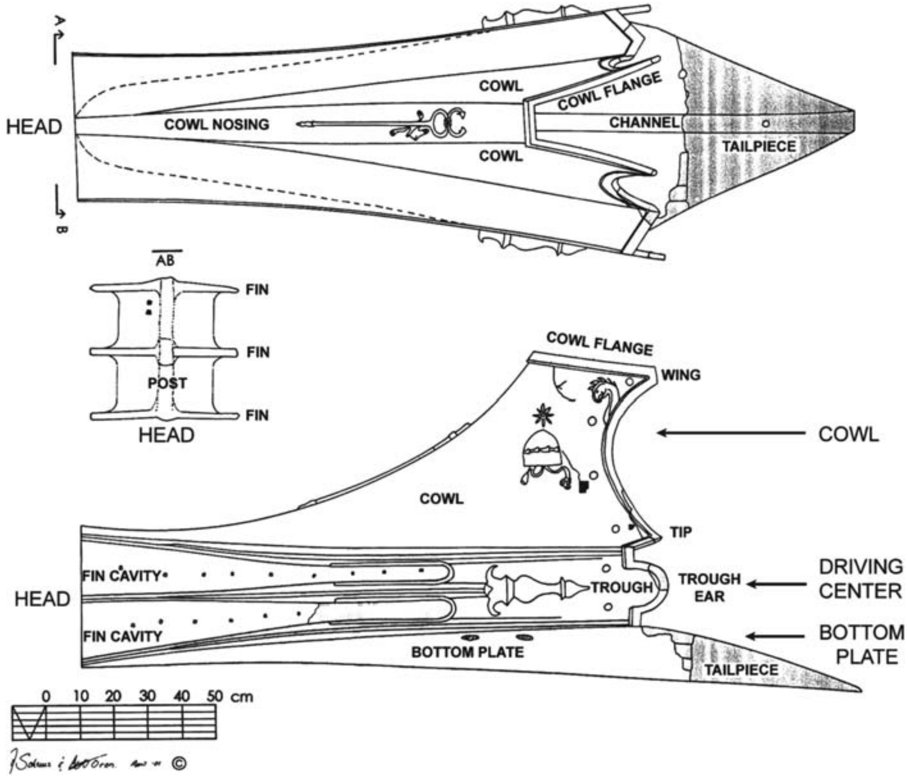

FIGURE 2.1 The Athlit ram. Adapted from line drawing by A. Oron and A. Shreur.

than a "three," the ram's size and weight now suggest that it came from a relatively small capital ship, by Hellenistic standards, most likely from a "four."[3] The ram was cast with a hollow interior that fit closely around the bow timbers of its warship. Fortunately for us, a thick layer of sediment covered this weapon soon after its loss and preserved the wood inside from decay, so that when the weapon was found, it still contained all 16 bow timbers in their original configurations. Subsequent study of this amazing artifact has revealed the extreme care with which it was made and fitted to its warship.

The Wood Inside the Ram

When the ram was pulled from the sea, it was a 600 kilo unit of waterlogged wood and metal that was extremely difficult to manipulate. Because the wood had become concreted to the sides of the bronze

3. For early estimates of its class, see Basch 1982; Frost 1982; Pomey 1983; and Morrison 1984, 217.

casting, the process of extraction proceeded slowly and carefully over a period of more than 18 months. The work was carried out by J. Richard Steffy and a team of Israeli conservators who carefully measured, sectioned, and removed the structural timbers that made up the ram's interior.[4] Ultimately, in 1991, Steffy published a full set of drawings plus a meticulous description of the ram's structure, the step-by-step process by which the ship's bow was constructed, and the reasons behind its careful design.[5]

Since the ram marks the locus of the collision between attacking and attacked vessels, the weapon must be designed to withstand the force that it generates. This was partly achieved by the support timbers inside the weapon and partly by the integrity of the ram's cast. When both worked in harmony, an attacking vessel was able to deliver a damaging blow and yet remain undamaged in the process. The architects of the Athlit ship accomplished this tricky feat by utilizing the entire bottom of the vessel as much as the ram, which served to disperse the intense forces generated at the ram's head to the ship's hull. The surface designed to withstand the collision was an area that measured less than half a square meter and was comprised of three horizontal fins, each 2 cm. thick, 44 cm. wide, and connected at their midpoints by a vertical post that was 41 cm. high (Fig. 2.1). The real power was generated by the momentum of the heavy hull, which transferred its force to the ram "by a pair of thick wales and bottom planking, reinforced at their junction by a ramming timber."[6] The shock from the blow was first relayed to the main waterline wales and through them to the ramming timber—made from a great log specially shaped into five different faces that was squeezed between both wales and notched to touch the keel and bottom planks. These bottom timbers were all rigidly interconnected by mortise and tenon joinery secured by thick oak pegs through which long copper nails were driven (Fig. 2.2). This careful construction insured that the forces of the collision were transferred from the ram—literally the ship's warhead—to the entire bottom of the ship's hull where they were absorbed harmlessly. With such a design, the Athlit ship was able to deliver powerful ramming blows and survive the collisions undamaged.

4. For the process of wood removal, see Steffy 1991, 6–11.

5. Steffy 1991, 6–39; see also Steffy 1994, 59–62.

6. Steffy 1994, 59, compared the ram to the head of a hammer.

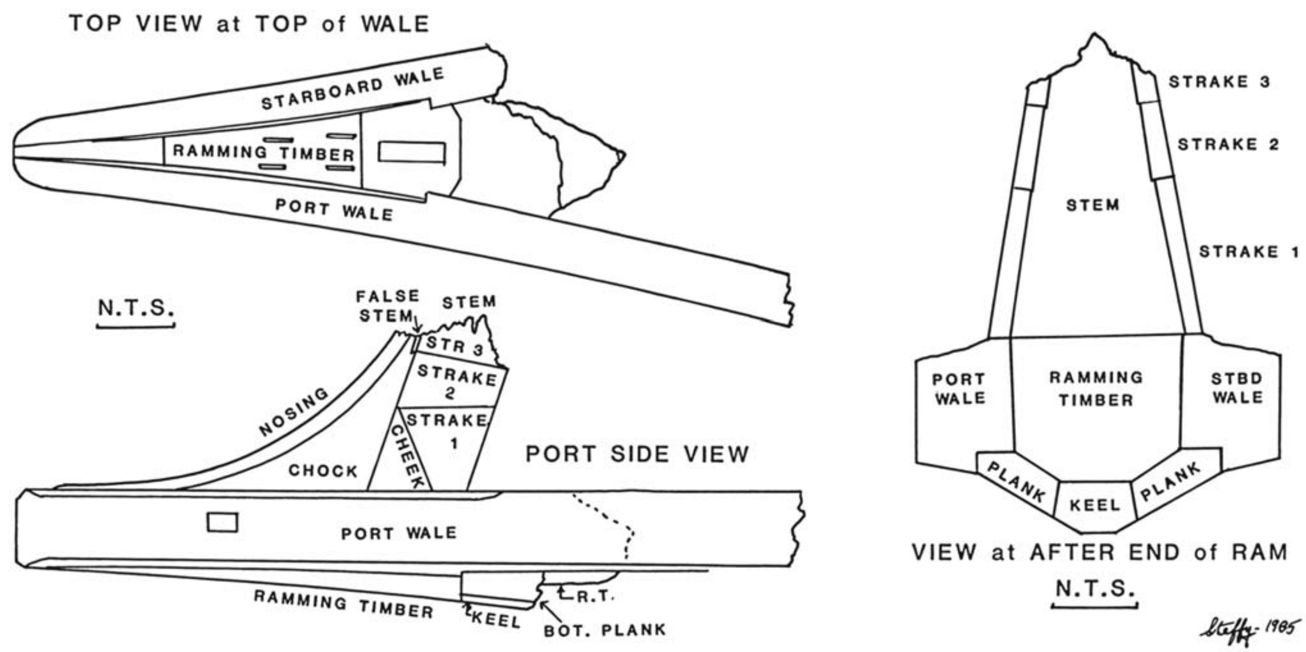

FIGURE 2.2 Bow structure inside the Athlit ram. Line drawing by J. Richard Steffy. Copyright © 1991, Texas A & M University Press.

The Ram's Casting

While Steffy and his colleagues struggled with the wood inside the ram, Elisha Linder, the director of the research team, asked Shlomo Eisenberg to x-ray the casting and look for internal fasteners. Following two unsuccessful attempts, the ram was transported to the Soreq Nuclear Research Center in Yavne, Israel, where a successful series of radiographs were finally recorded.[7] Although no fasteners were found, Eisenberg was unprepared for what the images revealed about the structure of the ram's bronze. At first, he was surprised to see no obvious joins, except for a small section of the bottom plate (see Fig. 2.1, "tailpiece"). Most of what we know about large-scale Greek and Roman casting derives from sculptural bronzes, that is, from statues. Generally speaking, these statues are cast in pieces and then joined together by solder or by mechanical joins hidden behind drapery, belts, straps, or other kinds of modeled flanges.[8] The Athlit ram, on the other hand, was apparently cast in a single pour, which represents a considerable technological achievement. According to Eisenberg, "Even today, casting the ram in such a manner would be considered a unique accomplishment."[9]

The images also revealed the cast to be extremely sound, particularly at the ramming head and along the driving center (Fig. 2.1), where the radiographs revealed no porosity flaws, gas holes, or fractures caused by shrinkage of the cooling metal after it was poured into the mold. Eisenberg, a professional metallurgist trained in failure analysis, described the metal's quality at the ramming head as "aircraft grade" when he showed me the radiographs in 1997.[10] Since then, Israeli conservator Asaf Oron has demonstrated convincingly that the ram was cast according to the lost wax process, a well-attested technique for producing hollow bronzes during the Classical and Hellenistic periods.[11]

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7. See Linder 1991, 5; and Breitman et al. 1991, 83.

8. See Mattusch 1996, 24.

9. Eisenberg 1991, 40.

10. Cf. Eisenberg 1991, esp. 43–44. Eisenberg proposed that the weapon was cast horizontally on its side in a two-part sandbox, a technique previously undocumented before the late Medieval period; see Maryon and Penderleith 1954, 628; Maryon 1957, 475; and Oron 2006, 63, 71–72.

11. Oron 2006. Oron's full reassessment of the ram, conducted in 2001, formed the basis for his master's thesis (= Oron 2001) available online by courtesy of the Nautical Archaeology Program at Texas A&M University (http://nautarch.tamu.edu/pdf-files/Oron-MA2001.pdf). For a basic treatment of metal casting, see Maryon and Plenderleith 1954, Vol. 1, 623–35 and Vol. 2, 475–81. An excellent discussion of the lost wax technique can be found in Cavanagh 1990, 145–60.

Although the general technique was well known from other kinds of casts like bronze statuary, Oron argued that its precise application to the ram was somewhat different. This was because the ram needed to fit snugly onto the bow of its warship which bore slight irregularities on its port and starboard sides. Since the ship's bow was not symmetrical, the ram had to be custom-made to match its asymmetry. This required the makers to build up a wax model of the final ram directly on the bow of the warship for which it was intended. Oron reconstructs the process as follows: once the ship's wooden bow was completed, workers coated with pitch the timbers to be inserted into the ram in order to make them slightly oversized. This was done to compensate for a known shrinkage coefficient that affects all bronze casts. After the pitch had hardened sufficiently, they brushed it with olive oil to keep the wax from sticking, and then built up a 1:1 wax model of the ram using a combination of wax slabs and paste. Once the model was finished and the surface decoration added, they removed it from the ship, inserted a core specially made of clay and organic material into the cavity left by the ship's bow timbers, and drove long iron rods, called chaplets, through the side walls of the wax model into its core. Next they added, in wax, a complex system of tubing that would admit metal into the mold through "gates" and allow gasses to escape via "vents." Finally, they invested or coated the model with refractory clay, insuring that the chaplets held together the entire package or mold, consisting of the exterior clay investment, the wax model with its gates and vents, and interior core.

The workmen next placed the mold into the casting pit head down, baked it to melt out the wax and, while the mold was still hot, poured molten bronze into it through the gating system (Fig. 2.3). As the metal flowed into the mold, it filled the ramming head first, then progressively filled the driving center, bottom plate, port and starboard cowls, wings, tips and trough ears, and reached all the vents (for the terms, see Fig. 2.1). Once the cast had cooled, workmen broke the mold, freed the ram, and lifted it from the pit using lifting lugs cast onto the weapon's sides. At this point, the workmen trimmed off excess metal, plugged the hole left in the head by the main inlet gate, trimmed the chaplets still protruding from the sides of the weapon, covered any resulting holes with bronze patches, and added the triangular tailpiece to the bottom plate. Cracks and imperfections were repaired with patches before the weapon was released to the shipwrights.[12]

12. See Oron 2006, 75.

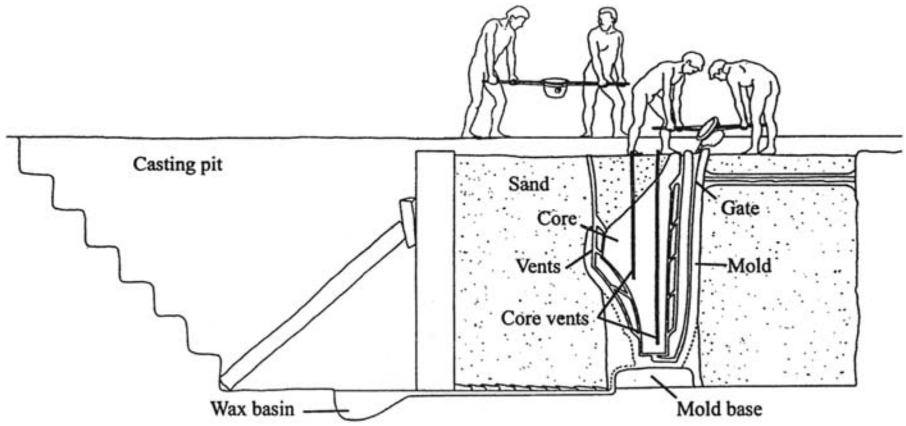

FIGURE 2.3 Ram casting pit in operation. Line drawing by A. Oron.

These men had already prepared the warship to receive its ram by removing the pitch used to oversize the ship's bow when the wax model was made. If the calculations were correct, the ram fit snugly when it was slid onto the bow, but if not, the workmen removed the ram and trimmed any necessary surfaces. After insuring a snug fit, they once again coated the bow and ram's interior with pitch, seated the weapon firmly into place, and then nailed it to the bow with long copper spikes driven through the cowl and troughs.

The process may look straight-forward when printed on a page, but the devil was in the details. Success resulted only when an elaborate set of linked techniques were executed perfectly: when the core, wax model, mold, gates, and vents were prepared in precisely the correct manner, when the mold was correctly positioned in the casting pit, and when it was carefully heated and the wax completely extracted. Before the pour, the copper and tin alloy had to be meticulously purified so that no inclusions made the final cast unsound. What is more, the foundry workers had to carefully control the temperatures of the melt, the pouring, and the cool-down phase, all of which became increasingly difficult with the large volume of metal required for filling the mold.

I say large, because the Athlit ram is much larger than most sculptural bronzes and, as a result, its manufacture required additional care. The Greeks seem to have learned how to cast large-scale bronzes by the last quarter of the sixth century, when statues like the Piraeus Apollo suggest that craftsmen were able to produce casts weighing as much as 300 kg. in a single pour.[13] Over the next century, when sculptural bronzes became thinner, less massive, and were cast in smaller sections, they obviously continued to refine the "old" techniques of large scale casting in the naval yards' foundries.[14]

Considering the ram's resilient cast and its solidly built support structure, we are fully justified in picturing the Athlit ship as a ramming machine capable of delivering and withstanding powerful blows at the bow. Everything about the ram's design and construction bespeaks brute force. Not surprisingly, when the ram was found, most scholars felt it came from a large class like a "nine" or a "ten," but this now seems not to be the case. In order to understand the reasons why, we must now consider some unique archaeological evidence that allows us to place this ram in a sequence with other ram sizes.

The Evidence from Augustus's Victory Monument for the Actian War

There is a hill near the modern city of Preveza on the west coast of Greece where one can still see the outlines of warship rams that fought in the Battle of Actium. The ghostly shapes appear on a monument built by Octavian ("Augustus" after 16 January 27 BCE) to glorify his victory over Antony and Cleopatra and to provide an important religious center for the victory city called Nikopolis built in the plain below. The monument was large and impressive, consisting of a large central altar flanked by a three-sided portico that was built on a hillside at the site of Octavian's personal camp. The entire complex was anchored in place by a massive retaining wall that bore

13. For the Piraeus Apollo, see Mattusch 1988, 74–75; for the weight of this and other casts, see Oron 2001, 39–45, esp. 41. Large scale bronzes from the first half of the fifth century include the Serpent Column from Istanbul (c. 479 BCE) and the Riace Bronzes (c. 460 BCE). The Serpent Column is demonstrably larger than the Athlit weapon (height = 5.35 m; max. diameter = approx. 60 cm.), but despite its easy accessibility in the ancient hippodrome area, no one has yet determined if it was joined together from separate pieces, or cast in a single pour; see Mattusch 1988, 96–97. This column was originally part of a famous memorial erected at Delphi to commemorate the Greek victory over Xerxes in 479 BCE; it was removed to Istanbul in the fourth century of our era.; see Mattusch 1988, 204. Both examples from Riace were cast in a number of pieces, the largest of which included the torso and the legs. Each statue must have weighed close to 375 kg.; see Oron 2001, 41.

14. Such a view supports the conclusions reached by S. Mark that warships fitted with cast rams (not reinforced cutwaters or forefeet) were developed during the sixth century; Mark 2008, 18–19.

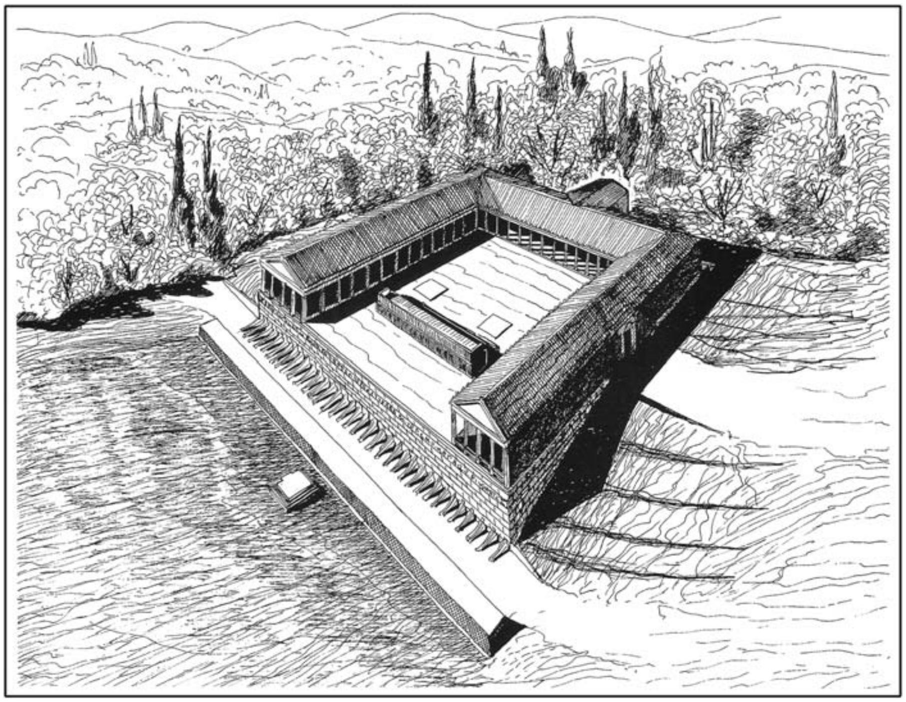

FIGURE 2.4 Actian Victory Monument, restored view. Line drawing by N. Vagenas.

a long inscription and held, imbedded in its face, the back ends of some 36–37 warship rams of at least six different sizes (Figs. 2.4 and 2.6).[15]

Over the years, the rams were removed, broken up, and recycled, statues were carted off to Constantinople, the site was abandoned to the weeds, and eventually forgotten. Relocated in 1913 when this region became part of modern Greece, the ruins were initially pronounced a temple of Apollo, but over the decades that followed, excavations progressively uncovered the long and massive retaining wall that originally held the rams. The rams themselves were displayed at ground level on a 5

15. For a general description of the monument up to 1987, see Murray and Petsas 1989. Since that time, the monument has been extensively excavated by the 12th Ephorate of Prehistoric and Classical Antiquities under the direction of K. L. Zachos. Annual reports of the work in Greek can be found in the "Chronika" of the *Archaologikon Deltion* of the Greek Archaeological Service from 1996 to 2002 (some are still in press); for a synopsis in English of the excavations from 1996 to 2002, see Zachos 2001a and 2003 (which is an English translation of Zachos 2001b with additions from the 2002 season), and also Zachos et al. 2008, 57–71. For a small, 6 kg. ram fragment found at the site, see Varoufakis 2007 with illustrations in Vol. 2, 343–45. The precise number of rams, 36 or 37, is difficult to determine because of the retaining wall's broken condition at its extremities.

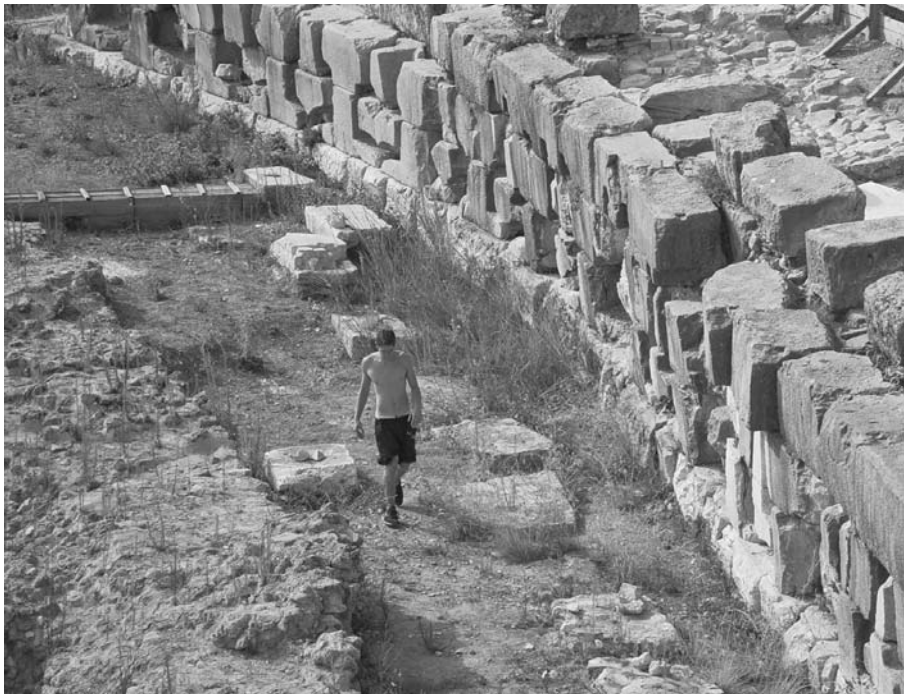

FIGURE 2.5 Actian Victory Monument, ram terrace, western end.

meter-wide terrace that was supported by a second, lower retaining wall. Bases, still preserved in front of many sockets, held bronze brackets that supported each weapon's ramming head and suggest the weapons' original lengths were no more than 2.5 m. (Fig. 2.5).

The Ram Sockets

Today, one can see the remains of 27 sockets, generally arranged in a progression from large to small beginning on the west and continuing to the east, or from left to right as you look at the wall (Fig. 2.6). While some are preserved better than others, each represents a complex cavity, 25 to 50 cm. in depth, that originally held the back end of a warship ram. As a result, these cuttings faithfully reproduce the weapons' cross-sectional dimensions for a distance of up to 50 cm. at a point beginning about 2 m. aft of the ramming head. These dimensions include the thickness and height of the main timbers that were removed from each ram to allow it to slide into its socket.[16]

16. For a complete presentation of the evidence, see Murray and Petsas 1989, 22–61; and also Murray 1996, 335–50.

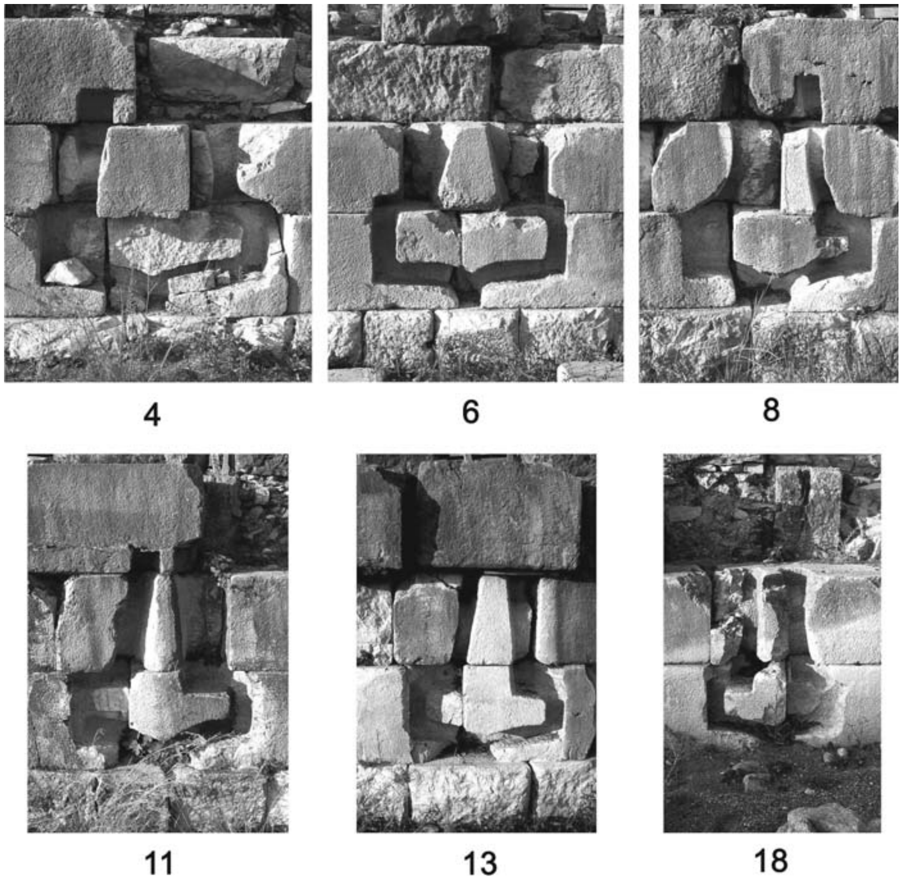

FIGURE 2.6 Actian Victory Monument, different sizes of sockets.

In order to "read" this information from each cutting, one needs to understand how the rams were fit into their respective sockets. A comparison of the Athlit ram's casting with a well-preserved socket like #13 shows what was involved. First, the timbers inside each ram were either trimmed back or removed to reveal the casting's hollow interior (Fig. 2.7). Next, the ram's tailpiece was cut off, if one existed. In this state, the ram was positioned next to the wall, which was constructed to the level of the second course blocks. At this point, the masons prepared to carve the grooves of the sockets' bottoms in the blocks of the second course.

How they next proceeded was determined by the degree to which the ram's exterior width increased from front to back. You can see from the top view in Figure 2.8 that the width of the Athlit ram is greater at "B" than it is at "A." Because the ram is inserted into the socket from the wall's front side, the exterior edge of the socket's groove (Fig. 2.9 at B) must be as wide as the ram's exterior dimension at Section B. But because the

FIGURE 2.7 Athlit ram, rear view.

bronze of the ram-casting angles inward from the trough ears toward the weapon's head, the interior edge of the socket's groove (which will be *inside* the ram-casting; Fig. 2.9 at A) must accommodate the interior dimensions of Section A. The width of the cut groove in each socket is defined by the difference between the *exterior* width of the casting at Section B and the *interior* width of the casting at Section A.

Once these dimensions were transferred to the wall, the lower portion of each socket was then cut into the appropriate blocks of the second course. The rams were then pushed back into place with their bottom plates and troughs sliding into the carved grooves in the second course. Because the blocks of the third course were cut with backward flaring grooves (Fig. 2.10, arrows indicate backward flare), they must have been cut away from the monument and then carefully maneuvered over the rams' cowls and down onto the top of the second course.[17] This was done, presumably, to match

17. See Murray and Petsas 1989, 57–59 for the details.

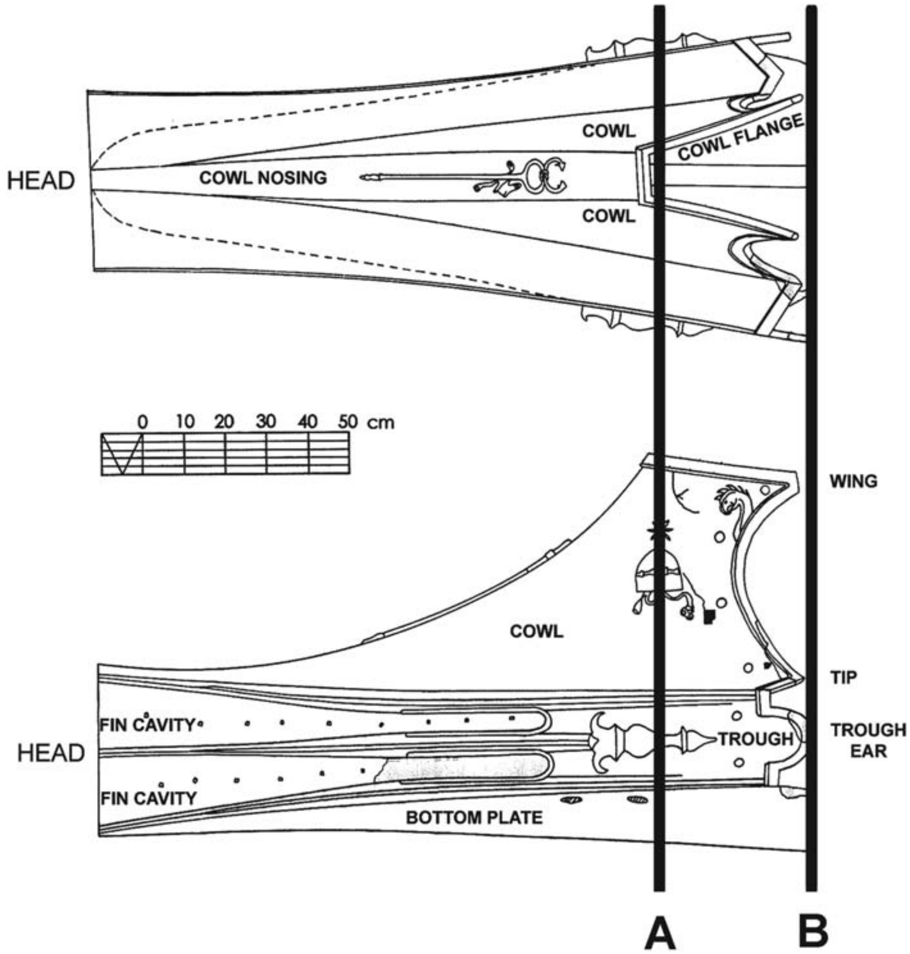

FIGURE 2.8 Athlit ram, area imbedded in hypothetical socket. Image adapted from line drawing by A. Oron.

the flare of the rams' cowls while reducing the width of the side grooves as much as possible. Even though such special care was taken to improve the "fit" of each ram in its socket, gaps still remained to the left and right of each ram. Whether these were left visible, or were concealed by a filler of some sort remains unknown, although a poem from the time of Nero mentions bee hives full of honey inside the rams, implying the existence of gaps between bronze and stone (Philippus in *Anth. Pal.* 6.236).[18]

18. For the date, see Cameron 1993, 56–65. At one time, I concluded from a few small fragments of marble revetment (0.011 m. thick) found on the ram terrace that these gaps may have been covered with a thin veneer of gray-white marble (Murray 1996, 437). Since no other traces of revetment have been found anywhere along the wall, I have since abandoned this view.

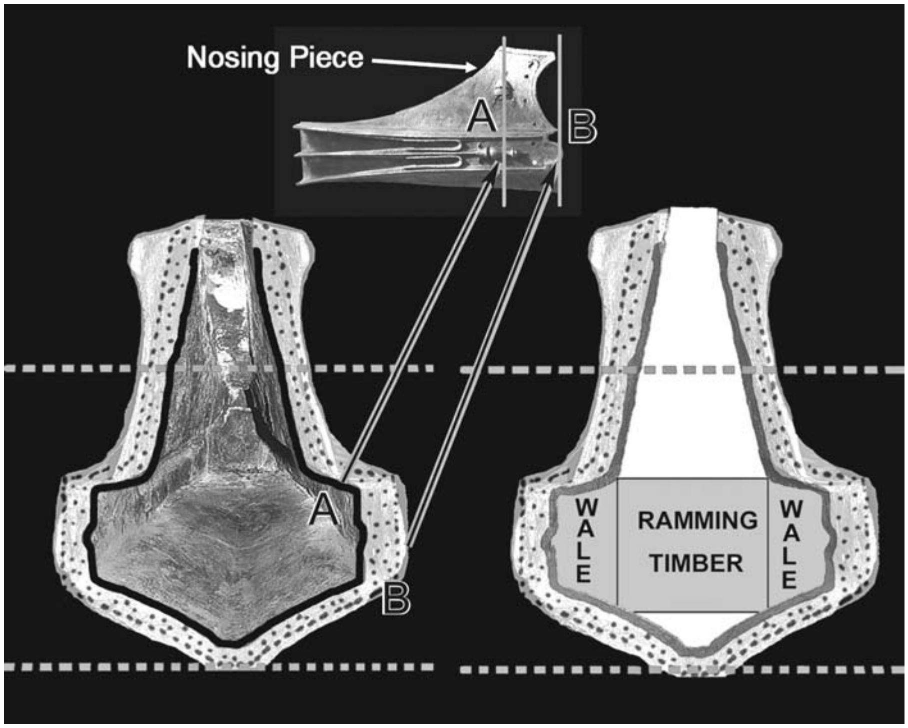

FIGURE 2.9 (Left): Hypothetical socket to fit the Athlit ram. (Right): Core of hypothetical socket showing configuration of timbers.

Since we are now in a position to consider the shapes and sizes of the sockets, let us begin with two simple observations. First, the sockets' outlines clearly show that rams similar in shape to the Athlit example were mounted here. And second, the Athlit ram is too small to fit any of the visible sockets still preserved *in situ* (Fig. 2.6).[19] The similarity in shape between the sockets and the Athlit ram is important for a number of reasons. First, it demonstrates beyond any doubt that both the Athlit and Actian warships were constructed following a similar design at the bow, with rams that sheathed both port and starboard wales along with a ramming timber squeezed in between. Second, it allows for an easy comparison between the sizes of Antony's warship bows and the timbers inside the Athlit ram. Finally, if we can determine the range of classes displayed on the monument, we might determine the class of the Athlit ship. On this final point, our evidence is reasonably clear.

19. The recent excavations of K. L. Zachos have recovered a number of socket blocks dislodged from the monument's eastern end, one of which (AM 153) seems to have held a weapon the size of the Athlit ram.

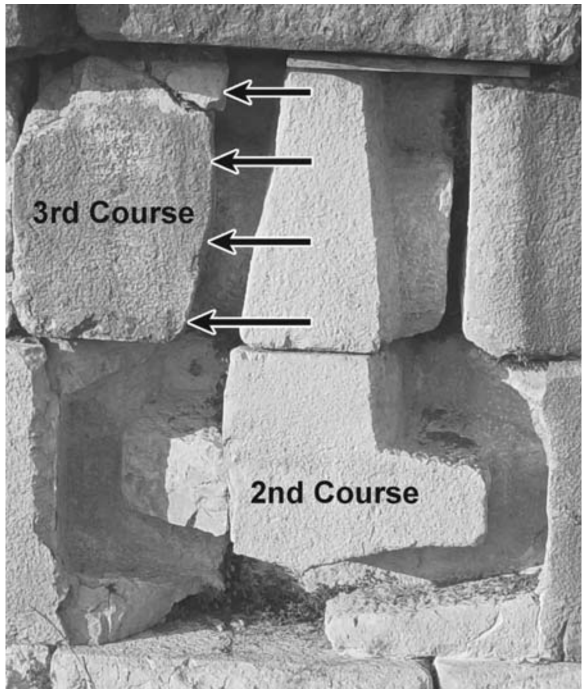

FIGURE 2.10 Socket #13, flare at third course (indicated by arrows).

The nature of the monument, a victory dedication to Neptune and Mars, plus the number of rams included in the display (36–37) make it likely that Octavian dedicated a *dekate* or one-tenth dedication from the more than 300 rams that fell into his hands during the Actian War.[20] Second, because of the special nature of this dedication—the official victory monument of the new Victory City—the future Augustus dedicated the most impressive display he was able to assemble; in other words, he displayed here the largest rams in his possession.

Now, what sizes were these? Again, the evidence is reasonably clear. Strabo (7.7.6) tells us that Octavian dedicated a set of complete warships at the nearby sanctuary of Apollo Actius—one from each of the ten different classes that had fought in the war—a "one," a "two," a "three," and so forth up to a "ten."[21] Unless Antony possessed only one "ten,"

20. For the evidence, see Murray and Petsas 1989, 137–41.

21. For the different traditions concerning the sizes of Antony's ships and the reason for preferring Strabo's account, see Murray and Petsas 1989, 99n25.

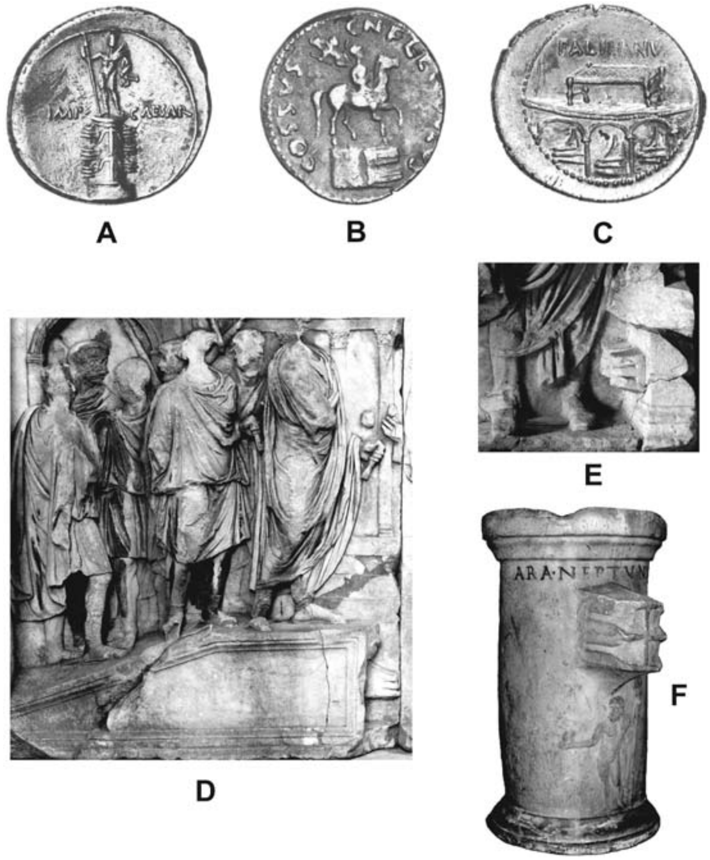

FIGURE 2.11 Examples of suspended rams. (A): *Columna rostrata* of Octavian depicted on a denarius, 29–27 BCE. Courtesy of the American Numismatic Society. (B): Equestrian statue of Octavian (?) *in rostris* depicted on a denarius minted by Cossus Cornelius Lentulus in 12 BCE. Courtesy of the American Numismatic Society. (C): "Antoninian Rostra" depicted on a denarius minted by Lollius Palicanus in 45 BCE. Courtesy of the American Numismatic Society. (D): *Rostra Aedis Divi Iulii* on the *Anaglypha Traiani* (detail from left panel). Early second century CE. (E): *Rostra Augusti* on the *Anaglypha Traiani* (detail from right panel). Early second century CE. (F): Rostrate altar (Augustan period?) with the inscription *Ara Neptuni*.

and our sources imply otherwise, we are faced with the unavoidable conclusion that rams up to the size of "tens" were displayed on this monument. Surely the largest sockets held rams from "tens," "nines," "eights," and so forth. The lower limit is a bit more difficult to determine and depends upon how many sizes one discerns in the preserved sockets. Initially I thought I could detect five or six different sizes, and concluded that surely "sixes" and perhaps "fives" were included in the display.[22] It now seems certain (see note 19) that at least one socket was smaller yet than those still *in situ* and thus increases the different sizes to six or seven. Because the visual boundaries between sizes are subject to personal opinion and render certainty impossible, we must consider other ways to assess the size of the smallest ram preserved on the monument.

One possible indicator is in the peculiar Roman tendency to suspend warship rams from statue bases, podia (like the Rostra in the Forum Romanum), and columns. The half-ton Athlit ram is simply too heavy and too elongated in shape to be easily suspended off the ground on a wall or column like we find in numerous preserved images of such monuments (Fig. 2.11). Furthermore, when the literary record provides details for rostral monuments with suspended rams, we find no secure evidence for rams from classes larger than "threes."[23] Although this evidence is suggestive rather than conclusive, it implies that the class of the Athlit ram must be larger than a "three." A similar impression emerges from the analysis of authentic three-bladed waterline rams and from images of warships that survive from the Hellenistic period through the first century CE.

Ships of Larger and Smaller Build: Differences in Ram Design

When describing the fleets that clashed off Anatolian Side in 190 BCE, the Roman historian Livy characterized the warships as follows: " . . . the royal fleet (of Antiochus III) was made up of 37 ships of larger size (*maioris formae*), among which were three 'sevens' and four 'sixes'; aside from these, there were 10 'threes'" (Livy 37.23.4–5). The curious expression "of larger size" recalls another passage where Livy referred to small, open vessels as being "of smaller size" (34.26.11: *minoris formae*).[24] For Livy, and presumably for others as well, this difference made it sensible to group "fours" with "sixes" and "sevens" as somehow *larger* and *heavier,* and "threes" with

22. Murray and Petsas 1989, 113–14.

23. For the evidence, see Murray and Petsas 1989, 105–13.

24. Although Livy 37.30.2 refers to "sixes" and "sevens" as being "of the largest size" (*maximae formae*), his basic framework seems to be derived from the comparative terminology of smaller and larger, rather than from small, large, and largest.

lemboi and other open warships as somehow *smaller* and *lighter*.[25] Furthermore, a comparison of warship rams—authentic examples, as well as detailed depictions in stone or paint—reveals two clearly defined groups. Because these groups may help to define the differences between "threes" and "fours," it is useful to consider this evidence now.

We should begin with the best evidence we possess, that is, authentic three-bladed waterline rams that survive from antiquity. With the recent discovery of two rams in the summer of 2008, we possessed seven authentic examples to analyze at the time this chapter was written (Table 2.1).[26] The smallest example, the Belgammel ram (formerly, Fitzwilliam ram, Fig. 2.12), exhibits a different design than the others and, because it adds little to our understanding of rams from "larger ships," will be omitted from our discussion.[27] The remaining six examples, however, possess the five basic elements that define the Athlit ram: a ramming head, driving center, troughs, cowl, and bottom plate.[28] They also divide naturally into two distinct sizes and seemingly correspond to Livy's evidence that "threes" fall among the smaller classes and "fours" among the larger ones. While such a conclusion might not seem immediately obvious, it results from a consideration of "fours" and their performance characteristics in relation to "threes."

25. We have already seen that Philo (*Polior.* D 29 with C 59) and Appian (*BC* 2.12.84 and 5.11.108) use adjectives such as "bigger" or "big" when speaking of warships. Appian (*BC* 5.11.99, 106) also utilizes the adjectives "heavy" (*bareiai*) and "lighter" (*kouphoterai*) to signify these differences. See also chapter 7.

26. Since writing this chapter, three more rams have been found by the Soprintendenza per i Beni Culturali e Ambientali del Mare and RPM Nautical Foundation off the Egadi (ancient Aegates) Islands of northwestern Sicily. One (called the Vincenzo T ram = Egade 3 ram) was found during the summer of 2010, and two more (the Claude D and Rachael R rams = Egade 4 and 5 rams) were found by mid-June 2011 along with two bronze helmets. Initial photographs of the weapons published on the website of the RPM Nautical Foundation reveal them to be roughly the same size as the Egade 2 (Catherine D) ram found nearby by the same team in 2008; see http://rpmnautical.org/index.html; and http://rpmnautical.org/egadi2010.htm. The team promises a full report after conservation and analysis have been completed.

27. Sleeswyk 1996, 431–32 suggests a way in which the Belgammel (Fitzwilliam) ram might be viewed as a *proembolion*, or subsidiary ram, by turning it upside-down. Although ingenious (Sleeswyk 1996, 448, Fig. 5), this position causes the bird's head on the ring above the ram (as it appears in my Fig. 2.11) to be oriented upside down and is therefore unlikely to be correct; see Nichols 1970–71, 85; and Pridemore 1996, 85. Despite its orientation, it is still possible that this small ram represents a *proembolion*. Most recently, a team of British researchers has arrived at a similar conclusion. For the results of their extensive research into the ram's function, date and metallurgy, see Adams et al. forthcoming.

28. Both the Piraeus and Egade 2 (Catherine D) rams have been damaged as a result of a violent blow to the head of the ram. The cowls have been largely sheared away, and in the case of the Egade 2 (Catherine D) ram, its upper fin is largely missing.

Table 2.1 Authentic Three-Bladed Waterline Rams (listed according to date of discovery, recovery or purchase; dimensions appear in Table 2.2).

Belgammel (Fitzwilliam) Ram

Discovery: Discovered in 1964 by a group of British recreational divers (Derek Schofield, Mick Lally, and Ken Oliver) at a depth of 25 m. off Wadi Belgammel, west of Tobruk, Libya.

Additional information: Originally named after the museum that displayed it; now named "Belgammel" from its find spot: see Adams et al. forthcoming; correspondence regarding the ram's original discovery is posted at http://www.don-simmonds.co.uk/ram.html (accessed June 13, 2011); Nichols 1970–71, 85 with fig. 14; Göttlicher 1978, no. 491a; Basch 1987, 407 with ill. 866; and Pridemore 1996, 74–98. This ram is not only extremely light (19.7 kg.), it lacks a bottom plate and is mounted on the bow of its ship in a way that differs from the others.

Athlit Ram

Discovery: Found on Nov. 11, 1980 by Yehoshua Ramon just to the north of Athlit, Israel.

Additional information: Casson and Steffy 1991. See text below.

Bremerhaven Ram

Discovery: Unknown. Purchased by the Deutsches Schiffahrtsmuseum, Bremerhaven, from Galeria Nefer, Zurich, in 1988.

Additional information: R. Bockius is currently preparing a full technical publication of the weapon that will be published by the Römisch-Germanisches Zentralmuseum.

Piraeus Ram

Discovery: Reportedly found near Cape Artemision in northern Euboea; donated to the Piraeus Archaeological Museum by Vasilis Kallios in 1996.

Additional information: Steinhauer 2002.

Egadi 1 (Trapani) Ram

Discovery: Precise findspot unknown. Recovered from an antiquities smuggler on June 15, 2004, in Trapani by the Commando Tutela Patrimonio Culturale of Rome in concert with the Nucleo Tutela Patrimonio Culturale of Palermo.

Additional information: Originally named 'Trapani' for the place of its recovery; now named 'Egadi 1' following the recovery of numerous rams of similar type off the nearby Egadi islands.

Unpublished. The ram is currently in the care of Dr. Sebastiano Tusa, Director of the Soprintendenza per i Beni Culturali e Ambientali del Mare (Department for Archaeological Heritage and the Environment of the Sea, hereafter Soprintendenza del Mare), Trapani, Sicily, who is undertaking its publication. I saw the ram at an exhibition in Rome in June 2008.

(continued)

Egadi 2 (Catherine D) Ram

Discovery: Found on June 26, 2008, during the Egadi Islands Survey off northwestern Sicily by RPM Nautical Foundation and the Soprintendenza del Mare of Sicily (codirectors Sebastiano Tusa and Jeff Royal).

Additional information: Unpublished. The dual nomenclature results from the directors' decision to name the rams after deceased loved ones while still preserving an indication of sequential numbering. Thus, the ram found in 2010 is named Egadi 3 (Vincenzo T) and the ones found by mid-June, 2011, are named Egadi 4 (Claude D) and Egadi 5 (Rachael R). Specific details and photos are presented on the website of RPM Nautical Foundation. Photos and measurements kindly provided by J. Royal.

Acqualadroni Ram

Discovery: Found in the sea by Alfonsa Moscato in the bay of Acqualadroni (Acquarone), Messina, on September 7, 2008.

Additional information: Unpublished. The ram is currently in the care of Dr. Sebastiano Tusa (see Egadi 1 ram), who is undertaking its publication. A notice of the find appeared in Modica 2008. From photographs published on the internet, the ram appears to be similar in size to the Egadi 1 and 2 examples and smaller than the Athlit ram. The ram was found with timbers still preserved inside.

How are "Fours" Larger than "Threes"?

As the smallest of the larger ship classes, "fours" help us more than any other class to understand the important differences between larger and smaller warships. In recent years, J. S. Morrison has published perhaps the most thorough treatment of the class, although the picture he presents is somewhat confusing. According to him, "'fours' were regularly cataphract and among the bigger ships." Despite this fact, when compared with a "three," the "four" was "a smaller two-level ship, cheaper to build and with double-manning and a smaller crew more economical to run."[29] In Morrison's view, "fours" are somehow smaller than "threes," perhaps in their freeboard (distance from waterline to deck) or overall length. He therefore provides no help with the question confronting us now, namely, in what way did authors like Livy and Appian consider "fours" to be "large" and "threes" small? The evidence from which we build our answer falls into two general

29. Morrison and Coates 1996, 257, 269; see also 267–69 for a description of the "four's" general characteristics.

Table 2.2 Authentic Three-Bladed Waterline Rams—Dimensions (in cm.) and Weights (in kg.).[1]

(max = maximum; H = height; L = length; W = width; est = estimated dimension)

Dimensions	Belgammel	Bremer-haven	Piraeus	Egadi 1	Egadi 2	Acquala-droni	Athlit
max H of ram	44.1	62.6	NA	80 (est)	NA	?	95
max L of ram	64	66.9	74	89 (display label)	76.5	?	226
H, ramming head	13.1	27.5	35	23 (est)	25 (est)	?	41.1
W, upper fin, ramming head	12.6	26	36 (est)	40 (est)	31.8 (est	?	44.2
H of trough, after end interior:	?	21 (est)	21 (est)	?	?	?	23
max. H of trough, after end exterior	9.4	22	23.5 (est)	20 (est)	17.4	?	24.5
H of preserved wale at after end of ram	NA	NA	NA	NA	NA	?	20
max L of driving center	64	43.5	59	57 (display label)	67	?	168
W of ram, rear, starboard to port trough	18 (est)	23.5	33–35 (est)	32 (est)	38.5	?	76
weight of ram casting in kg. (* = with wood)	19.7	53	80 (est.)	100–125 ?? (est)	?	200? *300?	465 *600
area (cm^2), wale-ramming timber unit	169.2	517.00	822.50	656.00 (est)	670.00	?	1824.00
H/L ratio: (L of driving center) ÷ (H of trough)	6.8	1.98	2.51	2.78	3.85	4.62	7

1. The weights and dimensions of the Belgammel (Fitzwilliam), Piraeus, and Athlit rams can be found in the literature cited in Table 2.1. Information for the Bremerhaven ram was kindly supplied by D. Ellmers (personal communication, 1988) and R. Bockius (personal communication, 2008); and for the Egadi 2 (Catherine D) ram by J. Royal (personal communication, 2009). Dimensions for the Egadi 1 (Trapani) ram have been secured from an exhibition display label and estimated from published photographs that included scales, so they represent estimates only. The same is true for the Acqualadroni ram. These weapons, plus those recently discovered during the Egadi Islands Survey, will add considerably to our knowledge of smaller rams when they are fully published; see n. 26.

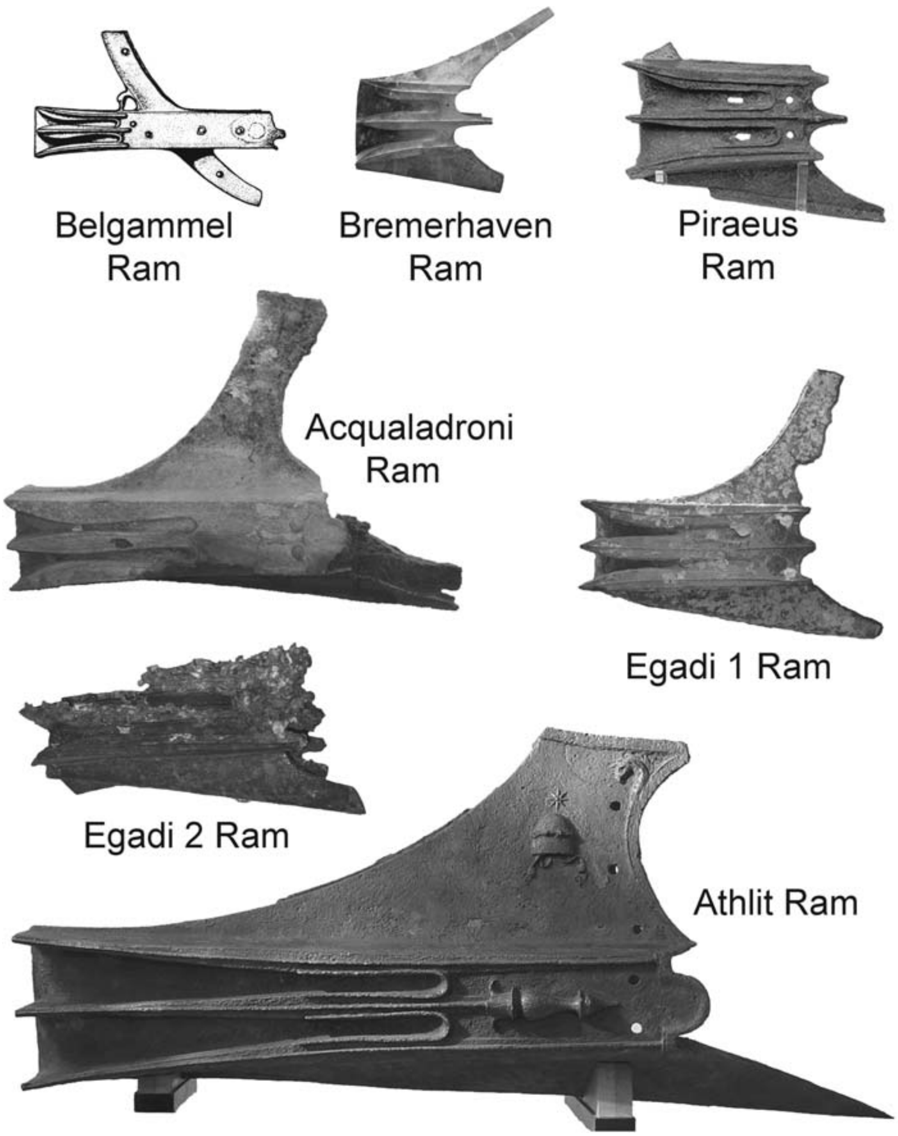

FIGURE 2.12 Authentic three-bladed waterline rams (cf. Table 2.1). *Belgammel Ram (Fitzwilliam Ram)*: Museum of Libya, Tripoli. *Bremerhaven Ram*: Deutsches Schiffahrtsmuseum, Bremerhaven. *Piraeus Ram*: Piraeus Archaeological Museum. *Acqualadroni Ram*: Currently undergoing conservation and study by the Soprintendenza del Mare of Sicily. *Egadi 1 (Trapani) Ram*: Currently undergoing study by the Soprintendenza del Mare of Sicily. *Egadi 2 (Catherine D) Ram*: Currently undergoing conservation and study by the Soprintendenza del Mare of Sicily. *Athlit Ram*: National Maritime Museum, Haifa.

categories: written (ancient texts and inscriptions) and artifactual (authentic rams and Actian sockets). As we consider the written evidence, the reader might also refer to Appendix A, where I have collected the relevant testimonia.

Written Evidence

Because "fours" were utilized in most of the major fleets, a fair amount of evidence survives regarding their chronological development, performance characteristics, and use by various naval commanders. Although we might logically expect "fours" to be the least expensive of the "larger" classes to build and deploy, there is no evidence to support Morrison's claim that "fours" were cheaper to build and man than were "threes." Athenian inscriptions that published the city's naval assets during the fourth century show clearly that when trierarchs of "fours" reimbursed the state for ship's gear, they paid 50% more than did trierarchs of "threes." Surely this reflects the greater costs associated with "fours," at least in fourth century Athens.[30]

From values preserved in these same lists, one can also see that this class had double-manned oars. Morrison was the first to notice this fact, although I believe we can refine his calculations slightly.[31] In 325/4 BCE, the *Epimeletai ton Neorion*, or board of ten who oversaw the naval yards, received 415 drachmai for a set of oars from a "four" that were characterized as "unfinished" or "rough" (*tarrou argou*). Many years earlier during the Peloponnesian War (in 411), a rough-hewn spar for a trireme oar (*kopeus*) was apparently worth 5 drachmai. Although we must use prices that are separated by almost nine decades for two different commodities (oar spars for "threes" and for "fours"), we can still get a general idea of the relative numbers involved. The money received for the unfinished oars of a "four" would purchase roughly 83 units if they cost 5 drachmai a piece. Even if we are off by a variance of 25% to account for the imprecise nature of our evidence, our calculations still indicate a relatively low number of oars for a "four" (roughly 40 to 50 per side) when compared to a "three," whose *tarros*, or full set, numbered 170 (85 per side). Since a full set of oars for a "four" must have numbered between 80 and 100 units, and since we know the ship could keep pace with "fives" and "threes" in fleet maneuvers, the oars must have been double manned.[32] If so, the oarcrew of an Athenian

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30. See Appendix A: "Physical Characteristics. Ship's Gear" (pp. 256–57) for the evidence. Gabrielsen 1994, 139–45 argues that payments from trierarchs for the replacement of hulls and gear represent averaged values resulting from all replacement costs charged to a particular group. Since "fours" were less numerous than "threes" and are listed with unique costs, perhaps the values associated with their gear more closely represent actual (i.e., non-averaged) values.

31. See Appendix A: "Physical Characteristics. Oarsystem" (pp. 255–56) for the evidence behind the statements in the text.

32. See Appendix A: "Physical Characteristics. Speed" (pp. 254–55).

"four," at 160–200 men, would have roughly equaled that on a "three" of the same period (170 men). It seems likely, then, that a "four" cost as much to man as did a "three." No savings here. And finally, since we suspect that "fours" normally carried more deck soldiers than did "threes" among the full crew, Morrison's conclusion that this class was more economical to run than "threes" must be incorrect.

In general, ancient references to "fours" imply they were heavier than "threes" and were considered to be an upgrade in size. Both "fours" and "fives" were expected to defeat "threes" in prow-to-prow ramming attacks, but when "fours" challenged "fives" in a similar way, "fours" were normally expected to lose. This is why Rhodian "fours" rigged fire pots at their prows to deter attacks on their bows from larger vessels.[33]

Artifactual Evidence

Let us return, for a moment, to my earlier statement that authentic three-bladed waterline rams divide visually into smaller and larger sizes (Fig. 2.12 and Table 2.2). If we consider the "smaller" rams to include the Bremerhaven, Piraeus, Egade 1 (Trapani), Egade 2 (Catherine D), and Acqualadroni examples (Tables 2.1–2 and Fig. 2.12), we see that, in general, they exhibit:

1) a shorter overall length than do the "larger" examples;
2) a "driving center" with height to length values between 1.8 and 4.62;[34]
3) the existence of short or shallow troughs with wale pockets that serve to envelope only the last half-meter of the wales (or less); and finally,
4) a shallow cowl or no cowl at all.

Among the "larger" examples of authentic rams, I include the Athlit weapon along with the Actian rams that were displayed on Augustus's Victory Monument at Nikopolis. Although the Actian rams may seem difficult to assess because they have physically disappeared, the monument's sockets preserve clear impressions of their cowls, the heights of their troughs, and their approximate lengths from the cuttings and bases preserved at the site. Enough detail survives to indicate the general shapes

33. See Appendix A: "Physical Characteristics. Ramming Characteristics" (pp. 257–58); for the Rhodian fire pots, see Livy 37.11, 30.3–5; Polyb. 21.7.1–4; App. *Syr.* 24; and Walbank 1999, Vol. 3, 97–99.

34. The height to length value represents how many trough heights "x" equal the driving center's length "y" (see Fig. 2.12).

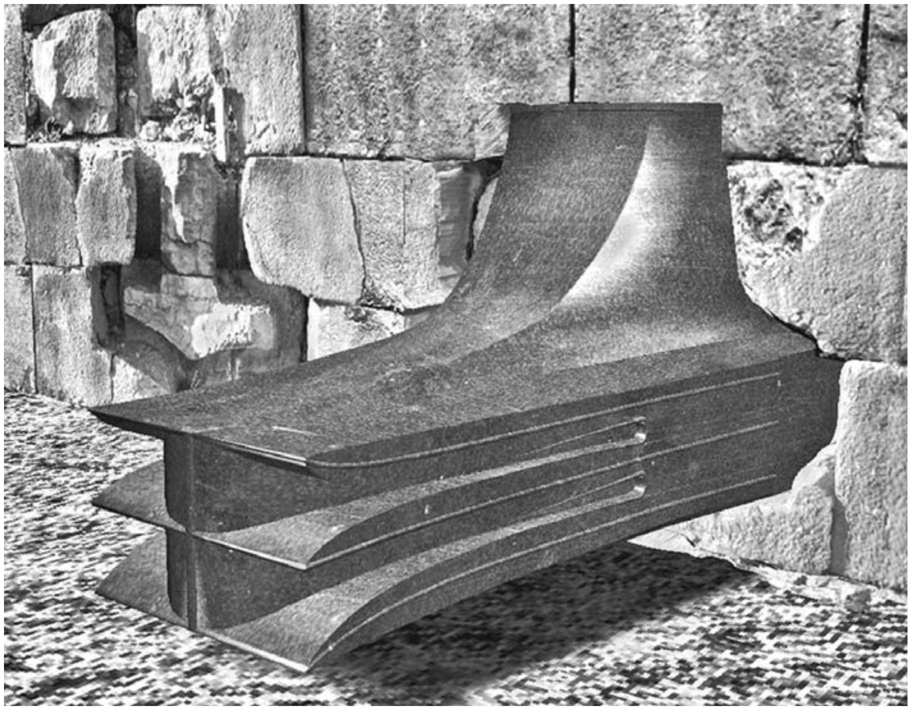

FIGURE 2.13 Hypothetical ram for socket #4. Model created by W. M. Murray and the Institute for the Visualization of History under the supervision of K. L. Zachos.

and sizes of many weapons once displayed along the wall. For example, Figure 2.3 attempts to visualize the weapon originally placed in socket #4.[35] Although we see a wide range of shapes and sizes in the sockets (Fig. 2.6), their characteristics include the following similarities with the Athlit ram:

1) a much larger size, weight and overall length than the smaller examples;
2) a "driving center" with height to length values between 3 and 7;
3) the existence of long or deep trough pockets that serve to envelope the ship's wales for a meter or more; and finally,
4) a deep cowl that envelopes the ship's hull timbers above the wales.

In sum, significant differences between the two groups involve: 1) the length of the driving center and corresponding depth of the trough pockets; 2) the height of the wales and corresponding height of the troughs; and 3) the existence or non-existence of a deep cowl.

35. For a brief explanation of the evidence and methodology employed to create the first model, see Murray 2007. Fig. 2.13 represents a series of further refinements made to the model in 2010.

Ships of Larger and Smaller Build: Pictorial Evidence

Because pictorial evidence from large or detailed ship representations often display the same characteristics observed in authentic rams, we might try to look for clues in these images regarding their classes. Before discussing this evidence, however, I must stress that such pictorial evidence was never intended to preserve the accuracy found in modern architectural plans. Ancient warships were complex machines whose long and narrow proportions challenged the skills of those who sculpted, painted, or drew them. In order to portray them effectively, artists often chose to shorten their originals, compress their curves, and omit certain details. Clearly, some artists were more skilled than were others in producing their models faithfully, while others purposefully ignored certain features in order to accentuate specific details for effect. Still others may have mixed elements from different sized galleys into a single image, thus blurring for us the original differences between closely related classes. As a result, an unexpected feature (or lack of one) might represent something meaningful or simply the inability or disinterest on the part of the artist to reproduce the original faithfully. Despite the difficulties, however, we would be foolish to ignore this evidence, although we must be mindful of its limitations and potential problems.

"Threes"

If we start with the earliest of the "smaller" examples (Fig. 2.14, A), we can see that a weapon like the Piraeus ram or Egade 1 (Trapani) ram would have fit the warship bow sculpted on the Democleides stele from the National Museum in Athens (Inv. # 752), dating to the early fourth century BCE. Although the original details of the ram's shape, once highlighted in paint, are now faded, the weapon's relative size is indicated by the blades represented at its head. Since "threes" dominated the navy in Athens during the time this relief was created, we can be fairly certain that the image represents a "three."

A similar sized weapon must be envisioned on the bow of a warship (ostensibly the *Argo*) sculpted on a third century honorific stele from Boeotia now in the Boston Museum of Fine Arts (Fig. 2.14, B). The class of warship serving as the model for this image is uncertain, although it displays similarities in scale to the vessel depicted on the Democleides stele and might reasonably be considered a "three." Explicit examples of "threes" can be seen in examples of warships from Nymphaion (Fig. 2.15, A and B) and

FIGURE 2.14 (A): Democleides Stele. Early fourth century BCE. National Archaeological Museum, Athens. (B): Warship Depicted on a Boeotian Stele. Third century BCE. Museum of Fine Arts, Boston. Photo © 2011 Museum of Fine Arts, Boston.

Pozzuoli (2.15, F) where they clearly display three levels of oars or oarports and bear apparently small rams. Similar examples appear in a number of warships modeled in plaster relief from Sicilian Soluntum (Solunto). Although in fragments, the models depict oarboxes with oarports set at three levels (Fig. 2.15, D) and small rams (C, E). It would seem, on this evidence, that the Piraeus and Egade 1 (Trapani) weapons correspond reasonably well to "threes" or to other warships that Livy would classify as "smaller" in size. We might say the same about the Egade 1 (Trapani) ram and the larger Acqualadroni weapon, which seem remarkably similar to rams depicted on a fresco from Pompeii showing a number of warships inside a series of arched openings interpreted as *navalia* or shipsheds (Fig. 2.16).[36] The composition of the original painting (which is now cut into three panels) is unrecorded. Since two of the vessels clearly show oarboxes with ports arranged in a diagonal line at three different levels (Fig. 2.16, A, left vessel), the ships are most likely "threes."

Before passing to the larger examples, I should note the well known, but sometimes ignored fact that "threes" from different cities and centuries displayed different oarsystems, and presumably other characteristics as well. For this reason, I do not mean to imply by my previous remarks that "threes" were similar over time and thus had similar rams. We possess ample written and pictorial evidence to demonstrate substantial variations

36. The paintings were found November 7–14, 1763, in Regio VI, 17 (Insula Occidentalis), 10; see Bragantini and Sampaolo 2009, 196–97 and Basch 1979, 291–94. They appear on three separate panels now in the Naples Museum (Inv. 8603, 8604, 1172).

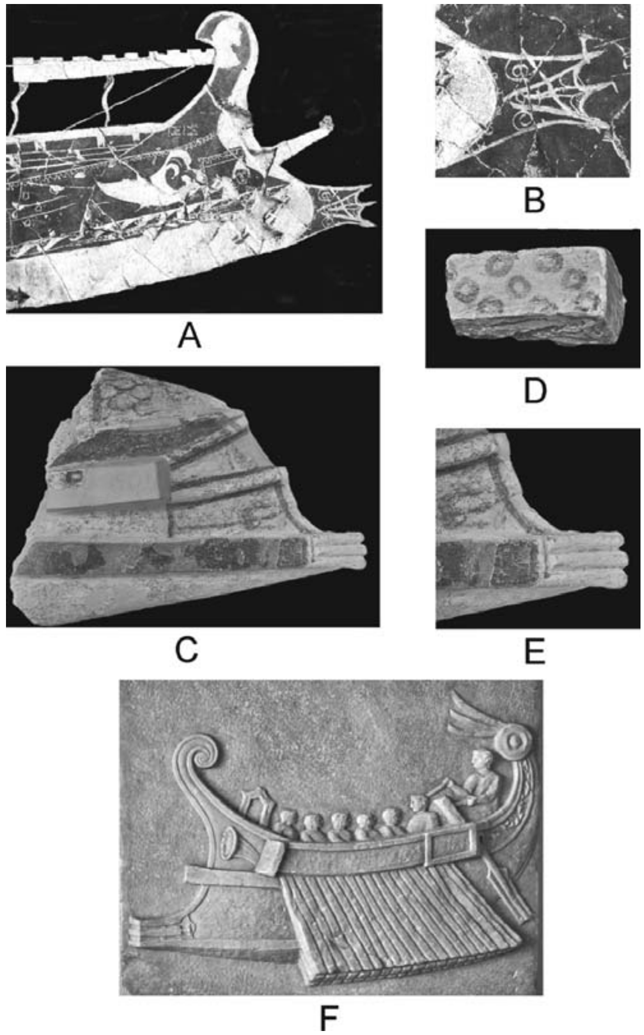

FIGURE 2.15 Warships from Nymphaion (Ukraine), Solunto (Sicily) and "Pozzuoli" (Italy) showing three levels of oars or oarports. (A, B): Warship prow from a scraffito at Nymphaion, Ukraine. Mid-third century BCE. (C, E): Plaster relief of warship prow from Soluntum (modern Solunto). (D): Plaster fragment of an oarbox found with the warship prow illustrated in C and E. (F): One of two marble reliefs depicting warships (frequently called the Pozzuoli Reliefs) found at Lago Fusaro, near Misenum, Italy. Augustan period.

in the design of the class.[37] And this surely explains the variations in the sizes and shapes of individual rams, such as the Egade 1 (Trapani) and Acqualadroni examples. Still, I think it reasonable, though I cannot prove it, to expect that these differences in design produced variations in ram

37. In an important article published in 1979 (Basch 1979), L. Basch emphatically argued against the notion of a single design for a trireme (i.e., the "Greek" one) and pointed out the

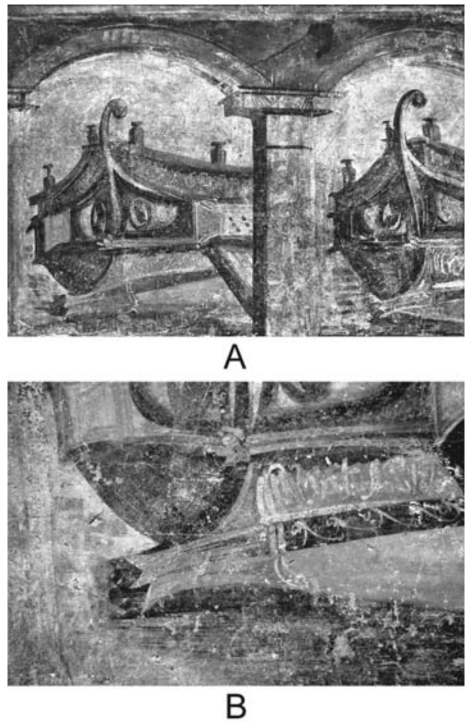

FIGURE 2.16 (A): Fresco, originally from Pompeii, depicting warship prows inside *navalia* (shipsheds). Second half of first century CE. (B): Ram on a warship prow depicted inside *navalia*, originally from Pompeii. Second half of 1^{st} century CE.

sizes that were less pronounced than the differences between rams of different classes.

"Fours" and "Fives"

Among the larger group of rams, the Athlit weapon commands our attention first (Fig. 2.17, A). While it clearly derives from one of the "larger" classes, the question remains: which one? The answer, a "four," may be suggested by the following evidence. The first item is a large sculpted

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different oar systems that are indicated by representations of Roman and Phoenician "threes." Although "threes" are normally classed among the "open" galleys in a fleet, we know from certain authors that "cataphract" versions existed as well: see App. *Mith.* 17 and 92; Memnon of Herakleia, *FGrH* 434, F1, 21, (= *FGrH*, Dritter Teil, Text, 24. Herakleia am Pontos, p. 351); Caes. *BC* 2.23. Casson 1995, 123–24 is no doubt correct that both versions of "threes" were built at the same time.

monument, built of six courses of travertine blocks, depicting a warship prow on the downstream end of the Tiber Island in Rome.[38] Fortunately, this monument caught the eye of the Venetian architect Giovanni-Battista Piranesi who drew a number of detailed views and plans of it in the mid-eighteenth century.[39] At that time, the warship exhibited both port and starboard sides, at least at its preserved end, but had already lost its ram (Fig. 2.18, B). Piranesi records the width of the bow just behind the missing ram as slightly more than 4 palms, or about 90 cm. from port to starboard wale (Fig. 2.18, A). In subsequent years, the ship was enveloped in a staircase leading up to the church of San Bartolomeo, but was still accessible enough for Friedrich Krauss to publish a series of detailed profile drawings in 1944.[40] He records the height of the port wale as roughly 38 cm. and this corresponds perfectly with Piranesi's plan (1.75 palms = 38 cm.). The monument alludes to the galley sent by Rome to Epidaurus to fetch the healing cult of Asclepius following a plague in the early third century BCE.[41] Although one cannot be certain of the ship's class, if the model is sculpted at full scale, or follows its original in every detail, it is clear from the size of its waterline wale that the original warship was larger than the "threes" we have just identified.[42] Such a conclusion also corresponds to the fact that Romans normally sent larger galleys, usually "fives," on mis-

38. The monument, located on the south end of the Tiber Island, was built in the first century BCE if we may judge from the stone used in its construction. See Göttlicher 1978, 81, no. 484, for bibliography not mentioned in my text and notes.

39. For Piranesi's plans and views, see Piranesi 1762, Tab. XI, XIIa-b, XIII; the best detailed view of the monument's prow appears in Vol. 4 of Piranesi's *Le Antichità Romane* (1756), Tab. XV. Piranesi used the late antique *palmus maior* roughly equal to 22.19 cm. These eighteenth-century works are now online as part of Brown University's Center for Digital Initiatives (http://dl.lib.brown.edu/index.html).

40. Krauss 1944, 159–72 with Beilagen I–VI. Piranesi's measurement of the monument's width (90 cm.) just behind the lost ram (see my Fig. 2.18, A) should be more accurate than the 120 cm. width Krauss calculates from traces and presents in his Section F. Krauss records the height of the port wale as roughly 37–38 cm. (Beilage VI, sections D´ = 37 cm.; E´ = 38 cm.; and F = 37 cm.).

41. For the details, see Richardson 1992, 3–4 (Aesculapius, Aedes) and 209–10 (Insula Tiberina). Basch 1987, 366, believes that the monument follows a Greek, not Roman, design.

42. Krauss 1944, 160, notes that the ship's width or beam is "greatly exaggerated" because it was built to conform to the island's topography. According to his analysis, the hull was widened without altering the ship's important characteristics or its overall appearance. While some features of the hull were deformed more than others, the height of vertical features like the wale remained unaffected.

sions involving prestige or ceremony.[43] Despite the uncertainty that such evidence frequently possesses, we will see from the next piece of evidence good reasons for identifying this warship with a "five."[44]

The second piece of evidence that helps to define the Athlit ship's class is a large marble ram found at Ostia just outside the Marina Gate near a funerary monument to honor one Gaius Cartilius Poplicola.[45] Since Poplicola's monument includes a sculpted frieze bearing at least two warships, it was thought by those who published the remains that a large marble ram, found some 68 meters to the north, was originally part of Poplicola's structure.[46] More recently, L. B. van der Meer has suggested that the ram belongs with a second funerary monument which he identifies with another Ostian notable, Publius Lucilius Gamala. Gamala is known from an inscription (*CIL* XIV, 375) to have donated money for a *bellum navale*, "naval war"—perhaps the war against Sextus Pompey in 38–36 BCE—which may explain the presence of the ram on this monument.[47] The ram in question is currently comprised of two blocks. The upper block, which seems to represent the ram's cowl with a lion's head protome, or decorative element, was found at the crossroads of the *decumanus* (the central N-S road) and the Via Epagathiana, about 350 m. to the northeast. The lower block was found where it is currently displayed, just to the north of the funerary monument at Regio III, Insula VII, Building 2.[48] The ram formed by these two blocks lacks certain "finished" elements like a bottom plate or indication of casting edges at the trough, and the cowl's forward edge does not match the nosing width on the top surface of the lower block (Fig. 2.19, B).

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43. See Appendix B: Physical Characteristics. Additional Characteristics of Usage.

44. J. F. Coates admits that the vessel can be reconstructed at a 1:1 scale as a two level "five," but dismisses this possibility because he feels that the resulting vessel would not be maximized for speed; see Coates in Morrison and Coates 1996, 296; Morrison (Morrison and Coates 1996, 229) suggests that the warship represents a "six." If "fives" were built primarily for their ramming characteristics and secondarily for speed, then Coates' objection is not a serious problem.

45. For this monument and its decorative relief, see Squarciapino et al. 1958, 171–81, 191–207; for the identity of Cartilius Poplicola, see Squarciapino et al. 1958, 209–19.

46. Such is the view expressed in the full publication of the monument: Squarciapino et al. 1958, 194–95, with Pls. 30–32, 39–43.

47. See Meer 2005, 101–102; he also argues (92, 101) that the funerary monument he identifies with Gamala is likely to be slightly earlier (ca. 30–20 BCE) than the monument of Poplicola (22–20 BCE).

48. See Squarciapino et al. 1958, 179, 194.

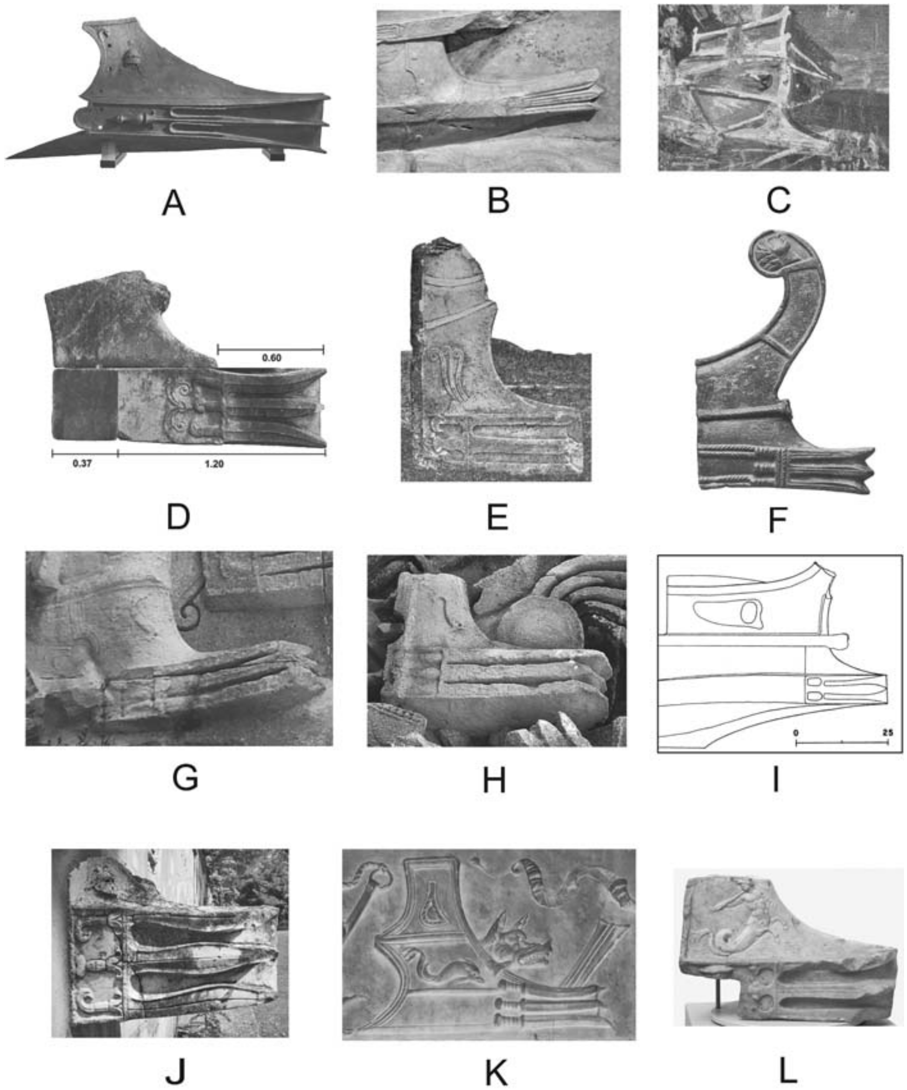

FIGURE 2.17 Rams from "warships of larger build." (A): Athlit ram (see Table 2.1; image mirrored). (B): Ram depicted on a warship relief from the Palatine. Augustan period. (C): Detail from a fresco panel showing paired warships, Temple of Isis, Pompeii. First century CE. (D): Marble ram, Ostia. Second half of first century BCE. (E): Marble ram, Nikopolis, Greece (now lost). Image (mirrored) from Papademetriou 1941, 30, Fig. 6. By permission of the Archaeological Society at Athens. (F): Bronze model of a ship's prow, formerly in the Altes Museum, Berlin (now lost). (G, H): Warship rams sculpted in relief on a triumphal arch at Orange (ancient Arausio), France. Reign of Tiberius. (I): Marble ship prow from Aquileia, Italy. First century CE. After a line drawing by A. L. Ermeti. (J): Marble ram, presumably from Rome or its environs (findpot unrecorded). Augustan period. Federico Zeri Collection, Mentana, Italy. (K): Ram on relief panel showing naval trophies and priests' emblems from Rome (precise findspot unrecorded). Augustan period. Palazzo dei Conservatori, Rome. (L): Marble ram, findspot unrecorded. Augustan period. Antikenmuseum, University of Leipzig.

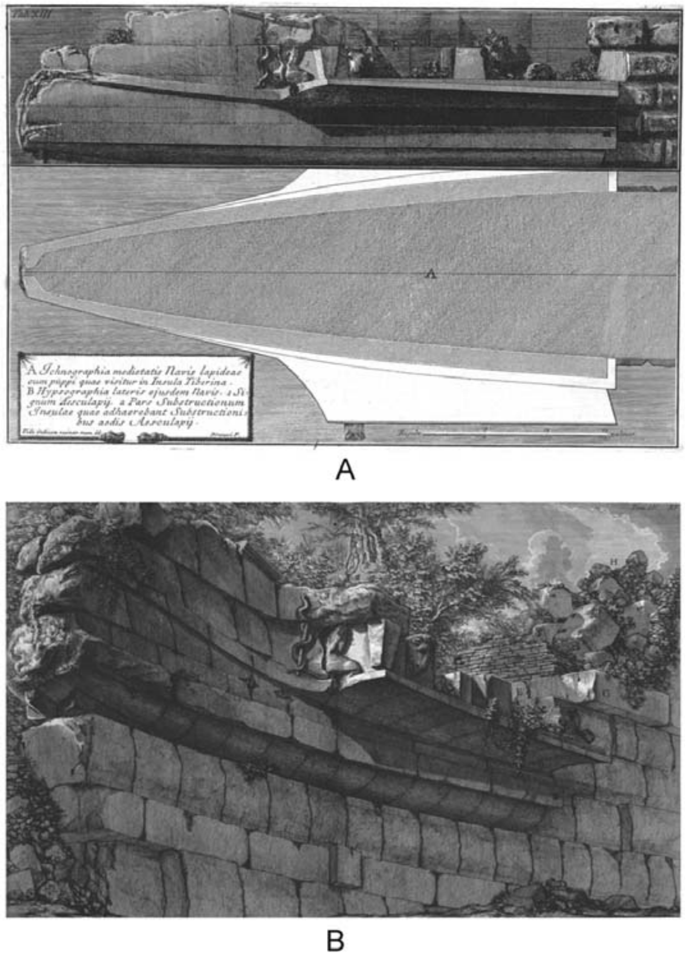

FIGURE 2.18 (A): Tiber Island Warship, side view and top plan by Giovanni-Battista Piranesi (1762). Vincent Buonanno Collection. (B): Tiber Island Warship, view from the ship's forward end by Piranesi (1756). Vincent Buonanno Collection.

Presumably, the ram's constituent blocks were placed in their current position because the clamp cuttings on the after ends of each block appeared to match (Fig. 2.19, C). This is unlikely, however, for the cuttings are carved to different depths, indicating they are not a matched pair.[49] If the blocks were precisely aligned according to the cuttings, the mismatch between the lower and upper block would become even more pronounced. Apart from the problems with the nosing contours, the blocks' current alignment produces a ram that is too stumpy in its proportions

49. The depth of the channel in the upper block is 0.014 m., while that of the lower block is 0.019 m.

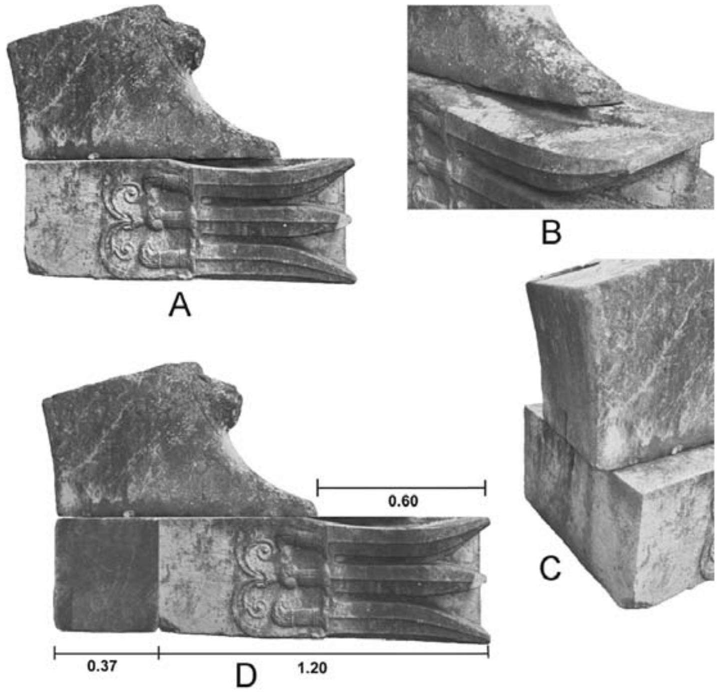

FIGURE 2.19 Marble ram, Ostia. Second half of first century BCE.

(Fig. 2.19, A). I suspect, therefore, that other blocks are missing from the original ensemble, and that the missing elements, if present, would alter the overall proportions of the ram's length, width, and height. For example, by repositioning the upper block to a point where its nosing contours seem to match the lower block, the ram's length, height, and width from trough to trough at its after end increase substantially (Fig. 2.19, D). If we cannot gain a sure sense of the ram's original size from its overall dimensions, we might still gauge its size from the height of its port and starboard troughs that measure 41.5 cm. This dimension is appropriate to receive wales equal in height to the one sculpted on the Tiber Island warship (Table 2.3).

A simple similarity in wale heights cannot be considered conclusive evidence, but it suggests that the scale of the Ostia weapon corresponds with the Tiber Island warship whose original model makes best sense as a "five." Furthermore, the Ostia ram's wale height corresponds to more than one of the smaller sockets (but not the smallest one) on the Actian Victory Monument at Nikopolis (Table 2.3). While these dimensions still require further refinement, they produce the following conditions:

1) The Ostia ram and Tiber Island warship seem to represent bow structures of roughly the same scale.
2) The wale height of this scale is almost twice that represented in the Athlit ram.
3) This scale corresponds to more than one of the *smaller* sockets on the Actian Victory Monument.
4) The Athlit ram corresponds to the *smallest* socket identified at the Victory Monument.
5) "Threes" seem to correspond to a set of rams smaller than the Athlit weapon.

Considering these five conditions and allowing for variances in size among different vessels of the same class, I believe it reasonable to conclude that the Athlit ram comes from a Hellenistic "four" and the Ostia ram and Tiber Island ship were modeled after the dimensions of a Roman "five." A more detailed analysis of the measurements from these monuments will be required to confirm this hypothesis fully, but I am hopeful we are close to resolving the issue.

Warships of "Larger" Size

Before concluding this discussion of pictorial images, we should note a few examples whose rams correspond to the characteristics of "larger"

Table 2.3 Trough Dimensions from Tiber Island Ship, Ostia Ram, and Sockets #13 and #15.

Ram / Ship / Socket	Width from port to starboard trough ears	Height of port trough	Height of starboard trough
Tiber Island Ship	90–120 cm.[1]	ca. 42 cm.[2]	–
Ostia Ram	ca. 90–100 cm.	41.5 cm.	41.5 cm.
Socket #13	103 cm.	37 cm.	40 cm.
Socket #15	100.5 cm.	44 cm.	40 cm.

1. Piranesi's measurement (1857) = 90 cm.; Krauss's measurement (1944) = 120 cm. from traces.
2. Since a 4 cm. difference exists between the height of the wale inside the Athlit ram and its trough height, I have estimated the total height of the trough for the Tiber island ship as roughly 42 cm.

weapons, but whose precise class cannot yet be determined. These include a sculpted ram that was found at Nikopolis in 1940 (Fig. 2.17, E, now lost), a sculpted warship of Augustan date in the Palatine Museum (B), a series of rams depicted on a relief from an Augustan building, now in the Capitoline Museum (K), a marble ram in the collection of the Archaeological Museum at the University of Leipzig (L), a marble ship's prow at Aquileia, Italy (I), and a detailed series of rams and prows sculpted on the first century CE triumphal arch at Orange in southern France (G, H). I might also add to this collection a sculpted warship ram, currently in the collection of the Villa Zeri outside Rome at Mentana (J), and the warships painted on a series of frescoes in the Temple of Isis at Pompeii (C). Although made by different artists at different times and for different purposes, each image (with one or two exceptions) displays the characteristic features of larger rams, including sizeable wales, deep trough pockets, and deep cowls.[50]

Of all these large examples, however, I wish to single out the warship rams from Orange because I feel they were modeled after the rams cut from Antony's prows at Actium. I say this because their rear profiles match perfectly the contours of the sockets at Nikopolis and because Actian rams would have provided natural models for the builders of this arch.[51] What is more, a few of these examples are shown on the bows of their warships (Fig. 2.20) and thus give the viewer an excellent sense of scale of rams from midsized polyremes ("sixes" to "tens") in relationship to their prows.

Conclusions

Our currently available evidence from authentic three-bladed waterline rams indicates the existence of two basic physical designs: one that corresponds to smaller warships and another that corresponds to larger ones. The dividing line seems to occur, just as Livy indicates, between the "threes" and "fours." The division between the two types involves significant differences in physical characteristics, namely, the length of the ram, the size of the wales, and the existence or non-existence of an enveloping cowl. These characteristics inform us about the main difference in performance between larger and

50. Certain problems can be seen in the Mentana ram (small scale, small cowl, and large wales), the Palatine Warship ram (which resembles the Athlit ram, but appears on the bow of a single-level warship), and Capitoline rams (which display an odd mix of characteristics). Each of these examples, however, resembles larger rams rather than smaller ones.

51. For the arch at Orange, see Amy et al. 1962; and Murray and Petsas 1989, 100–103 for the similarity between the profiles of the sockets and the rams depicted on this arch.

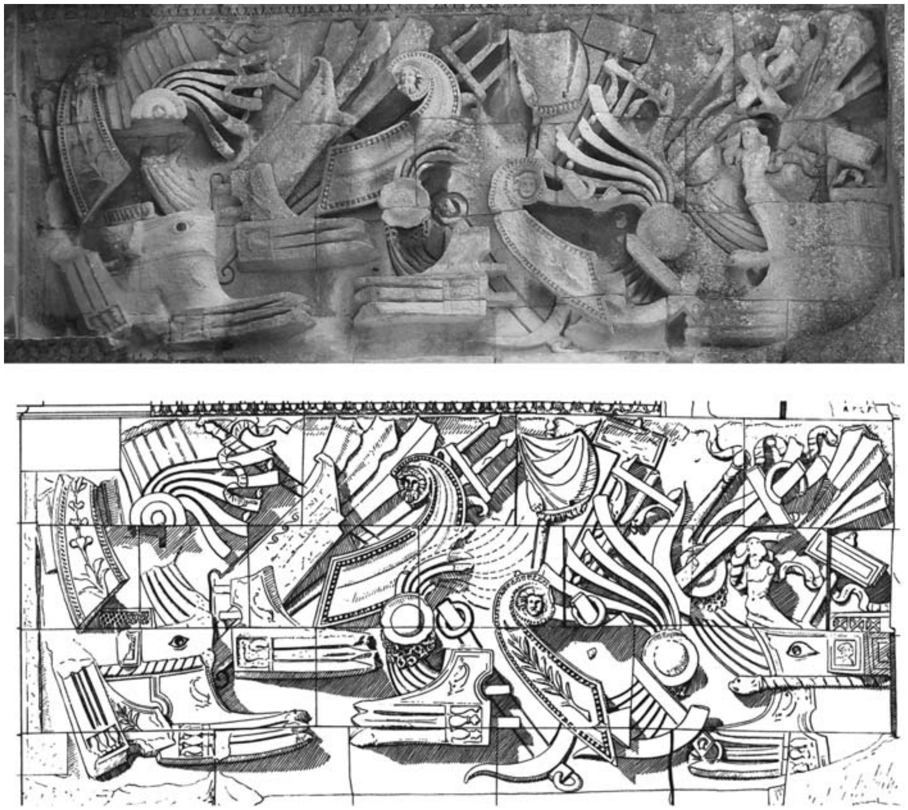

FIGURE 2.20 Panel showing naval spoils on a triumphal arch at Orange (ancient Arausio), France. Reign of Tiberius. Lower image from Amy et al. 1962, Plate 24.

smaller warships. Smaller warships were designed for speed and maneuverability and they tended to avoid prow-to-prow ramming attacks. These performance characteristics are indicated by their smaller rams, smaller wales, and lack of cowls. Larger warships were designed with heavier wales that required longer rams with deeper trough pockets and cowls to help distribute the shock of the ramming maneuver to the ship's structure, both below and above the waterline. These features correspond to the numerous references describing the use of frontal ramming techniques during this period. The evidence we possess for "fives" indicates that their wales are much heavier than those of "fours." This, too, is reflected in testimonia from the Hellenistic and Augustan periods that reveal the superiority of "fives" over "threes" and "fours" in frontal ramming encounters. As for ship representations, particularly those executed in large scale, one can see clear distinctions between smaller and larger rams as they are depicted on monuments from the fourth century BCE to the first century CE. The main differences parallel what we observe in authentic rams.

Until quite recently, our ability to visualize these changes in warship design depended entirely upon ancient texts and the power of our imaginations. We now know that the ram of a relatively small "cataphract" like the Athlit ship weighed more than one-half ton, and that it was so carefully manufactured that a modern metallurgist rates the quality of the cast at its ramming head as "aircraft grade." The intention was not to resist the vibrations produced by thousands of rpms but, rather, to withstand the crushing impact of head-to-head collisions with other warships of similar and larger mass. This simple quality—the need to resist failure in purposeful head-on collisions—must have played an important role in the development of larger and larger classes during the fourth and third centuries BCE. Driven by intense political rivalries, Alexander's successors drew from their stores of Persian treasure to build larger and heavier warships, one after another in quick succession. Because of the speed with which the new classes appeared, the driving force behind this "arms race," as it has been called, should have been something quite simple, like a desire to increase the warship's mass in order to increase the destructive power of its frontal ramming blow. When the Athlit ram was first discovered, many scholars wondered if it came from a large vessel like a "nine" or "ten."[52] We now know that the Athlit weapon was dwarfed by rams of this size that weighed perhaps four times as much and sheathed timbers four times more massive. As a result of this increase in mass, we can see how the new designs excelled in the kind of warfare that navies of this age were increasingly asked to perform—attacks on cities and their harbor defenses. Let us now turn to the subject of naval siege warfare.

52. See Morrison 1984, 216–17. It was once thought, incorrectly, that the weight of trireme rams could be calculated from an entry in the Athenian inventory lists. For the confusion this has caused in evaluating the class of the Athlit ram, see Murray 1985, 141 with notes.