

# Trireme

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A **trireme** (from Latin *triremis*, literally "three-oarer") was a type of galley, a Hellenistic-era warship that was used by the ancient maritime civilizations of the Mediterranean, especially the Phoenicians, ancient Greeks and Romans.

The trireme derives its name from its three rows of oars on each side, manned with one man per oar. The early trireme was a development of the penteconter, an ancient warship with a single row of 25 oars on each side, and of the bireme (Greek: δῆριππος), a warship with two banks of oars, probably of Phoenician origin.<sup>[1]</sup> As a ship it was fast and agile, and became the dominant warship in the Mediterranean from the 7th to the 4th centuries BC, when they were largely superseded by the larger quadriremes and quinqueremes. Triremes played a vital role in the Persian Wars, the creation of the Athenian maritime empire, and its downfall in the Peloponnesian War.

In English, no differentiation is made between the Greek *triērēs* and the Latin *triremis*. This is sometimes a source of confusion, as in other languages these terms refer to different styles of ships. Though the term today is used almost exclusively for ancient warships, modern historians also refer to medieval and early modern galleys with three banks of oars per side as triremes.<sup>[2]</sup> The rowing arrangement of these differed considerably, though, since knowledge of the multi-level structure of the original triremes was lost some time during Late Antiquity.



Roman trireme from Carthage, mosaic at Bardo Museum, Tunis

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## History

### Origin

The exact origin of the trireme is uncertain and debated, as our evidence comes from literary sources, depictions in reliefs and pottery fragments, which are open to misinterpretations. Depictions of two-tiered ships (*biremes*), with or without the *parexeiresia* (the outriggers, see below), are common in 8th century BC vases and pottery fragments, and it is at the end of that century that the first references to three-tiered ships are found. According to Thucydides, the trireme was *introduced to Greece* by the Corinthians in the late 8th century BC, and the Corinthian Ameinocles built four such ships for the Samians.<sup>[3]</sup> Although this was interpreted by later writers, Pliny and Diodorus, to mean that triremes were *invented* in Corinth,<sup>[4]</sup> it is likely that the earliest three-tiered warships originated in Phoenicia. Fragments from an 8th century relief at the Assyrian capital of Nineveh depicting the fleets of Tyre and Sidon have been interpreted as depicting two- and three-level warships, fitted with rams. The 2nd century Christian scholar Clement of Alexandria, drawing on earlier works, explicitly attributes the invention of the trireme (*trikrotos naus*, "three-tiered ship") to the Sidonians.<sup>[5]</sup>



Assyrian warship (probably built by Phoenicians) with two rows of oars, relief from Nineveh, ca. 700 BC

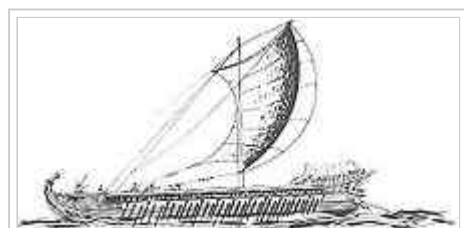
### Early use and development

Herodotus mentions that the Egyptian pharaoh Necho II (610–595 BC) built triremes on the Nile, for service in the Mediterranean, and in the Red Sea, but this reference is disputed by modern historians, and attributed to a confusion, since "triērēs" was by the 5th century used in the generic sense of "warship", regardless its type.<sup>[6]</sup> The first definite reference to the use of triremes in naval combat dates to ca. 525 BC, when, according to Herodotus, the tyrant Polycrates of Samos was able to contribute 40 triremes to a Persian invasion of Egypt.<sup>[7]</sup> Thucydides meanwhile clearly states that in the time of the Persian invasions, the majority of the Greek navies consisted of (probably two-tiered) penteconters and *ploia makrá* ("long ships").<sup>[8]</sup>

In any case, by the early 5th century, the trireme was becoming the dominant warship type of the eastern Mediterranean, with minor differences between the "Greek" and "Phoenician" types, as literary references and depictions of the ships on coins make clear. The first large-scale naval battle where triremes participated was the Battle of Lade during the Ionian Revolt, where the combined fleets of the Greek Ionian cities were defeated by the Persian fleet, composed of squadrons from their Phoenician, Carian, Cypriot and Egyptian subjects.



The Lenormant Relief, from the Athenian Acropolis, depicting the rowers of an *aphract* Athenian trireme, ca. 410 BC. Found in 1852, it is one of the main pictorial testaments to the layout of the trireme.



## The Persian Wars

A Greek trireme.

Partly as a result of Athenian support to the Ionian Greeks, the Persian Great King Darius started moving against metropolitan Greece. The Persian fleet roamed the Aegean Sea unopposed, but the first invasion force was defeated at the Battle of Marathon in 490 BC. The second invasion, under Xerxes, included a massive land army and a large navy, which were to cooperate closely.

Athens was at that time embroiled in a conflict with the neighbouring island of Aegina, which possessed a formidable navy. In order to counter this, and possibly with an eye already at the mounting Persian preparations, in 482 BC the Athenian statesman Themistocles used his political skills and influence to persuade the Athenian assembly to start the construction of 200 triremes, using the income of the newly discovered silver mines at Lavrion. The first clash with the Persian navy was at the Battle of Artemisium, where both sides suffered great casualties. However, the decisive naval clash occurred at Salamis, where Xerxes' invasion fleet was decisively defeated.

After Salamis and another Greek victory over the Persian fleet at Mycale, the Ionian cities were freed, and the Delian League was formed under the aegis of Athens. Gradually, the predominance of Athens turned the League effectively into an Athenian

Empire. The source and foundation of Athens' power was her strong fleet, composed of over 200 triremes. It not only secured control of the Aegean Sea and the loyalty of her allies, but also safeguarded the trade routes and the grain shipments from the Black Sea, which fed the city's burgeoning population. In addition, as it provided permanent employment for the city's poorer citizens, the fleet played an important role in both maintaining and promoting the radical Athenian form of democracy. Athenian maritime power is the first example of thalassocracy in world history. Aside from Athens, other major naval powers of the era included Syracuse, Corfu and Corinth.

"Tereus: *Where are you from?*

Euelpides: *From where the good triremes come (i.e. Athens)"*

*Aristophanes, The Birds*

In the subsequent Peloponnesian War, naval battles fought by triremes were crucial in the power balance between Athens and Sparta. Despite numerous land engagements, Athens was finally defeated through the destruction of her fleet during the Sicilian Expedition and finally, at the Battle of Aegospotami, at the hands of Sparta and her allies.

## Design

No surviving written source gives complete information on the construction or form of the trireme. Already in the 4th century, the writer Zosimus lamented the loss of the information concerning the trireme's construction.<sup>[9]</sup> It is worth noting that with the 1987 construction of *Olympias*, historians and researchers became aware of how dreadful the conditions aboard triremes truly were. For example, *Olympias* had to be cleaned every five days due to the stench of 170 rowers' sweat. Keep in mind that these modern rowers used toilet facilities, presumably unlike the rowers in antiquity.<sup>[10]</sup>



Model of a Greek trireme

Because the triremes had positive buoyancy, no remains of the ship have been found on the seabed,<sup>[11]</sup> and scholars have had to rely on indirect evidence in texts, depictions on monuments and amphorae, as well as indirect archaeological evidence, most prominently the ship sheds of Piraeus. Most of it concerns the "classical" type of the 5th century, especially as used by Athens. Valuable further information as to the validity of past assumptions was provided by the trireme reconstruction project (see below).

Triremes required a great deal of upkeep in order to stay afloat, as references to the replacement of ropes, sails, rudders, oars and masts in the middle of campaigns suggest.<sup>[10][12]</sup> They also would become waterlogged if left in the sea for too long. In order to prevent this from happening, ships would have to be pulled from the water during the night. The use of lightwoods meant that the ship could be carried ashore by as few as 140 men.<sup>[13]</sup> Beaching the ships at night however, would leave the troops vulnerable to surprise attacks. While well-maintained triremes would last up to 25 years, during the Peloponnesian War, Athens had to build nearly 20 triremes a year to maintain their fleet of 300.<sup>[10]</sup>



*Olympias*, a reconstruction of an ancient Athenian trireme.

The Athenian trireme had two great cables of about 47 mm in diameter and twice the ship's length called *hypozomata* (undergirding), and carried two spares. They were possibly rigged fore and aft from end to end along the middle line of the hull just under the main beams and tensioned to 13.5 tonnes force. The *hypozomata* were considered important and secret: their export from Athens was a capital offence.<sup>[14]</sup> This cable would act as a stretched tendon straight down the middle of the hull, and would have prevented hogging. Additionally, hull plank butts would remain in compression in all but the more severe sea conditions, reducing working of joints and consequent leakage.<sup>[15]</sup> The *hypozomata* would also have significantly braced the structure of the trireme against the stresses of ramming, giving it an important advantage in combat.<sup>[16]</sup>

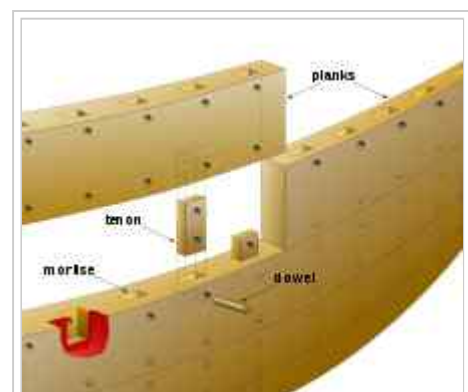
## Dimensions

Excavations of the ship sheds (*neōsoikoi*) at the harbour of Zea in Piraeus, which was the main war harbour of ancient Athens, were first carried out by I. Dragatsis and Wilhelm Dörpfeld in the 1880s.<sup>[17]</sup> These have provided us with a general outline of the Athenian trireme. The sheds were ca. 40 m long and just 6 m wide. These dimensions are corroborated by the evidence of Vitruvius, whereby the individual space allotted to each rower was 2 cubits.<sup>[18]</sup> With the Doric cubit of 0.49 m, this results in an overall ship length of just under 37 m.<sup>[19]</sup> The height of the sheds' interior was established as 4.026 metres<sup>[citation needed]</sup>, leading to estimates that the height of the hull above the water surface was ca. 2.15 metres. Its draught was relatively shallow, about 1 metre, which, in addition to the relatively flat keel and low weight, allowed it to be beached easily.<sup>[citation needed]</sup> This works

## Construction

Construction of the trireme differed from modern practice. The construction of a trireme was expensive and required around 6000 man-days of labor to complete.<sup>[20]</sup> The ancient Mediterranean practice was to build the outer hull first, and the ribs afterwards. To secure and strengthen the hull, cables (*hypozōmata*) were employed, fitted in the keel and stretched by means of windlasses. Hence the triremes were often called "girded" when in commission.<sup>[21]</sup>

The triremes were made of softwoods, primarily pine and fir, with the latter preferred, according to Theophrastos, for its lightness. Larch and plane were used for the ship's interior parts.<sup>[12]</sup> The large requirements of timber for ship



The mortise and tenon joint method of hull construction employed in ancient vessels.

construction led not only to the deforestation of much of southern Greece, but also to imports of timber from Macedon and Thrace, or even from as far as Lebanon.<sup>[12]</sup>

The use of lightwoods meant that the ship could be carried ashore by as few as 140 men,<sup>[13]</sup> but also that the hull soaked up water, which adversely affected its speed and maneuverability.

Once the triremes were seaworthy, it is argued that they were highly decorated with, "eyes, nameplates, painted figureheads, and various ornaments". These decorations were used both to show the wealth of the patrician and to make the ship frightening to the enemy. The home port of each trireme was signaled by the wooden statue of a deity located above the bronze ram on the front of the ship.<sup>[22]</sup> In the case of Athens, since most of the fleet's triremes were paid for by wealthy citizens, there was a natural sense of competition among the patricians to create the "most impressive" trireme, both to intimidate the enemy and to attract the best oarsmen.<sup>[22]</sup> Of all military expenditure, triremes were the most labor- and (in terms of men and money) investment-intensive.

## Propulsion and capabilities

The ship's primary propulsion came from the 170 oars (*kōpai*), arranged in three rows, with one man per oar. Evidence for this is provided by Thucydides, who records that the Corinthian oarsmen carried "each his oar, cushion (*hypersion*) and oarloop".<sup>[23]</sup> The ship also had two masts, a main (*istos megas*) and a small foremast (*istos akateios*), with square sails, while steering was provided by two steering oars at the stern (one at the port side, one to starboard).

Classical sources indicate that the trireme was capable of sustained speeds of ca. 6 knots at a relatively leisurely pace.<sup>[24]</sup> There is also a reference by Xenophon of a single day's voyage from Byzantium to Heraclea Pontica, which translates as an average speed of 7.37 knots.<sup>[25]</sup> These figures seem to be corroborated by the tests conducted with the reconstructed *Olympias*: a maximum speed of 8 knots and a steady speed of 4 knots could be maintained, with half the crew resting at a time.<sup>[26]</sup>

The distance a trireme could cover in a given day depended much on the weather. On a good day, the oarsmen, rowing for 6–8 hours, could propel the ship between fifty and sixty miles. There were rare instances however when experienced crews and new ships were able to cover nearly twice that distance (Thucydides mentions a trireme traveling 184 miles in one day).<sup>[27]</sup> The commanders of the triremes also had to stay aware of the condition of their men. They had to keep their crews comfortably paced so as not to exhaust them before battle.

## Crew

The total complement (*plērōma*) of the ship was about 200.<sup>[28][29]</sup> These were divided into the 170 rowers (*eretai*), who provided the ship's motive power, the deck crew headed by the trierarch, and a marine detachment. Perhaps the most interesting aspect pertaining to the men who composed the crew of the Athenian triremes was the fact that the ships were an extension of their democratic beliefs. The rich and poor rowed alongside each other and, as Victor Davis Hanson points out, "Served the larger civic interest of acculturating thousands as they worked together in cramped conditions and under dire circumstances."<sup>[30]</sup>

In the Athenian fleet, during the Peloponnesian War, there are a few variations to the typical crew layout of a trireme. One variation used a drastically reduced number of oarsmen so as to use the ship as a troop transport. The thranites would row from the top benches, while the rest of the space below would be filled up with hoplites. Another variation, which the Athenians used for transporting horses (the Athenian fleet had about 10 or so of these ships),<sup>[31]</sup> had 60 oarsmen, leaving the rest of the ship open for horses.

By design the trireme was meant for day-long journeys, with no capacity to stay at sea over night or carry the necessary provisions to sustain the men it carried. There were however storage facilities on board large enough to provide each crewman with the 2 gallons of fresh drinking water he would need to stay hydrated each day.<sup>[32]</sup> This meant that all those aboard were dependent upon the land and peoples of where they landed each night for supplies. Sometimes this would entail traveling up to fifty miles in order to procure the necessary provisions. In the Peloponnesian War, the beached Athenian fleet was caught unawares on more than one occasion, while out looking for food (Battle of Syracuse and Battle of Aegospotami). The cities, which suddenly found themselves needing to provide for all these sailors were usually agreeable and did not mind the extra business, but those in charge of the fleet and/or mission had to be careful not to completely deplete the 'host' city of resources.<sup>[33]</sup>

## Trierarch

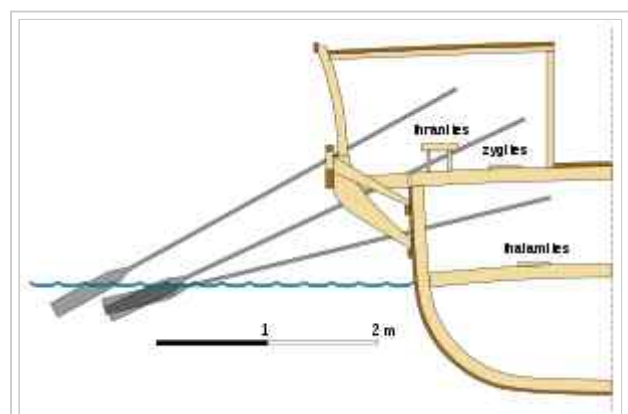
The ship's captain was known as the trierarch (*triērarchos*). He was a wealthy Athenian citizen (usually from the class of the *pentakosiomedimoi*), responsible for manning and maintaining the ship for 35 years, which otherwise belonged to Athens. The *triērarchia* was one of the liturgies of ancient Athens, and although it afforded great prestige, it constituted a great financial burden, so that in the 4th century, it was often shared by two citizens, and after 397 BC it was assigned to special boards.

## Deck crew

The deck and command crew (*hypēresia*) was headed by the helmsman, the *kybernētēs*, who was always an experienced seaman and was often the actual commander of the vessel. These experienced sailors were to be found on the upper levels of the triremes. Other officers were the bow lookout (*prōreus* or *prōratēs*), the boatswain (*keleustēs*), the quartermaster (*pentēkontarchos*), the shipwright (*naupēgos*), the piper (*aulētēs*) who gave the rowers' rhythm and two *toicharchoi*, in charge of the rowers on each side of the ship. What constituted these sailors' experience was a combination of superior rowing skill (physical stamina and/or consistency in hitting with a full stroke) and previous battle experience. The sailors were likely in their thirties and forties.<sup>[34]</sup> In addition, there were ten sailors handling the masts and the sails.<sup>[35]</sup>

## Rowers

Contrary to popular perception, in the ancient navies, crews were composed not of galley slaves but of free men. In the Athenian case in particular, service in the ships was the integral part of the military service provided by the lower classes, the *thētai*, although metics and hired foreigners were also accepted.<sup>[36][37]</sup> Although it has been argued that slaves formed part of the rowing crew in the Sicilian Expedition,<sup>[38]</sup> a typical Athenian trireme crew during the Peloponnesian War consisted of 80 citizens, 60 metics and 60 foreign hands.<sup>[39]</sup> Indeed, in the few emergency cases where slaves were used to crew ships, these were deliberately set free, usually before being employed.<sup>[40]</sup> For instance, the tyrant Dionysius I of Syracuse once set all slaves of Syracuse free to man his galleys, employing thus freedmen, but otherwise relied on citizens and foreigners as oarsmen.<sup>[41]</sup>



Depiction of the position and angle of the rowers in a trireme. The form of the *parexeiresia*, projecting from the deck, is clearly visible.

In the Athenian navy, the crews enjoyed long practice in peacetime, becoming skilled professionals and ensuring Athens' supremacy in naval warfare. The rowers were divided according to their positions in the ship into *thranitai*, *zygitai*, and *thalamitai*. According to the excavated Naval Inventories, lists of ships' equipment compiled by the Athenian naval boards, there were:

- 62 *thranitai* in the top row (*thranos* means "deck"). They rowed through the *parexeiresia*, an outrigger which enabled the inclusion of the third row of oars without significant increase to the height and loss of stability of the ship. Greater demands were placed upon their strength and synchronization than on those of the other two rows.<sup>[42]</sup>
- 54 *zygitai* in the middle row, named after the beams (*zygoi*) on which they sat.<sup>[42]</sup>
- 54 *thalamitai* or *thalamioi* in the lowest row, (*thamos* means "hold"). Their position was certainly the most uncomfortable, being underneath their colleagues and also exposed to the water entering through the oarholes, despite the use of the *askōma*, a leather sleeve through which the oar emerged.<sup>[43]</sup>

Coordinating the rowing required great skill and practice. It is not known exactly how this was done, but there are literary and visual references to the use of gestures and pipe playing to convey orders to rowers. In the sea trials of the reconstruction *Olympias*, it was evident that this was a difficult problem to solve, given the amount of noise that a full rowing crew generated. In Aristophanes play *The Frogs* two different rowing chants can be found: "*ryppapai*" and "*o opop*", both corresponding quite well to the sound and motion of the oar going through its full cycle.<sup>[44]</sup>

## Marines

A varying number of marines (*epibatai*), usually 10–20, were carried aboard for boarding actions. At the Battle of Salamis, each Athenian ship was recorded to have 14 hoplites and 4 archers (usually Scythian mercenaries) on board,<sup>[45]</sup> but Herodotus narrates that the Chiots had 40 hoplites on board at Lade<sup>[46]</sup> and that the Persian ships carried a similar number.<sup>[47]</sup> This reflects the different practices between the Athenians and other, less professional navies. Whereas the Athenians relied on speed and maneuverability, where their highly trained crews had the advantage, other states favored boarding, in a situation that closely mirrored the one that developed during the First Punic War. Grappling hooks would be used both as a weapon and for towing damaged ships (ally or enemy) back to shore. When the triremes were along side each other, marines would either spear the enemy or hop across and cut the enemy down with their swords.<sup>[48]</sup> As the presence of too many heavily armed hoplites on deck tended to destabilize the ship, the *epibatai* were normally seated, only rising to carry out any boarding action.<sup>[49]</sup> The hoplites belonged to the middle social classes, so that they came immediately next to the trierarch in status aboard the ship.

## Tactics

In the ancient world, naval combat relied on two methods: ramming and boarding. Artillery in the form of ballistas and catapults was widespread, especially in later centuries, but its inherent technical limitations meant that it could not play a decisive role in combat. Rams (*embolon*) were fitted to the prows of warships, and were used to rupture the hull of the enemy ship. The preferred method of attack was to come in from astern, with the aim not of creating a single hole, but of rupturing as big a length of the enemy vessel as possible. The speed necessary for a successful impact depended on the angle of attack; the greater the angle, the lesser the speed required. At 60 degrees, 4 knots was enough to penetrate the hull, while it increased to 8 knots at 30 degrees. If the target for some reason was in motion in the direction of the attacker, even less speed was required, and especially if the hit came amidships.<sup>[50]</sup> Another method was to brush alongside the enemy ship, with oars drawn in, in order to break the enemy's oars and render the ship immobile, to be finished off with ease. In any

case, prior to engagement, the masts and railings of the ship were taken down, hindering any attempt at using grappling hooks. The Athenians especially became masters in the art of ramming, using light, un-decked (*aphraktai*) triremes.

### On-board forces

Unlike the naval warfare of other eras, boarding an enemy ship was not the primary offensive action of triremes. Triremes' small size allowed for a limited number of marines to be carried aboard. During the 5th and 4th centuries, the trireme's strength was in its maneuverability and speed, not its armor or boarding force. That said, fleets less confident in their ability to ram were prone to load more marines onto their ships.

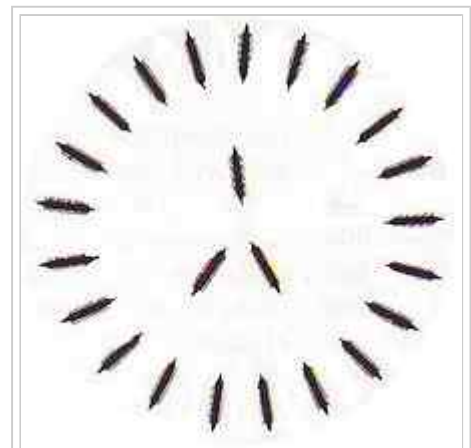
On the deck of a typical trireme in the Peloponnesian War there were 4 or 5 archers and 10 or so marines.<sup>[51]</sup> These few troops were peripherally effective in an offensive sense, but critical in providing defense for the oarsmen. Should the crew of another trireme board, the marines were all that stood between the enemy troops and the slaughter of the men below. It has also been recorded that if a battle were to take place in the calmer water of a harbor, oarsmen would join the offensive and throw stones (from a stockpile aboard) to aid the marines in harassing/attacking other ships.<sup>[51]</sup>

Most of the rowers (108 of the 170 - the *zygitai* and *thalamitai*), due to the design of the ship, were unable to see the water and therefore, rowed blindly.<sup>[52]</sup>

### Naval strategy in the Peloponnesian War

Squadrons of triremes employed a variety of tactics. The *periplous* (Gk., "sailing around") involved outflanking or encircling the enemy so as to attack them in the vulnerable rear; the *diekplous* (Gk., "Sailing out through") involved a concentrated charge so as to break a hole in the enemy line, allowing galleys to break through and then wheel to attack the enemy line from behind; and the *kyklos* (Gk., "circle") and the *mēnoeidēs kyklos* (Gk. "half-circle"), were defensive tactics to be employed against these manoeuvres. In all of these manoeuvres, the ability to accelerate faster, row faster, and turn more sharply than one's enemy was very important.

It is well known that Athens' strength in the Peloponnesian War came from its navy, whereas Sparta's came from its land-based Hoplite army. As the war progressed however the Spartans came to realize that if they were to undermine Pericles' strategy of outlasting the Peloponnesians by remaining within the walls of Athens indefinitely (a strategy made possible by Athens' Long Walls and fortified port of Piraeus), they were going to have to do something about Athens superior naval force. Once Sparta gained Persia as an ally, they had the funds necessary to construct the new naval fleets necessary to combat the Athenians. Sparta was able to build fleet after fleet, eventually destroying the Athenian fleet at the Battle of Aegospotami. The Spartan General Brasidas best summed up the difference in approach to naval warfare between the Spartans and the Athenians: "Athenians relied on speed and maneuverability on the open seas to ram at will clumsier ships; in contrast, a Peloponnesian armada might win only when it fought near land in calm and confined waters, had the greater number of ships in a local theater, and if its better-trained marines on deck and hoplites on shore could turn a sea battle into a contest of infantry."<sup>[53]</sup> In addition, compared to the high-finesse of the Athenian navy (superior oarsmen who could outflank and ram enemy triremes from the side), the Spartans (as well as their allies and other enemies of



A schematic view of what the circular *kyklos* formation would have looked like from above.



Athens) would focus mainly on ramming Athenian triremes head on. It would be these tactics, in combination with those outlined by Brasidas, that led to the defeat of the Athenian fleet at the Second Battle of Syracuse during the Sicilian Expedition.

### **Paying the price at sea**

Once a naval battle was underway, for the men involved, there were numerous ways for them to meet their end. Drowning was perhaps the most common way for a crew member to perish. Once a trireme had been rammed, the ensuing panic that engulfed the men trapped below deck no doubt extended the amount of time it took the men to escape. Inclement weather would greatly decrease the crew's odds of survival, leading to a situation like that off Cape Athos in 411 (12 of 10,000 men were saved).<sup>[54]</sup> An estimated 40,000 Persians died in the Battle of Salamis. In the Peloponnesian War, at the Battle of Arginusae six Athenian generals were executed for failing to rescue several hundred of their men clinging to wreckage in the water.<sup>[55]</sup>

If the men did not meet a watery grave, they might be taken prisoner by the enemy. In the Peloponnesian War, "Sometimes captured crews were brought ashore and either cut down or maimed - often grotesquely, by cutting off the right hand or thumb to guarantee that they could never row again."<sup>[56]</sup> The image found on an early-5th-century black-figure, depicting prisoners bound and thrown into the sea being pushed and prodded under water with poles and spears, shows that enemy treatment of captured sailors in the Peloponnesian War was often quite brutal.<sup>[57]</sup> The idea of troops being speared amid the wreckage of destroyed ships seems the most common way of dealing with enemy sailors in the Peloponnesian War.

Naval Battles were far more of a spectacle than the hoplite battles on land. Sometimes the battles raging at sea were watched by thousands of spectators on shore.<sup>[48]</sup> Along with this greater spectacle, came greater consequences for the outcome of any given battle. Whereas the average percentage of fatalities from a land battle were between 10-15%, in a sea battle, the forces engaged ran the risk of losing their entire fleet. The number of ships and men in battles was sometimes very high. At the Battle of Arginusae for example, 263 ships were involved, making for a total of 55,000 men, and at the Battle of Aegospotami more than 300 ships and 60,000 seamen were involved.<sup>[58]</sup> In Battle of Aegospotami, the city-state of Athens lost what was left of its navy: the once 'invincible' thalassocracy lost 170 ships (costing some 400 talents), and the majority of the crews were either killed, captured or lost.<sup>[58]</sup>

## **Changes of engagement and construction**

During the Hellenistic period, the light trireme was supplanted by larger warships in dominant navies, especially the pentere/quinquereme. The maximum practical number of oar banks a ship could have was three. So the numbers did not refer to the banks of oars any more (for biremes, triremes and quinqueremes), but to the number of rowers per vertical section, with several men on each oar. The reason for this development was the increasing use of armour on the bows of warships against ramming attacks, which again required heavier ships for a successful attack. This increased the number of rowers per ship, and also made it possible to use less well-trained personnel for moving these new ships. This change was accompanied by an increased reliance on tactics like boarding, missile skirmishes and using warships as platforms for artillery.

Triremes continued to be the mainstay of all smaller navies. While the Hellenistic kingdoms did develop the quinquereme and even larger ships, most navies of the Greek homeland and the smaller colonies could only afford triremes. It was used by the Diadochi Empires and sea powers like Syracuse, Carthage and later Rome. The difference to the classical 5th century Athenian ships was

that they were armoured against ramming and carried significantly more marines. Lightened versions of the trireme and smaller vessels were often used as auxiliaries, and still performed quite effectively against the heavier ships, thanks to their greater manoeuvrability.

With the rise of Rome the biggest fleet of quinqueremes temporarily ruled the Mediterranean, but during the civil wars after Caesar's death the fleet was on the wrong side and a new warfare with light liburnians was developed. By Imperial times the fleet was relatively small and had mostly political influence, controlling the grain supply and fighting pirates, who usually employed light biremes and liburnians. But instead of the successful liburnians of the Greek Civil War, it was again centred around light triremes, but still with many marines. Out of this type of ship, the dromon developed.

## Reconstruction

*Main article: Olympias (trireme)*

In 1985–1987 a shipbuilder in Piraeus, financed by Frank Welsh (an author, Suffolk banker, writer and trireme enthusiast), advised by historian J. S. Morrison and naval architect John F. Coates (who with Welsh founded the Trireme Trust that initiated and managed the project), and informed by evidence from underwater archaeology, built a reconstructed Athenian trireme, *Olympias*.

Crewed by 170 volunteer oarsmen and oarswomen, *Olympias* in 1988 achieved 9 knots (17 km/h or 10.5 mph). These results, achieved with inexperienced crew, suggest that the ancient writers were not exaggerating about straight-line performance. In addition, *Olympias* was able to execute a 180 degree turn in one minute and in an arc no wider than two and one half (2.5) ship-lengths. Additional sea trials took place in 1987, 1990, 1992 and 1994. In 2004 *Olympias* was used ceremonially to transport the Olympic Flame from the port of Keratsini to the main port of Piraeus as the 2004 Olympic Torch Relay entered its final stages in the run-up to the 2004 Summer Olympics opening ceremony.

The builders of the reconstruction project concluded that it effectively & conclusively proved what had previously been in doubt, i.e.- that Athenian triremes were arranged with the crew positioned in a staggered arrangement on three levels with one person per oar. This architecture would have made optimum use of the available internal dimensions. However since modern humans are on average approximately 6 cm (2 inches) taller than Ancient Greeks (and the same relative dimensions can be presumed for oarsmen and other athletes), the construction of a craft which followed the precise dimensions of the ancient vessel led to cramped rowing conditions and consequent restrictions on the modern crew's ability to propel the vessel with full efficiency, which perhaps explains why the ancient speed records stand unbroken.

## See also

- Trierarch
- Penteconter

## Notes

- ↑ Casson (1995), pp. 57–58
- ↑ See index in Morrison (2004) for examples.
- ↑ Thucydides I.13.2-5
- ↑ Diodorus, *Bibliotheca historica*, XIV.42.3
- ↑ *Stromata*, I.16.36
- ↑ The Age of the Galley, p. 45-46
- ↑ Herodotus, III.44

8. ^ Thucydides I.14.1-3
9. ^ Zosimus, *Historia Nova*, V.20
10. ^ <sup>a b c</sup> Hanson (2006), p. 260
11. ^ The Age of the Galley, p. 62
12. ^ <sup>a b c</sup> Fields (2007), p. 10
13. ^ <sup>a b</sup> *IG I.153*
14. ^ The 18th Jenkin Lecture, 1 October 2005: Some Engineering Concepts applied to Ancient Greek Trireme Warships (<http://www.soue.org.uk/souenews/issue5/jenkinlect.html>)
15. ^ Proceedings of 1st INTERNATIONAL SYMPOSIUM ON SHIP CONSTRUCTION IN ANTIQUITY PIRAEUS, 30 AUGUST - 1 SEPTEMBER 1985: THE TRIERES, ITS DESIGN AND CONSTRUCTION (<http://ina.tamu.edu/library/tropis/volumes/1/Coats,%20John%20-%20The%20trieres,%20its%20design%20and%20construction.pdf>)
16. ^ SHIPS & WAYS OF OTHER DAYS, BY E. KEBLE CHATTERTON ([http://www.archive.org/stream/shipswaysofother00chatrich/shipswaysofother00chatrich\\_djvu.txt](http://www.archive.org/stream/shipswaysofother00chatrich/shipswaysofother00chatrich_djvu.txt))
17. ^ Piraeus: Cantharus, Zea, Munichia (<http://www.rgzm.de/Navis2/Home/HarbourFullTextOutput.cfm?HarbourNR=Piraeus>) , from the Römisch-Germanisches Zentralmuseum of Mainz
18. ^ Vitruvius, *De architectura* I.2.4
19. ^ Fields (2007), p. 8
20. ^ Hanson (2006), p. 262
21. ^ Fields (2007), p. 9
22. ^ <sup>a b</sup> Hanson (2006), p. 239
23. ^ Thucydides, II.93.3
24. ^ The Age of the Galley, p. 58–59
25. ^ The Age of the Galley, p. 58
26. ^ Adrian Goldsworthy, *The Fall of Carthage: The Punic Wars 265-246 BC*, Cassell 2003, p. 98
27. ^ Hanson (2006), p. 261
28. ^ Thucydides VI.8, VIII.29.2
29. ^ Xenophon, *Hellenica*, I.5.3-7
30. ^ Hanson (2006), p. 252
31. ^ Hanson (2006), p. 257
32. ^ Hanson (2006), p. 258
33. ^ Hanson (2006), p. 259)
34. ^ A War Like No Other, p. 238-9
35. ^ Fields (2007), p. 14–15
36. ^ Rachel L. Sargent, “The Use of Slaves by the Athenians in Warfare”, *Classical Philology*, Vol. 22, No. 3 (Jul., 1927), pp. 264-279 (266-268)
37. ^ Ruschenbusch, Eberhard, “Zur Besatzung athenischer Trieren“, *Historia*, Vol. 28 (1979), pp. 106-110 (106 & 110)
38. ^ A. J. Graham, “Thucydides 7.13.2 and the Crews of Athenian Triremes”, *Transactions of the American Philological Association*, Vol. 122 (1992), pp. 257-270 (258-262)
39. ^ Ruschenbusch, Eberhard, “Zur Besatzung athenischer Trieren“, *Historia*, Vol. 28 (1979), pp. 106-110 (110)
40. ^ Casson (1991), p. 188
41. ^ Rachel L. Sargent, “The Use of Slaves by the Athenians in Warfare”, *Classical Philology*, Vol. 22, No. 3 (Jul., 1927), pp. 264-279 (277)
42. ^ <sup>a b</sup> Fields (2007), p. 13
43. ^ Fields (2007), p. 13-14
44. ^ Morrison, Coats & Rankov (2000), pp. 248-50
45. ^ Plutarch, *Parallel Lives* Themistocles XIV
46. ^ Herodotus, VI.15.2
47. ^ Herodotus, VII.184.2
48. ^ <sup>a b</sup> Hanson (2006), p. 254
49. ^ Fields (2007), p.15
50. ^ John Coates, "The Naval Architecture and Oar Systems of Ancient Galleys" in *The Age of the Galley*, p. 133.
51. ^ <sup>a b</sup> Hanson (2006), p. 242
52. ^ Hanson (2006), p. 240
53. ^ Hanson (2006), p. 255
54. ^ Hanson (2006), p. 246-47
55. ^ Hanson (2006), p. 246

- 56. <sup>^</sup> Hanson (2006), p. 247-8
- 57. <sup>^</sup> Hanson (2006), p. 248
- 58. <sup>^ a b</sup> Hanson (2006), p. 264

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## External links

- *A Dictionary of Greek and Roman Antiquities* (1890), entry on "Warships" (http://www.perseus.tufts.edu/cgi-bin/ptext?doc=Perseus:text:1999.04.0063&query=id%3D%234755&word=trireme)
- E. J. de Meester's page (http://home.tiscali.nl/~meester7/engtrireme.html)
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- History and archeology of the ship - lecture notes - 26. Triremes (http://www.cma.soton.ac.uk/HistShip/shlect26.htm) , from the Centre for Maritime Archaeology of the University of Southampton
- Merchant ships page (http://gmsbc.blogspot.com/)
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