

Medieval Shipping

A Wikipedia Compilation

by

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Contents

1	Caravel	1
1.1	History	1
1.2	Design	1
1.3	See also	2
1.4	References	2
1.5	External links	2
2	Carrack	6
2.1	Origins	8
2.2	Carracks in Asia	10
2.3	Famous carracks	10
2.4	See also	12
2.5	References	12
2.6	Further reading	12
2.7	External links	12
3	Cog (ship)	13
3.1	Design	14
3.2	History	14
3.3	Gallery	15
3.4	See also	15
3.5	References	15
3.5.1	Footnotes	15
3.5.2	Bibliography	15
3.6	External links	15
4	Fire ship	16
4.1	History	16
4.1.1	Ancient era, first uses	17
4.1.2	Age of fighting sail, refinement	17
4.1.3	Use in the Greek War of Independence	18
4.1.4	19th and 20th centuries, obsolescence	18
4.2	Notable uses	18

4.3	See also	19
4.4	References	19
4.5	External links	20
5	Hellburners	24
5.1	History	24
5.1.1	First use against Antwerp ship bridge	25
5.1.2	Influence on the Battle of Gravelines	26
5.2	References	26
5.3	External links	26
6	Galleon	27
6.1	Etymology	27
6.2	History	27
6.3	Construction	30
6.4	Distinguishing features	30
6.5	The oldest English drawings	30
6.6	Notable galleons	30
6.7	In Literature	32
6.8	See also	32
6.9	Notes	32
6.10	References	32
6.11	External links	33
7	Galley	34
7.1	Definition and terminology	35
7.2	History	36
7.2.1	The first warships	38
7.2.2	Hellenistic era and rise of the Republic	39
7.2.3	Roman Imperial era	39
7.2.4	Eastern Mediterranean	40
7.2.5	Western Mediterranean	41
7.2.6	Development of the true galley	41
7.2.7	Transition to sailing ships	42
7.2.8	Introduction of guns	44
7.2.9	Mediterranean decline	45
7.2.10	Use in northern Europe	46
7.3	Construction	48
7.3.1	The trireme	49
7.3.2	Roman era	50
7.3.3	Middle Ages	51
7.3.4	Standardization	52

7.4	Propulsion	54
7.4.1	Rowing	54
7.4.2	Galley slaves	55
7.4.3	Sails	57
7.5	Armament and tactics	57
7.5.1	Introduction of the ram	57
7.5.2	Boarding prevails	57
7.5.3	Gun galleys	59
7.6	Royal prestige and power symbolism	60
7.7	Surviving examples	62
7.7.1	Original vessels	62
7.7.2	Reconstructions	63
7.7.3	Archaeological finds	63
7.8	Notes	63
7.9	References	69
7.10	External links	71
8	Junk (ship)	72
8.1	Etymology	73
8.2	Building	73
8.2.1	Sail plan	73
8.2.2	Hull design	74
8.3	History	77
8.3.1	2nd century junks (Han Dynasty)	77
8.3.2	10–13th century junks (Song Dynasty)	78
8.3.3	14th century junks (Yuan Dynasty)	78
8.3.4	15–17th century junks (Ming Dynasty)	79
8.3.5	Accounts of medieval travellers	81
8.3.6	19th century junks (Qing Dynasty)	82
8.3.7	20th century junks	84
8.4	See also	86
8.5	Notes	86
8.6	References	88
8.7	External links	88
9	Longship	90
9.1	Types of longships	91
9.1.1	Karvi	91
9.1.2	Snekja	91
9.1.3	Skeid	91
9.1.4	Drekkar	92
9.1.5	Transport	92

9.2	Construction	92
9.2.1	Keel, stems and hull	94
9.2.2	Timber	96
9.2.3	Sail and mast	96
9.2.4	Rudder	97
9.2.5	Anchors	97
9.2.6	Ship builders toolkit	97
9.2.7	Replica longships	98
9.3	Navigation and propulsion	98
9.3.1	Navigation	98
9.3.2	Propulsion	99
9.4	Legacy	99
9.5	Notable longships	100
9.6	See also	101
9.7	Notes	101
9.8	References	102
9.9	External links	102
10	Louchuan	103
10.1	Description	104
10.2	References	104
10.3	See also	104
10.4	Text and image sources, contributors, and licenses	105
10.4.1	Text	105
10.4.2	Images	107
10.4.3	Content license	111

Chapter 1

Caravel

Not to be confused with **Carvel** (boat building).

A **caravel** (Portuguese: *caravela*, IPA: [kə'rə'velə]) is a small, highly maneuverable **sailing ship** developed in the 15th century by the Portuguese to explore along the West African coast and into the Atlantic Ocean. The **lateen** sails gave her speed and the capacity for sailing to **windward** (beating). Caravels were used by the Portuguese for the oceanic exploration voyages during the 15th and 16th centuries in the **age of discovery**.

1.1 History

Until the 15th century, Europeans were limited to coastal **cabotage** navigation using the **barge** (*barca*) or the **balinger** (*barinel*), ancient **Mediterranean** cargo vessels of around 50 to 200 tons. These boats were fragile, with only one mast with a fixed square **sails** that could not overcome the navigational difficulties of Southward oceanic exploration, as the strong winds, **shoals** and strong **ocean currents** easily overwhelmed their abilities.

The caravel was developed in about 1451, based on existing fishing boats under the sponsorship of Prince Henry the Navigator of Portugal, and soon became the preferred vessel for Portuguese explorers like Bartholomeu Dias, Vasco Da Gama or Ferdinand Magellan (Fernão de Magalhães). Its name may derive from an ancient boat type known as *carabus* in **Latin** and *καραβός* in **Greek**, later **Arabized** to *qārib'*, *indicating some continuity of its carvel build through the ages*.^[2] *They were agile and easier to navigate, with a tonnage of 50 to 160 tons and 1 to 3 masts, with lateen triangular sails allowing beating.*

Being smaller and having a shallow **keel**, the caravel could sail upriver in shallow coastal waters. With the lateen sails attached, it was highly maneuverable and could sail much nearer the wind, while with the square Atlantic-type sails attached, it was very fast. Its economy, speed, agility, and power made it esteemed as the best sailing vessel of its time. The limited capacity for cargo and crew were their main drawbacks, but did not hinder its success.

The exploration done with caravels made possible the **spice trade** of the Portuguese and the Spanish. However, for the trade itself, the caravel was later replaced by the larger **nau** which was more profitable for trading. The caravel was one of the pinnacle ships in Iberian Ship Development from 1400-1600.

1.2 Design

Due to its lighter weight and thus greater speed, the caravel was a boon to sailors. Early caravels generally carried two or three masts with lateen sails, while later types had four masts. Early caravels such as the *caravela tilhada* of the 15th century had an average length of between 12 and 18 m (40 to 60 feet), an average capacity of 40 to 50 tons,^[3] a high length-to-beam ratio of around 3.5 to 1, and narrow ellipsoidal frame (unlike the circular frame of the **nau**), making them very fast and maneuverable but with somewhat low capacity. Towards the end of the 15th century, the caravel was occasionally modified by giving it the same rig as a **carrack** with a **foresail**, **square mainsail** and **lateen mizzen**, but not the carrack's high **forecastle** or much of a **sternpalace**, which would make it unweatherly. In this form it was sometimes known as *caravela redonda* (a bulging square sail is said to be round, *redonda*, in the Iberian tradition). It was in such ships that Christopher Columbus set out on his expedition in 1492; *Santa Maria* was a ~100 ton **carrack** (same as: **nau**) which served as the flagship, and *Pinta* and *Niña* were smaller caravels of around 15–20

m with a beam of 6 m and displacing around 60-75 tons.

In the transition to the 16th century, the Portuguese created a specialized fighting ship also called *caravela redonda* or square rigged caravel (also *caravela de armada*), to act as an escort in Brazil and in the East Indies route. It had a foremast with square sails and three other masts with a lateen each, for a total of 4 masts. The hull was galleon-shaped, and it is considered a forerunner of the fighting galleon. The Portuguese Man o' War was named after this curious type of fighting ship which was in use until the 17th century.

1.3 See also

- Iberian ship development, 1400–1600
- Notorious - a replica caravel in Australia

1.4 References

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- [2] Sleeswyk, André W. (1998). "Carvel-planking and Carvel Ships in the North of Europe". *Archaeonautica* 14: 223–228 (224f.).
- [3] Russell, Peter E. (2000). *Prince Henry 'the Navigator': A Life*. Yale University Press. p. 229. ISBN 0-300-09130-3.

1.5 External links

- *Museu da Marinha* (Portuguese)
- *Museu da Marinha, fac-similes*, (Portuguese)
- *Instituto Camões. Caravela*
- *Durchbruch am Kap des Schreckens dir. Axel Engstfeld, Germany 2002, 52m. ZDF* (German)



Portuguese caravel. This was the standard model used by the Portuguese in their voyages of exploration. The lateen rigged caravel was able to sail close to the wind, closer than square rigged vessels.. It could accommodate about 20 sailors.^[1]



A lateen-rigged caravel, Caravela Latina



A replica of the caravel Boa Esperança in the city of Lagos, Portugal



A typical round caravel or caravela de armada (of 1501-1502), with origin in the Portuguese model of caravela redonda or square-rigged caravel (Livro das Armadas). There were also some other European and Mediterranean types of ships, also called round caravels, during the turn of the century and in the 16th century



Lisbon and the Tagus (1572). Galleon in the center (one type of Portuguese galleon), carracks, galley, round caravels, and caravels (lateen), among other vessels

Chapter 2

Carrack

For the rocks off the Cornish coast, see [The Carracks](#).

A **carrack** or **nau** was a three- or four-masted sailing ship developed in the 15th century by the [Genoese](#) for use in

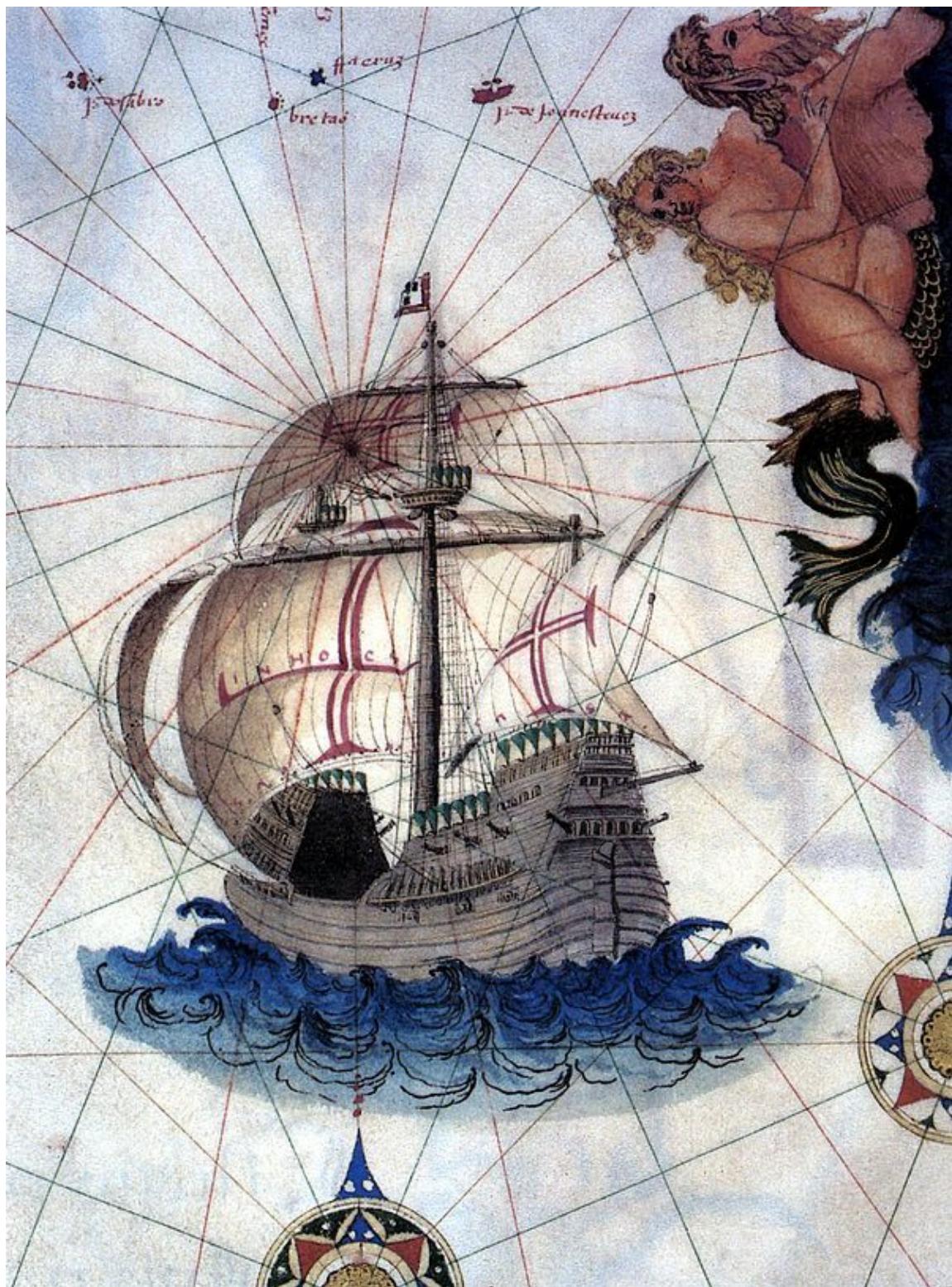


The first portrayed carrack in a Sienese painting from 1300 by A. Lorenzetti .

commerce. They were widely used by Europe's 15th-century maritime powers, from the Mediterranean to northwest Europe, although each region had models of slightly different design. The [Portuguese](#) and the [Spanish](#) utilized them for oceanic travel and to explore the world. They were usually [square-rigged](#) on the [foremast](#) and [mainmast](#) and [lateen-rigged](#) on the [mizzenmast](#). They had a high rounded [stern](#) with large [aftcastle](#), [forecastle](#) and [bowsprit](#) at the [stem](#).

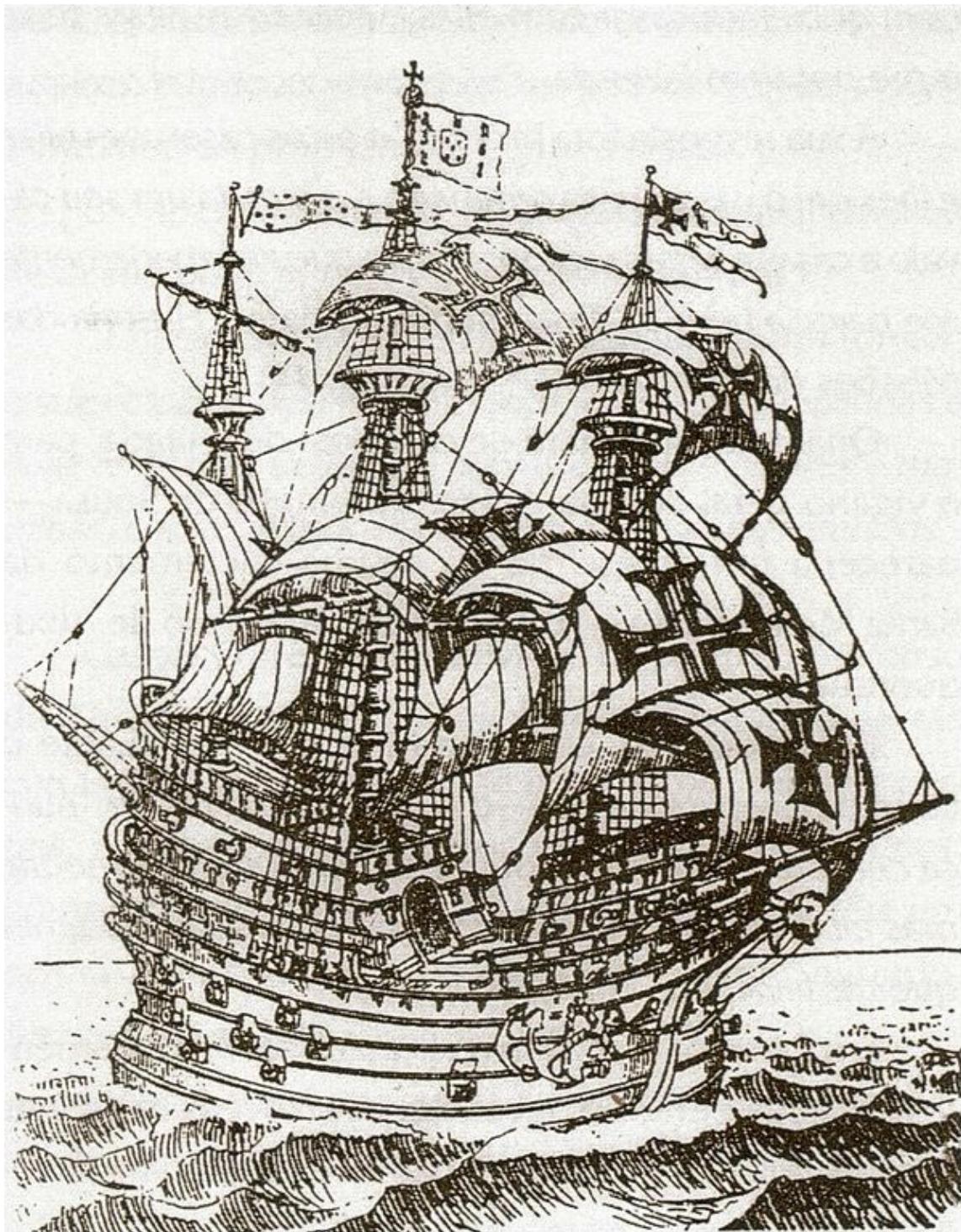
Carracks were ocean-going ships: large enough to be stable in heavy seas, and roomy enough to carry provisions for long voyages. In Genoese the ship was called **caracca** or **nao** (ship), in Portuguese **nau**, while in Spanish **carraca** or **nao**. In French it was called a **caraque** or **nef**. The name carrack probably derives from the Arab **Harraqa**, a type of ship that first appeared along the shores of the Tigris and Euphrates rivers around the 9th century.

As the forerunner of the great ships of the [age of sail](#), the carrack was one of the most influential ship designs in



A Portuguese Carrack, as depicted in a map made in 1565.

history; while ships became more specialized, the basic design remained unchanged throughout this time period.^[1]



Famous nau Frol de la Mar (launched in 1501 or 1502), in the 16th-century “Roteiro de Malaca”

2.1 Origins

By the Late Middle Ages the cog, and cog-like square-rigged vessels, were widely used along the coasts of Europe, in the Baltic, and also in the Mediterranean. Given the conditions of the Mediterranean, but not exclusively restricted to it, **galley** type vessels were extensively used there, as were various two masted vessels, including the **caravels** with their lateen sails. These and similar ship types were familiar to Portuguese navigators and shipwrights. As the Portuguese gradually extended their explorations and trade ever further south along Africa's Atlantic coast during the 15th century they needed a larger and more advanced ship for their long oceanic adventures. Gradually, they developed their own



Nao Victoria, one of the most famous carracks, a *replica* of Magellan's ship

models of oceanic carracks, generalizing their use in the end of the century for inter-oceanic travel. In addition to the average tonnage naus, were also built some large naus (carracks) in the reign of John II, but being only widespread after the turn of the century. The Portuguese carracks were usually very large ships for their time (often over 1000 tons), and having the future large naus of the India run and of the China and Japan trade, also other new types of design.

The origin of the word *carrack* is usually traced back through the medieval European languages to the *Arabic*, and

from thence to the Greek κέρκουρος (*kerkouros*) meaning approximately "lighter (barge)" (literally, "shorn tail", a possible reference to the ship's flat stern). Its attestation in Greek literature is distributed in two closely related lobes. The first distribution lobe, or area, associates it with certain light and fast merchantmen found near **Cyprus** and **Corfu**. The second is an extensive attestation in the **Oxyrhynchus** corpus, where it seems most frequently to describe the Nile barges of the **Ptolemaic** pharaohs. Both of these usages may lead back through the **Phoenician** to the **Akkadian** *kalakku*, which denotes a type of river barge. The Akkadian term is assumed to be derived from a Sumerian antecedent. Sumerian antecedent A modern reflex of the word is found in Arabic and **Turkish** *kelek* "raft; riverboat".^[2] from a fusion and modification of aspects of the ship types they knew operating in both the Atlantic and Mediterranean and a new, more advanced form of sail rigging that allowed much improved sailing characteristics in the heavy winds and waves of the Atlantic ocean.

A typical three-masted carrack such as the *São Gabriel* had six sails: bowsprit, foresail, mizzen, spritsail, and two topsails.

2.2 Carracks in Asia

From around 1515, Portugal had trade exchanges with **Goa** in **Portuguese India**, consisting of 3 to 4 carracks leaving **Lisbon** with silver to purchase cotton and spices in India. Out of these, only one carrack went on to **Ming China** in order to purchase silk, also in exchange for Portuguese silver.

From the time of the acquisition of **Macau** in 1557, and their formal recognition as trade partners by the Chinese, the Portuguese Crown started to regulate trade to **Japan**, by selling to the highest bidder the annual "Captaincy" to Japan, in effect conferring exclusive trading rights for a single carrack bound for Japan every year. That trade continued with few interruptions until 1638, when it was prohibited on the grounds that the ships were smuggling priests into Japan.

In the middle of the 16th century the first **galleons** were developed from the carrack. The galleon design came to replace that of the carrack although carracks were still in use as late as the early 17th century.

2.3 Famous carracks



Columbus' Ships (G.A. Closs, 1892): The Santa Maria and Pinta are shown as carracks; the Niña (left), as a caravel.



Model of the carrack Madre de Deus, in the Maritime Museum, Lisbon. Built based on another design, later in Portugal (1589), she was the largest ship in the world in its time. She had seven decks

- *Santa María*, in which Christopher Columbus made his first voyage to America in 1492.
- *São Gabriel*, flagship of Vasco da Gama, in the 1497 Portuguese expedition from Europe to India by circumnavigating Africa.
- *Flor do Mar* or *Flor de la Mar*, served over nine years in the Indian Ocean, sinking in 1512 with Afonso de Albuquerque after the conquest of Malacca with a huge booty, making it one of the mythical lost treasures.
- *Victoria*, the first ship in history to circumnavigate the globe (1519 to 1522), and the only survivor of the Spanish expedition.
- *La Dauphine*, Verrazzano's ship to explore the Atlantic coast of North America in 1524.
- *Grande Hermine*, in which Jacques Cartier first navigated the Saint Lawrence River in 1535. The first European ship to sail on this river past the Gulf.
- *Santo António*, or *St. Anthony*, the personal property of King John III of Portugal, wrecked off Gunwalloe Bay in 1527, the salvage of whose cargo almost led to a war between England and Portugal.
- *Great Michael*, a Scottish ship, at one time the largest in Europe.
- *Mary Rose*, *Henri Grâce à Dieu* and *Peter Pomegranate*, built during the reign of Henry VIII — English military carracks like these were often called great ships.
- *Grace Dieu*, commissioned by Henry V
- *Santa Catarina do Monte Sinai*, a war ship built in India by the Portuguese
- *Santa Anna*, a particularly modern design commissioned by the Knights Hospitaller in 1522 and sometimes hailed as the first armoured ship.

- *Madre de Deus*, which was seized by the Royal Navy off Flores Island. Built in Lisbon during 1589, it was the world's largest ship. It was stolen by the English in 1592 with an enormously valuable cargo that is still considered as the second-largest treasure ever found.
- *Santa Catarina*, Portuguese carrack which was seized by the Dutch East India Company off Singapore in 1603.
- *Nossa Senhora da Graça*, Portuguese carrack sunk in a Japanese attack near Nagasaki in 1610
- *Peter von Danzig*, ship of the Hanseatic League in 1460s-1470s.

2.4 See also

- Medieval ships
- Portuguese India Armadas

2.5 References

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2.6 Further reading

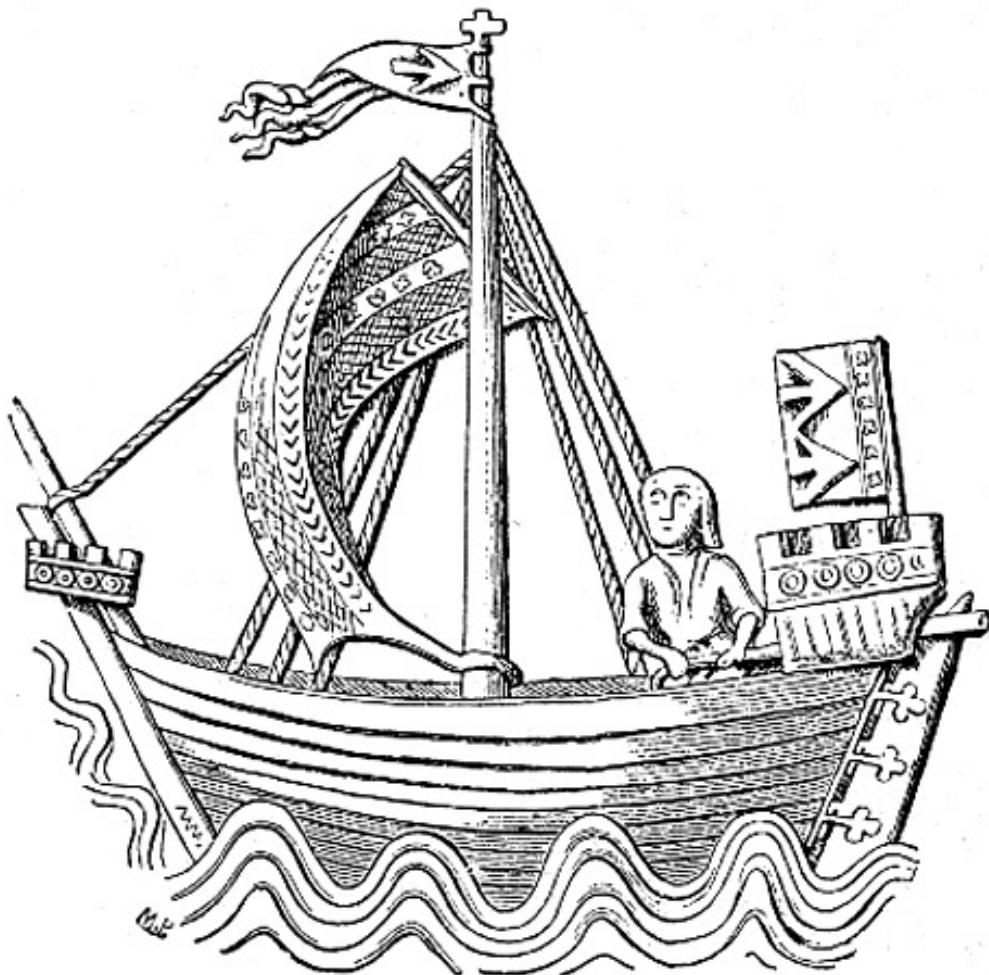
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2.7 External links

- The Development of the Square-Rigged Ship: *from the carrack to the full-rigger*
- Computer modeling of a Portuguese carrack

Chapter 3

Cog (ship)



Relatively proportioned cog in the Seal of Stralsund

A **cog** (or **cog-built** vessels) is a type of ship that first appeared in the 10th century, and was widely used from around the 12th century on. Cogs were generally built of oak, which was an abundant timber in the Baltic region of Prussia. This vessel was fitted with a single mast and a square-rigged single sail. These vessels were mostly associated with seagoing trade in medieval Europe, especially the Hanseatic League, particularly in the Baltic Sea region. They ranged from about 15 meters to 25 meters in length (49 ft to 82 ft) with a beam of 5 to 8 meters (16 ft to 26 ft), and the largest cog ships could carry up to about 200 tons.^[1]

3.1 Design

Cogs were characterized by a flush-laid flat bottom at midships but gradually shifted to overlapped strakes near the posts. They had full **lapstrake** planking covering the sides, generally starting from the bilge strakes, and double-clenched **iron** nails for plank fastenings. The **keel**, or keelplank, was only slightly thicker than the adjacent garboards and had no **rabbet**. Both **stem** and **stern** posts were straight and rather long, and connected to the keelplank through intermediate pieces called **hooks**. The lower plank hoods terminated in **rabbets** in the hooks and posts, but upper hoods were nailed to the exterior faces of the posts. **Caulking** was generally tarred moss that was inserted into curved grooves, covered with wooden laths, and secured by metal staples called **sintels**. Finally, the cog-built structure could not be completed without a stern-mounted hanging central **rudder**, which was a unique northern development.^[2] Cogs used to have open hulls and could be rowed short distances. In the 13th century they received decks.

The most famous cog still in existence today is the **Bremen cog** from the 1380s.

3.2 History

Cogs are first mentioned in 948 AD, in **Muiden** near Amsterdam. These early cogs were influenced by the Norse **Knarr**, which was the main trade vessel in northern Europe at the time, and probably used a steering oar, as there is nothing to suggest a stern rudder in northern Europe until about 1240.^[3]



Reconstructed excavated cog from 1380 at Deutsches Schifffahrtmuseum

Current archaeological evidence points to the Frisian coast, Western Jutland, as the possible birthplace of this type of vessel. The transformation of the cog into a true seagoing trader came not only during the time of the intense trade between West and East, but also as a direct answer to the closure of the western entrance to the **Limfjord**. For centuries, Limfjord in northern Jutland offered fairly protected passage between the **North Sea** and the Baltic. Due to unusual geographical conditions and strong currents, the passage was constantly filling with sand and was completely blocked by the 12th century. This change produced new challenges. Bigger ships that could not be pulled across the sand bars had to sail around the Jutland peninsula and circumnavigate the dangerous Cape **Skagen** to get to the Baltic. This resulted in major modifications to old ship structures, which can be observed by analyzing evolution of the earliest cog finds of **Kollerup**, **Skagen**, and **Kolding**.

The need for spacious and relatively inexpensive ships led to the development of the first workhorse of the **Hanseatic**

League, the cog. The new and improved cog was no longer a simple Frisian coaster but a sturdy seagoing trader, which could cross even the most dangerous passages. Fore and stern castles would be added for defense against pirates, or to enable use of these vessels as warships, such as used at the [Battle of Sluys](#).

Eventually, around the 14th century, the cog reached its structural limits, resulting in the desperate need for a quick replacement. The replacement, the [hulk](#), already existed but awaited reconditioning. Although there is no evidence that hulks descended from the cogs, it is clear that a lot of technological ideas were adapted from one to the other and vice versa.^[4] The transition from cogs to hulks was not linear. According to some interpretations, both vessels coexisted for many centuries but followed diverse lines of evolution.^[5]

3.3 Gallery

- Model of a cog
- Reconstruction of the cog “[Roland von Bremen](#)”
- Cross-section of hull

3.4 See also

- Medieval ships
- Knarr

3.5 References

3.5.1 Footnotes

- [1] “[Hamburg Museum - Medieval Hamburg \(4\) - The Cog - A Cargo-carrying Vessel of the Middle Ages](#)”. Retrieved April 5, 2013.
- [2] Hocker, 1991; Crumlin-Pedersen, 2000
- [3] Description and pictures of cogs
- [4] Crumlin-Pedersen, 2000
- [5] Gardiner & Unger, 1994

3.5.2 Bibliography

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- Gardiner, R. & Unger, R. 1994. *Cogs, caravels and galleons: the sailing ship, 1000–1650*. Annapolis.

3.6 External links

- Description and pictures of cogs
- The sailing properties of the Hanse cog in comparison with other cargo sailships
- Pictures of the Kampen cog replica High resolution photos

Chapter 4

Fire ship

This article is about a ship deliberately set on fire. For the firefighting vessel, see [Fireboat](#).

A **fire ship**, used in the days of wooden rowed or sailing ships, was a ship filled with combustibles, deliberately set



Dutch fire ship attack on the English flagship Royal James at the Battle of Solebay (1672). Painting by Willem van de Velde the Younger

on fire and steered (or, where possible, allowed to drift) into an enemy fleet, in order to destroy ships, or to create panic and make the enemy break formation.^[1] Ships used as fire ships were usually old and worn out or purpose-built inexpensive vessels. An explosion ship or *hellburner* was a variation on the fire ship, intended to cause damage by blowing up in proximity to enemy ships. Fireships were famously used to great effect by the English against the Spanish Armada during the Battle of Gravelines.^[2]

4.1 History

4.1.1 Ancient era, first uses

See also: Early thermal weapons

Possibly the oldest account of the military use of a fire ship is recorded by the Greek historian **Thucydides** on the occasion of the failed **Athenian Sicilian Expedition** (415–413 BC).^[3] In the episode, the Athenian expeditionary force successfully repels an attack by the **Syracusans**:

The rest [of the Athenian force] the enemy tried to burn by means of an old merchantman which they filled with faggots and pine-wood, set on fire and let drift down the wind which blew full on the Athenians. The Athenians, however, alarmed for their ships, contrived means for stopping it and putting it out, and checking the flames and the nearer approach of the merchantman, thus escaped the danger.

A fire ship was used in the **Battle of Red Cliffs** (208) on the **Yangtze River** when **Huang Gai** assaulted the enemy naval force with a fire ship filled with bundles of kindling, dry reeds, and fatty oil.

Fire ships were decisively employed by the **Vandals** against the armada sent by the Eastern Roman Empire, in the **Battle of Cap Bon** (468).

The invention of **Greek fire** in 673 increased the use of fire ships, at first by the Greeks and afterward by other nations as they came into possession of the secret of manufacturing this substance. In 951 and again in 953 **Russian** fleets narrowly escaped destruction by fire ships.

4.1.2 Age of fighting sail, refinement

While fire ships were used in the Medieval period, notably during the **crusades**, these were typically ships that were set up with combustibles on an adhoc basis. The career of the modern fire ship, as a naval vessel type designed for this particular function and made a permanent addition to a fleet, roughly parallels the era of cannon-armed sailing ships, beginning with the defeat of the Spanish Armada in 1588 and lasting until the English victory over the Turks at the **Battle of Navarino** in 1827. The first modern fireships were put to use in early 17th century Dutch and Spanish fleet actions during the **Thirty Years War**. Their use increased throughout that century, with purpose-built fireships a permanent part of many naval fleets, ready to be deployed whenever necessary. While only used sparingly during the Napoleonic Wars, fire ships as a distinct class were part of the British Royal Navy until 1808, at which point the use of permanently designated fire ships attached to British squadrons disappeared.^[4] Fire ships continued to be used, sometimes to great effect such as by the U.S. Navy at the **Battle of Tripoli Harbor** in 1804 and by the British Navy's **Thomas Cochrane** at the **Battle of the Basque Roads** in 1809, but for the most part they were considered an obsolete weapon by the early 19th century.

Warships of the **age of sail** were highly vulnerable to fire. Made of wood, with seams caulked with tar, ropes greased with fat, and stores of gunpowder, there was little that would not burn. Accidental fires destroyed many ships, so fire ships presented a terrifying threat. With the wind in exactly the right direction a fire ship could be cast loose and allowed to drift onto its target, but in most battles fire ships were equipped with **skeleton crews** to steer the ship to the target (the crew were expected to abandon ship at the last moment and escape in the ship's boat). Fire ships were most devastating against fleets which were at anchor or otherwise restricted in movement. At sea, a well-handled ship could evade a fire ship and disable it with cannon fire. Other tactics were to fire at the ship's boats and other vessels in the vicinity, so that the crew could not escape and therefore might decide not to ignite the ship, or to wait until the fire ship had been abandoned and then tow it aside with small maneuverable vessels such as **galleys**.

The role of incendiary vessels changed throughout the age of the modern fire ship. The systematic use of fire ships as part of naval actions peaked around the **Third Anglo-Dutch War**. Whereas just twenty years before a naval fleet might have six to seven fire ships, by the **Battle of Solebay** in 1672 both the Dutch and English fleets employed typically between 20 and 30 fire ships, and sometimes more.^[5] By this time, however, admirals and captains had become very experienced with the limitations of fire ship attacks and had learned how to avoid them during battle. Great numbers of fire ships were expended during the **Third Dutch War** without destroying enemy men-of-war, and fire ships had become a way to harass and annoy the enemy, rather than destroy him.^[6] The successful use of fire ships at the **Battle of La Hogue** and **Cherbourg** in 1692 marked both the greatest achievement of a fire ship attack since the Spanish Armada, and also the last significant success for fire ships. Though fire ships as a specified class sailed with the British Royal Navy for another century, they would never have a significant impact on a naval victory. Once the most feared weapons in naval arsenals, fire ships had declined in both importance and numbers, so that by the mid-18th century

only five to six British fire ships would be at sea at a time, and the Royal Navy attempted only four attacks using modern fire ships between 1697 and 1800.^[7] Hastily outfitted ad hoc fire ships continued to be used in naval warfare; for example, a large number of fire rafts were used in mostly ineffective attacks on the British fleet by American forces during the American Revolution at Philadelphia, on the Hudson River, and elsewhere. The end of the modern fire ship came in the early 19th century, when the British began to use hastily outfitted fire ships at engagements such as Boulogne and Dunkirk despite the presence of purpose-built fire ships in the fleet. The last modern fire ship in the British Royal Navy was *Thais*, the only designated fire ship out of the entire navy of 638 warships when she was converted to a ship sloop in 1808.^[8]

4.1.3 Use in the Greek War of Independence

In the **Greek War of Independence**, 1821-1832, the extensive use of fire ships by the Greeks allowed them to counterbalance the Turkish naval superiority in terms of ship size and artillery power.^[9] As the small fire ships were much more maneuverable than enemy ships of the line, especially in the coasts of the Aegean Sea where the islands, islets, reefs, gulfs and straits restrained big ships from being easily moved, they were a serious danger for the ships of the Turkish fleet. Many naval battles of the Greek war of independence were won by the use of fire ships. The successful use of fireships required the use of the element of surprise (a visible similarity with modern day naval special operations). It is considered an important landmark in Greek naval tradition.

4.1.4 19th and 20th centuries, obsolescence

From the beginning of the 19th century, **steam** propulsion and the use of iron, rather than wood, in shipbuilding gradually came into use, making fire ships less of a threat. During **World War II** in September 1940, there was a British sortie codenamed **Operation Lucid** to send old oil tankers into French ports to destroy barges intended for the planned invasion of Britain; it was abandoned when both tankers broke down.^[10] Ships or boats packed with explosives could still be effective. Such a case was **Operation Chariot** of 1942, in which the old destroyer **HMS Campbeltown** was packed with explosives and rammed into the dry dock at Saint-Nazaire, France, to deny its use to the battleship **Tirpitz**, which could not drydock anywhere else on the French west coast. In the Mediterranean, the **Italian Navy** made good use of high-speed boats filled with explosives, mostly against moored targets. Each boat, called by the Italians **MTM (Motoscafo da Turismo Modificato)**, carried 300 kilograms (660 lb) of explosive charge inside its bow. Their best-known action was the 1941 assault on Souda Bay, which resulted in the destruction of cruiser **HMS York** and the Norwegian tanker **Pericles**, of 8,300 tons.^{[11][12]}

In 1946, as part of **Operation Crossroads**, the American landing ship **LSM-60** demonstrated the potential of explosives ships containing **nuclear weapons**. Eight vessels were sunk in the test in addition to **LSM-60**, including the aircraft carrier **Saratoga**.^[13] The successful attack by Yemeni insurgents in a speedboat packed with explosives on the guided missile destroyer **USS Cole** in 2000 is another extension of the idea. Another explosive ship attack took place in April 2004, during the **Iraq War**, when three motor craft laden with explosives attempted the bombing of Khawr Al Amaya Oil Terminal in the **Persian Gulf**. In an apparent **suicide bombing**, one blew up and sank a **rigid inflatable boat** from **USS Firebolt** as it pulled up alongside, killing two US Navy personnel and one member of the **US Coast Guard**.^[14]

4.2 Notable uses

Notable fire ship attacks include:

- Alexander the Great's **Siege of Tyre** in 332 BC. The Tyrians used the fire ship in attempt to destroy Alexander's **mole**.^[15]
- Syracuse in their battle with the Athenian fleet
- Huang Gai's attack on Cao Cao at the **Battle of Red Cliffs**, 208.
- **Battle of San Juan de Ulúa** in 1568. John Hawkins' flagship *Jesus of Lübeck* was attacked by a fire ship before being stormed by Spanish seamen
- **Siege of Antwerp** in 1585. Both fire ships and **exploding vessels** were employed together for the first time.

- Francis Drake's attack on the Spanish Armada moored at Gravelines in 1588. The fire ships did no damage, but the Spanish scattered in panic and were easy prey for English ships.^[2]
- Maarten Tromp's attack on the Spanish fleet moored off the Kent coast in the Battle of the Downs in 1639. The Spanish fleet was destroyed.
- Michiel de Ruyter's attack on the anchored English fleet at the battle of Solebay in 1672 in which HMS *Royal James* was burned, killing Vice-Admiral Edward Montagu, 1st Earl of Sandwich, and wounding *Royal James*'s captain, Richard Haddock.^[16]
- The destruction of 15 French ships of the line, including *Soleil Royal*, *Admirable* and *Triomphant*, in 1692, after the Battle of La Hougue.^[17]
- US attack on Tripoli during the First Barbary War in 1804 by USS *Intrepid*.
- The Russian attack on the Turkish fleet at the Battle of Chesma, 1770.
- Thomas Cochrane's attack on the French in the Battle of the Basque Roads, 1809.
- Multiple successful Greek attacks on large Turkish ships of the line during the Greek War of Independence, 1821-1832.
- Chinese attacks on British ships during the First Opium War, 1839-1842.

4.3 See also

- Hellburners
- MT explosive motor boat
- Shinyo (suicide boat)
- List of fireships of the Royal Navy
- Operation Lucid

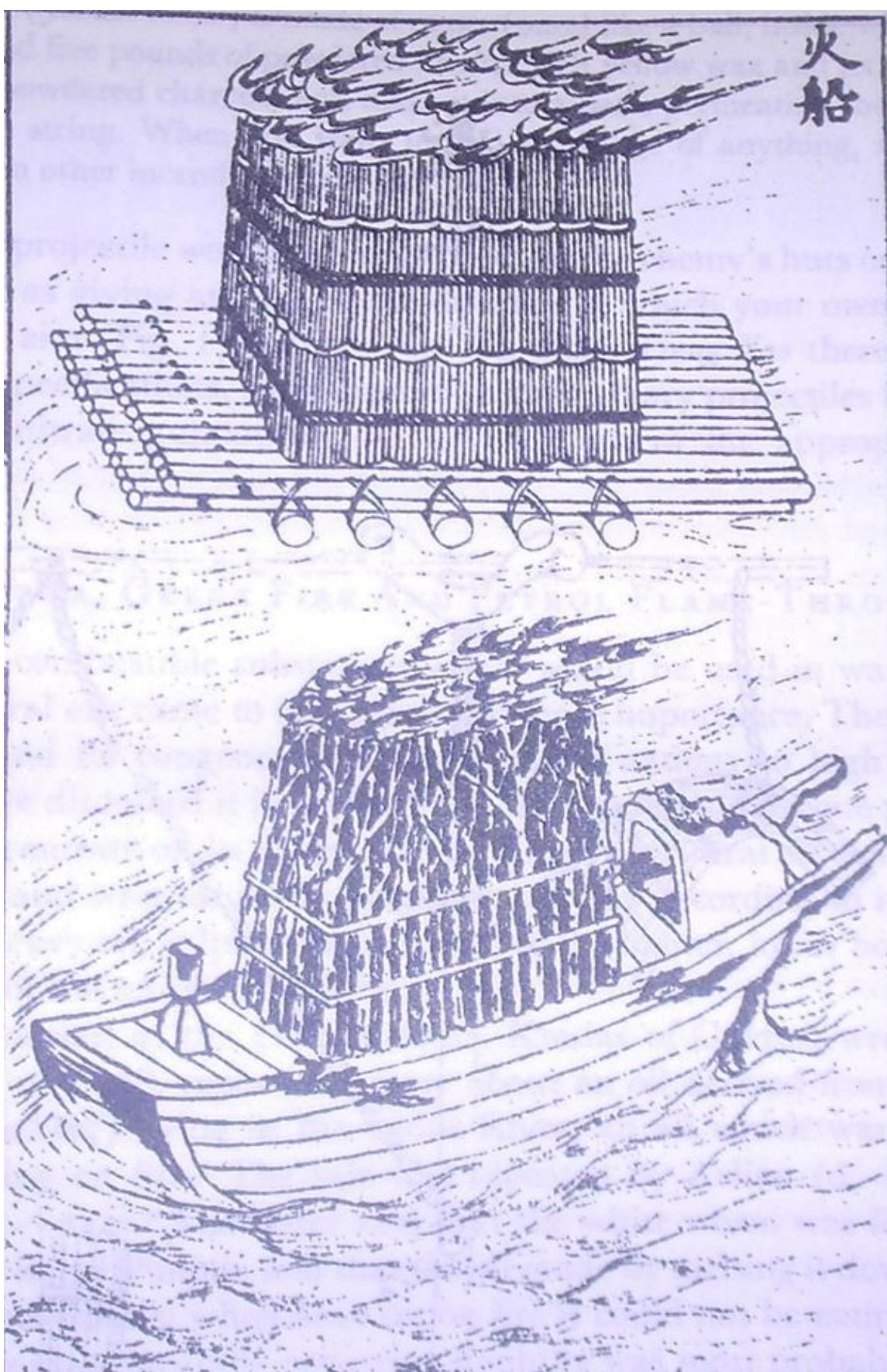
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- [3] Thucydides, *History of the Peloponnesian War*, 7.53.4
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- [5] The Fireship and its Role in the Royal Navy by James Coggleshall. Master's Thesis, Texas A&M University, 1997, p. 15
- [6] The Fireship and its Role in the Royal Navy by James Coggleshall. Master's Thesis, Texas A&M University, 1997, p. 16
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- [8] The Fireship and its Role in the Royal Navy by James Coggleshall. Master's Thesis, Texas A&M University, 1997, p. 18-19
- [9] Brewer, David (2003). The Greek War of Independence: The Struggle for Freedom from Ottoman Oppression and the Birth of the Modern Greek Nation. Overlook Press. p 93
- [10] "Battle of Britain, September 1940". naval-history.net.
- [11] Greene, Jack & Massignani, Alessandro: *The Naval War in the Mediterranean, 1940-1943*. Chatam Publishing, London, 1998, page 141. ISBN 1-86176-057-4
- [12] Sadkovich, James: *The Italian Navy in World War II*. Greenwood Press, Westport, 1994, page 25. ISBN 0-313-28797-X
- [13] Daly, Thomas M.: *Crossroads at Bikini*. United States Naval Institute Proceedings July 1986, pp.64-73.

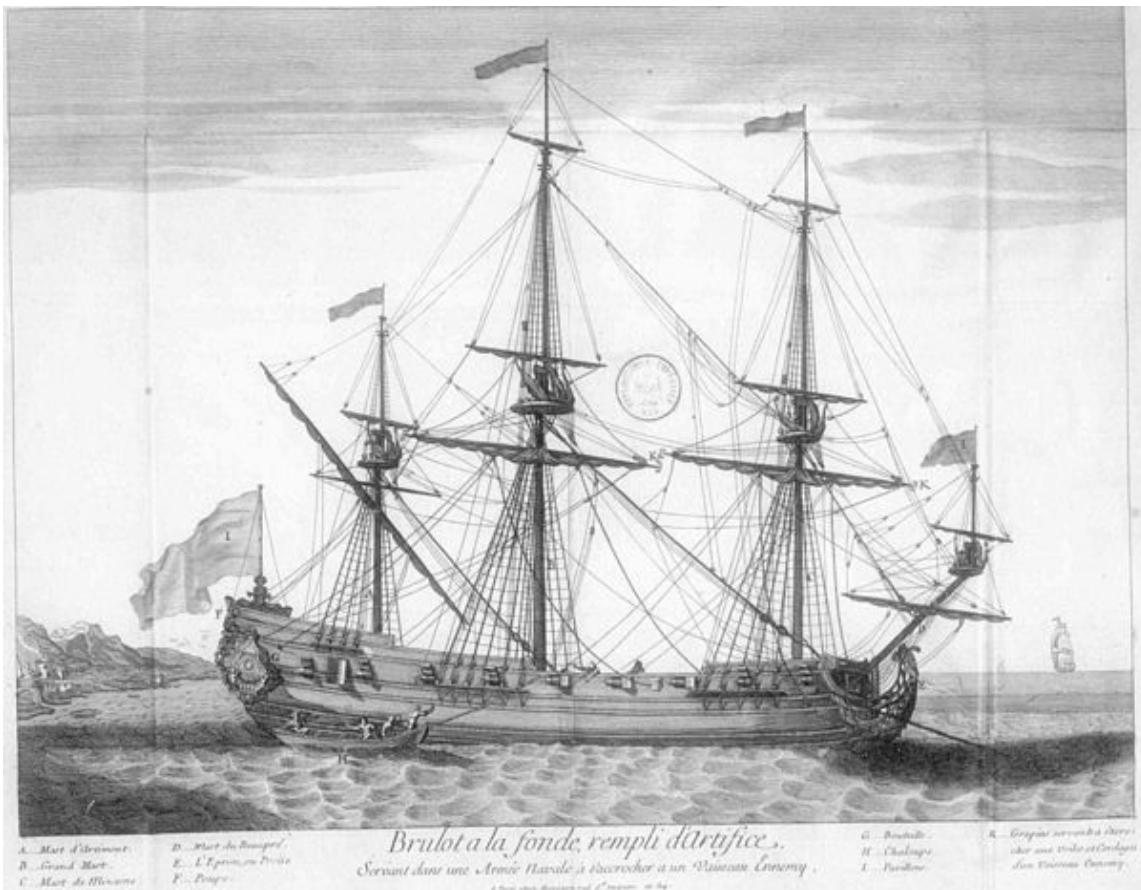
- [14] Suicide bombing attack claims first Coast Guardsman since Vietnam War by Kendra Helmer. Stars and Stripes, 27 April 2004
- [15] Alexander's mole
- [16] The Fireship and its Role in the Royal Navy by James Coggeshall. Master's Thesis, Texas A&M University, 1997, pp. 14-16
- [17] The Fireship and its Role in the Royal Navy by James Coggeshall. Master's Thesis, Texas A&M University, 1997, pp. 16-18

4.5 External links

Media related to Fire ships at Wikimedia Commons



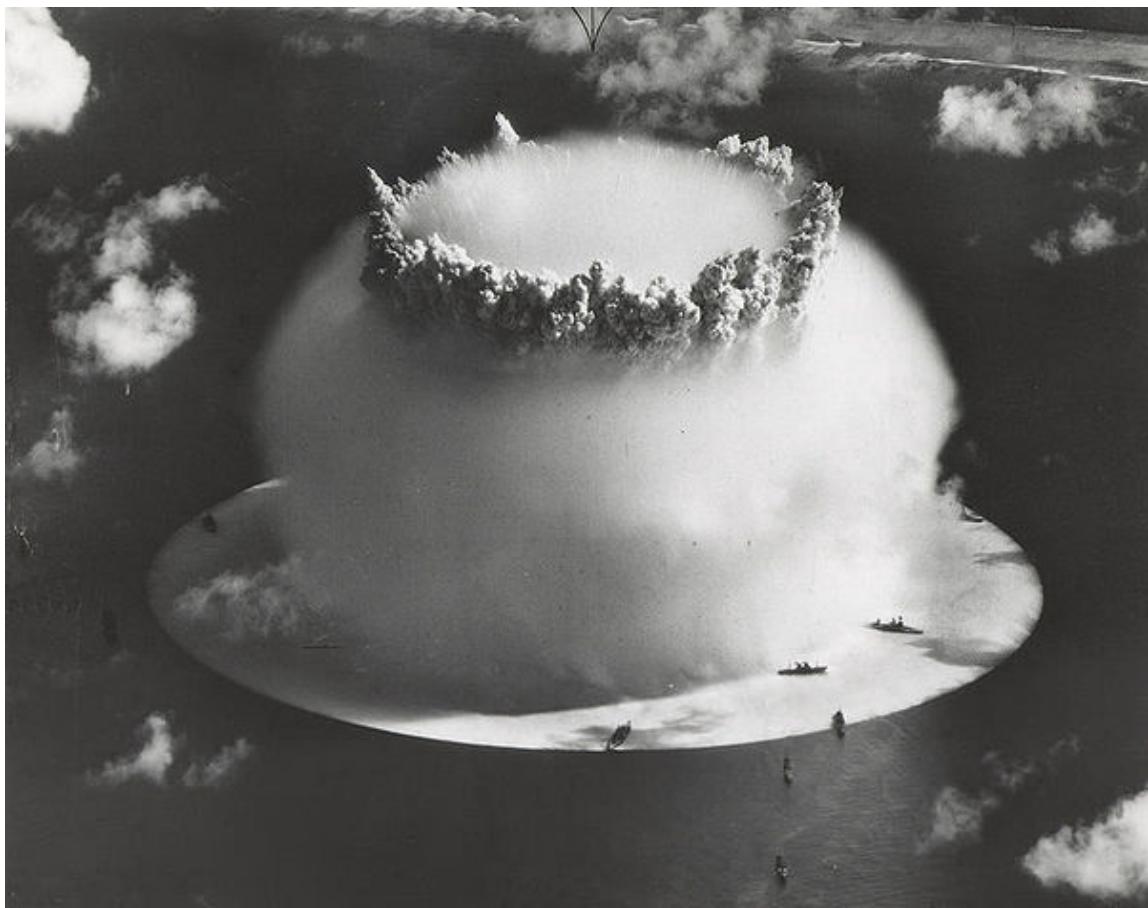
Chinese fire ships of the Song dynasty (960-1279)



French fireship at anchorage. The full-resolution image shows details specific to fireships, notably the exit door between the two aftmost gunports; the chain securing an escape boat; an aperture below exit door to light a fuse; and grappling hooks on the yardarms.



The attack on the Turkish frigate in the Gulf of Eressos at the Greek island of Lesvos by a fire ship commanded by Dimitrios Papanikolis during the Greek War of Independence - Painting by Konstantinos Volanakis



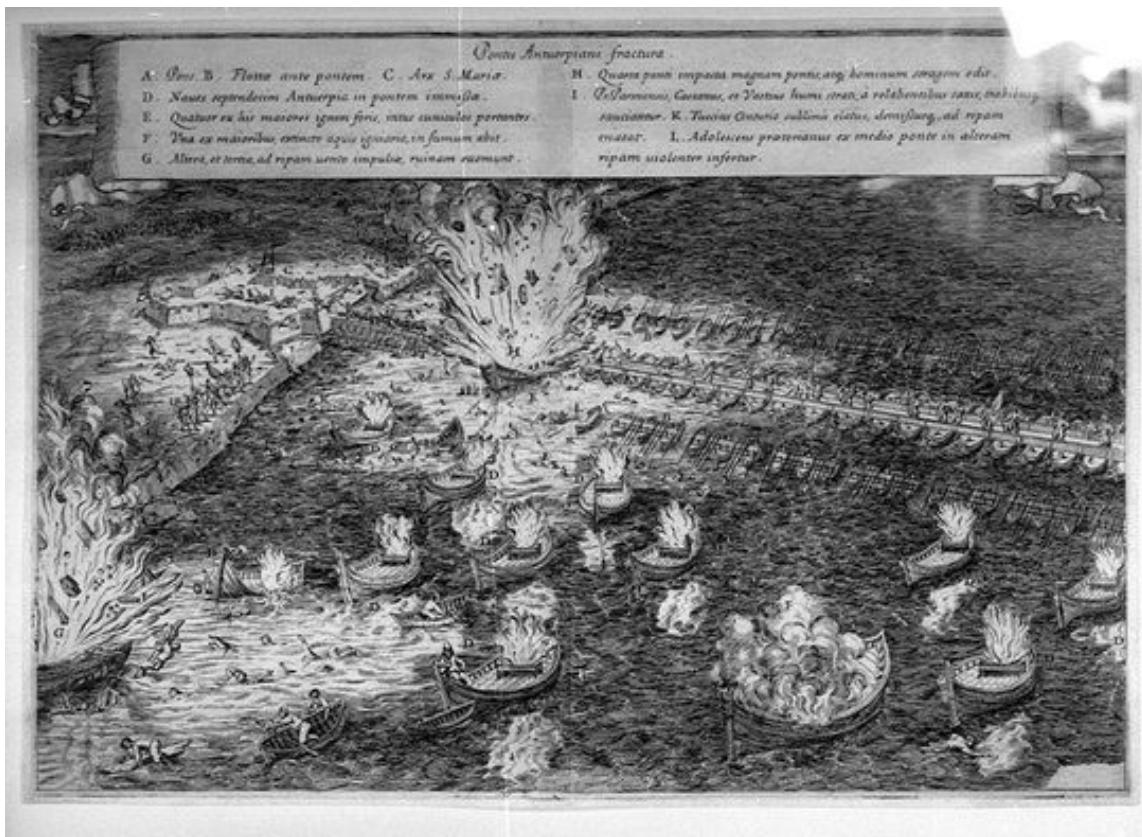
Operation Crossroads (Event Baker), conducted at Bikini Atoll (1946).

Chapter 5

Hellburners

“Hellburner” redirects here. For the science fiction novel, see [Devil to the Belt](#).

Hellburners (Dutch: *hellebranders*; *brander* is Dutch for “burner”) were specialised fireships used in the Siege



Hellburners at Antwerp by Famiani Strada

of Antwerp (1584-1585) during the Eighty Years’ War between the Dutch rebels and the Habsburgs. They were floating bombs, also called “Antwerp Fire”, and did immense damage to the Spanish besiegers.^[1] Hellburners have been described as an early form of weapons of mass destruction^[2]

5.1 History

5.1.1 First use against Antwerp ship bridge

The hellburners were constructed by the Italian engineer Federigo Giambelli, who had been hired and subsidised by Elizabeth I of England, unofficially supporting the rebels, to assist the city. In the winter of 1585 Antwerp was besieged by the army of Alexander Farnese, the commander of the Habsburg forces in the Spanish Netherlands, who had constructed an eight hundred metres long ship bridge over the River Scheldt near Kalloo between Antwerp and the sea, to starve the population by blockade; it had been completed on 25 February. To supply the city it was imperative to destroy the ship bridge.

Giambelli first proposed to use three medium-sized merchantmen, the *Oranje*, *Post* and *Gulden Leeuw*, but this was refused, only two smaller vessels being made available: the *Fortuyn* ("Fortune") and *Hoop* ("Hope") of about seventy tons. The innovative part of the project consisted in the *Hoop* employing a **fuse** consisting of a combined **clockwork** and **flintlock** mechanism provided by an Antwerp **watchmaker**, Bory; the *Fortuyn* used a delayed fuse mechanism.

To ensure destruction, very large charges were used. To intensify and channel the explosion an oblong "fire chamber" was constructed on each ship, a metre in diameter. The bay was fitted with a brick floor, a foot thick and five metres wide; the walls of the chamber were five feet thick; the roof consisted of old tombstones, stacked vertically and sealed with **lead**. The chambers with a length of twelve metres were each filled with a charge of about 7000 pounds of high quality corned gunpowder. On top of the chambers a mixture of rocks and iron shards and other objects was placed, again covered in slabs; the spaces next to the chambers were likewise filled. The whole was covered with a conventional wooden deck.

The two fireships were successfully used in the night of 4–5 April 1585.^[3] Giambelli had prepared 32 normal fireships to be first launched in several waves to deceive the Spaniards. In fact the commander supervising the operation, Vice-Admiral Jacob Jacobsen, set all ships on their course in quick succession, from fort *Boerenschans*, the hellburners last. The current and ebb tide carried the ships towards the bridge. As their decks were piled with wood and small charges with slow fuses were apparent, all made the impression of being conventional fireships, causing the Spanish troops to try to extinguish the fire.

The *Fortuyn* ran ashore on the west river bank some distance from the bridge and its, probably only partial, explosion did little damage to the Spanish forces, but the *Hoop* drifted along the same bank between the river shore and a protective row of anchored ships forming a raft in front of the main bridge and touched the latter near the junction of the fixed wooden shore structure and the attached ships. When the **time bomb** aboard the *Hoop* exploded, about eight hundred troops were killed, the sconce *Santa Maria* was devastated and the ship bridge was ripped apart over a distance of sixty metres; the blast was heard in a fifty mile radius. Farnese himself was wounded. However, the damage to the bridge was quickly repaired and a rebel relief fleet failed to exploit the opportunity to break through, because it was at first mistakenly thought the attempt at the bridge had been unsuccessful.

Last of all came the two infernal ships, swaying unsteadily with the current; the pilots of course, as they neared the bridge, having noiselessly effected their escape in the skiffs. The slight fire upon the deck scarcely illuminated the dark phantom-like hulls. Both were carried by the current clear of the raft, which, by a great error of judgment, as it now appeared, on the part of the builders, had only been made to protect the floating portion of the bridge. The 'Fortune' came first, staggering inside the raft, and then lurching clumsily against the dyke, and grounding near Kalloo, without touching the bridge. There was a moment's pause of expectation. At last the slow match upon the deck burned out, and there was a faint and partial explosion, by which little or no damage was produced...

The troops of Parma, crowding on the palisade, and looking over the parapets, now began to greet the exhibition with peals of derisive laughter. It was but child's play, they thought, to threaten a Spanish army, and a general like Alexander Farnese, with such paltry fire-works as these. Nevertheless all eyes were anxiously fixed upon the remaining fire-ship, or "hell-burner," the 'Hope,' which had now drifted very near the place of its destination. Tearing her way between the raft and the shore, she struck heavily against the bridge on the Kalloo side, close to the block-house at the commencement of the floating portion of the bridge. A thin wreath of smoke was seen curling over a slight and smouldering fire upon her deck...

The clockwork had been better adjusted than the slow match in the 'Fortune.' Scarcely had Alexander reached the entrance of Saint Mary's Fort, at the end of the bridge, when a horrible explosion was heard. The 'Hope' disappeared, together with the men who had boarded her, and the block-house, against which she had struck, with all its garrison, while a large portion of the bridge, with all the troops stationed upon it, had vanished into air. It was the work of a single instant. The Scheldt yawned to its lowest depth, and then cast its waters across the dykes, deep into the forts, and far over the land. The earth shook as with the throb of a volcano. A wild glare lighted up the scene for one moment, and was then succeeded

by pitchy darkness. Houses were toppled down miles away, and not a living thing, even in remote places, could keep its feet. The air was filled with a rain of plough-shares, grave-stones, and marble balls, intermixed with the heads, limbs, and bodies, of what had been human beings. Slabs of granite, vomited by the flaming ship, were found afterwards at a league's distance, and buried deep in the earth. A thousand soldiers were destroyed in a second of time; many of them being torn to shreds, beyond even the semblance of humanity.

Richebourg disappeared, and was not found until several days later, when his body was discovered; doubled around an iron chain, which hung from one of the bridge-boats in the centre of the river. The veteran Robles, Seigneur de Billy, a Portuguese officer of eminent service and high military rank, was also destroyed. Months afterwards, his body was discovered adhering to the timber-work of the bridge, upon the ultimate removal of that structure, and was only recognized by a peculiar gold chain which he habitually wore. Parma himself was thrown to the ground, stunned by a blow on the shoulder from a flying stake. The page, who was behind him, carrying his helmet, fell dead without a wound, killed by the concussion of the air.^[4]

5.1.2 Influence on the Battle of Gravelines

The events in Antwerp gave the hellburners an immediate notoriety; the concept generated enormous interest with military experts all over Europe. The fireships sent against the Spanish Armada on 7 August 1588 in the night before the Battle of Gravelines were taken to be 'hellburners', because Giambelli was known to be employed by Elizabeth in England at that date and eight regular warships, much larger than typical fireships of the time, had been sacrificed for the attack. They were actually nowhere near as deadly, the English at that moment even lacking the gunpowder to resupply their ships for regular use, but were successful in breaking the fleet's formation, their mistaken identity contributing to the panic. Giambelli was in fact working on constructing a mined ship beam from masts, costing £2000, to block the Thames against an invasion.^[5]

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5.3 External links

- *The Hellburners of Antwerp* (picture)

Chapter 6

Galleon

For other uses, see [Galleon \(disambiguation\)](#).

A **galleon** was a large, multi-decked sailing ship used primarily by European states from the 16th to 18th centuries.



A Spanish galleon (left) firing its cannons at a Dutch warship (right). Cornelis Verbeeck, ca. 1618/1620

6.1 Etymology

The term "Galleon" large ship, comes from Old French 'Galion' "little ship" (13c.), from Spanish 'Galeón' "armed merchant ship", from Portuguese 'Galeão' "war ship", from Byzantine Greek 'Galea' "galley" (see galley) + augmentative suffix -on.^[2] Another possible origin is the Old French word *galie* meaning galley.^[3] The term was originally given to certain types of war *galleys* in the Middle Ages. The *Annali Genovesi* mentions galleons of 80, 64 and 60 oars, used for battle and on missions of exploration, in the 12th and 13th centuries. It is very likely that the *galleons* and *galliots* mentioned in the accounts of the crusades were the same vessels. Later, when the term started to be applied to sail only vessels, it meant, like the English term "man of war", a warship that was otherwise no different from the other sailing ships of the time.

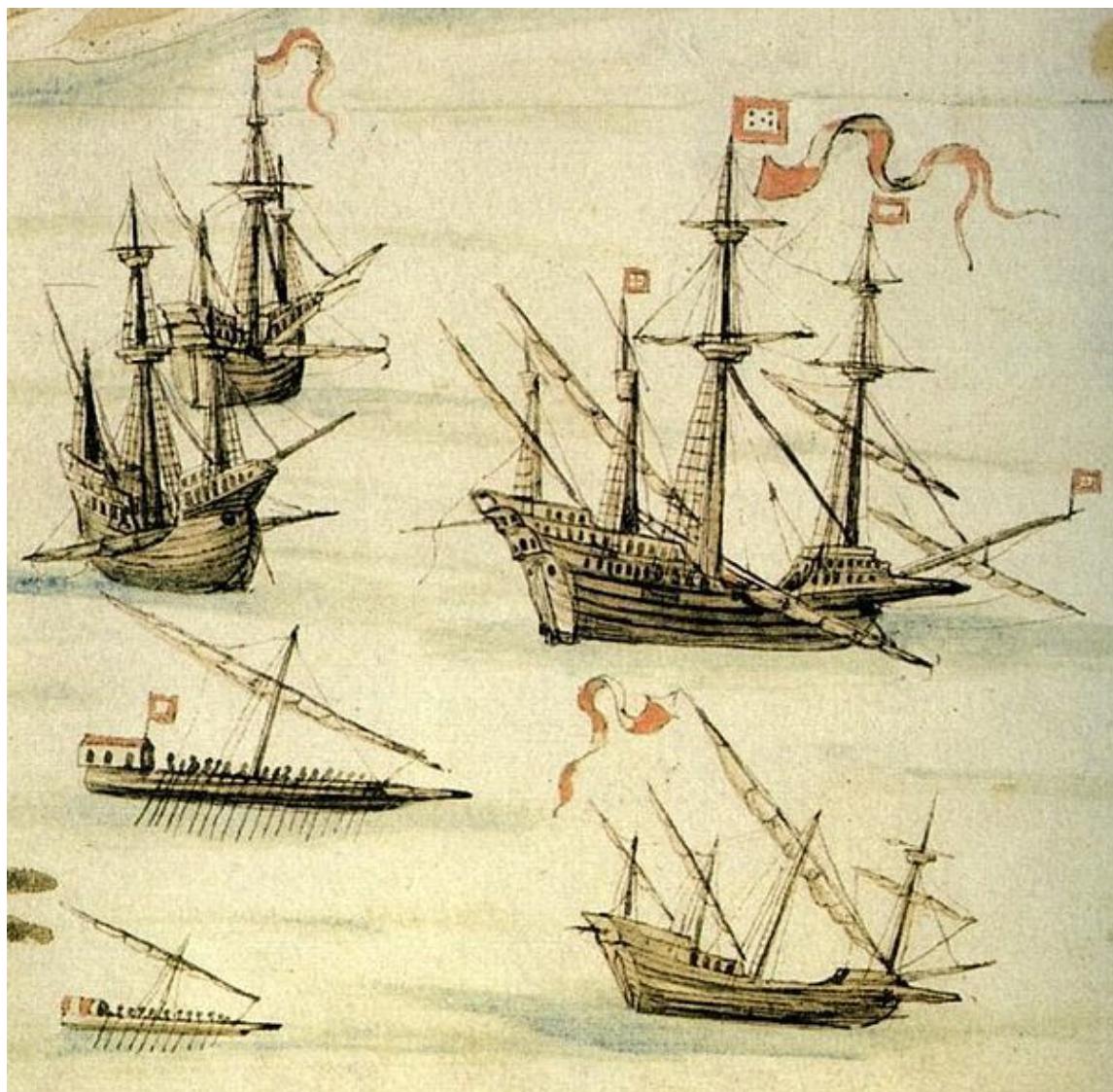
6.2 History

Documentary sources point to a new type of sailing ship built in early 16th century [Venice](#). It was called *Gallioni* and used by the Venetians against pirates. By the second half of the century, Galleons were already seen along the Mediterranean.^[4] A lowering of the forecastle and elongation of the [hull](#) gave galleons an unprecedented level of stability in the water, and reduced wind resistance at the front, leading to a faster, more maneuverable vessel. The galleon differed from the older types primarily by being longer, lower and narrower, with a square tuck stern instead of a round tuck, and by having a snout or head projecting forward from the bows below the level of the forecastle. In [Portugal](#) at least, carracks were usually very large ships for their time (often over 1000 tons), while galleons were



A Spanish galleon

mostly under 500 tons, although the Manila galleons were to reach up to 2000 tons. With the introduction of the galleon in [Portuguese India Armadas](#) during the first quarter of the 16th century,^{[5][6]} carracks gradually began to be less armed and became almost exclusively cargo ships (which is why the Portuguese Carracks were pushed to such large sizes), leaving any fighting to be done to the galleons. One of the largest and most famous of Portuguese galleons was the *São João Baptista* (nicknamed Botafogo, 'spitfire'), a 1,000-ton galleon built in 1534, said to have carried



Carracks, galleon (center/right), square rigged caravel (below), galley and fusta (galliot) depicted by D. João de Castro on the "Suez Expedition" (part of the Portuguese Armada of 72 ships sent against the Ottoman fleet anchored in Suez, Egypt, in response to its entry in the Indian Ocean and the [siege of Diu in 1538](#)) - Tábuas da India in the João de Castro's Roteiro do Mar Roxo (Routemap of the Red Sea) of 1540-1541. - Despite this kind of ship (or only a close model of art) was already depicted in the heraldry of the Foral of Lisbon (of D. Manuel I) in 1502, it is in 1510 (as also in some of the following years after 1510) the appearance of the Portuguese oceanic galleon in the records. It is however from 1519 that their number increases substantially, but gradually. It was an evolution and a gradual improvement in the design made during the first quarter of the century - technical improvement which continued until the second half of the century. The Portuguese galleon evolved from the [square rigged caravel](#) and was a compromise between the great carrack or nau and the aforementioned square rigged caravel or war caravel (also called *caravela de armada* or Portuguese man of war) that evolved into a new design of ship, but keeping its hull design similar to the galley.^[11] It was also more maneuverable, more robust and heavily armed.

366 guns. Carracks also tended to be lightly armed and used for transporting cargo in all the fleets of other Western European states, while galleons were purpose-built warships, and were stronger, more heavily armed, and also cheaper to build (5 galleons could cost around the same as 3 carracks) and were therefore a much better [investment](#) for use as warships or transports. There are disputes about its origins and development but each Atlantic sea power built types suited to its needs, while constantly learning from their rivals. It was the captains of the Spanish navy, Pedro Menéndez de Avilés and Álvaro de Bazán, who designed the definitive long and relatively narrow hulled galleon in the 1550s.^{[7][8]}

The galleon was powered entirely by wind, using [sails](#) carried on three or four masts, with a [lateen sail](#) continuing to be used on the last (usually third and fourth) masts. They were used in both military and trade applications, most famously in the Spanish treasure fleet, and the Manila Galleons. While carracks played the leading role in early global

explorations, galleons also played a part in the 16th and 17th centuries. In fact, galleons were so versatile that a single vessel may have been refitted for wartime and peacetime roles several times during its lifespan. The galleon was the prototype of all square rigged ships with three or more masts for over two and a half centuries, including the later full rigged ship.

The principal warships of the opposing English and Spanish fleets in the 1588 confrontation of the Spanish Armada were galleons, with the modified English "race built" galleons developed by John Hawkins proving decisive, while the capacious Spanish galleons, designed primarily as transports, showed great endurance in the battles and in the great storms on the voyage home; most survived the ordeal.

6.3 Construction

Galleons were constructed from oak (for the keel), pine (for the masts) and various hardwoods for hull and decking. Hulls were usually carvel-built. The expenses involved in galleon construction were enormous. Hundreds of expert tradesmen (including carpenters, pitch-melters, blacksmiths, coopers, shipwrights, etc.) worked day and night for months before a galleon was seaworthy. To cover the expense, galleons were often funded by groups of wealthy businessmen who pooled resources for a new ship. Therefore, most galleons were originally consigned for trade, although those captured by rival states were usually put into military service.

The most common gun used aboard a galleon was the demi-culverin, although gun sizes up to demi-cannon were possible.

Because of the long periods often spent at sea and poor conditions on board, many of the crew often perished during the voyage; therefore advanced rigging systems were developed so that the vessel could be sailed home by an active sailing crew a fraction of the size aboard at departure.

6.4 Distinguishing features

The most distinguishing features of the galleon include the long beak, the lateen-rigged mizzenmasts, and the square gallery at the stern off the captain's cabin. In larger galleons, a fourth mast was added, usually a lateen-rigged mizzen, called the bonaventure mizzen.

The galleon continued to be used into the 18th century, by which time purpose-built vessels such as the fluyt, the brig and the full rigged ship, both as a trading vessel and ship of the line, rendered it obsolete for trade and warfare respectively.

6.5 The oldest English drawings

The oldest known scale drawings in England are in a manuscript called "Fragments of Ancient Shipwrightry" made in about 1586 by Mathew Baker, a master-shipwright. This manuscript, held at the Pepysian Library, Magdalene College, Cambridge, provides an authentic reference for the size and shape of typical English galleons built during this period. Based on these plans, the Science Museum, London has built a 1:48 scale model ship that is an exemplar of galleons of this era.^[9]

6.6 Notable galleons

- *São João Baptista* nicknamed *Botafogo*, the most powerful warship when launched (1534) by the Portuguese; became famous during the Conquest of Tunis (1535), where it was commanded by Infante Luís, Duke of Beja.
- *Adler von Lübeck* the largest ship of its day when launched in 1566.
- The *Manila galleons*, Spanish trading ships that sailed once or twice per year across the Pacific Ocean between Manila in the Philippines and Acapulco in New Spain (now Mexico); (1565 - 1815).
- *San Salvador*, flagship vessel in the João Rodrigues Cabrilho's 1542 exploration of present day California in the United States.



Model of English galleon sporting a bonaventure mizzen mast

- *San Pelayo*, the large 906-ton galleon which served as the flagship of Pedro Menéndez de Avilés during his expedition to establish St. Augustine, Florida in 1565. Ironically, the vessel was so large it could not enter St. Augustine's harbor, so Menéndez ordered it offloaded and sent it back to Hispaniola. At a later date her crew mutinied and sailed to Europe where the ship wrecked off the coast of Denmark.
- *Golden Hind*, the ship in which Sir Francis Drake circumnavigated the globe 1577 – 1580
- *Ark Raleigh*, the ship was designed and built by Sir Walter Raleigh. It was later chosen by Lord Howard, admiral of the fleet to be the flagship of the English fleet in the fight against the Spanish Armada in 1588 and was summarily renamed the *Ark Royal*.
- *Revenge*, a galleon built in 1577, the flagship of Sir Francis Drake in the Battle of the Spanish Armada in 1588, was captured by a Spanish fleet off Flores in the Azores in 1591 and sank while being sailed back to Spain.
- *São Martinho*, the Portuguese galleon, the flagship of Duke of Medina Sidonia, commander-in-chief of the Spanish Armada.
- *Triumph*, the largest Elizabethan galleon; flagship of Sir Martin Frobisher in the Battle of the Spanish Armada
- *San Juan Bautista* (originally called Date Maru, 大戦丸 in Japanese). She crossed the Pacific Ocean from Japan to New Spain in 1614. She was of the Spanish galleon type, known in Japan as Nanban-Sen (南蛮船).
- *Nuestra Señora de la Concepción*, a Spanish Galleon, known to its crew as *Cacafuego* for its strong cannon.^[10] It was captured by Sir Francis Drake in 1578 and all its treasures were brought to England. It was holding treasures mined in one year by the Spanish in the Americas.
- *Padre Eterno*, a Portuguese galleon launched in 1663. It was considered to be the biggest ship of its time, carrying 144 pieces of artillery and able to carry up to 2.000t of cargo.

- *Vasa*, the only original galleon to be preserved. It sank in 1628 and was raised in 1961 for preservation as a museum ship.

6.7 In Literature

The Galleon or Gold-Galleon (G) is also used as a currency in the Harry Potter series by J.K. Rowling

6.8 See also

- Spanish treasure fleet
- Manila galleons
- Fluyt
- Portuguese India Armadas
- Square Rigged Caravel

6.9 Notes

- [1] Galeão - *Navegações Portuguesas* by Francisco Contente Domingues (Portuguese)
- [2] <http://www.etymonline.com/index.php?term=galleon>
- [3] “Collins Concise English Dictionary”. Retrieved 21 Feb 2014.
- [4] *Archaeology and the Social History of Ships*. books.google.com. Retrieved 8 August 2014.
- [5] Os Navios e as Técnicas Náuticas Atlânticas nos Séculos XV e XVI: Os Pilares da Estratégia 3C - Rear Admiral Antonio Silva Ribeiro - *Revista Militar* (Portuguese)
- [6] Galeão - *Navegações Portuguesas* by Francisco Contente Domingues (Portuguese)
- [7] “The galleon evolved in response to Spain’s need for an ocean-crossing cargo ship that could beat off corsairs. Pedro de Menéndez, along with Álvaro de Bazán (hero of Lepanto), is credited with developing the prototypes which had the long hull - and sometimes the oars - of a galley married to the poop and prow of a *nao* or merchantman. Galeones were classed as 1-, 2- or 3-deckers, and stepped two or more masts rigged with square sails and topsails (except for a lateen sail on the mizzenmast). Capacity ranged up to 900 tons or more. Menéndez’ *San Pelayo* of 1565 was a 900 ton galleon which was also called a *nao* and *galeaza*. She carried 77 crewmen, 18 gunners, transported 317 soldiers and 26 families, as well as provisions and cargo. Her armament was iron.”p.100 *Menéndez: Pedro Menéndez de Avilés, Captain General of the Ocean Sea* Albert C. Manucy, published 1992 by Pineapple Press, Inc
- [8] Walton, Timothy R. (2002). *The Spanish Treasure Fleets*. Pineapple Press Inc, p. 57. ISBN 1-56164-261-4
- [9] Fragments of Ancient English Shipwrightry
- [10] Little, Benerson (2010). “Spanish Galleons and Portuguese Carracks”. *Pirate Hunting: The Fight Against Pirates, Privateers, and Sea Raiders from Antiquity to the Present*. Washington, DC: Potomac. p. 145. ISBN 978-1-59797-291-8. Called by her crew *Cacafuego...* fire shitter

6.10 References

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6.11 External links

- The Development of the Full-Rigged Ship From the Carrack to the Full-Rigger

Chapter 7

Galley

For other uses, see [Galley \(disambiguation\)](#).

A **galley** is a type of ship that is propelled mainly by [rowing](#). The galley is characterized by its long, slender hull,



A model of a Maltese design typical of the 16th century, the last great era of the war galley

shallow [draft](#) and low clearance between sea and railing. Virtually all types of galleys had sails that could be used in favorable winds, but human strength was always the primary method of propulsion. This allowed galleys freedom to move independently of winds and currents, and with great precision. The galley originated among the seafaring civilizations around the [Mediterranean Sea](#) in the early first millennium BC and remained in use in various forms until the early 19th century in warfare, trade and piracy.

Galleys were the warships used by the early Mediterranean naval powers, including the [Greeks](#), [Phoenicians](#) and [Romans](#). They remained the dominant types of vessels used for war and piracy in the Mediterranean Sea until the last decades of the 16th century. As warships, galleys carried various types of weapons throughout their long existence, including [ram](#), [catapults](#) and [cannons](#), but also relied on their large crews to overpower enemy vessels in boarding actions. They were the first ships to effectively use heavy [cannons](#) as anti-ship weapons. As highly efficient gun

platforms they forced changes in the design of medieval seaside fortresses as well as refinement of sailing warships.

The zenith of galley usage in warfare came in the late 16th century with battles like that at Lepanto in 1571, one of the largest naval battles ever fought. By the 17th century, however, sailing ships and hybrid ships like the xebec displaced galleys in naval warfare. They were the most common warships in the **Atlantic Ocean** during the Middle Ages, and later saw limited use in the **Caribbean**, the **Philippines** and the **Indian Ocean** in the **early modern** period, mostly as patrol craft to combat **pirates**. From the mid-16th century galleys were in intermittent use in the **Baltic Sea**, with its short distances and extensive archipelagoes. There was a minor revival of galley warfare in the 18th century in the wars between **Russia**, **Sweden** and **Denmark**.

7.1 Definition and terminology

The term “galley” derives from the medieval **Greek** *galea*, a smaller version of the **dromon**, the prime warship of the **Byzantine navy**.^[1] The origin of the Greek word is unclear but could possibly be related to *galeos*, “dog-fish; small shark”.^[2] The word “galley” has been attested in English from c. 1300^[3] and has been used in most European languages from around 1500 both as a general term for oared warships, and from the Middle Ages and onwards more specifically for the Mediterranean-style vessel.^[4] It was only from the 16th century that a unified galley concept came in use. Before that, particularly in antiquity, there was a wide variety of terms used for different types of galleys. In modern historical literature, “galley” is occasionally used as a general term for various types of oared vessels larger than boats, though the “true” galley is defined as the ships belonging to the Mediterranean tradition.^[5]



The English-built Charles Galley, a “galley frigate” built in the 1670s. It was not a “true” galley, but the term still became part of its name due to its oars.

Ancient galleys were named according to the number of oars, the number of banks of oars or lines of rowers. The terms are based on contemporary language use combined with more recent compounds of Greek and Latin words. The earliest Greek single-banked galleys are called **triaconters** (from *triakontoroi*, “thirty-oars”) and **pentecounters** (*pentēkontoroi*, “fifty-oars”).^[6] For later galleys with more than one row of oars, the terminology is based on Latin numerals with the suffix **-reme** from *rēmus*, “oar”. A **monoreme** has one bank of oars, a **bireme** two and a **trireme**

three. Since the maximum banks of oars was three, any expansion above that did not refer to additional banks of oars, but of additional rowers for every oar. *Quinquereme* (*quintus + rēmus*) was literally a “five-oar”, but actually meant that there were several rowers to certain banks of oars which made up five lines of oar handlers. For simplicity, they have by many modern scholars been referred to as “fives”, “sixes”, “eights”, “elevens”, etc. Anything above six or seven rows of rowers was not common, though even a very exceptional “forty” is attested in contemporary source. Any galley with more than three or four lines of rowers is often referred to as a “polyreme”.^[7]

Archaeologist Lionel Casson has used the term “galley” to describe all North European shipping in the early and high Middle Ages, including *Viking* merchants and even their famous *longships*, though this is rare.^[8] Oared military vessels built on the British Isles in the 11th to 13th centuries were based on Scandinavian designs, but were nevertheless referred to as “galleys”. Many of them were similar to *birlinns*, close relatives of longship types like the *snekja*. By the 14th century, they were replaced with *balingers* in southern Britain while longship-type “Irish galleys” remained in use throughout the Middle Ages in northern Britain.^[9]



Watercolor of United States ships at the battle of Valcour Island, depicting several “row galleys”; similar function, but based on very different designs than Mediterranean galleys.

Medieval and early modern galleys used a different terminology than their ancient predecessors. Names were based on the changing designs that evolved after the ancient rowing schemes were forgotten. Among the most important is the Byzantine *dromon*, the predecessor to the Italian *galea sotilla*. This was the first step toward the final form of the Mediterranean war galley. As galleys became an integral part of an advanced, early modern system of warfare and state administration, they were divided into a number of ranked grades based on the size of the vessel and the number of its crew. The most basic types were the following: large commander “lantern galleys”, half-galleys, galiots, fustas, brigantines and *fregatas*. Naval historian Jan Glete has described as a sort of predecessor of the later rating system of the Royal Navy and other sailing fleets in Northern Europe.^[10]

The French navy and the British Royal Navy built a series of “galley frigates” from c. 1670–1690 that were small two-decked sailing cruisers with a set of oarports on the lower deck. The three British galley frigates also had distinctive names - *James Galley*, *Charles Galley* and *Mary Galley*.^[11] In the late 18th century, the term “galley” was in some contexts used to describe minor oared gun-armed vessels which did not fit into the category of the classic Mediterranean type. During the American Revolutionary War, and other wars with France and Britain, the early US Navy and other navies built vessels that were called “galleys” or “row galleys”, though they were actually brigantines or Baltic gunboats.^[12] This type of description was more a characterization of their military role, and was in part due to technicalities in administration and naval financing.^[13]

7.2 History

Among the earliest known watercraft were canoes made from hollowed-out logs, the earliest ancestors of galleys. Their narrow hulls required them to be paddled in a fixed sitting position facing forwards, a less efficient form of propulsion than rowing with proper oars, facing backwards. Seagoing paddled craft have been attested by finds of terracotta sculptures and lead models in the region of the Aegean Sea from the 3rd millennium BC. However, archaeologists believe that the Stone Age colonization of islands in the Mediterranean around 8,000 BC required fairly large, seaworthy vessels that were paddled and possibly even equipped with sails.^[14] The first evidence of more complex craft that are considered to prototypes for later galleys comes from Ancient Egypt during the Old Kingdom (c. 2700–2200 BC). Under the rule of pharaoh Pepi I (2332–2283 BC) these vessels were used to transport troops to raid settlements along the Levantine coast and to ship back slaves and timber.^[15] During the reign of Hatshepsut

(c. 1479–57 BC), Egyptian galleys traded in luxuries on the Red Sea with the enigmatic Land of Punt, as recorded on wall paintings at the Mortuary Temple of Hatshepsut at Deir el-Bahari.^[16]



Assyrian warship, a bireme with pointed bow. 700 BC

Shipbuilders, probably Phoenician, a seafaring people who lived on the southern and eastern coasts of the Mediterranean, were the first to create the two-level galley that would be widely known under its Greek name, *dīrēs*, or bireme.^[17] Even though the Phoenicians were among the most important naval civilizations in early Antiquity, little detailed evidence have been found concerning the types of ships they used. The best depictions found so far have been small, highly stylized images on seals which depict crescent-shape vessels equipped with one mast and banks of oars. Colorful frescoes on the Minoan settlement on Santorini (c. 1600 BC) show more detailed pictures of vessels with ceremonial tents on deck in a procession. Some of these are rowed, but others are paddled with men laboriously bent over the railings. This has been interpreted as a possible ritual reenactment of more ancient types of vessels, alluding to a time before rowing was invented, but little is otherwise known about the use and design of Minoan ships.^[18]

In the earliest days of the galley, there was no clear distinction between ships of trade and war other than their actual usage. River boats plied the waterways of ancient Egypt during the Old Kingdom (2700–2200 BC) and seagoing galley-like vessels were recorded bringing back luxuries from across the Red Sea in the reign of pharaoh Hatshepsu. Fitting rams to the bows of vessels sometime around the 8th century BC resulted in a distinct split in the design of warships, and set trade vessels apart, at least when it came to use in naval warfare. The Phoenicians used galleys for transports that were less elongated, carried fewer oars and relied more on sails. Carthaginian galley wrecks found off Sicily that date to the 3rd or 2nd century BC had a length to breadth ratio of 6:1, proportions that fell between the 4:1 of sailing merchant ships and the 8:1 or 10:1 of war galleys. Merchant galleys in the ancient Mediterranean were intended as carriers of valuable cargo or perishable goods that needed to be moved as safely and quickly as possible.^[19]

The first Greek galleys appeared around the second half of the 2nd millennium BC. In the epic poem, the *Iliad*, set in the 12th century BC, galleys with a single row of oarsmen were used primarily to transport soldiers to and from various land battles.^[20] The first recorded naval battle, the battle of the Delta between Egyptian forces under Ramesses III and the enigmatic alliance known as the Sea Peoples, occurred as early as 1175 BC. It is the first known engagement between organized armed forces, using sea vessels as weapons of war, though primarily as fighting platforms. It was

distinguished by being fought against an anchored fleet close to shore with land-based archer support.^[21]

The first true Mediterranean galleys usually had between 15 and 25 pairs of oars and were called triaconters or penteconters, literally “thirty-” and “fifty-oared”, respectively. Not long after they appeared, a third row of oars was added by the addition to a bireme of an **outrigger**, a projecting construction that gave more room for the projecting oars. These new galleys were called *trierēs* (“three-fitted”) in Greek. The **Romans** later called this design the *triremis*, trireme, the name it is today best known under. It has been hypothesized that early types of triremes existed as early as 700 BC, but the earliest conclusive literary reference dates to 542 BC.^[22] With the development of triremes, penteconters disappeared altogether. Triaconters were still used, but only for scouting and express dispatches.^[23]

7.2.1 The first warships



A reconstruction of an ancient Greek galley squadron based on images of modern replica Olympias

The earliest use for galleys in warfare was to ferry fighters from one place to another, and until the middle of the 2nd millennium BC had no real distinction from merchant freighters. Around the 14th century BC, the first dedicated fighting ships were developed, sleeker and with cleaner lines than the bulkier merchants. They were used for raiding, capturing merchants and for dispatches.^[24] During this early period, raiding became the most important form of organized violence in the Mediterranean region. Maritime classicist historian **Lionel Casson** used the example of Homer's works to show that seaborne raiding was considered a common and legitimate occupation among ancient maritime peoples. The later **Athenian** historian **Thucydides** described it as having been “without stigma” before his time.^[25]

The development of the **ram** sometime before the 8th century BC changed the nature of naval warfare, which had until then been a matter of boarding and hand-to-hand fighting. With a heavy projection at the foot of the **bow**, sheathed with metal, usually **bronze**, a ship could incapacitate an enemy ship by punching a hole in its planking. The relative speed and nimbleness of ships became important, since a slower ship could be outmaneuvered and disabled by a faster one. The earliest designs had only one row of rowers that sat in undecked hulls, rowing against **tholes**, or oarports, that were placed directly along the railings. The practical upper limit for wooden constructions fast and maneuverable enough for warfare was around 25-30 oars per side. By adding another level of oars, a development

that occurred no later than c. 750 BC, the galley could be made shorter with as many rowers, while making them strong enough to be effective ramming weapons.^[26]

The emergence of more advanced states and intensified competition between them spurred on the development of advanced galleys with multiple banks of rowers. During the middle of the first millennium BC, the Mediterranean powers developed successively larger and more complex vessels, the most advanced being the classical trireme with up to 170 rowers. Triremes fought several important engagements in the naval battles of the Greco-Persian Wars (502–449 BC) and the Peloponnesian War (431–404 BC), including the battle of Aegospotami in 405 BC, which sealed the defeat of the [Athens by Sparta](#) and its allies. The trireme was an advanced ship that was expensive to build and to maintain due to its large crew. By the 5th century, advanced war galleys had been developed that required sizable states with an advanced economy to build and maintain. It was associated with the latest in warship technology around the 4th century BC and could only be employed by an advanced state with an advanced economy and administration. They required considerable skill to row and oarsmen were mostly free citizens who had years of experience at the oar.^[27]

7.2.2 Hellenistic era and rise of the Republic

Main article: [Hellenistic-era warships](#)

As civilizations around the Mediterranean grew in size and complexity, both their navies and the galleys that made up their numbers became successively larger. The basic design of two or three rows of oars remained the same, but more rowers were added to each oar. The exact reasons are not known, but are believed to have been caused by addition of more troops and the use of more advanced ranged weapons on ships, such as [catapults](#). The size of the new naval forces also made it difficult to find enough skilled rowers for the one-man-per-oar system of the earliest triremes. With more than one man per oar, a single rower could set the pace for the others to follow, meaning that more unskilled rowers could be employed.^[28]

The successor states of [Alexander the Great](#)'s empire built galleys that were like triremes or biremes in oar layout, but manned with additional rowers for each oar. The ruler [Dionysius I of Syracuse](#) (ca. 432–367 BC) is credited with pioneering the “five” and “six”, meaning five or six rows of rowers plying two or three rows of oars. [Ptolemy II](#) (283–46 BC) is known to have built a large fleet of very large galleys with several experimental designs rowed by everything from 12 up to 40 rows of rowers, though most of these are considered to have been quite impractical. Fleets with large galleys were put in action in conflicts such as the [Punic Wars](#) (246–146) between the [Roman republic](#) and [Carthage](#), which included massive naval battles with hundreds of vessels and tens of thousands of soldiers, seamen and rowers.^[29]

Most of the surviving documentary evidence comes from Greek and Roman shipping, though it is likely that merchant galleys all over the Mediterranean were highly similar. In Greek they were referred to as *histiokopos* (“sail-oar-er”) to reflect that they relied on both types of propulsion. In Latin they were called *actuaria (navis)* (“ship that moves”) in Latin, stressing that they were capable of making progress regardless of weather conditions. As an example of the speed and reliability, during an instance of the famous “*Carthago delenda est*”-speech, [Cato the Elder](#) demonstrated the close proximity of the Roman arch enemy Carthage by displaying a fresh fig to his audience that he claimed had been picked in North Africa only three days past. Other cargoes carried by galleys were honey, cheese, meat and live animals intended for [gladiator](#) combat. The Romans had several types of merchant galleys that specialized in various tasks, out of which the *actuaria* with up to 50 rowers was the most versatile, including the *phaselus* (lit. “bean pod”) for passenger transport and the *lembus*, a small-scale express carrier. Many of these designs continued to be used until the Middle Ages.^[30]

7.2.3 Roman Imperial era

The battle of [Actium](#) in 31 BC between the forces of [Augustus](#) and [Mark Antony](#) marked the peak of the Roman fleet arm. After Augustus' victory at Actium, most of the Roman fleet was dismantled and burned. The [Roman civil wars](#) were fought mostly by land forces, and from the 160s until the 4th century AD, no major fleet actions were recorded. During this time, most of the galley crews were disbanded or employed for entertainment purposes in mock battles or in handling the sail-like sun-screens in the larger Roman arenas. What fleets remained were treated as auxiliaries of the land forces, and galley crewmen themselves called themselves *milites*, “soldiers”, rather than *nautae*, “sailors”.^[31]

The Roman galley fleets were turned into provincial patrol forces that were smaller and relied largely on [liburnians](#), compact biremes with 25 pairs of oars. These were named after an [Illyrian tribe](#) known by Romans for their sea



Depictions of two compact liburnians used by the Romans in their campaigns against the Dacians in the early 2nd century AD; reliefs from Trajan's Column, c. 113 AD.

roving practices, and these smaller craft were based on, or inspired by, their vessels of choice. The liburnians and other small galleys patrolled the rivers of continental Europe and reached as far as the Baltic, where they were used to fight local uprisings and assist in checking foreign invasions. The Romans maintained numerous bases around the empire: along the rivers of Central Europe, chains of forts along the northern European coasts and the British Isles, Mesopotamia and North Africa, including Trabzon, Vienna, Belgrade, Dover, Seleucia and Alexandria. Few actual galley battles in the provinces are found in records. One action in 70 AD at the unspecified location of the “Island of the Batavians” during the Batavian Rebellion was recorded, and included a trireme as the Roman flagship.^[32] The last provincial fleet, the *classis Britannica*, was reduced by the late 200s, though there was a minor upswing under the rule of Constantine (272–337). His rule also saw the last major naval battle of the Roman Empire, the battle of Hellespont of 324. Some time after Hellespont, the classical trireme fell out of use, and its design forgotten.^[33]

7.2.4 Eastern Mediterranean

A transition from galley to sailing vessels as the most common types of warships began in the high Middle Ages (c. 11th century). Large high-sided sailing ships had always been formidable obstacles for galleys. To low-freeboard oared vessels, the bulkier sailing ships like the *carrack* and the *cog* were almost like floating fortresses, being difficult to board and even harder to capture. Galleys remained useful as warships throughout the entire Middle Ages because of their maneuverability. Sailing ships of the time had only one mast, usually with just a single, large square sail. This made them cumbersome to steer and it was virtually impossible to sail into the wind direction. Galleys therefore were still the only ship type capable of coastal raiding and amphibious landings, both key elements of medieval warfare.^[34]

In the eastern Mediterranean, the *Byzantine Empire* struggled with the incursion from invading Muslim Arabs from the 7th century, leading to fierce competition, a buildup of fleet, and war galleys of increasing size. Soon after conquering Egypt and the Levant, the Arab rulers built ships highly similar to Byzantine dromons with the help of local *Coptic* shipwrights former Byzantine naval bases.^[35] By the 9th century, the struggle between the Byzantines and Arabs had turned the Eastern Mediterranean into a no man's land for merchant activity. In the 820s *Crete* was captured by Andalusian Muslims displaced by a failed revolt against the *Emirate of Cordoba*, turning the island into a base for (galley) attacks on Christian shipping until the island was recaptured by the Byzantines in 960.^[36]

7.2.5 Western Mediterranean

In the western Mediterranean and Atlantic, the division of the **Carolingian Empire** in the late 9th century brought on a period of instability, meaning increased piracy and raiding in the Mediterranean, particularly by newly arrived Muslim invaders. The situation was worsened by raiding Scandinavian **Vikings** who used longships, vessels that in many ways were very close to galleys in design and functionality and also employed similar tactics. To counter the threat, local rulers began to build large oared vessels, some with up to 30 pairs of oars, that were larger, faster and with higher sides than Viking ships.^[37] Scandinavian expansion, including incursions into the Mediterranean and attacks on both Muslim Iberia and even Constantinople itself, subsided by the mid-11th century. By this time, greater stability in merchant traffic was achieved by the emergence of Christian kingdoms such as those of France, Hungary and Poland. Around the same time, Italian port towns and city states, like **Venice**, **Pisa** and **Amalfi**, rose on the fringes of the Byzantine Empire as it struggled with eastern threats.^[38]

After the fall of the Western Roman Empire, the old Mediterranean economy collapsed and the volume of trade went down drastically. Its eastern successor, the **Byzantine Empire**, neglected to revive overland trade routes but was dependent on keeping the sea lanes open to keep the empire together. Bulk trade fell around 600-750 while the luxury trade increased. Galleys remained in service, but were profitable mainly in the luxury trade, which set off their high maintenance cost.^[39] In the 10th century, there was a sharp increase in piracy which resulted in larger ships with more numerous crews. These were mostly built by the growing city-states of Italy which were emerging as the dominant sea powers, including **Venice**, **Genoa** and **Pisa**. Inheriting the Byzantine ship designs, the new merchant galleys were similar **dromons**, but without any heavy weapons and both faster and wider. They could be manned by crews of up to 1,000 men and were employed in both trade and warfare. A further boost to the development of the large merchant galleys was the upswing in Western European pilgrims traveling to the Holy Land^[40]

In Northern Europe, Viking longships and their derivations, **knarrs**, dominated trading and shipping, though developed separately from the Mediterranean galley tradition. In the South galleys continued to be useful for trade even as sailing vessels evolved more efficient hulls and rigging; since they could hug the shoreline and make steady progress when winds failed, they were highly reliable. The zenith in the design of merchant galleys came with the state-owned *great galleys* of the **Venetian Republic**, first built in the 1290s. These were used to carry the lucrative trade in luxuries from the east such as spices, silks and gems. They were in all respects larger than contemporary war galleys (up to 46 m) and had a deeper draft, with more room for cargo (140-250 t). With a full complement of rowers ranging from 150 to 180 men, all available to defend the ship from attack, they were also very safe modes of travel. This attracted a business of carrying affluent pilgrims to the Holy Land, a trip that could be accomplished in as little 29 days on the route **Venice-Jaffa**, despite landfalls for rest and watering or for respite from rough weather.^[41]

7.2.6 Development of the true galley

Late medieval maritime warfare was divided in two distinct regions. In the Mediterranean galleys were used for raiding along coasts, and in the constant fighting for naval bases. In the Atlantic and Baltic there was greater focus on sailing ships that were used mostly for troop transport, with galleys providing fighting support.^[42] Galleys were still widely used in the north and were the most numerous warships used by Mediterranean powers with interests in the north, especially the French and Iberian kingdoms.^[43]

During the 13th and 14th century, the galley evolved into the design that was to remain essentially the same until it was phased out in the early 19th century. The new type descended from the ships used by Byzantine and Muslim fleets in the early Middle Ages. These were the mainstay of all Christian powers until the 14th century, including the great maritime republics of Genoa and Venice, the Papacy, the Hospitallers, Aragon and Castile, as well as by various pirates and corsairs. The overall term used for these types of vessels was *gallei sottili* ("slender galleys"). The later Ottoman navy used similar designs, but they were generally faster under sail, and smaller, but slower under oars.^[44] Galley designs were intended solely for close action with hand-held weapons and projectile weapons like bows and crossbows. In the 13th century the Iberian kingdom of **Aragon** built several fleet of galleys with high castles, manned with Catalan crossbowmen, and regularly defeated numerically superior **Angevin** forces.^[45]

From the first half of the 14th century the Venetian *galere da mercato* ("merchantman galleys") were being built in the shipyards of the state-run **Arsenal** as "a combination of state enterprise and private association, the latter being a kind of consortium of export merchants", as Fernand Braudel described them.^[46] The ships sailed in convoy, defended by archers and slingers (*ballestieri*) aboard, and later carrying cannons. In **Genoa**, the other major maritime power of the time, galleys and ships in general were more produced by smaller private ventures.

In the 14th and 15th centuries merchant galleys traded high-value goods and carried passengers. Major routes in



A 13th-century war galley depicted in a Byzantine-style fresco.

the time of the early Crusades carried the pilgrim traffic to the Holy Land. Later routes linked ports around the Mediterranean, between the Mediterranean and the Black Sea (a grain trade soon squeezed off by the Turkish capture of Constantinople, 1453) and between the Mediterranean and Bruges—where the first Genoese galley arrived at Sluys in 1277, the first Venetian *galere* in 1314—and Southampton. Although primarily sailing vessels, they used oars to enter and leave many trading ports of call, the most effective way of entering and leaving the Lagoon of Venice. The Venetian *galera*, beginning at 100 tons and built as large as 300, was not the largest merchantman of its day, when the Genoese *carrack* of the 15th century might exceed 1000 tons.^[48] In 1447, for instance, Florentine galleys planned to call at 14 ports on their way to and from Alexandria.^[49] The availability of oars enabled these ships to navigate close to the shore where they could exploit land and sea breezes and coastal currents, to work reliable and comparatively fast passages against the prevailing wind. The large crews also provided protection against piracy. These ships were very seaworthy; a Florentine great galley left Southampton on 23 February 1430 and returned to its port at Pisa in 32 days. They were so safe that merchandise was often not insured.^[50] These ships increased in size during this period, and were the template from which the galleass developed.

7.2.7 Transition to sailing ships

As early as 1304 the type of ship required by the Danish defence organization changed from galley to cog, a flat-bottomed sailing ship.^[51]

During the early 15th century, sailing ships began to dominate naval warfare in northern waters. While the galley still remained the primary warship in southern waters, a similar transition had begun also among the Mediterranean powers. A Castilian naval raid on the island of Jersey in 1405 became the first recorded battle where a Mediterranean power employed a naval force consisting mostly of cogs or *nefs*, rather than the oared-powered galleys. The battle of Gibraltar between Castile and Portugal in 1476 was another important sign of change; it was the first recorded battle where the primary combatants were full-rigged ships armed with wrought-iron guns on the upper decks and in the waists, foretelling of the slow decline of the war galley.^[52]

The transition from the Mediterranean war galley to the sailing vessel as the preferred method of vessel in the Mediterranean is tied directly to technological developments and the inherent handling characteristics of each vessel types. The primary factors were changing sail design, the introduction of cannons aboard vessels, and the handling characteristics of the vessels.

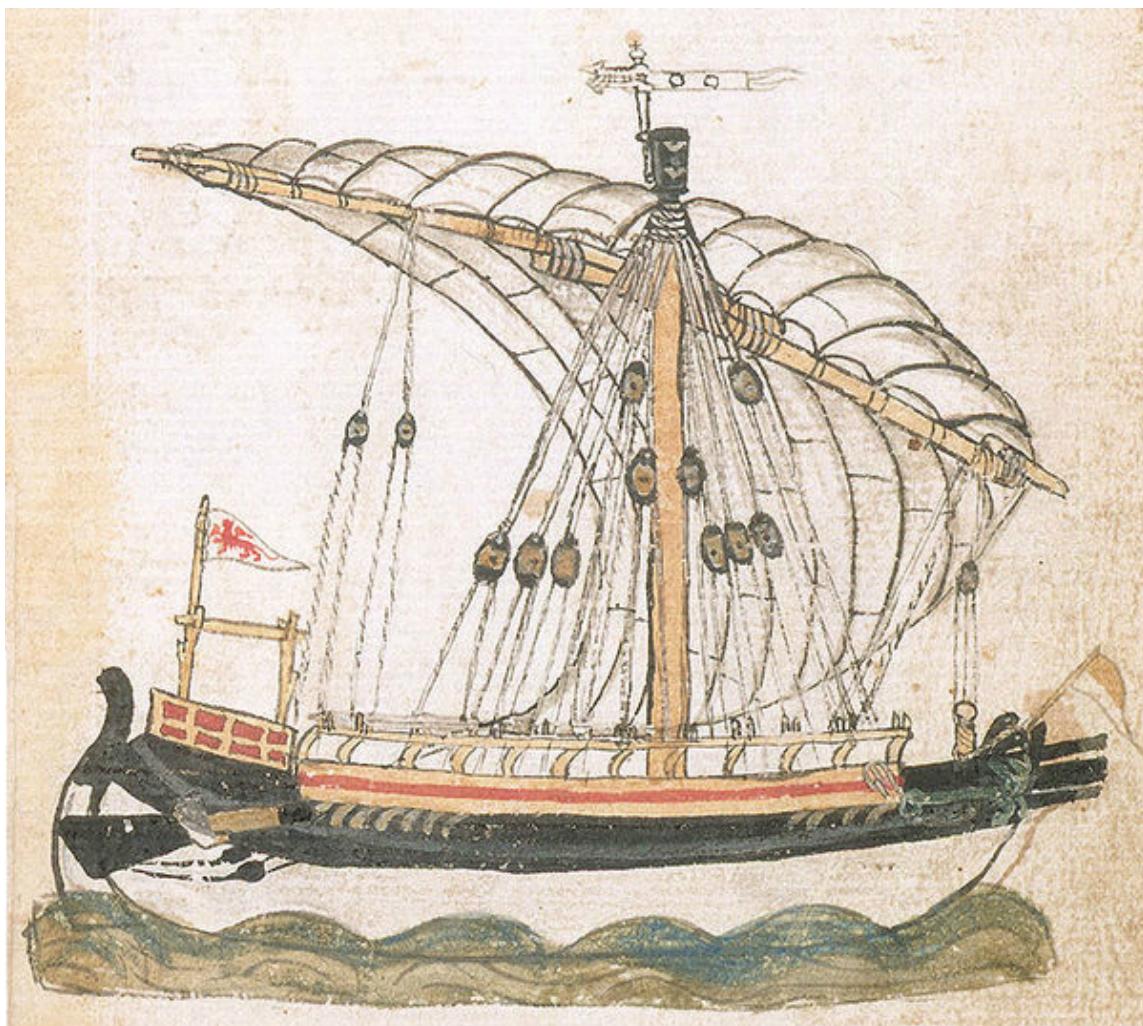


Illustration of a 15th-century trade galley from a manuscript by Michael of Rhodes (1401–1445) written in 1434.

The sailing vessel was always at the mercy of the wind for propulsion, and those that did carry oars were placed at a disadvantage because they were not optimized for oar use. The galley did have disadvantages compared to the sailing vessel though. Their smaller hulls were not able to hold as much cargo and this limited their range as the crews were required to replenish food stuffs more frequently.^[53] The low freeboard of the galley meant that in close action with a sailing vessel, the sailing vessel would usually maintain a height advantage. The sailing vessel could also fight more effectively farther out at sea and in rougher wind conditions because of the height of their freeboard.^[54]

Under sail, an oared warship was placed at much greater risk as a result of the piercings for the oars which were required to be near the waterline and would allow water to ingress into the galley if the vessel heeled too far to one side. These advantages and disadvantages led the galley to be and remain a primarily coastal vessel. The shift to sailing vessels in the Mediterranean was the result of the negation of some of the galley's advantages as well as the adoption of gunpowder weapons on a much larger institutional scale. The sailing vessel was propelled in a different manner than the galley but the tactics were often the same until the 16th century. The real-estate afforded to the sailing vessel to place larger cannons and other armament mattered little because early gunpowder weapons had limited range and were expensive to produce. The eventual creation of cast iron cannons allowed vessels and armies to be outfitted much more cheaply. The cost of gunpowder also fell in this period.^[55]

The armament of both vessel types varied between larger weapons such as bombards and the smaller swivel guns. For logistical purposes it became convenient for those with larger shore establishments to standardize upon a given size of cannon. Traditionally the English in the North and the Venetians in the Mediterranean are seen as some the earliest to move in this direction. The improving sail rigs of northern vessels also allowed them to navigate in the coastal waters of the Mediterranean to a much larger degree than before.^[56] Aside from warships the decrease in the cost of gunpowder weapons also led to the arming of merchants. The larger vessels of the north continued to mature while the galley retained its defining characteristics. Attempts were made to stave this off such as the addition of

fighting castles in the bow, but such additions to counter the threats brought by larger sailing vessels often offset the advantages of galley.^[57]

7.2.8 Introduction of guns



Painting of the battle of Haarlemmermeer of 1573 by Hendrick Cornelisz Vroom. Note the use of small sailing vessels and galleys on both sides.

From around 1450, three major naval powers established a dominance over different parts of the Mediterranean using galleys as their primary weapons at sea: the **Ottomans** in the east, Venice in the center and **Habsburg Spain** in the west.^[58] The core of their fleets were concentrated in the three major, wholly dependable naval bases in the Mediterranean: **Constantinople**, **Venice** and **Barcelona**.^[59] Naval warfare in the 16th century Mediterranean was fought mostly on a smaller scale, with raiding and minor actions dominating. Only three truly major fleet engagements were actually fought in the 16th century: the battles of **Preveza** in 1538, **Djerba** in 1560 and **Lepanto** in 1571. Lepanto became the last large all-galley battle ever, and was also one of the largest battle in terms of participants anywhere in early modern Europe before the **Napoleonic Wars**.^[60]

Occasionally the Mediterranean powers employed galley forces for conflicts outside the Mediterranean. Spain sent galley squadrons to the Netherlands during the later stages of the **Eighty Years' War** which successfully operated against Dutch forces in the enclosed, shallow coastal waters. From the late 1560s, galleys were also used to transport silver to Genoese bankers to finance Spanish troops against the Dutch uprising.^[61] Galleasses and galleys were part of an invasion force of over 16,000 men that conquered the **Azores** in 1583. Around 2,000 galley rowers were on board ships of the famous 1588 **Spanish Armada**, though few of these actually made it to the battle itself.^[62] Outside European and Middle Eastern waters, Spain built galleys to deal with pirates and privateers in both the Caribbean and the Philippines.^[63] Ottoman galleys contested the Portuguese intrusion in the Indian Ocean in the 16th century, but failed against the high-sided, massive Portuguese carracks in open waters.^[64]

Despite the huge loss of men and material after the loss of the Spanish Armada in 1588 Spain maintained four permanent galley squadrons. Together they formed the largest galley navy in the Mediterranean in the early 17th century. They formed the backbone of the Spanish war fleet and were used for ferrying troops, supplies, horses and munitions to Spain's Italian and African possessions.^[65] The Ottoman Turks attempted to contest the Portuguese rise to power in the **Indian Ocean** in the 16th century with Mediterranean-style galleys, but were foiled by the formidable

Portuguese **carracks**. Even though the carracks themselves were soon surpassed by other types of sailing vessels, their greater range, great size and high superstructures, armed with numerous **wrought** iron guns easily outmatched the short-ranged, low-freeboard Turkish galleys.^[64] The Spanish used galleys to more success in their colonial possessions in the Caribbean and the Philippines to hunt pirates^[66] and were used sporadically in the Netherlands and the Bay of Biscay.^[67]

Galleys had been synonymous with warships in the Mediterranean for at least 2,000 years, and continued to fulfill that role with the invention of gunpowder and heavy artillery. Though early 20th-century historians often dismissed the galleys as hopelessly outclassed with the first introduction of naval artillery on sailing ships,^[68] it was the galley that was favored by the introduction of heavy **naval guns**. Galleys were a more “mature” technology with long-established tactics and traditions of supporting social institutions and naval organizations. In combination with the intensified conflicts this led to a substantial increase in the size of galley fleets from c. 1520–80, above all in the Mediterranean, but also in other European theatres.^[69] Galleys and similar oared vessels remained uncontested as the most effective gun-armed warships in theory until the 1560s, and in practice for a few decades more, and were actually considered a grave risk to sailing warships.^[70] They could effectively fight other galleys, attack sailing ships in calm weather or in unfavorable winds (or deny them action if needed) and act as floating siege batteries. They were also unequaled in their amphibious capabilities, even at extended ranges, as exemplified by French interventions as far north as Scotland in the mid-16th century.^[71]

Heavy artillery on galleys was mounted in the bow, which aligned easily with the long-standing tactical tradition of attacking head on, bow first. The ordnance on galleys was heavy from its introduction in the 1480s, and capable of quickly demolishing the high, thin medieval stone walls that still prevailed in the 16th century. This temporarily upended the strength of older seaside fortresses, which had to be rebuilt to cope with gunpowder weapons. The addition of guns also improved the amphibious abilities of galleys as they could make assaults supported with heavy firepower, and were even more effectively defended when beached stern-first.^[72] An accumulation and generalizing of bronze cannons and small firearms in the Mediterranean during the 16th century increased the cost of warfare, but also made those dependent on them more resilient to manpower losses. Older ranged weapons, like bows or even crossbows, required considerable skill to handle, sometimes a lifetime of practice, while gunpowder weapons required considerably less training to use successfully.^[73] According to a highly influential study by military historian John F. Guilmartin, this transition in warfare, along with the introduction of much cheaper cast iron guns in the 1580s, proved the “death knell” for the war galley as a significant military vessel.^[74] Gunpowder weapons began to displace men as the fighting power of armed forces, making individual soldiers more deadly and effective. As offensive weapons, firearms could be stored for years with minimal maintenance and did not require the expenses associated with soldiers. Manpower could thus be exchanged for capital investments, something which benefited sailing vessels that were already far more economical in their use of manpower. It also served to increase their strategic range and to out-compete galleys as fighting ships.^[75]

7.2.9 Mediterranean decline

Atlantic-style warfare based on heavily armed sailing ships began to change the nature of naval warfare in the Mediterranean in the 17th century. In 1616, a small Spanish squadron of five galleons and a **patache** was used to cruise the eastern Mediterranean and defeated a fleet of 55 galleys at the **battle of Cape Celidonia**. By 1650, war galleys were used primarily in the wars between Venice and the **Ottoman Empire** in their struggle for strategic island and coastal trading bases and until the 1720s by both France and Spain but for largely amphibious and cruising operations or in combination with heavy sailing ships in a major battle, where they played specialized roles. An example of this was when a Spanish fleet used its galleys in a mixed naval/amphibious battle in the second 1641 **battle of Tarragona**, to break a French naval blockade and land troops and supplies.^[76] Even a purely Mediterranean power like Venice began to construct sail only warships in the latter part of the century. Christian and Muslim corsairs had been using galleys in sea roving and in support of the major powers in times of war, but largely replaced them with **xebecs**, various sail/oar hybrids, and a few remaining light galleys in the early 17th century.^[77]

No large all galley battles were fought after the gigantic clash at Lepanto in 1571, and galleys were mostly used as cruisers or for supporting sailing warships as a rearguard in fleet actions, similar to the duties performed by **frigates** outside the Mediterranean.^[78] They could assist damaged ships out of the line, but generally only in very calm weather, as was the case at the **Battle of Málaga** in 1704.^[79] For small states and principalities as well as groups of private merchants, galleys were more affordable than large and complex sailing warships, and were used as defense against piracy. Galleys required less timber to build, the design was relatively simple and they carried fewer guns. They were tactically flexible and could be used for naval ambushes as well amphibious operations. They also required few skilled seamen and were difficult for sailing ships to catch, but vital in hunting down catching other galleys and oared



The Battle of Lepanto in 1571, naval engagement between allied Christian forces and the Ottoman Turks.

raiders.^[79]

The largest galley fleets in the 17th century were operated by the two major Mediterranean powers, France and Spain. France had by the 1650s become the most powerful state in Europe, and expanded its galley forces under the rule of the absolutist “Sun King” Louis XIV. In the 1690s the French galley corps (*Corps des galères*) reached its all-time peak with more than 50 vessels manned by over 15,000 men and officers, becoming the largest galley in the world at the time.^[80] Though there was intense rivalry between France and Spain, not a single galley battle occurred between the two great powers after, and virtually no battles between other nations either.^[81] During the War of the Spanish Succession, French galleys were involved in actions against Antwerp and Harwich,^[82] but due to the intricacies of alliance politics there were never any Franco-Spanish galley clashes. In the first half of the 18th century, the other major naval powers in North Africa, the Order of Saint John and the Papal States all cut down drastically on their galley forces.^[83] Despite the lack of action, the galley corps received vast resources (25-50% of the French naval expenditures) during the 1660s centuries.^[84] It was maintained as a functional fighting force right up until its abolishment in 1748, though its primary function was more of a symbol of Louis XIV’s absolutist ambitions.^[85]

The last recorded battle in the Mediterranean where galleys played a significant part was at Matapan in 1717, between the Ottomans and Venice and its allies, though they had little influence on the final outcome. Few large-scale naval battles were fought in the Mediterranean throughout most of the remainder of the 18th century. The Tuscan galley fleet was dismantled around 1718, Naples had only four old vessels by 1734 and the French Galley Corps had ceased to exist as an independent arm in 1748. Venice, the Papal States and the Knights of Malta were the only state fleets that maintained galleys, though in nothing like their previous quantities.^[86] By 1790, there were less than 50 galleys in service among all the Mediterranean powers, half of which belonged to Venice.^[87]

7.2.10 Use in northern Europe

Oared vessels remained in use in northern waters for a long time, though in subordinate role and in particular circumstances. In the Italian Wars, French galleys brought up from the Mediterranean to the Atlantic posed a serious threat to the early English Tudor navy during coastal operations. The response came in the building of a considerable fleet of oared vessels, including hybrids with a complete three-masted rig, as well as a Mediterranean-style galleys (that were even attempted to be manned with convicts and slaves).^[88] Under King Henry VIII, the English navy used several kinds of vessels that were adapted to local needs. English *galliasses* (very different from the Mediterranean vessel of the same name) were employed to cover the flanks of larger naval forces while *pinnaces* and *rowbarges* were used for scouting or even as a backup for the *longboats* and tenders for the larger sailing ships.^[89] During the Dutch Revolt (1566–1609) both the Dutch and Spanish found galleys useful for amphibious operations in the many shallow waters around the Low Countries where deep-draft sailing vessels could not enter.^[82]



Dutch ships ramming Spanish galleys in the *Battle of the Narrow Seas*, October 1602.

While galleys were too vulnerable to be used in large numbers in the open waters of the Atlantic, they were well-suited for use in much of the Baltic Sea by Denmark, Sweden, Russia and some of the Central European powers with ports on the southern coast. There were two types of naval battlegrounds in the Baltic. One was the open sea, suitable for large sailing fleets; the other was the coastal areas and especially the chain of small islands and archipelagos that ran almost uninterrupted from Stockholm to the Gulf of Finland. In these areas, conditions were often too calm, cramped and shallow for sailing ships, but they were excellent for galleys and other oared vessels.^[90] Galleys of the Mediterranean type were first introduced in the [Baltic Sea](#) around the mid-16th century as competition between the Scandinavian states of Denmark and Sweden intensified. The Swedish galley fleet was the largest outside the Mediterranean, and served as an auxiliary branch of the army. Very little is known about the design of Baltic Sea galleys, except that they were overall smaller than in the Mediterranean and they were rowed by army soldiers rather than convicts or slaves.^[91]

Baltic revival and decline

Galleys were introduced to the [Baltic Sea](#) in the 16th century but the details of their designs are lacking due to the absence of records. They might have been built in a more regional style, but the only known depiction from the time shows a typical Mediterranean vessel. There is conclusive evidence that Denmark became the first Baltic power to build classic Mediterranean-style galleys in the 1660s, though they proved to be generally too large to be useful in the shallow waters of the Baltic archipelagos. Sweden and especially Russia began to launch galleys and various rowed vessels in great numbers during the [Great Northern War](#) in the first two decades of the 18th century.^[92] Sweden was late in the game when it came to building an effective oared fighting fleet, while the Russian galley forces under Tsar [Peter I](#) developed into a supporting arm for the sailing navy and a well-functioning auxiliary of the army which infiltrated and conducted numerous raids on the eastern Swedish coast in the 1710s.^[93]

Sweden and Russia became the two main competitors for Baltic dominance in the 18th century, and built the largest galley fleets in the world at the time. They were used for amphibious operations in Russo-Swedish wars of 1741–43 and 1788–90. The last galleys ever constructed were built in 1796 by Russia, and remained in service well into



A painting of the *Battle of Grengam* in 1720 by Ferdinand Perrot (1808–41) showing a large Russian galley engaging Swedish frigates at close range. Note the crowded fighting platform (rambade) in the bow.

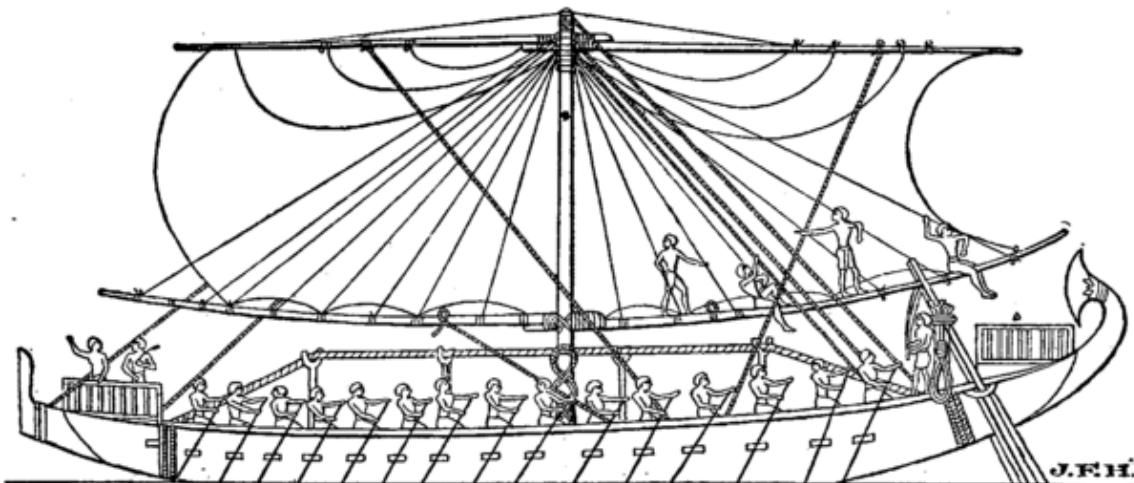
the 19th century, but saw little action.^[94] The last time galleys were deployed in action was when the Russian navy attacked Åbo (Turku) in 1854 as part of the Crimean War.^[95] In the second half of the 18th century, the role of Baltic galleys in coastal fleets was replaced first with hybrid “archipelago frigates” (like the *turuma* or *pojama*) and *xebecs*, and after the 1790s with various types of gunboats.^[96]

7.3 Construction

Galleys have since their first appearance in ancient times been intended as highly maneuverable vessels, independent of winds by being rowed, and usually with a focus on speed under oars. The profile has therefore been that of a markedly elongated hull with a ratio of breadth to length at the waterline of at least 1:5, and in the case of ancient Mediterranean galleys as much as 1:10 with a small draught, the measurement of how much of a ship’s structure that is submerged under water. To make it possible to efficiently row the vessels, the freeboard, the height of the railing to the surface of the water, was by necessity kept low. This gave oarsmen enough leverage to row efficiently, but at the expense of seaworthiness. These design characteristics made the galley fast and maneuverable, but more vulnerable to rough weather.

The documentary evidence for the construction of ancient galleys is fragmentary, particularly in pre-Roman times. Plans and schematics in the modern sense did not exist until the 17th century and nothing like them has survived from ancient times. How galleys were constructed has therefore been a matter of looking at circumstantial evidence in literature, art, coinage and monuments that include ships, some of them actually in natural size. Since the war galleys floated even with a ruptured hull and virtually never had any ballast or heavy cargo that could sink them, not a single wreckage of one has so far been found. The only exception has been a partial wreckage of a small Punic *liburnian* from the Roman era, the *Marsala Ship*.^[97]

On the funerary monument of the Egyptian king *Sahure* (2487–2475 BC) in *Abusir*, there are relief images of vessels with a marked *sheer* (the upward curvature at each end of the hull) and seven pairs of oars along its side, a number that was likely to have been merely symbolical, and steering oars in the stern. They have one mast, all lowered and vertical posts at stem and stern, with the front decorated with an *Eye of Horus*, the first example of such a decoration. It was later used by other Mediterranean cultures to decorate seagoing craft in the belief that it helped to guide the



Egyptian ship on the Red Sea, about 1250 B.C. [From Torr's "Ancient Ships."]

Mr. Langton Cole calls attention to the rope *truss* in this illustration, stiffening the beam of the ship. No other such use of the truss is known until the days of Modern engineering.

Illustration of an Egyptian rowed ship of c. 1250 BC. Due to a lack of a proper keel, the vessel has a truss, a thick cable along its length, to prevent it from losing its shape.

ship safely to its destination. These early galleys apparently lacked a **keel** meaning they lacked stiffness along their length. Therefore they had large cables connecting stem and stern resting on massive crutches on deck. They were held in tension to avoid **hogging**, or bending the ship's construction upwards in the middle, while at sea.^[15] In the 15th century BC, Egyptian galleys were still depicted with the distinctive extreme sheer, but had by then developed the distinctive forward-curving stern decorations with ornaments in the shape of **lotus flowers**.^[98] They had possibly developed a primitive type of keel, but still retained the large cables intended to prevent hogging.^[16]

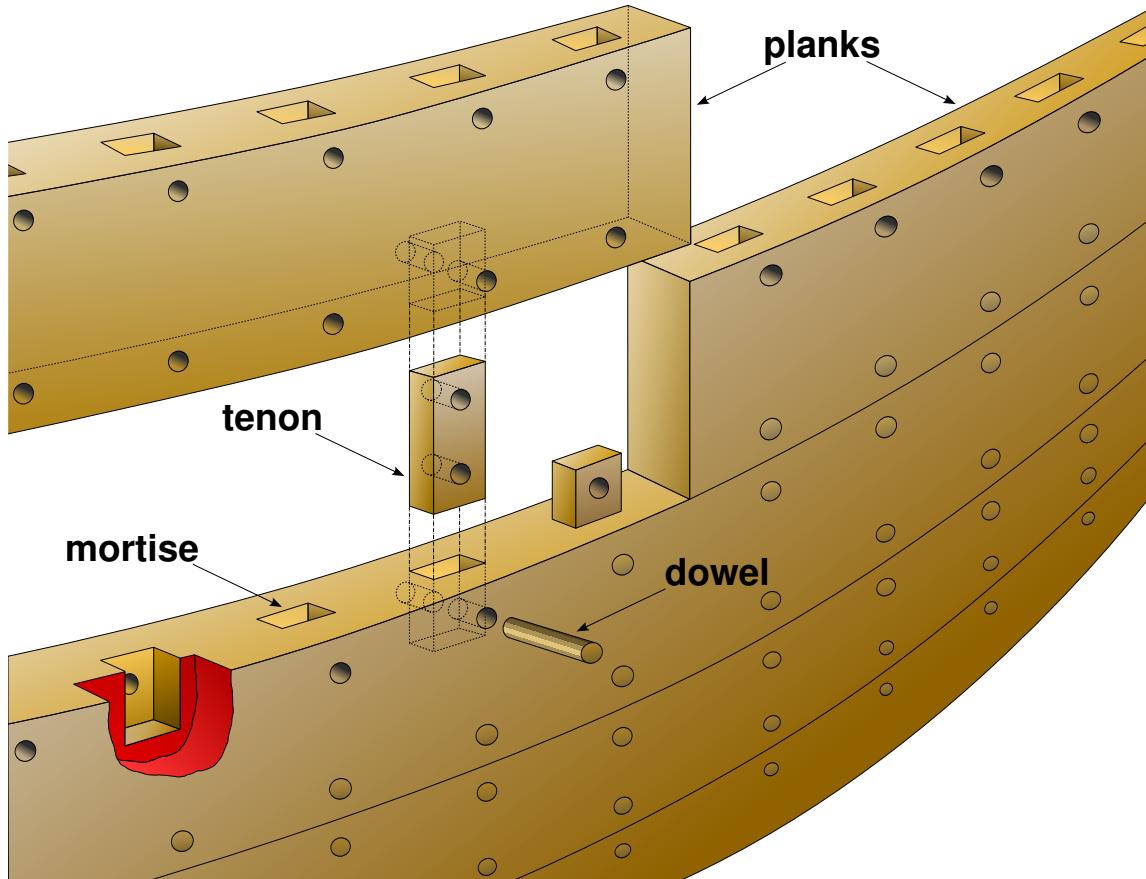
The design of the earliest oared vessels is mostly unknown and highly conjectural. They likely used a **mortise** construction, but were sewn together rather than pinned together with nails and dowels. Being completely open, they were rowed (or even paddled) from the open deck, and likely had "ram entries", projections from the bow lowered the resistance of moving through water, making them slightly more hydrodynamic. The first true galleys, the **triaconters** (literally "thirty-oarers") and **penteconters** ("fifty-oarers") were developed from these early designs and set the standard for the larger designs that would come later. They were rowed on only one level, which made them fairly slow, likely only 5-5.5 knots. By the 8th century BC the first galleys rowed at two levels had been developed, among the earliest being the two-level **penteconters** which were considerably shorter than the one-level equivalents, and therefore more maneuverable. They were an estimated 25 m in length and displaced 15 tonnes with 25 pairs of oars. These could have reached an estimated top speed of up to 7.5 knots, making them the first genuine warships when fitted with bow rams. They were equipped with a single **square sail** on mast set roughly halfway along the length of the hull.^[100]

7.3.1 The trireme

Main article: **trireme**

By the 5th century BC, the first **triremes** were in use by various powers in the eastern Mediterranean. It had now become a fully developed, highly specialized vessel of war that was capable of high speeds and complex maneuvers. At nearly 40 m in length, displacing almost 50 tonnes, it was more than three times as expensive than a two-level **penteconter**. A trireme also had an additional mast with a smaller square sail placed near the bow.^[101] Up to 170 oarsmen sat on three levels with one oar each that varied slightly in length. To accommodate three levels of oars, rowers sat staggered on three levels. Arrangement of the three levels are believed to have varied, but the most well-documented design made use of a projecting structure, or **outrigger**, where the **oarlock** in the form of a **thole pin** was placed. This allowed the outermost row of oarsmen enough **leverage** for full strokes that made efficient use of their oars.^[102]

The first dedicated war galleys fitted with rams were built with a **mortise** and **tenon** technique, a so-called **shell-first** method. In this, the planking of the hull was strong enough to hold the ship together structurally, and was also



A schematic view of the *mortise and tenon* technique for shipbuilding that dominated the Mediterranean until the 7th century AD.^[99]

watertight without the need for *caulking*. Hulls had sharp bottoms without *keelsons* in order to support the structure and were reinforced by transverse framing secured with dowels with nails driven through them. To prevent the hull from *hogging* there was a *hypozoma*, a thick cable that connected bow with stern. It was kept taught to add strength to the construction along its length, but its exact design or the method of tightening is not known.^[104] The ram, the primary weapon of Ancient galleys from around the 8th to the 4th century, was not attached directly on the hull but to a structure extending from it. This way the ram could twist off if got stuck after ramming rather than breaking the integrity of the hull. The ram fitting consisted of a massive, projecting timber and the ram itself was a thick bronze casting with horizontal blades that could weigh from 400 kg up to 2 tonnes.^[101]

7.3.2 Roman era

Galleys from 4th century BC up to the time of the early Roman Empire in the 1st century AD became successively larger. Three levels of oars was the practical upper limit, but it was improved on by making ships longer, broader and heavier and placing more than one rower per oar. Naval conflict grew more intense and extensive, and by 100 BC galleys with four, five or six rows of oarsmen were commonplace and carried large complements of soldiers and catapults. With high freeboard (up to 3 m) and additional tower structures from which missiles could be shot down onto enemy decks, they were intended to be like floating fortresses.^[105] Designs with everything from eight rows of oarsmen and upwards were built, but most of them are believed to have been impractical show pieces never used in actual warfare.^[106] Ptolemy IV, the Greek pharaoh of Egypt 221-205 BC is recorded as building a gigantic ship with *forty* rows of oarsmen, though no specification of its design remains. One suggested design was that of a huge trireme catamaran with up to 14 men per oar and it is assumed that it was intended as a showpiece rather than a practical warship.^[107]

With the consolidation of Roman imperial power, the size of both fleets and galleys decreased considerably. The



The stern of the modern trireme replica Olympias with twin side rudders.

huge polyremes disappeared and the fleet were equipped primarily with triremes and liburnians, compact biremes with 25 pairs of oars that were well suited for patrol duty and chasing down raiders and pirates.^[108] In the northern provinces oared patrol boats were employed to keep local tribes in check along the shores of rivers like the Rhine and the Danube.^[109] As the need for large warships disappeared, the design of the trireme, the pinnacle of ancient war ship design, fell into obscurity and was eventually forgotten. The last known reference to triremes in battle is dated to 324 at the battle of the Hellespont. In the late 5th century the Byzantine historian Zosimus declared the knowledge of how to build them to have been long since forgotten.^[110]

7.3.3 Middle Ages

The earliest medieval galley specification comes from an order of Charles I of Sicily, in 1275 AD.^[111] Overall length 39.30 m, keel length 28.03 m, depth 2.08 m. Hull width 3.67 m. Width between outriggers 4.45 m. 108 oars, most 6.81 m long, some 7.86 m, 2 steering oars 6.03 m long. Foremast and middle mast respectively heights 16.08 m, 11.00 m; circumference both 0.79 m, yard lengths 26.72 m, 17.29 m. Overall deadweight tonnage approximately 80 metric tons. This type of vessel had two, later three, men on a bench, each working his own oar. This vessel had much longer oars than the Athenian trireme which were 4.41 m & 4.66 m long.^[112] This type of warship was called *galia sottil*.^[113]

The dromon and the galea

The primary warship of the Byzantine navy until the 12th century was the **dromon** and other similar ship types. Considered an evolution of the Roman **liburnian**, the term first appeared in the late 5th century, and was commonly used for a specific kind of war-galley by the 6th century.^[114] The term *dromōn* (literally “runner”) itself comes from the Greek root *drom- (άō)*, “to run”, and 6th-century authors like Procopius are explicit in their references to the speed of these vessels.^[115] During the next few centuries, as the naval struggle with the Arabs intensified, heavier versions with two or possibly even three banks of oars evolved.^[116]



The Athlit ram, a preserved original warship ram from around 530–270 BC. It weighs nearly half a tonne and was probably fitted to a “five” or a “four”.^[103]

The accepted view is that the main developments which differentiated the early dromons from the liburnians, and that henceforth characterized Mediterranean galleys, were the adoption of a full **deck**, the abandonment of **rams** on the bow in favor of an above-water spur, and the gradual introduction of **lateen** sails.^[117] The exact reasons for the abandonment of the ram are unclear. Depictions of upward-pointing beaks in the 4th-century *Vatican Vergil* manuscript may well illustrate that the ram had already been replaced by a spur in late Roman galleys.^[118] One possibility is that the change occurred because of the gradual evolution of the ancient shell-first construction method, against which rams had been designed, into the skeleton-first method, which produced a stronger and more flexible hull, less susceptible to ram attacks.^[119] At least by the early 7th century, the ram's original function had been forgotten.^[120]

The dromons that Procopius described were single-banked ships of probably 25 oars per side. Unlike ancient vessels, which used an **outrigger**, these extended directly from the hull.^[121] In the later **bireme** dromons of the 9th and 10th centuries, the two oar banks were divided by the deck, with the first oar bank was situated below, whilst the second oar bank was situated above deck; these rowers were expected to fight alongside the marines in boarding operations.^[122] The overall length of these ships was probably about 32 meters.^[123] The **stern** (*prymnē*) had a tent that covered the captain's berth;^[124] the prow featured an elevated forecastle that acted as a fighting platform and could house one or more siphons for the discharge of **Greek fire**;^[125] and on the largest dromons, there were wooden castles on either side between the masts, providing archers with elevated firing platforms.^[126] The bow spur was intended to ride over an enemy ship's oars, breaking them and rendering it helpless against missile fire and boarding actions.^[127]

7.3.4 Standardization

From the 12th century, the design of war galleys evolved into the form that would remain largely the same until the building of the last war galleys in the late 18th century. The length to breadth-ratio was a minimum of 8:1. A rectangular **telaro**, an **outrigger**, was added to support the oars and the rowers' benches were laid out in a diagonal herringbone pattern angled aft on either side of a central gangway, or *corsia*.^[128] It was based on the form of the **galea**, the smaller Byzantine galleys, and would be known mostly by the Italian term *gallia sottile* (literally “slender galley”). A second, smaller mast was added sometime in the 13th century and the number of rowers was rose from

two to three rowers per bench as a standard from the late 13th to the early 14th century.^[129] The *gallei sottili* would make up the bulk the main war fleets of every major naval power in the Mediterranean, assisted by the smaller *galiotte*, as well as the Christian and Muslim *corsairs* fleets. Ottoman galleys were very similar in design, though in general smaller, faster under sail, but slower under oars.^[130] The standard size of the galley remained stable from the 14th until the early 16th century, when the introduction of naval artillery began to have effects on design and tactics.^[131]



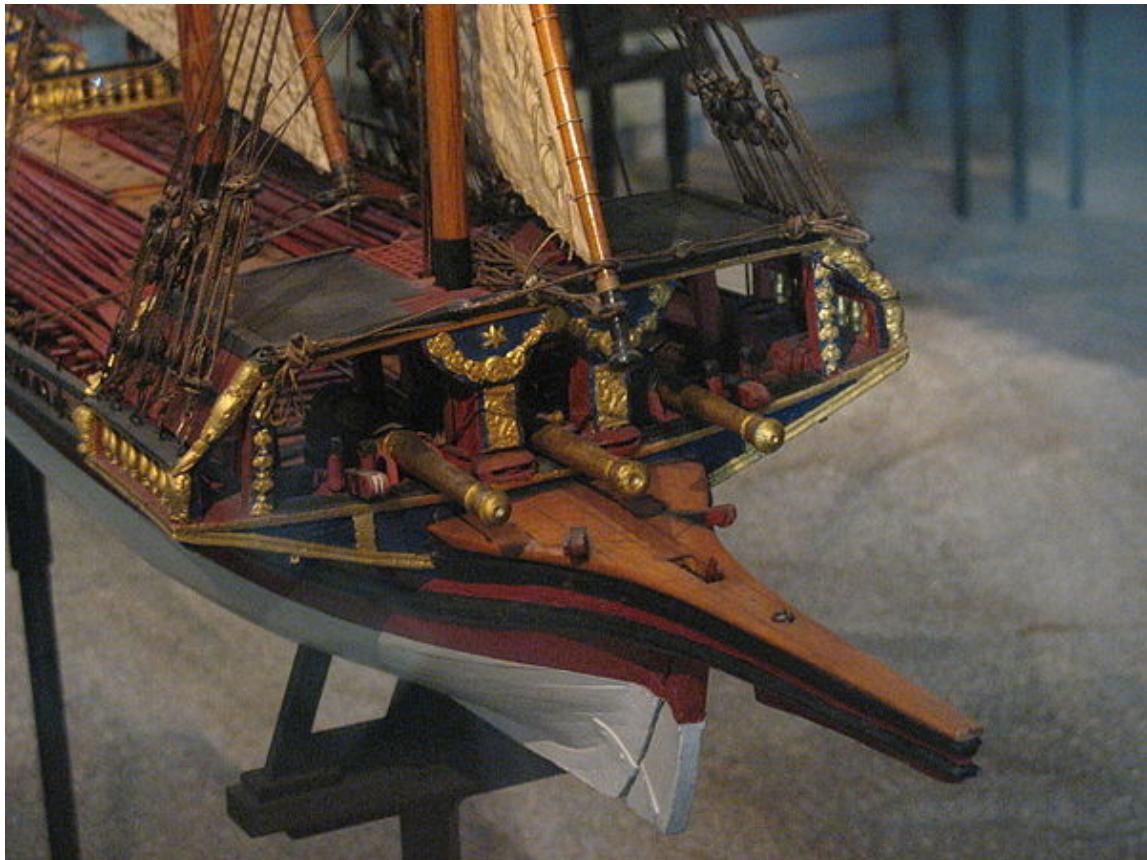
A Venetian galea sottila from the late 15th century from Vittore Carpaccio's Return of the Ambassadors in the series *Legend of Saint Ursula* (1497–1498). Note the oars arranged in groups of three according to the *alla sensile* rowing method.

The traditional two side rudders were complemented with a stern rudder sometime after c. 1400 and eventually the side rudders disappeared altogether.^[132] It was also during the 15th century that large artillery pieces were first mounted on galleys. Burgundian records from the mid-15th century describe galleys with some form of guns, but do not specify the size. The first conclusive evidence of a large cannon mounted on a galley comes from a woodcut of a Venetian galley in 1486.^[133] The first guns were fixed directly on timbers in the bow and aimed directly forwards, a placement that would remain largely unchanged until the galley disappeared from active service in the 19th century.^[134]

With the introduction of guns in the bows of galleys, a permanent wooden structure called *rambade* (French: *rambade*; Italian: *rambata*; Spanish: *arrumbada*) was introduced. The *rambade* became standard on virtually all galleys in the early 16th century. There were some variations in the navies of different Mediterranean powers, but the overall layout was the same. The forward-aiming battery was covered by a wooden platform which gave gunners a minimum of protection, and functioned as both a staging area for boarding attacks and as a firing platform for on-board soldiers.^[135] After its introduction, the *rambade* became a standard detail on every fighting galley until the very end of galley era in the early 19th century.^[136]

In the mid-17th century, galleys reached what has been described as their “final form”.^[137] Galleys had looked more or less the same for over four centuries and a fairly standardized classification system for different sizes of galleys had been developed by the Mediterranean bureaucracies, based mostly on the number of benches in a vessel.^[10] A Mediterranean galley would have 25–26 pairs of oars with five men per oar (c. 250 rowers), 50–100 sailors and 50–100 soldiers for a total of about 500 men. The exceptions were the significantly larger “flagships” (often called *lanternas*, “lantern galleys”) that had 30 pairs of oars and up to seven rowers per oar. The armament consisted of one heavy 24- or 36-pounder gun in the bows flanked by two to four 4- to 12-pounders. Rows of light *swivel guns* were often placed along the entire length of the galley on the railings for close-quarter defense. The length-to-width ratio of the ships was about 8:1, with two main masts carrying one large *lateen* sail each. In the Baltic, galleys were generally shorter with a length-to-width ratio from 5:1 to 7:1, an adaptation to the cramped conditions of the Baltic archipelagos.^[138]

A single *mainmast* was standard on most war galleys until c. 1600. A second, shorter mast could be raised temporarily in the bows, but became permanent by the early 17th century. It was stepped slightly to the side to allow for the recoil of the heavy guns; the other was placed roughly in the center of the ship. A third smaller mast further astern, akin to a *mizzen mast*, was also introduced on large galleys, possibly in the early 17th century, but was standard at least by the early 18th century.^[139] Galleys had little room for provisions and depended on frequent resupplying and were



The ubiquitous bow fighting platform (rambade) of early modern galleys. This model is of a 1715 Swedish galley, somewhat smaller than the standard Mediterranean war galley, but still based on the same design.

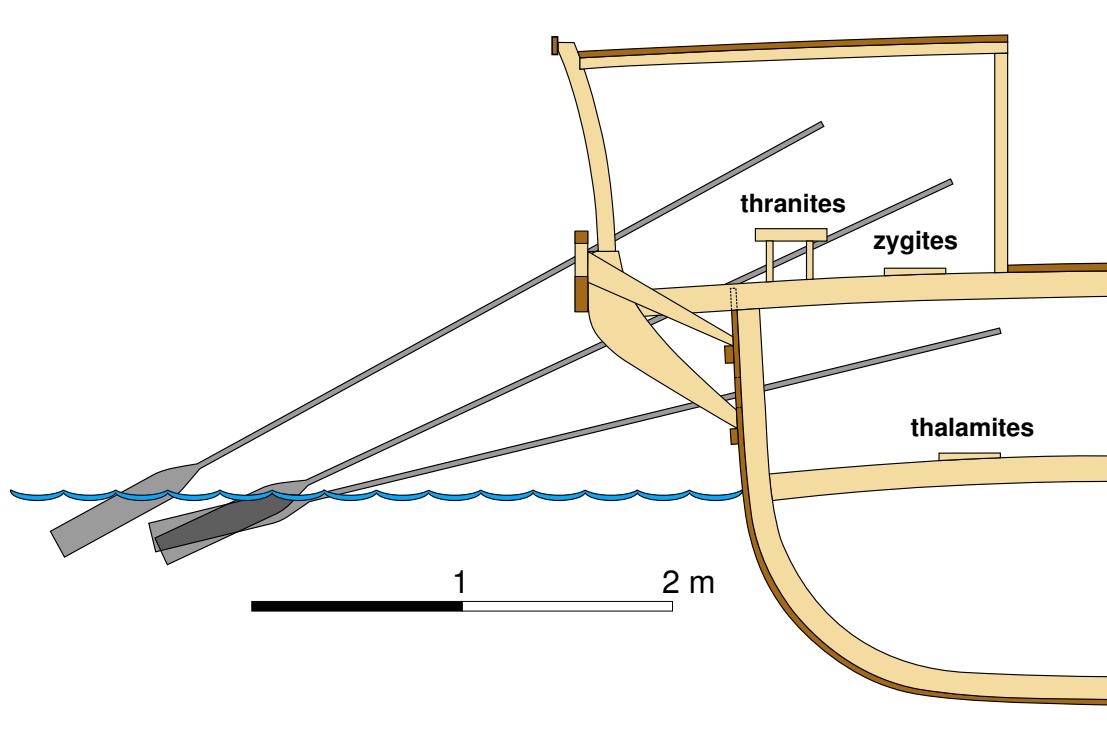
often beached at night to rest the crew and cook meals. Where cooking areas were actually present, they consisted of a clay-lined box with a hearth or similar cooking equipment fitted on the vessel in place of a rowing bench, usually on the port (left) side.^[140]

7.4 Propulsion

Throughout their long history, galleys relied on rowing as the most important means of propulsion. The arrangement of rowers during the 1st millennium BC developed gradually from a single row up to three rows arranged in a complex, staggered seating arrangement. Anything above three levels, however, proved to be physically impracticable. Initially, there was only one rower per oar, but the number steadily increased, with a number of different combinations of rowers per oar and rows of oars. The ancient terms for galleys was based on the numbers of rows or rowers plying the oars, not the number of rows of oars. Today it is best known by a modernized Latin terminology based on numerals with the ending "-reme" from *rēmus*, "oar". A *trireme* was a ship with three rows of oarsmen, a *quadrireme* four, a *hexareme* six, and so forth. There were warships that ran up to ten or even eleven rows, but anything above six was rare. A huge *forty*-rowed ship was built during the reign of Ptolemy IV in Egypt. Little is known about its design, but it is assumed to have been an impractical prestige vessel.

7.4.1 Rowing

Ancient rowing was done in a fixed seated position, the most effective rowing position, with rowers facing the stern. A sliding stroke, which provided the strength from both legs as well as the arms, was suggested by earlier historians, but no conclusive evidence has supported it. Practical experiments with the full-scale reconstruction *Olympias* has shown that there was insufficient space, while moving or rolling seats would have been highly impractical to construct with ancient methods.^[141] Rowers in ancient war galleys sat below the upper deck with little view of their surroundings. The rowing was therefore managed by supervisors, and coordinated with pipes or rhythmic chanting.^[142] Galleys were



Modern reconstruction of a cross-section of an ancient Greek trireme, showing the three levels of rowers.

highly maneuverable, able to turn on their axis or even to row backwards, though it required a skilled and experienced crew.^[143] In galleys with an arrangement of three men per oar, all would be seated, but the rower furthest inboard would perform a stand-and-sit stroke, getting up on his feet to push the oar forwards and then sitting down again to pull it back.^[143]

The faster a vessel travels, the more energy it uses. Reaching high speed requires energy which a human-powered vessel is incapable of producing. Oar system generate very low amounts of energy for propulsion (only about 70 W per rower) and the upper limit for rowing in a fixed position is around 10 knots.^[144] Ancient war galleys of the kind used in Classical Greece are by modern historians considered to be the most energy efficient and fastest of galley designs throughout history. A full-scale replica of a 5th-century BC trireme, the *Olympias* was built 1985–87 and was put through a series of trials to test its performance. It proved that a cruising speed of 7–8 knots could be maintained for an entire day. Sprinting speeds of up to 10 knots were possible, but only for a few minutes and would tire the crew quickly.^[145] Ancient galleys were built very light and the original triremes are assumed to never have been surpassed in speed.^[146] Medieval galleys are believed to have been considerably slower, especially since they were not built with ramming tactics in mind. A cruising speed of no more than 2–3 knots has been estimated. A sprint speed of up to 7 knots was possible for 20–30 minutes, but risked exhausting the rowers completely.^[147]

Rowing in headwinds or even moderately rough weather was difficult as well as exhausting.^[148] In high seas, ancient galleys would set sail to run before the wind. They were highly susceptible to high waves, and could become unmanageable if the rowing frame (*apostis*) came awash. Ancient and medieval galleys are assumed to have sailed only with the wind more or less astern with a top speed of 8–9 knots in fair conditions.^[149]

7.4.2 Galley slaves

Main article: Galley slave

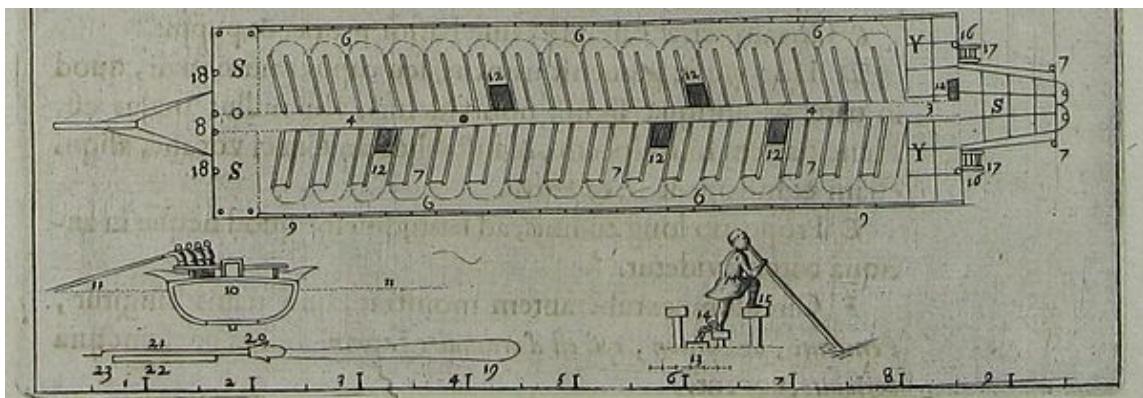
Contrary to the popular image of rowers chained to the oars, conveyed by movies such as *Ben Hur*, there is no evidence that ancient navies ever made use of condemned criminals or slaves as oarsmen, with the possible exception of Ptolemaic Egypt.^[150] Literary evidence indicates that Greek and Roman navies relied on paid labor or ordinary soldiers to man their galleys.^{[151][152]} Slaves were put at the oars only in times of extreme crisis. In some cases, these people were given freedom thereafter, while in others they began their service aboard as free men. Roman merchant vessels (usually sailing vessels) were manned by slaves, sometimes even with slaves as ship's master, but this was



Model of a Venetian three-banked galley rowed *alla sensile*, with three rowers sharing a bench but handling one oar each

seldom the case in merchant galleys.^[153]

It was only in the early 16th century that the modern idea of the *galley slave* became commonplace. Galley fleets as well as the size of individual vessels increase in size, which required more rowers. The number of benches could not be increased without lengthening hulls beyond their structural limits, and more than three oars per bench was not practicable. The demand for more rowers also meant that the relatively limited number of skilled oarsmen could not keep up with the demand of large galley fleets. It became increasingly common to man galleys with convicts or slaves, which required a simpler method of rowing. The older method of employing professional rowers using the *alla sensile* method (one oar per man, with two to three sharing the same bench) was gradually phased out in favor of rowing *a scaluccio*, which required less skill.^[154] A single large oar was used for each bench, with several rowers working it together and the number of oarsmen per oar rose from three up to five. In some very large command galleys, there could be as many as seven to an oar.^[155]



An illustration from 1643 showing the layout of rowing benches as well and placement of rowers on a galley with 16 pairs of oars. It also shows a rower at the top of the stroke using the standing rowing technique typical of a scaluccio rowing.

All major Mediterranean powers sentenced criminals to galley service, but initially only in time of war. Christian naval powers like Spain frequently employed Muslim captives and prisoners of war. The Ottoman navy and its North African corsair allies often put Christian prisoners to the oars, but also mixed volunteers. Spain relied on mostly servile rowers, in great part because its organizational structure was geared toward employing slaves and convicts.^[156] Venice was one of few major naval powers that used almost only free rowers, a result of their reliance on *alla sensile* rowing which required skilled professional rowers. The Knights of Saint John used slaves extensively, as did the Papal States, Florence and Genoa and North African *ghazi* corsairs relied almost entirely on Christian slaves for rowers.^[157]

At Baltic, both Swedish and Russian navies used *conscripts* as rowers. They also fought as naval infantry.

7.4.3 Sails

In ancient galleys under sail, most of the moving power came from a single square sail. It was rigged on a mast somewhat forwards of the center of the ship with a smaller mast carrying a head sail in the bow. Triangular lateen sails are attested as early as the 2nd century AD, and gradually became the sail of choice for galleys. By the 9th century lateens were firmly established as part of the standard galley rig. The lateen rig was more complicated and required a larger crew to handle than a square sail rig, but this was not a problem in the heavily manned galleys.^[158] Belisarius' Byzantine invasion fleet of 533 was at least partly fitted with lateen sails, making it probable that by the time the lateen had become the standard rig for the dromon,^[159] with the traditional square sail gradually falling from use in medieval navigation in the Mediterranean.^[160] Unlike a square sail rig, the **spar** of a lateen sail did not pivot around the mast. To change **tacks**, the entire spar had to be lifted over the mast and to the other side. Since the spar was often much longer than the mast itself, and not much shorter than the ship itself, it was a complex and time-consuming maneuver.^[161]

7.5 Armament and tactics

Main article: Galley tactics

In the earliest times of naval warfare boarding was the only means of deciding a naval engagement, but little to nothing is known about the tactics involved. In the first recorded naval battle in history, the **battle of the Delta**, the forces of Egyptian Pharaoh **Ramesses III** won a decisive victory over a force made up of the enigmatic group known as the **Sea Peoples**. As shown in commemorative reliefs of the battle, Egyptian archers on ships and the nearby shores of the Nile rain down arrows on the enemy ships. At the same time Egyptian galleys engage in boarding action and **capsize** the ships of the Sea Peoples with ropes attached to grappling hooks thrown into the rigging.^[162]

7.5.1 Introduction of the ram

Around the 8th century BC, **ramming** began to be employed as war galleys were equipped with heavy bronze rams. Records of the **Persian Wars** in the early 5th century BC by the Ancient historian **Herodotus** (c. 484-25 BC) show that by this time ramming tactics had evolved among the Greeks. The formations adapted for ramming warfare could either be in columns in line ahead, one ship following the next, or in a line abreast, with the ships side by side, depending on the tactical situation and the surrounding geography. The primary methods for attack was either to break through the enemy formation or to outflank it.^[163] Ramming itself was done by smashing into the rear or side of an enemy ship, punching a hole in the planking. This did not actually sink an ancient galley unless it was heavily laden with cargo and stores. With a normal load, it was buoyant enough to float even with a breached hull. Breaking the enemy's oars was another way of rendering ships immobile, rendering them easier targets. If ramming was not possible or successful, the on-board complement of soldiers would attempt to board and capture the enemy vessel by securing it with grappling irons, accompanied by missile fire with arrows or javelins. Trying to set the enemy ship on fire by hurling incendiary missiles or by pouring the content of fire pots attached to long handles is thought to have been used, especially since smoke below decks would easily disable rowers.^[164] Rhodes was the first naval power to employ this weapon, sometime in the 3rd century, and used it to fight off head-on attacks or to frighten enemies into exposing their sides for a ramming attack.^[165]

A successful ramming was difficult to achieve; just the right amount of speed and precise maneuvering were required. Fleets that did not have well-drilled, experienced oarsmen and skilled commanders relied more on boarding with superior infantry (such as increasing the complement to 40 soldiers). Ramming attempts were countered by keeping the bow towards the enemy until the enemy crew tired, and then attempting to board as quickly as possible. A double-line formation could be used to achieve a breakthrough by engaging the first line and then rushing the rearguard in to take advantage of weak spots in the enemy's defense. This required superiority in numbers, though, since a shorter front risked being flanked or surrounded.^[166]

7.5.2 Boarding prevails

Despite the attempts to counter increasingly heavy ships, ramming tactics were gradually superseded in the last centuries BC by the Macedonians and Romans, both primarily land-based powers. Hand-to-hand fighting with large



The ram bow of the trireme Olympias, a modern full-scale reconstruction of a classical Greek trireme.



The Byzantine fleet repels the Rus' attack on Constantinople in 941. The Byzantine dromons are rolling over the Rus' vessels and smashing their oars with their spurs.

complements of heavy infantry supported by ship-borne catapults dominated the fighting style during the Roman era, a move that was accompanied by the conversion to heavier ships with larger rowing complements and more men per oar. Though effectively lowering mobility, it meant that less skill was required from individual oarsmen. Fleets thereby became less dependent on rowers with a lifetime of experience at the oar.^[28]

By late antiquity, in the 1st centuries AD, ramming tactics had completely disappeared along with the knowledge of the design of the ancient trireme. Medieval galleys instead developed a projection, or “spur”, in the bow that was

designed to break oars and to act as a boarding platform for storming enemy ships. The only remaining examples of ramming tactics were passing references to attempts to collide with ships in order to destabilize or capsize them.^[167]



Byzantine ship attacking with Greek fire. Madrid Skylitzes manuscript, 11th century.

The Byzantine navy, the largest Mediterranean war fleet throughout most of the early Middle Ages, employed crescent formations with the flagship in the center and the heavier ships at the horns of the formation, in order to turn the enemy's flanks. Similar tactics are believed to have been employed by the Arab fleets they frequently fought from the 7th century onwards. The Byzantines were the first to employ Greek fire, a highly effective incendiary liquid, as a naval weapon. It could be fired through a metal tube, or *siphon* mounted in the bows, similar to a modern flame thrower. The properties of Greek fire were close to that of napalm and was a key to several major Byzantine victories. By 835, the weapon had spread to the Arabs, who equipped *harraqas*, "fireships", with it. The initial stages in naval battles was an exchanges of missiles, ranging from combustible projectiles to arrows, caltrops and javelins. The aim was not to sink ships, but to deplete the ranks of the enemy crews before the boarding commenced, which decided the outcome. Once the enemy strength was judged to have been reduced sufficiently, the fleets closed in, the ships grappled each other, and the marines and upper bank oarsmen boarded the enemy vessel and engaged in hand-to-hand combat.^[167] Byzantine dromons had *pavesades*, racks along the railings, on which marines could hang their shields, providing protection to the deck crew.^[168] Larger ships also had wooden castles on either side between the masts, which allowed archers to shoot from an elevated firing position.^[126]

Later medieval navies continued to use similar tactics, with the *line abreast* formation as standard. As galleys were intended to be fought from the bows, and were at their weakest along the sides, especially in the middle. The crescent formation employed by the Byzantines continued to be used throughout the Middle Ages. It would allow the wings of the fleet to crash their bows straight into the sides of the enemy ships at the edge of the formation.^[169]

Roger of Lauria (c. 1245–1305) was a successful medieval naval tactician who fought for the Aragon navy against French Angevin fleets in the War of the Sicilian Vespers. At the Battle of Malta in July 1283, he lured out Angevin galleys that were beached stern-first by openly challenging them. Attacking them in a strong defensive position head-on would have been very dangerous since it offered good cohesion, allowed rowers to escape ashore and made it possible to reinforce weak positions by transferring infantry along the shore. He also employed skilled crossbowmen and almogavars, light infantry, that were more nimble in ship-to-ship actions than heavily-armed and armored French soldiers.^[170] At the battle of the Gulf of Naples in 1284, his forces launched clay cooking pots filled with soap before attacking; when the pots broke against the enemy decks, they became perilously slippery and difficult for heavy infantry to keep their feet on.^[171]

7.5.3 Gun galleys

The earliest guns were of large calibers, and were initially of wrought iron, which made them weak compared to cast bronze guns that would become standard in the 16th century. They were at first fixed directly on timbers in the bow, aiming directly forwards. This placement would remain largely unchanged until the galley disappeared



Battle between Venetian and Holy Roman fleets; detail of fresco by Spinello Aretino 1407–1408.

from active service in the 19th century.^[134] The introduction of heavy guns and small arms did not change tactics considerably. If anything, it accentuated the bow as the offensive weapon, being both a staging area for boarders and the given position for small arms and cannons. The galley was capable of outperforming sailing vessel in early battles. It retained a distinct tactical advantage even after the initial introduction of naval artillery because of the ease with which it could be brought to bear upon an opposing vessel.^[172]

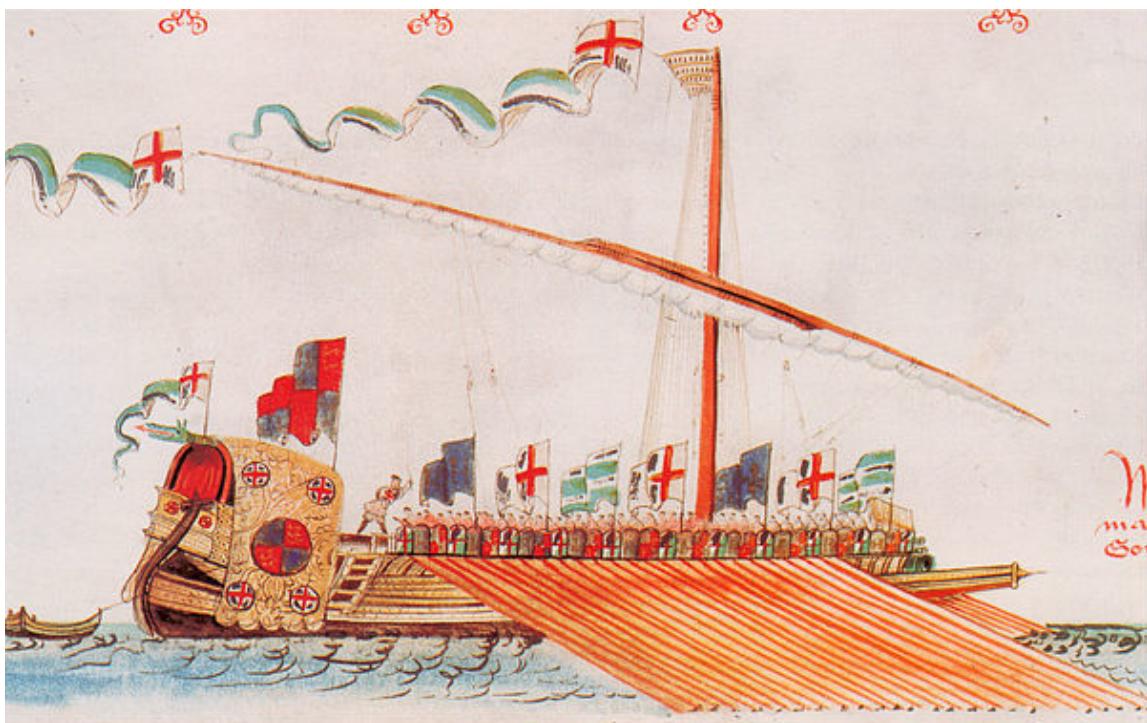
In large-scale galley-to-galley engagements, tactics remained essentially the same until the end of the 16th century. Cannons and small firearms were introduced around the 14th century, but did not have immediate effects on tactics; the same basic crescent formation in line abreast that was employed at the battle of Lepanto in 1571 was used by the Byzantine fleet almost a millennium earlier.^[173] Artillery on early gun galleys was not used as a long-range standoff weapon against other gun-armed ships. The maximum distance at which contemporary cannons were effective, c. 500 m (1600 ft), could be covered by a galley in about two minutes, much faster than the reload time of any heavy artillery. Gun crews would therefore hold their fire until the last possible moment, somewhat similar to **infantry tactics** in the pre-industrial era of short range firearms.^[174] The weak points of a galley remained the sides and especially the rear, the command center. Unless one side managed to outmaneuver the other, battle would be met with ships crashing into each other head on. Once fighting began with ships locking on to one another bow to bow, the fighting would be fought over the front line ships. Unless a galley was completely overrun by an enemy boarding party, fresh troops could be fed into the fight from reserve vessels in the rear.^[175]

7.6 Royal prestige and power symbolism

Galleys were used for purely ceremonial purposes by many rulers and states. In early modern Europe, galleys enjoyed a level of prestige that sailing vessels did not enjoy. Galleys had from an early stage been commanded by the leaders of land forces, and fought with tactics adapted from land warfare. As such, they enjoyed the prestige associated with land battles, the ultimate achievement of a high-standing noble or king. In the Baltic, the Swedish king **Gustav I**, the founder of the modern Swedish state, showed particular interest in galleys, as was befitting a Renaissance prince. Whenever traveling by sea, Gustav, the court, royal bureaucrats and the royal bodyguard would travel by galley.^[176] Around the same time, English king **Henry VIII** had high ambitions to live up to the reputation of the omnipotent Renaissance ruler and also had a few Mediterranean-style galleys built (and even manned them with slaves), though the English navy relied mostly on sailing ships at the time.^[89]

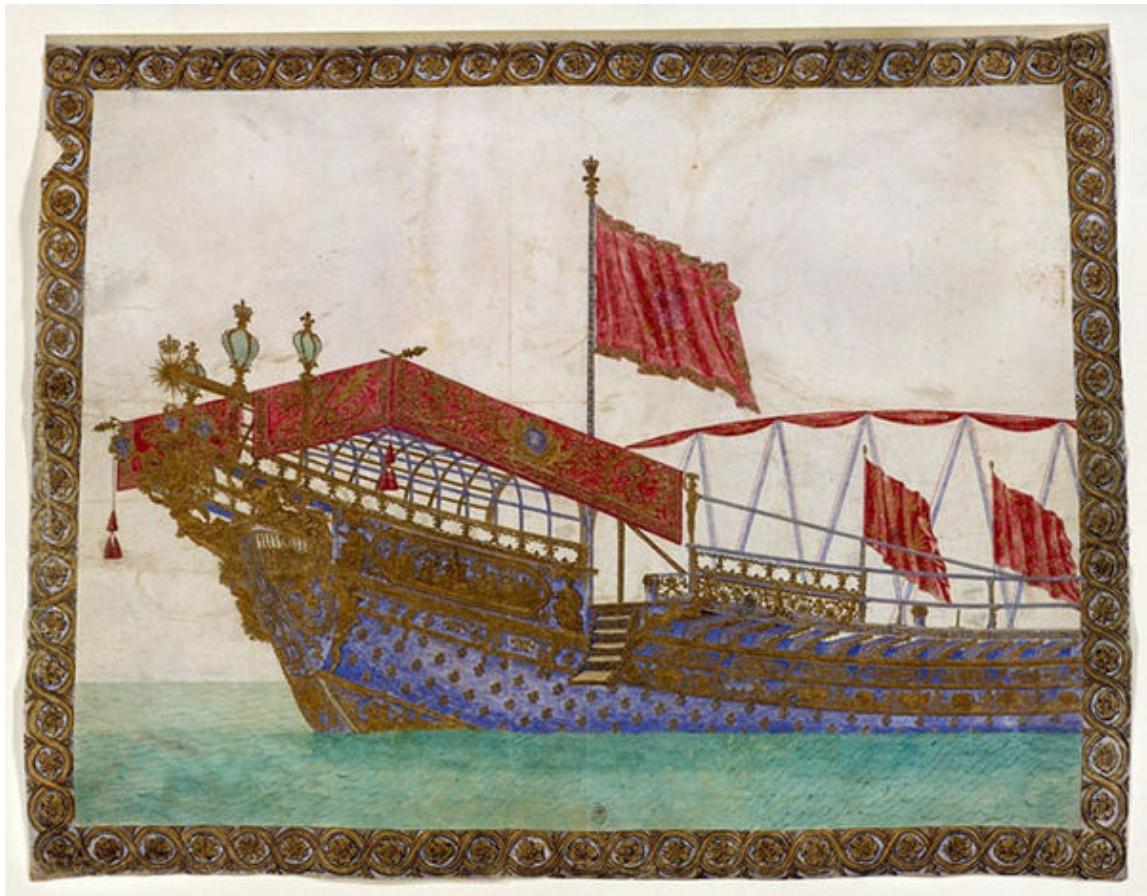


Contemporary depiction of the battle of Lepanto in 1571 that shows the strict formations of the opposing fleets. Fresco in the Gallery of Maps in Vatican Museum.



The Galley Subtle, one of the very few Mediterranean-style galleys employed by the English. This illustration is from the Anthony Roll (c. 1546) and was intended as its centerpiece.

Despite the rising importance of sailing warships, galleys were more closely associated with land warfare, and the prestige associated with it. British naval historian Nicholas Rodger has described this as display of “the supreme symbol of royal power ... derived from its intimate association with armies, and consequently with princes”.^[177] This was put to perhaps its greatest effect by the French “Sun King”, Louis XIV, in the form of a dedicated galley corps. Louis and the French state created a tool and symbol of royal authority that did little fighting, but was a potent extension of absolutist ambitions. Galleys were built to scale for the royal flotilla at the Grand Canal at Versailles for the amusement of the court.^[178] The royal galleys patrolled the Mediterranean, forcing ships of other states to salute the King’s banner, convoyed ambassadors and cardinals, and obediently participating in naval parades and royal pageantry. Historian Paul Bamford described the galleys as vessels that “must have appealed to military men and to aristocratic officers ... accustomed to being obeyed and served”.^[179]



Gouache of a late 17th century French royal galley. The vessel is richly decorated with red and blue damask, brocade and velvet for the stern canopy and flags, and carved gilded ornaments on railings, outrigger and hull.

Sentencing criminals, political dissenters and religious deviants as galley rowers also turned the galley corps into a large, feared, and cost-effective prison system.^[180] French Protestants were particularly ill-treated at the oar and though they were only a small minority, their experiences came to dominate the legacy of the king’s galleys. In 1909, French author Albert Savine (1859–1927) wrote that “[a]fter the Bastille, the galleys were the greatest horror of the old regime”.^[181] Long after convicts stopped serving in the galleys, and even after the reign of Napoleon, the term *galérien* (“galley rower”) remained a general term for forced labor and convicts serving harsh sentences.^[182]

7.7 Surviving examples

7.7.1 Original vessels

The naval museum in Istanbul contains the galley *Kadırga* (Turkish for “galley”, ultimately from Byzantine Greek *katergon*), dating from the reign of Mehmed IV (1648–1687). She was the personal galley of the sultan, and remained in service until 1839. She is presumably the only surviving galley in the world, albeit without its masts. It is 37 m



La Liberté, a full-scale replica of a 17th-century galley in Switzerland, though without any rowing benches

long, 5.7 m wide, has a draught of about 2 m, weighs about 140 tons, and has 48 oars powered by 144 oarsmen.

7.7.2 Reconstructions

A 1971 reconstruction of the *Real*, the flagship of John of Austria in the Battle of Lepanto (1571), is in the Museu Marítim in Barcelona. The ship was 60 m long and 6.2 m wide, had a draught of 2.1 m, weighing 239 tons empty, was propelled by 290 rowers, and carried about 400 crew and fighting soldiers at Lepanto. She was substantially larger than the typical galleys of her time.

A group called “The Trireme Trust” operates, in conjunction with the Greek Navy, a reconstruction of an ancient Greek Trireme, the *Olympias*.^[183]

7.7.3 Archaeological finds

In 1965, the remains of a small Venetian galley sunk in 1509 were found in Lake Garda, Italy. The vessel had been burned and only the lower hull remained.^[184] In the mid 1990s, a sunken galley was found close to the island of San Marco in Boccalama, in the Venice Lagoon.^[185] The relic is mostly intact and it was not recovered due to high costs.

7.8 Notes

- [1] Pryor (2002), pp. 86–87; Anderson (1962), pp. 37–39
- [2] Henry George Liddell & Robert Scott *Galeos, A Greek-English Lexicon*
- [3] *Oxford English Dictionary* (2nd edition, 1989), “galley”
- [4] See for example *Svenska Akademiens ordbok*, “galeja” or “galär” and *Woordenboek der Nederlandsche Taal*, “galeye”
- [5] Anderson (1962), pp. 1, 42; Lehmann (1984), p. 12
- [6] Casson (1971), pp. 53–56
- [7] Murray (2012), p. 3
- [8] Casson (1995), p. 123

- [9] Rodger (1997), pp. 66—68
- [10] Glete (1993), p. 81
- [11] Winfield (2009), pp. 116—118
- [12] Karl Heinz Marquardt, “The Fore and Aft Rigged Warship” in Gardiner & Lavery (1992), p. 64
- [13] Mooney (1969), p. 516
- [14] Wachsmann (1995), p. 10
- [15] Wachsmann (1995), p. 11—12
- [16] Wachsmann (1995), pp. 21—23
- [17] Casson (1995), pp. 57—58
- [18] Wachsmann (1995), pp. 13—18
- [19] Casson (1995), pp. 117—21
- [20] Morrison, Coates & Rankov (2000), p. 25
- [21] Wachsmann (1995), pp. 28—34
- [22] Morrison, Coates & Rankov, pp. 32—35
- [23] Casson (1991), p. 87
- [24] Casson (1991), pp. 30—31
- [25] Casson (1991), pp. 44—46
- [26] Morrison, Coates & Rankov, (2000), pp. 27—32
- [27] Morrison, Coates & Rankov (2000), pp. 38—41
- [28] Morrison, Coates & Rankov (2000), pp. 48—49
- [29] Morrison (1995), pp. 66—67
- [30] Casson (1995), pp. 119—23
- [31] Rankov (1995), pp. 78—80
- [32] Rankov (1995), pp. 80—81
- [33] Rankov (1995), pp. 82—85
- [34] Rodger, (1997), pp. 64—65
- [35] Unger (1980), pp. 53—55.
- [36] Unger (1980), pp. 96—97
- [37] Unger (1980), p. 80
- [38] Unger (1980), pp. 75—76
- [39] Unger (1980), pp. 40, 47
- [40] Unger (1980), p. 102—4
- [41] Casson (1995), pp. 123—126
- [42] Glete (2000), p. 2
- [43] Mott (2003), pp. 105—6
- [44] Pryor (1992), pp. 64—69
- [45] Mott (2003), p. 107
- [46] Braudel, *The Perspective of the World*, vol. III of *Civilization and Capitalism* (1979) 1984:126

- [47] Higgins, Courtney Rosali (2012) *The Venetian Galley of Flanders: From Medieval (2-Dimensional) Treatises to 21st Century (3-Dimensional) Model*. Master's thesis, Texas A&M University
- [48] Fernand Braudel, *The Mediterranean in the Age of Philip II* I, 302.
- [49] Pryor (1992), p. 57
- [50] Mallett (1967)
- [51] Bass, p. 191
- [52] Mott (2003), pp. 109–111
- [53] Hattendorf and Unger (2003) pp, 70
- [54] Glete (2000) pp 18
- [55] Glete, (2000) pp. 23
- [56] Glete, (2000) pp. 28
- [57] Guilmartin (1974) pp. 252
- [58] Glete (1993), p. 114
- [59] Guilmartin (1974), p. 101
- [60] Glete (1993), pp. 114–15
- [61] Glete (2000), pp. 154, 163
- [62] Glete (2000), pp., 156, 158-59
- [63] Bamford (1973), p. 12; Mott, 113-14
- [64] Mott (2003), p. 112
- [65] Goodman (1997), pp. 11–13
- [66] Bamford (1973), p. 12
- [67] Mott (2003), pp. 113–14
- [68] See especially Rodger (1996)
- [69] Glete (2003), p. 27
- [70] The British naval historian Nicholas Rodger describes this as a “crisis in naval warfare” which eventually led to the development of the galleon, which combined ahead-firing capabilities, heavy broadside guns and a considerable increase in maneuverability by introduction of more advanced sailing rigs; Rodger (2003), p. 245. For more detailed arguments concerning the development of broadside armament, see Rodger (1996).
- [71] Glete (2003), p. 144
- [72] Guilmartin (1974), pp. 264–66
- [73] Guilmartin (1974), p. 254
- [74] Guilmartin (1974), p. 57
- [75] Glete (2003), pp. 32–33
- [76] Glete (2000), p. 183
- [77] Jan Glete, “The Oared Warship” in Gardiner & Lavery (1992), p. 99
- [78] Rodger (2003), p. 170
- [79] Bamford (1974), pp. 14–18
- [80] Bamford (1974), p. 52
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- [82] Lehmann (1984), p. 12
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- [84] Bamford (1974), pp. 23–25
- [85] Bamford (1974), pp. 277–278
- [86] Bamford, (1974), pp. 272–73; Anderson, (1962), pp. 71–73
- [87] Glete (1992), p. 99
- [88] Rodger (1997), p. 208–12
- [89] John Bennel, “The Oared Vessels” in Knighton & Loades (2000), pp. 35–37.
- [90] Rodger (2003), pp. 230–30; see also R. C. Anderson, *Naval Wars in the Baltic*, pp. 177–78
- [91] Glete (2003), pp. 224–25
- [92] Anderson (1962), pp. 91–93; Berg, “Skärgårdsflottans fartyg” in Norman (2000) pp. 51
- [93] Glete, “Den ryska skärgårdsflottan” in Norman (2000), p. 81
- [94] Anderson (1962), p. 95
- [95] Bondioli, Burlet & Zysberg (1995), p. 205
- [96] Jan Glete, “Den ryska skärgårdsflottan: Myt och verklighet” in Norman (2000), pp. 86–88
- [97] Coates (1995), p. 127
- [98] This flower-inspired stern detail would later be widely used by both Greek and Roman ships.
- [99] Unger (1980), pp. 41–42
- [100] Coates (1995), p. 136–37
- [101] Coates (1995), pp. 133–34; Morrison, Coates & Rankov (2000), pp. 165–67
- [102] Coates (1995), pp. 137–38
- [103] Casson (1991), pp. 135–36
- [104] Coates (1995), pp. 131–32
- [105] Coates (1995), pp. 138–40
- [106] Morrison, Coates & Rankov (2000), p. 77
- [107] Shaw(1995), pp. 164–65
- [108] Hocker (1995), p. 88
- [109] Rankov (1995), pp. 80–83
- [110] Rankov (1995), p. 85
- [111] See both Bass and Pryor
- [112] Morrison p. 269
- [113] Landström
- [114] Pryor & Jeffreys (2006), pp. 123–125
- [115] Pryor & Jeffreys (2006), pp. 125–126
- [116] Pryor (1995), p. 102
- [117] Pryor & Jeffreys (2006), p. 127
- [118] Pryor & Jeffreys (2006), pp. 138–140
- [119] Pryor & Jeffreys (2006), pp. 145–147, 152

- [120] Pryor & Jeffreys (2006), pp. 134–135
- [121] Pryor (1995), pp. 103–104
- [122] Pryor & Jeffreys (2006), pp. 232, 255, 276
- [123] Pryor & Jeffreys (2006), pp. 205, 291
- [124] Pryor & Jeffreys (2006), p. 215
- [125] Pryor & Jeffreys (2006), p. 203
- [126] Pryor (1995), p. 104
- [127] Pryor & Jeffreys (2006), pp. 143–144
- [128] Anderson (1962), pp. 52, 54–55
- [129] Pryor (1992), p. 64
- [130] Pryor (1992), pp. 66–69
- [131] Anderson (1962), pp. 55–56
- [132] Pryor refers to claims that stern rudders evolved by the Byzantines and Arabs as early as the 9th century, but refutes it due to lack of evidence. Anderson (1962), pp. 59–60; Pryor (1992), p. 61.
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- [134] Guilmartin (1974), p. 216
- [135] Guilmartin (1974), p. 200
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- [140] Lehmann (1984), p. 22
- [141] Morrison, Coates & Rankov, *The Athenian Trireme*, pp. 246–47; Shaw (1995), pp. 168–169
- [142] Morrison, Coates & Rankov, *The Athenian Trireme*, pp. 249–52
- [143] Morrison, Coates & Rankov, *The Athenian Trireme*, pp. 246–47
- [144] Coates 1995, pp. 127–28
- [145] Shaw (1995), p. 169
- [146] Shaw (1995), p. 163
- [147] Guilmartin (1974), pp. 210–211
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- [154] From Italian *remo di scaluccio* from *scala*, “ladder; staircase”; Anderson (1962), p. 69
- [155] Guilmartin (1974), pp. 226–227

- [156] Guilmartin (1974), pp. 109–112
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- [162] Wachsmann (1995), pp. 28–34, 72
- [163] Morrison, Coates & Rankov (2000), pp. 42–43, 92–93
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- [166] Casson (1991), pp. 90–91
- [167] Hocker (1995), pp. 95, 98–99.
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7.10 External links

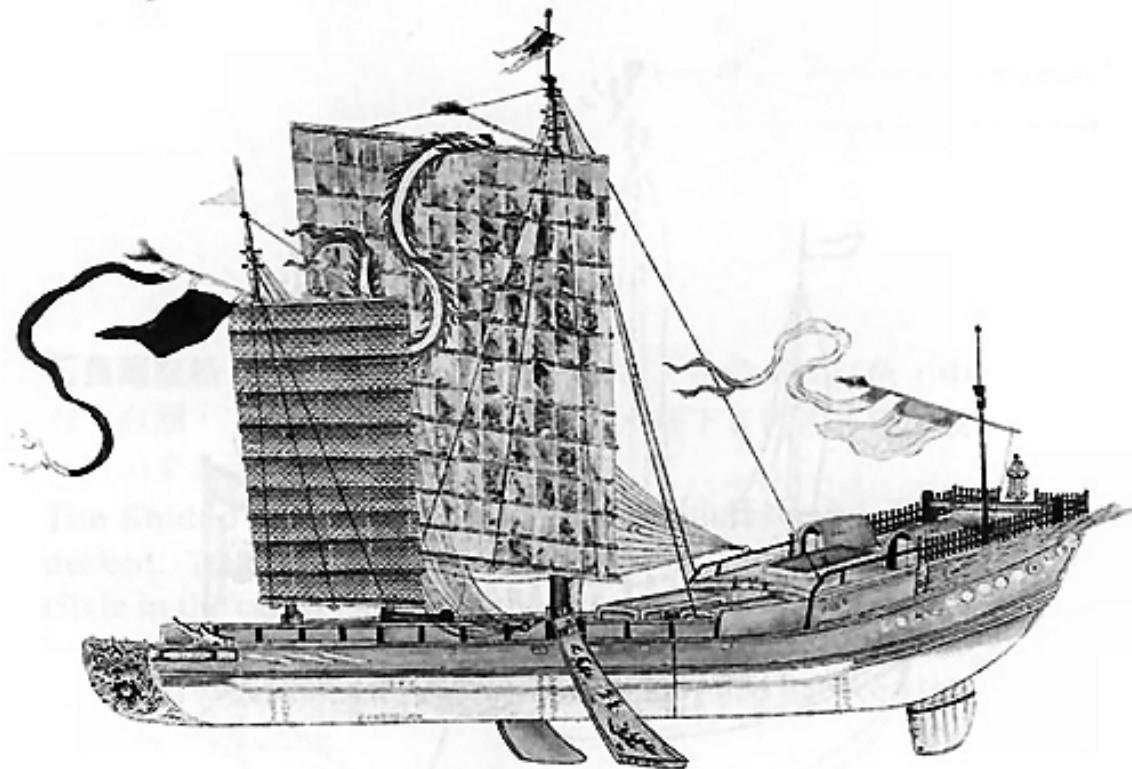
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Chapter 8

Junk (ship)

This article is about the history of the sailing vessel in China. For modern developments and sailing techniques, see [Junk Rig](#).

A **junk** is an ancient Chinese sailing ship design that is still in use today. Junks were developed during the Song



A junk from the 13th Century, Song Dynasty

Dynasty (960–1279)^[1] and were used as seagoing vessels as early as the 2nd century CE. They evolved in the later dynasties, and were used throughout [Asia](#) for extensive ocean voyages. They were found, and in lesser numbers are still found, throughout [South-East Asia](#) and [India](#), but primarily in [China](#), perhaps most famously in [Hong Kong](#). Found more broadly today is a growing number of modern recreational junk-rigged sailboats.

The term *junk* may be used to cover many kinds of boat—ocean-going, cargo-carrying, [pleasure boats](#), live-aboards. They vary greatly in size and there are significant regional variations in the type of rig, however they all employ fully battened sails.^[2]



A modern junk in Hong Kong in 2006

8.1 Etymology

The term ultimately stems from the Chinese *chuán* (船, “boat; ship”), also based on and pronounced as [dzu:ŋ] (Péh-ōe-jī: *chūn*) in the Min Nan variant of Chinese, or *zhōu* (舟), the old word for a sailing vessel. It entered the English language in the 17th century through the Portuguese *junco* from the Javanese *jong*.^{[3][4]} The modern Standard Chinese word for an ocean-going wooden cargo vessel is *cáo* (艚).^[5]

8.2 Building

Junks were efficient and sturdy ships that sailed long distances as early as the 2nd century CE. They incorporated numerous technical advances in sail plan and hull designs that were later adopted in Western shipbuilding.

The historian Herbert Warington Smyth considered the junk as one of the most efficient ship designs, stating that “As an engine for carrying man and his commerce upon the high and stormy seas as well as on the vast inland waterways, it is doubtful if any class of vessel... is more suited or better adapted to its purpose than the Chinese or Indian junk, and it is certain that for flatness of sail and handiness, the Chinese rig is unsurpassed.”}

8.2.1 Sail plan

The structure and flexibility of junk sails make the junk fast and easily controlled. The sails of a junk can be moved inward toward the long axis of the ship, allowing the junk to sail into the wind.

The sails include several horizontal members, called "battens", which provide shape and strength. Junk sails are controlled at their trailing edge by lines much in the same way as the mainsail on a typical sailboat, but in the junk sail each batten has a line attached to its trailing edge where on a typical sailboat a single line (the sheet) is attached only to the boom. The sails can also be easily reefed and adjusted for fullness, to accommodate various wind strengths. The battens also make the sails more resistant than other sails to large tears, as a tear is typically limited to a single



Junk near Hong Kong, circa 1880.

“panel” between battens. In South China the sails have a curved roach especially towards the head, similar to a typical balanced lug sail. The main drawback to the junk sail is its high weight caused by the typically 6 heavy full length battens.. With high weight aloft and no deep keel, junks were known to capsize when lightly laden due to their high centre of gravity. The top batten is heavier and similar to a gaff. Junk sails have much in common with the most aerodynamically efficient sails used today in windsurfers or catamarans.

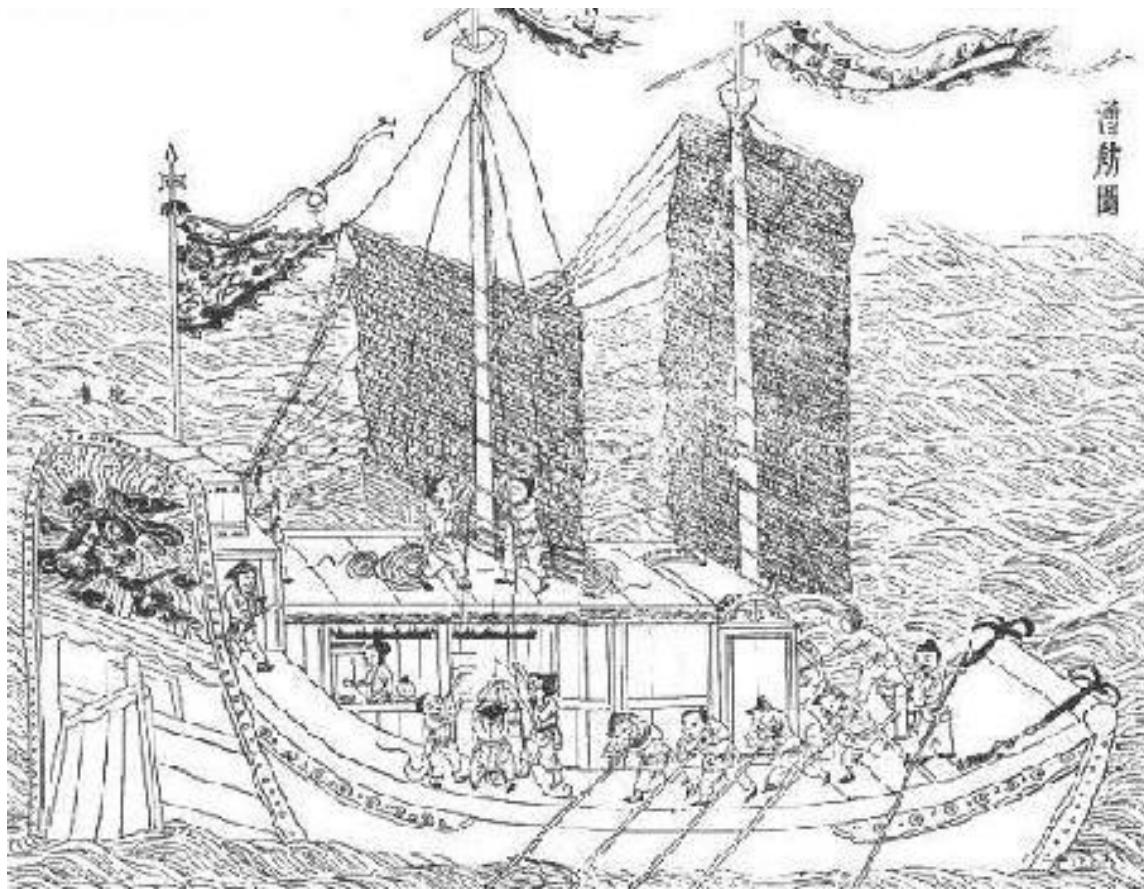
The standing rigging is mainly absent.

The sail-plan is also spread out between multiple masts, allowing for a powerful sail surface, with a low centre of effort which reduces the tipping moment.

Flags were hung from the masts to bring good luck and women to the sailors. A legend among the Chinese during the junk’s heyday regarded a dragon which lived in the clouds. It was said that when the dragon became angry, it created typhoons and storms. Bright flags, with Chinese writing on them, were said to please the dragon. Red was best, as it would induce the dragon to help the sailors.

8.2.2 Hull design

Classic junks were built of softwoods (although of teak in Guangdong) with the outside shape built first. Then multiple internal compartment/bulkheads accessed by separate hatches and ladders, reminiscent of the interior structure of bamboo were built in. Traditionally, the hull has a horseshoe-shaped stern supporting a high poop deck. The bottom is flat in a river junk with no keel (similar to a sampan), so that the boat relies on a daggerboard,^[6] leeboard or very large rudder to prevent the boat from slipping sideways in the water.^[7] Ocean-going junks have a curved hull in section with a large amount of tumblehome in the topsides. The planking is edge nailed on a diagonal. Iron nails or spikes have been recovered from a Canton dig dated to circa 221 BCE. For caulking the Chinese used a mix of ground lime with Tung oil together with chopped hemp from old fishing nets which set hard in 18 hours. Junks have narrow



A two-masted Chinese junk, from the *Tiangong Kaiwu* of Song Yingxing, published in 1637.

waterlines which accounts for their speed in moderate conditions. The largest junks, the treasure ships commanded by Zheng He, were built for world exploration in the 15th century, and according to some interpretations may have been over 120 metres (390 ft) in length, or larger, based on the size of the rudder post that was found.

Oars

Junks employed stern-mounted rudders centuries before their adoption in the West, though the rudder's origin, form and construction was completely different. It was an innovation which permitted the steering of large, high-freeboard ships, and, due to its well-balanced design, allowed height adjustment according to the depth of the water or for grounding. A sizable junk can have a rudder that needs up to three members of the crew to control in strong weather helm. Lee helm is reduced by using a leeboard or dagger board. The world's oldest known depiction of a stern-mounted rudder can be seen on a pottery model of a junk dating from before 1st century AD,^[8] though some scholars think this may be a steering oar - a possible interpretation given that the model is of a river boat that was probably towed or poled.

From sometime in the 13th to 15th centuries, many junks began incorporating "fenestrated" rudders (rudders with large diamond-shaped holes in them), probably adopted to lessen the force needed to direct the steering of the rudder.

The rudder is reported to be the strongest part of the junk. In the *Tiangong Kaiwu* "Exploitation of the Works of Nature" (1637), Song Yingxing wrote, "The rudder-post is made of elm, or else of *langmu* or of *zumu*." The Ming author also applauds the strength of the *langmu* wood as "if one could use a single silk thread to hoist a thousand *jun* or sustain the weight of a mountain landslide."

Separate compartments

Another characteristic of junks, interior compartments or bulkheads, strengthened the ship and slowed flooding in case of holing. Ships built in this manner were written of in Zhu Yu's book *Pingzhou Table Talks*, published by 1119



The Kangxi Emperor (r. 1654–1722) on a tour, seated prominently on the deck of a junk ship.

during the Song Dynasty.^[9] Again, this type of construction for Chinese ship hulls was attested to by the Moroccan Muslim Berber traveler Ibn Battuta (1304–1377 AD), who described it in great detail (refer to [Technology of the Song Dynasty](#)).^[10] Although some historians have questioned whether the compartments were watertight, most believe that watertight compartments did exist in Chinese junks. All wrecks discovered so far have [limber holes](#); these are different from the free flooding holes that are located only in the foremost and aftermost compartments, but are at the base of the transverse bulkheads allowing water in each compartment to drain to the lowest compartment, thus facilitating pumping. It is believed from evidence in wrecks that the limber holes could be stopped either to allow the carriage of liquid cargoes or to isolate a compartment that had sprung a leak.

Benjamin Franklin wrote in a 1787 letter on the project of mail packets between the United States and France:

As these vessels are not to be laden with goods, their holds may without inconvenience be divided into separate apartments, after the Chinese manner, and each of these apartments caulked tight so as to keep out water.

—Benjamin Franklin, 1787^[11]

In 1795, Sir Samuel Bentham, inspector of dockyards of the [Royal Navy](#), and designer of six new sailing ships, argued for the adoption of “partitions contributing to strength, and securing the ship against foundering, as practiced by the Chinese of the present day”. His idea was not adopted. Bentham had been in China in 1782, and he acknowledged that he had got the idea of watertight compartments by looking at Chinese junks there. Bentham was a friend of [Isambard Brunel](#), so it is possible that he had some influence on Brunel’s adoption of longitudinal, strengthening bulkheads in the lower deck of the [SS Great Britain](#). Bentham had already by this time designed and had built a segmented barge for use on the Volga River, so the idea of transverse hull separation was evidently in his mind. Perhaps more to the point, there is a very large difference between the transverse bulkheads in Chinese construction, which offer no longitudinal strengthening, and the longitudinal members which Brunel adopted, almost certainly inspired by the bridge engineering in which he and his contemporaries in iron shipbuilding innovation were most versed.

Due to the numerous foreign primary sources that hint to the existence of true watertight compartments in junks, historians such as **Joseph Needham** proposed that the limber holes were stopped up as noted above in case of leakage. He addresses the quite separate issue of free-flooding compartments on pg 422 of *Science and Civilisation in Ancient China*:

Less well known is the interesting fact that in some types of Chinese craft the foremost (and less frequently also the aftermost) compartments is made free-flooding. Holes are purposely contrived in the planking. This is the case with the salt-boats which shoot the rapdown from Tzuliuching in Szechuan, the gondola-shaped boats of the Poyang Lake, and many sea going junks. The Szechuanese boatmen say that this reduces resistance to the water to a minimum, and the device must certainly cushion the shocks of pounding when the boat pitches heavily in the rapids, for she acquires and discharges water ballast rapidly just at the time when it is most desirable to counteract buffeting at stem and stern. The sailors say that it stops junks flying up into the wind. It may be the reality at the bottom of the following story, related by Liu Ching-Shu of the +5th century, in his book *I Yuan* (Garden of Strange Things)

In Fu-Nan (Cambodia) gold is always used in transactions. Once there were (some people who) having hired a boat to go from east to west near and far, had not reached their destination when the time came for the payment of the pound (of gold) which had been agreed upon. They therefore wished to reduce the quantity (to be paid). The master of the ship then played a trick upon them. He made (as it were) a way for the water to enter the bottom of the boat, which seemed to be about to sink, and remained stationary, moving neither forward nor backward. All the passengers were very frightened and came to make offerings. The boat (afterwards) returned to its original state.

This, however, would seem to have involved openings which could be controlled, and the water pumped out afterwards. This was easily effected in China (still seen in Kuangtung and Hong Kong), but the practice was also known in England, where the compartment was called the 'wet-well', and the boat in which it was built, a 'well-smack'. If the tradition is right that such boats date in Europe from +1712 then it may well be that the Chinese bulkhead principle was introduced twice, first for small coastal fishing boats at the end of the seventeenth century, and then for large ships a century later. However, the wet well is probably a case of parallel invention since its manner of construction is quite different from that of Chinese junks, the wet well quite often not running the full width of the boat, but only occupying the central part of the hull either side of the keel.

Leeboards and centerboards

Leeboards and centerboards, used to stabilize the junk and to improve its capability to sail upwind, are documented from a 759 CE book by Li Chuan. The innovation was adopted by Portuguese and Dutch ships around 1570. Junks often employ a daggerboard that is forward on the hull which allows the center section of the hull to be free of the daggerboard trunk allowing larger cargo compartments. Because the daggerboard is located so far forward, the junk must use a balanced rudder to counteract the imbalance of lateral resistance.

Other innovations included the square-pallet bilge pump, which was adopted by the West during the 16th century for work ashore, the western chain pump, which was adopted for shipboard use, being of a different derivation. Junks also relied on the compass for navigational purposes. However, as with almost all vessels of any culture before the late 19th century, the accuracy of magnetic compasses aboard ship, whether from a failure to understand deviation (the magnetism of the ship's iron fastenings) or poor design of the compass card (the standard drypoint compasses were extremely unstable), meant that they did little to contribute to the accuracy of navigation by dead reckoning.

8.3 History

The first records of junks can be found in references dating to the **Han Dynasty** (220 BCE-200 CE).

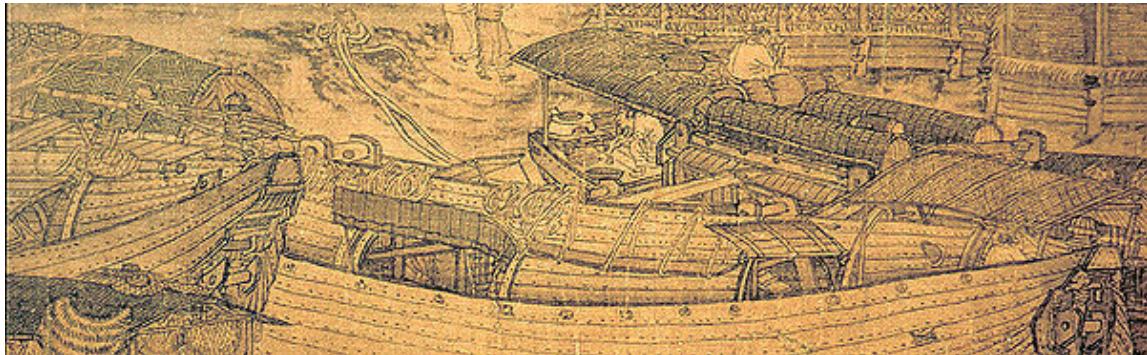
8.3.1 2nd century junks (Han Dynasty)

The 3rd century book "Strange Things of the South" (《南史》) by Wan Chen (万辰) describes junks capable of carrying 700 people together with 260 tons of cargo ("more than 10,000 "石"). He explains the ship's design as follows:

The four sails do not face directly forward, but are set obliquely, and so arranged that they can all be fixed in the same direction, to receive the wind and to spill it. Those sails which are behind the most windward one receiving the pressure of the wind, throw it from one to the other, so that they all profit from its force. If it is violent, (the sailors) diminish or augment the surface of the sails according to the conditions. This oblique rig, which permits the sails to receive from one another the breath of the wind, obviates the anxiety attendant upon having high masts. Thus these ships sail without avoiding strong winds and dashing waves, by the aid of which they can make great speed

—Wan Chen, ^[12]

A 260 CE book by Kang Tai (康泰) also described ships with seven masts, traveling as far as Syria.



Detail of a ship on Along the River During Qingming Festival, by Zhang Zeduan (1085–145).

8.3.2 10–13th century junks (Song Dynasty)

The great trading dynasty of the Song employed junks extensively. The naval strength of the Song, both mercantile and military, became the backbone of the naval power of the following Yuan dynasty. In particular the Mongol invasions of Japan (1274–84), as well as the Mongol invasion of Java, essentially relied on recently acquired Song naval capabilities.

8.3.3 14th century junks (Yuan Dynasty)

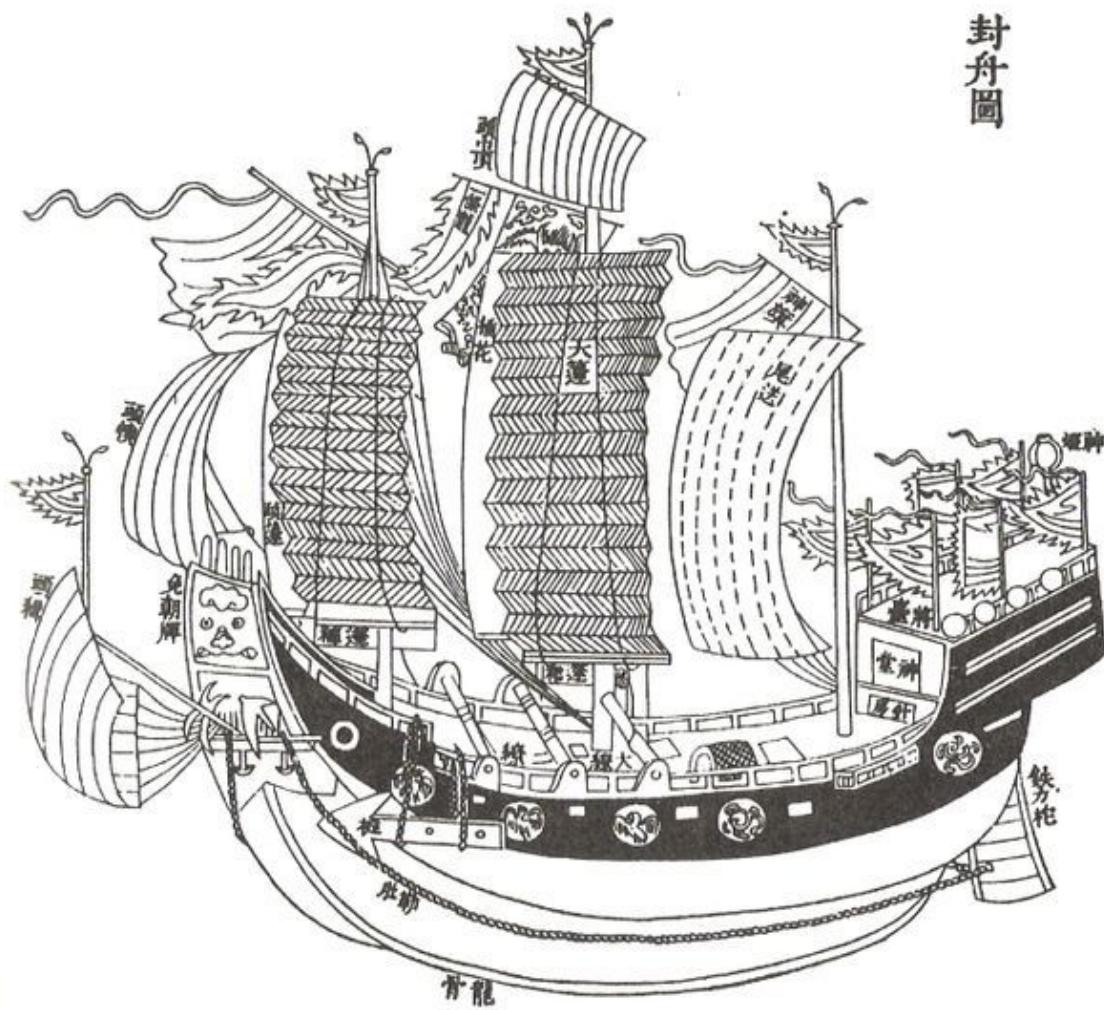
The enormous dimensions of the Chinese ships of the Medieval period are described in Chinese sources, and are confirmed by Western travelers to the East, such as Marco Polo, Ibn Battuta and Niccolò da Conti. According to Ibn Battuta, who visited China in 1347:

...We stopped in the port of Calicut, in which there were at the time thirteen Chinese vessels, and disembarked. On the China Sea traveling is done in Chinese ships only, so we shall describe their arrangements. The Chinese vessels are of three kinds; large ships called chunks (*junks*), middle sized ones called zaws (*dhow*s) and the small ones kakams. The large ships have anything from twelve down to three sails, which are made of bamboo rods plaited into mats. They are never lowered, but turned according to the direction of the wind; at anchor they are left floating in the wind.

A ship carries a complement of a thousand men, six hundred of whom are sailors and four hundred men-at-arms, including archers, men with shields and crossbows, who throw naphtha. Three smaller ones, the “half”, the “third” and the “quarter”, accompany each large vessel. These vessels are built in the towns of Zaytun (a.k.a. Zaitun; today's Quanzhou; 泉州) and Sin-Kalan. The vessel has four decks and contains rooms, cabins, and saloons for merchants; a cabin has chambers and a lavatory, and can be locked by its occupants.

This is the manner after which they are made; two (*parallel*) walls of very thick wooden (*planking*) are raised and across the space between them are placed very thick planks (*the bulkheads*) secured longitudinally and transversely by means of large nails, each three ells in length. When these walls have thus been built the lower deck is fitted in and the ship is launched before the upper works are finished.

—Ibn Battuta



A 15th-century Ming Dynasty junk, Fengzhou

8.3.4 15–17th century junks (Ming Dynasty)

Expedition of Zheng He

The largest junks ever built were possibly those of Admiral Zheng He, for his expeditions in the Indian Ocean. According to Chinese sources, the fleet for Zheng's 1405 expedition comprised nearly 30,000 sailors and over 300 ships at its height.

The dimensions of Zheng He's ships according to ancient Chinese chronicles are disputed by modern scholars (see below):

- *Treasure ships*, used by the commander of the fleet and his deputies (Nine-masted junks, claimed by the Ming Shi to be about 420 feet long and 180 feet wide).
- *Horse ships*, carrying tribute goods and repair material for the fleet (Eight-masted junks, about 340 feet long and 140 feet wide)
- *Supply ships*, containing food-staple for the crew (Seven-masted junks, about 260 feet long and 115 feet wide).
- *Troop transports* (Six-masted junks, about 220 feet long and 83 feet wide).
- *Fuchuan warships* (Five-masted junks, about 165 feet long).
- *Patrol boats* (Eight-oared, about 120 feet long).



Early 17th-century Chinese woodblock print, thought to represent Zheng He's ships

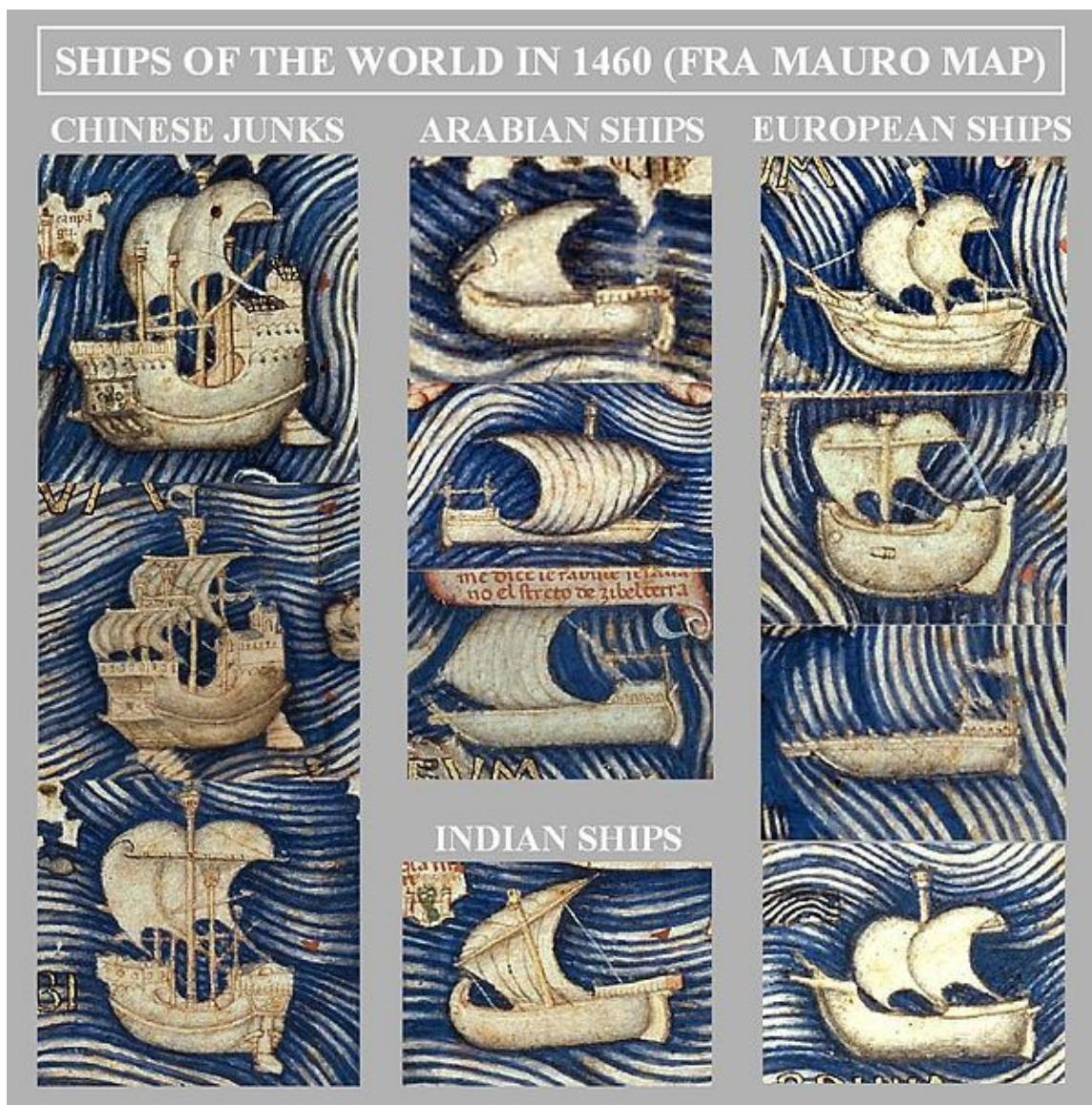
- Water tankers, with 1 month's supply of fresh water.

Some recent research suggests that the actual length of the biggest treasure ships may have been between 390–408 feet (119–124 m) long and 160–166 feet (49–51 m) wide,^[13] while others estimate them to be 200–250 feet (61–76 m) in length.^[14]

Conquest of Taiwan

In 1661, a naval fleet of 400 junks and 25,000 men led by the Ming loyalist Zheng Chenggong (Cheng Ch'eng-kung in Wade-Giles, known in the West as Koxinga), arrived in Taiwan to oust the Dutch from Zeelandia. Following a nine-month siege, Cheng captured the Dutch fortress Fort Zeelandia. A peace treaty between Koxinga and the Dutch Government was signed at Castle Zeelandia on February 1, 1662, and Taiwan became Koxinga's base for the Kingdom of Tungning.

8.3.5 Accounts of medieval travellers



Ships of the world in 1460, according to the Fra Mauro map. Chinese junks are described as very large, three or four-masted ships.

Niccolò da Conti in relating his travels in Asia between 1419 and 1444, matter-of-factly describes huge junks of about 2,000 tons:

They make ships larger than ours, about 2,000 tons in size, with five sails and as many masts. The lower part is made of three decks, so as to better resist storms, which occur frequently. These ships are separated into several compartments, so that if one is touched during a storm, the others remain intact.
—Niccolò da Conti, ^[15]

Also, in 1456, the Fra Mauro map described the presence of junks in the Indian Ocean as well as their construction:

The ships called junks (lit. “Zonchi”) that navigate these seas carry four masts or more, some of which can be raised or lowered, and have 40 to 60 cabins for the merchants and only one tiller. They can navigate without a compass, because they have an astrologer, who stands on the side and, with an astrolabe in hand, gives orders to the navigator.

—Text from the Fra Mauro map, 09-P25, ^[16]



Detail of the Fra Mauro Map relating the travels of a junk into the Atlantic Ocean in 1420. The ship also is illustrated above the text.

Fra Mauro further explains that one of these junks rounded the **Cape of Good Hope** and travelled far into the Atlantic Ocean, in 1420:

About the year of Our Lord 1420 a ship, what is called an Asian *Junk* (lit. “Zoncho de India”), on a crossing of the Sea of India towards the “Isle of Men and Women”, was diverted beyond the “Cape of Diab” (Shown as the **Cape of Good Hope** on the map), through the “Green Isles” (lit. “isole uerde”, **Cabo Verde Islands**), out into the “Sea of Darkness” (Atlantic Ocean) on a way west and southwest. Nothing but air and water was seen for 40 days and by their reckoning they ran 2,000 miles and fortune deserted them. When the stress of the weather had subsided they made the return to the said “Cape of Diab” in 70 days and drawing near to the shore to supply their wants the sailors saw the egg of a bird called *roc*, which egg is as big as an amphora.

—Text from Fra Mauro map, 10-A13, ^[17]

Asian trade

Chinese junks were used extensively in Asian trade during the 16th and 17th century, especially to Southeast Asia and to Japan, where they competed with Japanese Red Seal Ships, Portuguese carracks and Dutch galleons. Richard Cocks, the head of the English trading factory in Hirado, Japan, recorded that 50 to 60 Chinese junks visited Nagasaki in 1612 alone.

These junks were usually three masted, and averaging between 200 and 800 tons in size, the largest ones having around 130 sailors, 130 traders and sometimes hundreds of passengers.

8.3.6 19th century junks (Qing Dynasty)

Large, ocean-going junks played a key role in Asian trade until the 19th century. One of these junks, *Keying*, sailed from China around the **Cape of Good Hope** to the United States and England between 1846 and 1848. Many junks were fitted out with carronades and other weapons for naval or piratical uses. These vessels were typically called “war junks” or “armed junks” by Western navies which began entering the region more frequently in the 18th century. The British, Americans and French fought several naval battles with war junks in the 19th century, during the First Opium War, Second Opium War and in between.



A Chinese junk in Japan, at the beginning of the Sakoku period (1644-1648 Japanese woodblock print)

At sea, junk sailors co-operated with their Western counterparts. For example, in 1870 survivors of the English



Junk Keying travelled from China to the United States and England between 1846 and 1848.

barque *Humberstone* shipwrecked off Formosa, were rescued by a junk and landed safely in Macao.^[18]

8.3.7 20th century junks

In 1938, E. Allen Petersen escaped the advancing Japanese armies by sailing a 36-foot (11 m) junk, *Hummel Hummel*, from Shanghai to California with his wife Tani and two White Russians (Czar loyalists).^[19] In 1939, Richard Halliburton was lost at sea with his crew while sailing a specially constructed junk, *Sea Dragon*, from Hong Kong to the World Exposition in San Francisco.

In 1955, six young men sailed a Ming Dynasty-style junk from Taiwan to San Francisco. The four-month journey aboard the *Free China* was captured on film and their arrival into San Francisco made international front-page news. The five Chinese-born friends saw an advertisement for an international trans-Atlantic yacht race, and jumped at the opportunity for adventure. They were joined by the then US Vice-Consul to China, who was tasked with capturing the journey on film. Enduring typhoons and mishaps, the crew, having never sailed a century-old junk before, learned along the way. The crew included Reno Chen, Paul Chow, Loo-chi Hu, Benny Hsu, Calvin Mehlert and were led by skipper Marco Chung. After a journey of 6,000 miles (9,700 km), the *Free China* and her crew arrived into San Francisco Bay in fog on August 8, 1955. Shortly afterward the footage was featured on ABC television's *Bold Journey* travelogue. Hosted by John Stephenson and narrated by ship's navigator Paul Chow, the program highlighted the adventures and challenges of the junk's sailing across the Pacific, as well as some humorous moments aboard ship.^[20]

In 1959 a group of Catalan men, led by Jose Maria Tey, sailed from Hong Kong to Barcelona on a junk named *Rubia*. After their successful journey this junk was anchored as a tourist attraction at one end of Barcelona harbor, close to where **La Rambla** meets the sea. Permanently moored along with it was an alleged reproduction of Columbus' caravel "Santa Maria" during the 1960s and part of the 1970s.^[21]

In 1960 Lt. Col. Herbert George "Blondie" Hasler, (Herbert Hasler), DSO, OBE, (27 February 1914 – 5 May 1987)



Bundesarchiv, Bild 137-035403
Foto: o. Ang. | 1898/1914

Junks in Tsingtau harbour (1898)

sailed in the first Observer Single-handed Transatlantic Race (OSTAR) from Plymouth to New York. His yacht was a modified Folkboat, called *Jester*, which at 25-foot (7.6 m), was one of the smallest boats in the race.

The *Jester* relied on a **junk rig** to reduce the physical effort of handling a conventional rig single-handed. Safety was also increased as the junk rig enabled all sail-handling to be completed from the safety of a central control hatch. Hasler realised that he could sail *Jester* across the Atlantic without ever leaving the cabin. Hasler in *Jester* finished second, taking 48 days to cross the Atlantic.

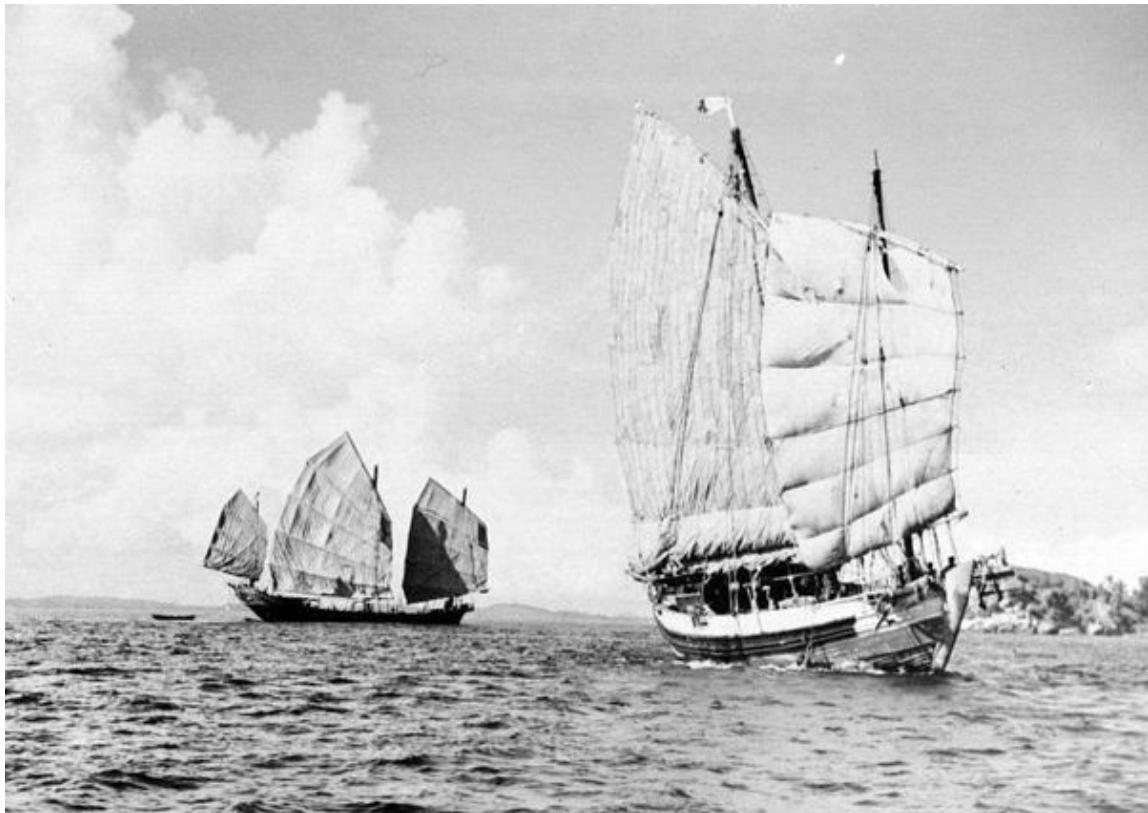
In 1968, Bill King sailed off on a junk schooner in the controversial Sunday Times Golden Globe Race.

In 1981, Christoph Swoboda had a 65 feet (LoA) *Bedar* built by the boatyard of Che Ali bin Ngah on Duyong island in the estuary of the Terengganu river on the East coast of Malaysia. The *Bedar* is one of the two types of Malay junk schooners traditionally built there. He sailed this junk with his family and one friend to the Mediterranean and then continued with changing crew to finally finish a circumnavigation in 1998. He sold this vessel in 2000 and in 2004 he started to build a new junk in Duyong with the same craftsmen: the Pinas (or Pinis) *Naga Pelangi*, in order to help keep this ancient boat building tradition alive. This boat finished to be fitted out in 2010 and is working as a charter boat in the Andaman and the South China Sea.^[22]

In 1985, a Belgian Francis Clément ordered a 55 feet traditional Malay Junk “Pinis” at Che Ali Bin Ngah (Chengal boat carpenter) on Pulau Duyong (KT) Malaysia. In 1995 the boat (BILBO) was launched and finally reached Turkey in 1997 with the help of 5 Italian friend sailor teams. Today BILBO is anchored at the GRAU DU ROI harbour in Camargue France.,^{[23][24]}

A growing number of designs of modern recreational junk-rigged sailboats has emerged, such as Benford Design Group’s *Badger* known from Annie Hill’s book *Voyaging on a Small Income*. Tom MacNaughton of MacNaughton Group also has several popular junk rigged designs.

For long travels with few crew, the simplicity of the junk rig in terms of construction, maintenance and handling makes it an important alternative to more prevalent designs. Most notably the safety that follows from extremely simple reefing, which is particularly important with few crew and deteriorating conditions, minimizes the need to work on deck while exposed to bad weather. Simple construction means lower cost and simpler repairs.



Junks Sin Tong Heng and Tek Hwa Seng in the Dutch East Indies (1936)

8.4 See also

- Junk rig
- Keying
- Lorcha
- Tongkang

8.5 Notes

- [1] Crossley, Pamela Kyle, Daniel R. Headrick, Steven W. Hirsch, Lyman L. Johnson, and David Northrup. “Song Industries.” *The Earth and Its Peoples*. By Richard W. Bulliet. 4th ed. Boston: Houghton Mifflin, 2008. 279–80. Print.
- [2] Julia Jones *The Salt-stained book*, Golden Duck, 2011, p127
- [3] *Collins Compact Dictionary*. HarperCollins. 2002. p. 483. ISBN 0-00-710984-9.
- [4] *Junk*, Online Etymology Dictionary.
- [5] <http://www.zdic.net/zd/zi/ZdicE8Zdic89Zdic9A.htm>
- [6] http://www.friend.ly.net/users/dadadata/junk/platt/platt_chinese_sail.html “The masts, hull and standing rigging” section, paragraph 2, retrieved 13 Aug 09.
- [7] http://www.thomashoppe.net/Revival_of_the_Chinese_Junk “Materials and dimensions” section, paragraph 5, retrieved 13 Aug 09.
- [8] Konstam, Angus. 2007. *Pirates: Predators of the Seas*. 23-25
- [9] Needham, Volume 4, Part 3, 463.



The Bedar Naga Pelangi, after her circumnavigation sailing off Kuala Terengganu, Malaysia 1998

- [10] Needham, Volume 4, Part 3, 469.
- [11] Benjamin Franklin (1906). *The writings of Benjamin Franklin*. The Macmillan Company. pp. 148–149. Retrieved 5 October 2012.
- [12] "Strange Things of the South", Wan Chen, from Robert Temple
- [13] *When China Ruled the Seas*, Louise Levathes, p.80
- [14] Sally K. Church: The Colossal Ships of Zheng He: Image or Reality ? (p.155-176) Zheng He; Images & Perceptions In: South China and Maritime Asia , Volume 15, Hrsg: Ptak, Roderich /Höllmann Thomas, O. Harrasowitz Verlag, Wiesbaden, (2005)
- [15] Niccolò da Conti, "Le Voyage aux Indes"
- [16] Fra Mauro map, 09-P25, original Italian: "Le naue ouerçonchi che nauegano questo mar portano quattro albori e, oltra de questi, do' che se può meter e leuar et ha da 40 in 60 camerele per i marchadanti e portano uno solo timon; le qual nauega sença bossolo, perché i portano uno astrologo el qual sta in alto e separato e con l'astrolabio in man dà ordene al nauegar")
- [17] Text from Fra Mauro map, 10-A13, original Italian: "Circa hi ani del Signor 1420 una naue ouerçoncho de india discorse per una trauersa per el mar de india a la uia de le isole de hi homeni e de le done de fuora dal cauo de diab e tra le isole uerde e le oscuritade a la uia de ponente e de garbin per 40 cornade, non trouando mai altro che aiere e aqua, e per suo



Traditional Malaysian Junk BILBO (1997)

arbitrio iscorse 2000 mia e declinata la fortuna i fece suo retorno in çorni 70 fina al sopradito cau de diab. E acostandose la naue a le rieue per suo bisogno, i marinari uedeno uno ouo de uno oselo nominato chrocho, el qual ouo era de la grandeça de una bota d'anfora.”

- [18] Robinson, Annie *Maritime Maryport Dalesman* 1978 p.31 ISBN 0852064802
- [19] “E. Allen Petersen Dies at 84; Fled Japanese on Boat in '38”. *The New York Times*. 14 June 1987.
- [20] Charles W. Cushman Photograph Collection>> Results >> Details
- [21] Jose Maria Tey, *Hong Kong to Barcelona in the Junk “Rubia”*, George G. Harrap & Co. Ltd, London 1962
- [22] 50 Years Malaysian-German Relations, Embassy of the Federal Republic of Germany, p132/133
- [23] <http://www.mifasol.org/BILBO/Bilbo-Bibliography>, BILBO Bibliography
- [24] <http://forum.woodenboat.com/showthread.php?3071-Cengal,Malayan Chengal timber>

8.6 References

- Needham, Joseph (1986). *Science and Civilization in China, Volume 4, Physics and Physical Technology, Part 3, Civil Engineering and Nautics*. Taipei: Caves Books Ltd.
- Pirates and Junks in Late Imperial South China

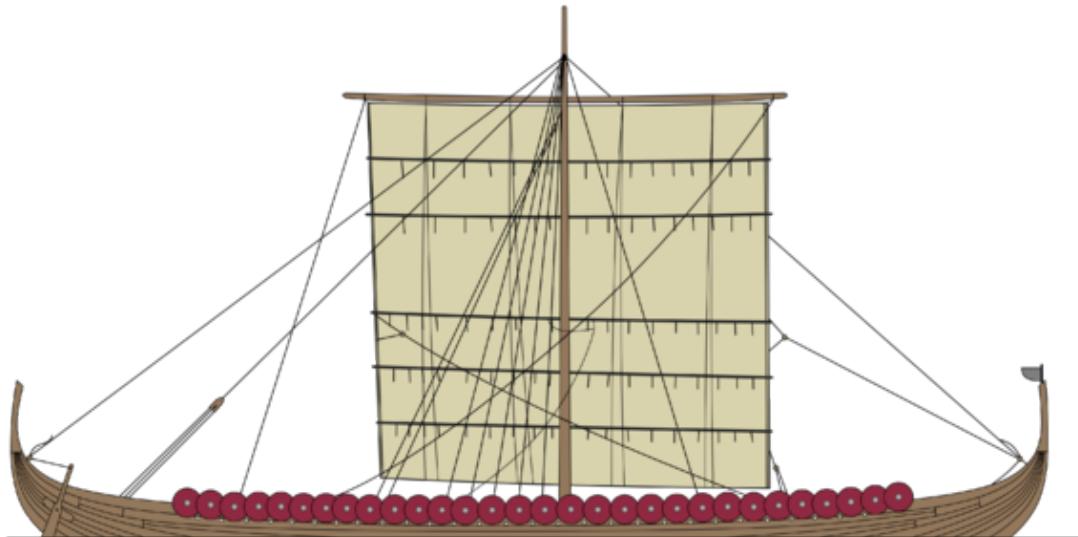
8.7 External links

- World of Boats (EISCA) Collection ~ Keying II Hong Kong Junk
- China Seas Voyaging Society

- The Free China, homepage of one of the last remaining 20th century junks, with video.
- The Junk and Advanced Cruising Rig Association, The JRA

Chapter 9

Longship



Schematic drawing of the longship type. They were not always equipped with shields.

Longships were a type of ship invented and used by the **Vikings** for trade, commerce, exploration, and warfare during the **Viking Age**. The longship's design evolved over many centuries, beginning in the **Stone Age** with the invention of the **umiak** and continuing up until the 9th century with ships like **Nydam** and **Kvalsund**. The longship appeared in its complete form between the 9th and 13th centuries. The character and appearance of these ships have been reflected in Scandinavian boat-building traditions until today. The particular skills and methods employed in making longships are still used world wide, often with modern adaptations. They were all made out of wood, with cloth sails (woven wool) and had lots of details and carvings on the hull.

The longships were characterized as a graceful, long, narrow and light wooden boat, with a shallow-draft hull designed for speed. The ship's shallow draft allowed navigation in waters only one metre deep and permitted random beach landings, while its light weight enabled it to be carried over **portages** or used bottoms up for shelter in camps. Longships were also double-ended, the symmetrical bow and stern letting the ship to reverse direction quickly without a turn around; this trait proved particularly useful at northern latitudes, where icebergs and sea ice posed hazards to navigation. Longships were fitted with **oars** along almost the entire length of the boat itself. Later versions had a rectangular sail on a single mast, which was used to replace or augment the effort of the rowers, particularly during long journeys.^[1] The average speed of Viking ships varied from ship to ship, but lay in the range of 5–10 knots (9.3–18.5 km/h) and the maximum speed of a longship under favorable conditions, was around 15 knots (28 km/h).^[2]

Longships were the epitome of naval power in their time, and were highly valued possessions. They were often

commonly owned by coastal farmers and commissioned by kings in times of conflict, in order to quickly assemble a large and powerful naval force. While longships were used by the Norse in warfare, they were mostly used for troop transports, not warships. In the tenth century, longships would sometimes be tied together in offshore battles to form a steady platform for infantry warfare. During the 9th century peak of the Viking expansion, large fleets set out to attack the degrading Frankish empire by attacking up navigable rivers such as the Seine. Rouen was sacked in 841, the year after the death of Louis the Pious, a son of Charlemagne. Quentovic, near modern Etables, was attacked in 842 and 600 Danish ships attacked Hamburg in 845. In the same year 129 ships returned to attack up the Seine.^[3] They were called “dragonships” by enemies such as the English^[4] because they had a dragon-shaped bow. The Norse had a strong sense of naval architecture, and during the early medieval period they were advanced for their time.^{[5][6]}

9.1 Types of longships

Longships can be classified into a number of different types, depending on size, construction details, and prestige. The most common way to classify longships is by the number of rowing positions on board.

9.1.1 Karvi

The **Karvi** (or *karve*) are the smallest vessel that is considered a longship. According to the 10th century **Gulating Law**, a ship with 13 rowing benches is the smallest ship suitable for military use. A ship with between 6 and 16 benches would be classified as a Karvi. These ships were considered to be “general purpose” ships, mainly used for fishing and trade, but occasionally were commissioned for military use. While most longships held a length to width ratio of 7:1, the Karvi ships were closer to 4.5:1. The **Gokstad Ship** is a famous Karvi ship, built around the end of the 9th century, excavated in 1880 by Nicolay Nicolaysen. It was approximately 23 m (75 feet) long with 16 rowing positions.

9.1.2 Snekkjja

The **snekkjja** (or *snekke*), meaning 'thin and projecting,' was typically the smallest longship used in warfare and was classified as a ship with at least 20 rowing benches. A typical snekkja might have a length of 17 m (56 feet), a width of 2.5 m (8.2 feet), and a draught of only 0.5 m (1.6 feet). It would carry a crew of around 41 men (40 oarsmen and one cox).

Snekkjjas were one of the most common types of ship. According to Viking lore, **Canute the Great** used 1,200 in Norway in 1028,^[7] and **William the Conqueror** used about 600 for the invasion of Britain in 1066 in the post Viking period.

The Norwegian snekkjas, designed for deep fjords and Atlantic weather, typically had more draught than the Danish model designed for low coasts and beaches. Snekkjjas were so light that they had no need of ports – they could simply be beached, and potentially even carried across a portage.

The snekkjas continued to evolve after the end of the Viking age, with later Norwegian examples becoming larger and heavier than Viking age ships. They are still being used in Norway, and are now called **snekke**.

9.1.3 Skeid

Skeid (*skeið*), meaning ‘that which cuts through water,’ ships were larger warships, consisting of more than 30 rowing benches. Ships of this classification are some of the largest (see **Busse**) longships ever discovered. A group of these ships was discovered by Danish archaeologists in **Roskilde** during development in the harbor-area in 1962 and 1996–97. The ship discovered in 1962, **Skuldelev 2** is an oak-built Skeid longship. It is believed to have been built in the **Dublin** area around 1042. **Skuldelev 2** could carry a crew of some 70–80 and measures just less than 30 m (98 feet) in length. In 1996–97 archaeologists discovered the remains of another ship in the harbour. This ship, called the **Roskilde 6**, at 37 m (121 feet) is the longest Viking ship ever discovered and has been dated to around 1025.^[8]



Full-scale replica of a Viking snekkja based in Morąg, Poland

9.1.4 Drekkar

Drekkar are known from historical sources, such as the 13th century *Göngu-Hrólfs Saga* (the Saga of Rollo). Here, the ships are described as elegant and ornately decorated, and used by those who went raiding and plundering. According to the historical sources the ships' prows carried carvings of menacing beasts, such as dragons and snakes, allegedly to protect the ship and crew, and to ward off the terrible sea monsters of Norse mythology. It is however likely that the carvings, like those on the Oseberg ship, might have had a ritual purpose, or that the purported effect was to frighten enemies and townspeople. No true dragon ship, as defined by the sagas, has been found by archaeological excavation.

9.1.5 Transport

On 10 September 2007, Professor Stephen Harding of the University of Nottingham, used ground penetrating radar (GPR) equipment to pinpoint the location of a 1,000-year-old Viking transport longship (Nordic clinker design) beneath 2–3 m (6–10 feet) of clay in Meols, Wirral, (a well-known settling place of Vikings). The ship had been previously uncovered in 1938 during excavation of a car park. Workers at the time covered the ship over again so as not to delay construction.^[9]

9.2 Construction

The first longships can trace their origin back to between 500 and 300 BC, when the Danish Hjortspring boat was built.^[10] It was fastened with cord, not nailed, and paddled, not rowed. It had rounded cross sections and although 20 m (65 feet) long was only 2 m (6 feet) wide. The rounded sections gave maximum displacement for the lowest wetted surface area, similar to a modern narrow rowing skiff, so were very fast but had little carrying capacity. The shape suggests mainly river use. Unlike later boats, it had a low bow and stern. A distinctive feature is the two-prong cutaway bow section.



The Stora Hammars I stone showing armed warriors in a longship.

The first true longship, that was rowed was the Nydam ship built in Denmark around 350 AD. It also had very rounded underwater sections but had more pronounced flair in the topsides, giving it more stability as well as keeping more water out of the boat at speed or in waves. It had no sail. It was of lapstrake construction fastened with iron nails. The bow and stern had slight elevation. The keel was a flattened plank about twice as thick as a normal strake plank but still not strong enough to withstand the downwards thrust of a mast.

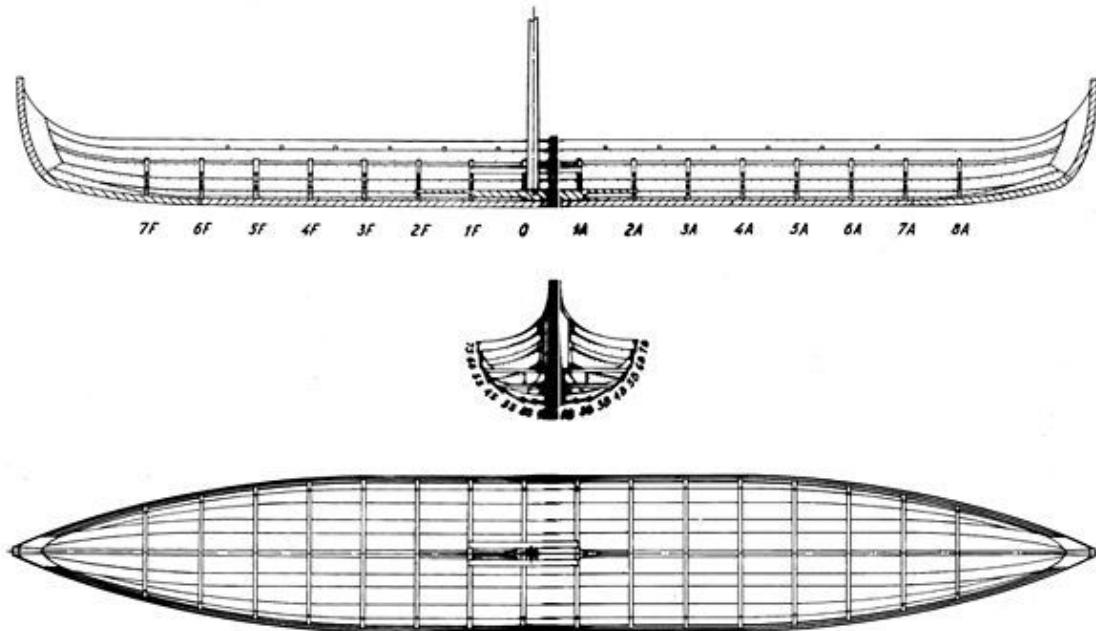
The Sutton Hoo longship, sometimes referred to as the ghost ship of the Wufflings, is about 27 m × 4.5 m (89 by 15

feet) maximum beam and built about 625 AD. It is associated with the Saxons. The ship was crushed by the weight of soil when buried but most details have been reconstructed. The ship was similar in hull section to the Nydam ship with flared topsides. Compared to later longships, the oak planks are wide—about 250 mm (9.8 inches) including laps, with less taper at bow and stern. Planks were 25 mm (0.98 inches) thick. The 26 heavy frames are spaced at 850 mm (33 inches) in the centre. Each frame tapers from the turn of the bilge to the inwale. This suggests that knees were used to brace the upper two or three topside planks but appear to have rotted away. The hull had a distinctive leaf shape with the bow sections much narrower than the stern quarters. There were nine wide planks per side. The ship had a light keel plank but pronounced stem and stern deadwood. The reconstruction suggests the stern was much lower than the bow. It had a steering oar to starboard braced by an extra frame. The raised prow extended about 3.7 m (12 feet) above the keel and the hull was estimated to draw 750 mm (30 inches) when lightly laden. Between each futtock the planks were lapped in normal clinker style and fastened with six iron rivets per plank. There is no evidence of a mast, sail, or strengthening of the keel amidships but a half-sized replica, the Soe Wylfing, sailed very well with a modest sail area.

Sails started to be used from possibly the 8th century. The earliest had either plaited or chequered pattern, with narrow strips sewn together.^[11]

About 700 AD the Kvalsund ship was built. It is the first with a true keel. Its cross sectional shape was flatter on the bottom with less flair to the topsides. This shape is far more stable and able to handle rougher seas. It had the high prow of the later longships. After several centuries of evolution, the fully developed longship emerged some time in the middle of the ninth century. Its long, graceful, menacing head figure carved in the stern, such as the Oseburg ship, echoed the designs of its predecessors. The mast was now square in section and located toward the middle of the ship, and could be lowered and raised. The hull's sides were fastened together to allow it to flex with the waves, combining lightness and ease of handling on land. The ships were large enough to carry cargo and passengers on long ocean voyages, but still maintained speed and agility, making the longship a versatile warship and cargo carrier.

9.2.1 Keel, stems and hull



Schematic drawing of a longship construction. This drawing is representing the Sebbe Als ship. It is a reconstructed snekke from Denmark.

The Viking shipbuilders had no written diagrams or standard written design plan. The shipbuilder pictured the longship before its construction, based on previous builds, and the ship was then built from the keel up. The keel and stems were made first. The shape of the stem was based on segments of circles of varying sizes. The keel was



The ships design gave both strength, agility and versatility. They could navigate the open ocean, coastal waters, fjords and many rivers and could be landed on a random beach. The pictured ship is the reconstructed Inme Gram.

an inverted T shape to accept the garboard planks. In the longships the keel was made up of several sections spliced together and fastened with treenails. The next step was building the strakes – the lines of planks joined endwise from stern to stern. Nearly all longships were **clinker** (also known as *lapstrake*) built, meaning that each hull plank overlapped the next. Each plank was hewn from an oak tree so that the finished plank was about 25 mm (0.98 inches) thick and tapered along each edge to a thickness of about 20 mm (0.79 inches). The planks were radially hewn so that the grain is approximately at right angles to the surface of the plank. This provides maximum strength, an even bend and an even rate of expansion and contraction in water. In modern terms this is called quarter sawn timber and has the least natural shrinkage of any cut section of wood. The plank above the turn of the bilge, the *meginhufr*, was about 37 mm (1.5 inches) thick on very long ships, but narrower to take the strain of the crossbeams. This was also the area subject to collisions. The planks overlapped by about 25 mm (0.98 inches)–30 mm (1.2 inches) and were joined by iron rivets. Each overlap was stuffed with wool or animal hair or sometimes hemp soaked in pine tar to ensure water tightness. At midlength, where the planks are straight, the rivets are about 170 mm (6.7 inches) apart but were closer together as the planks sweep up to the curved bow and stern. There is considerable twist and bend in the end planks. This was achieved by using both thinner (by 50%) and narrower planks. In more sophisticated builds, forward planks were cut from natural curved trees called reaction wood. Planks were installed unseasoned or wet. Partly worked stems and sterns have been located in bogs. It has been suggested they were stored there over winter to stop the wood drying and cracking. The moisture in wet planks allowed the builder to force the planks into a more acute bend if need be. Once dry it would stay in the forced position. At the bow and the stern builders were able to create hollow sections, or compound bends, at the waterline making the entry point very fine. In less sophisticated ships short and nearly straight planks were used at the bow and stern. Where long timber was not available, or the ship was very long, the planks were butt joined although over lapping scarf joints, fixed with nails were also used.

As the planks reached the desired height, the interior frame (futtocks) and cross beams were added. Frames were placed close together which is an enduring feature of thin planked ships, still used today on some lightweight wooden racing craft such as those designed by Bruce Farr. Viking boat builders used a spacing of about 850 mm (33 inches). Part of the reason for this spacing was to achieve the correct distance between rowing stations and to create space for the chests used by Norse sailors as thwarts (seats). The bottom futtocks next to the keel were made from natural L-shaped crooks. The upper futtocks were usually not attached to the lower futtocks to allow some hull twist. The parts were held together with iron rivets, hammered in from the outside of the hull and fastened from the inside with a rove (washers). The surplus rivet was then cut off. A ship normally used about 700 kg (1,500 pounds) of iron nails

in a 18 m (59 feet) long ship. In some ships the gap between the lower uneven futtock and the lapstrake planks was filled with a spacer block about 200 mm (7.9 inches) long. In later ships spruce stringers were fastened lengthwise to the futtocks roughly parallel to the keel. Longships had about five rivets for each yard (90 cm or 35 inches) of plank. In many early ships trenails (trenails, trunnels) were used to fasten large timbers. First, a hole about 20 mm (0.79 inches) wide hole was drilled through two adjoining timbers, a wooden pegs inserted which was split and a thin wedge inserted to expand the peg. Some trenails have been found with traces of linseed oil suggesting that trenails were soaked before the pegs were inserted. When dried the oil would act as a semi waterproof weak filler/glue.

The longships' narrow deep keel provided strength beneath the waterline. A typical size keel of a longer ship was 100 mm × 300 mm (3.9 by 11.8 inches) amidships, tapering in width at the bow and stern. Sometimes there was a false outer keel to take the wear while being dragged up a beach. These large timbers were shaped with both adze and broadaxe. At the bow the cut water was especially strong, as longboats sailed in ice strewn water in spring. Hulls up to 560 cm (18.4 feet) wide gave stability, making the longship less likely to tip when sailed. The greater beam provided more moment of leverage by placing the crew or any other mobile weight on the windward side. Oceangoing longships had higher topsides about a 1 m (3.3 feet) high to keep out water. Higher topsides were supported with knees with the long axis fastened to the top of the crossbeams. The hull was waterproofed with animal hair, wool, hemp or moss drenched in pine tar. In the autumn the ships would be tarred and then left in a boathouse over the winter to allow time for the tar to dry. To keep the sea out, wooden disks were put into the oar holes. These could be shut from the inside when the oars were not in use. A drain plug hole about 25 mm (0.98 inches) was drilled in the garboard plank on one side to allow rain water drainage.

The oars did not use rowlocks or thole pins but square holes cut below the gunwale line. The holes were also used for belaying mooring lines and sail sheets. At the bow the forward upper futtock protruded about 400 mm (16 inches) above the sheerline and was carved to retain anchor or mooring lines.

9.2.2 Timber

Analysis of timber samples from Viking long boats shows that a variety of timbers were used, but there was strong preference for oak which was associated with *Odin* in Viking mythology. Oak is a heavy, durable timber that can be easily worked by adze and axe when green (wet/unseasoned). Generally large and prestigious ships were made from oak. Other timber used were ash, elm, pine, spruce and larch. Spruce is light and seems to have been more common in later designs for internal hull battens (stringers). Although it is used for spars in modern times there is as yet no evidence the Vikings used spruce for masts. All timber was used unseasoned. The bark was removed by a bark spade. This consisted of a 1.2-metre long (3.9 ft) wooden handle with a T crossbar at the upper end, fitted with a broad chisel-like cutting edge of iron. The cutting edge was 60 mm (2.4 inches) wide and 80 mm (3.1 inches) long with a 120-millimetre long (4.7 in) neck where the handle was inserted. It appears that in cold winters wood work stopped and partly completed timber work was buried in mud to prevent it drying out. Timber was worked with iron adzes and axes. Most of the smoothing was done with a side axe. Other tools used in woodwork were hammers, wedges, drawknives, planes and saws. Iron saws were probably very rare. The doomsday book in England (1086 AD) records only 13 saws. Possibly these were pit saws and it is uncertain if they were used in longship construction.

9.2.3 Sail and mast

Even though no longship sail has been found, accounts verify that longships had square sails. Sails measured perhaps 11 m (35 feet) to 12 m (40 feet) across, and were made of *rough wool* cloth. Unlike in *knarrs*, a longship sail was not stitched.

The sail was held in place by the mast which was up to 16 m (52 feet) tall. Its base was about 250 mm × 180 mm (9.8 by 7.1 inches). The mast was supported by a large wooden maststep called a *kerling* ("Old Woman" in Old Norse) that was semicircular in shape. (Trent) The *kerling* was made of oak, and about 700 mm (28 inches) wide and up to 6 m (20 feet) long in the larger ships. It usually heavily tapered into a joint with the internal *keelson*, although *keelsons* were by no means universal. The *kerling* lay across two strong frames that ran width-wise above the keel in the centre of the boat. The *kerling* also had a companion: the "mast fish," a wooden timber above the *kerling* just below deck height that provided extra help in keeping the mast erect. It was a large wooden bulk of timber about 3 m (9.8 feet) long with a 1.4-metre long (4.6 ft) slot, facing aft to accommodate the mast as it was raised. This acted as a mechanism to catch and secure the mast before the stays were secured. It was an early form of mast partner but was aligned fore and aft. In later longships there is no mast fish-the mast partner is an athwartwise beam similar to more modern construction. Most masts were about half the length of the ship so that it did not project beyond

the hull when unstepped. When lowered the mast foot was kept in the base of the mast step and the top of the mast secured in a natural wooden crook about 1.5–2.5 m (4 feet 11 inches–8 feet 2 inches) high, on the port side, so that it did not interfere with steering on the starboard side.

There is a suggestion that the rig was sometimes used in a lateen style with the top cross spar dipped at an angle to aid sailing to windward i.e. the spar became the luff. There is little or no evidence to support this theory. No explanation is offered as to how this could be accomplished with a square sail as the lower reefed portion of the sail would be very bulky and would prevent even an approximation of the laminar flow necessary for windward sailing. There is no evidence of any triangular sails in use. Masts were held erect by side stays and possibly fore and aft stays. Each side stay was fitted at its lower end with a 150-millimetre long (5.9 in) toggle. There were no chain plates. The lower part of the side stay consisted of ropes looped under the end of a knee of upper futtock which had a hole underneath. The lower part of the stay was about 500–800 mm (1.6–2.6 feet) long and attached to a combined flat wooden turnblock and multi V jamb cleat called an angel (maiden, virgin). About 4 turns of rope went between the angel and the toggle to give the mechanical advantage to tighten the side stays. At each turn the v shape at the bottom of the angels “wings” jambed the stay preventing slippage and movement.

9.2.4 Rudder

Early long boats used some form of steering oar but by the 10th century the side rudder (called a steerboard, which is why that side of the vessel is now called starboard) was well established. It consisted of a length of timber about 2.4 m (7 feet 10 inches) long. The upper section was rounded to a diameter of about 150 mm (5.9 inches). The lower blade was about 1.8 m × 0.4 m (5 feet 11 inches by 1 foot 4 inches). The steerboard on the *Gokstad ship* in the Viking Ship Museum in Oslo, Norway, is about 20 cm (8 inches) wide, completely flat inboard and with about a 7.6 cm (3 inches) maximum width at the center of the foil. The head of the rudder shaft had two square holes about 200–300 mm (7.9–11.8 inches) apart. When the rudder was in its normal position the tiller was inserted in the upper hole so that the tiller faced athwartwise. The shaft was attached to the gunwale by a U shaped joint. Near the stern, about halfway down the starboard topsides, was a rounded wooden block about 150 mm (5.9 inches) in diameter and 100 mm (3.9 inches) high, with a central hole for a rope. This corresponded to a hole in the midsection of the rudder blade. From the outside the rope ran through the blade, through the round block and topsides and was fastened inside the hull. The flexibility of the hemp rope allowed the blade to pivot. When beached or in shallow water the tiller was moved to the lower hole, the blade rope was slackened and the rudder head pulled up so the rudder could operate in shallow waters. Modern facsimiles are reported to steer quite well but require a very large amount of physical effort compared to the modern fore and aft tiller.

9.2.5 Anchors

Longships for the most part used two different kinds of anchors. The most common was a natural wood yoke formed from a tree branch. The weight was supplied by a stone passing laterally through the U of the yoke. The top of the yolk was closed by either a length of hardwood or a curved iron head, which kept the stone in place. One side of the head stuck out so it could dig into mud or sand. In Denmark an iron Viking age anchor has been found that resembles the modern fisherman's anchor but without the crossbar. The cross bar may have rusted away. These anchors had an iron ring to which the hemp warp was attached.

9.2.6 Ship builders toolkit

At the height of Viking expansion into Dublin and Jorvik 875–954 AD the longship reached a peak of development such as the *Gokstad ship* 890. Archaeological discoveries from this period at Coppergate, York, show the shipwright had a large range of sophisticated woodwork tools. As well as the heavy adze, broad axe, wooden mallets and wedges, the craftsman had steel tools such as anvils, files, snips, awls, augers, gouges, draw knife, knives, including folding knives, chisels and small 300 mm (12 inches) long bow saws with antler handles. Edged tools were kept sharp with sharpening stones from Norway. One of the most sophisticated tools was a 25 mm (0.98 inches) diameter twist drill bit, perfect for drilling hole for treenails. Simple mechanical pole wood lathes were used to make cups and bowls.

9.2.7 Replica longships

Since the discovery of the original longships in the 1800s, many boat builders have built many **Viking ship** replicas. However, most have not been able to resist the temptation to use more modern techniques and tools in construction. In 1892–93 a full-size near-replica of the Gokstad ship, the **Viking**, was built by the Norwegian Magnus Andersen in Bergen. It was used to sail the Atlantic. It had a deeper keel with 1.5 m (4 feet 11 inches) draught to stiffen the hull and a range of non-authentic triangular sails to help performance and big fenders on each gunwale filled with reindeer hair to give extra buoyancy in case of swamping. The skipper recorded that the keel bowed upwards as much as 20 mm (0.79 inches) and the gunwale flexed inwards as much as 150 mm (5.9 inches) in heavy seas.^[12] A half-size replica of the Sutton Hoo longship has been equipped with a substantial sail, despite the original having oar power only.

9.3 Navigation and propulsion

9.3.1 Navigation



A replica of the Gokstad ship, named **Viking** was sailed across the Atlantic to the World's Columbian Exposition in 1893

The Vikings were experts in judging speed and wind direction, and in knowing the current and when to expect high and low tides. Viking navigational techniques are not well understood, but historians postulate that the Vikings probably had some sort of primitive astrolabe and used the stars to plot their course.

The Danish archaeologist Thorkild Ramskou suggested in 1967 that the "sun-stones" referred to in some sagas might have been natural crystals capable of polarizing skylight. The mineral cordierite occurring in Norway has the local name "Viking's Compass." Its changes in colour would allow determining the sun's position (azimuth) even through an overcast or foggy horizon.^[13]

An ingenious navigation method is detailed in *Viking Navigation Using the Sunstone, Polarized Light and the Horizon Board* by Leif K. Karlsen.^[14] To derive a course to steer relative to the sun direction, he uses a sun-stone (Solarsteinn) made of **Iceland spar** (optical calcite or Silfurberg), and a "horizon-board." The author constructed the latter from an Icelandic saga source, and describes an experiment performed to determine its accuracy. Karlsen also discusses why on North Atlantic trips the Vikings might have preferred to navigate by the sun rather than by stars, as at high latitudes in summer the days are long and the nights short.

A Viking named Stjerner Oddi compiled a chart showing the direction of sunrise and sunset, which enabled navigators to sail longships from place to place with ease. Almgren, an earlier Viking, told of another method: “All the measurements of angles were made with what was called a ‘half wheel’ (a kind of half sun-diameter which corresponds to about sixteen minutes of arc). This was something that was known to every skipper at that time, or to the long-voyage pilot or *kendtmand* (‘man who knows the way’) who sometimes went along on voyages... When the sun was in the sky, it was not, therefore, difficult to find the four points of the compass, and determining latitude did not cause any problems either.” (Algrem)

Birds provided a helpful guide to finding land. A Viking legend states that Vikings used to take caged crows aboard ships and let them loose if they got lost. The crows would instinctively head for land, giving the sailors a course to steer.

Archaeologists have found two devices which they interpret as navigation instruments. Both appear to be sundials with *gnomon* curves etched on a flat surface. The devices are small enough to be held flat in the hand at 70 mm (2.8 inches) diameter. A wooden version dated to about 1000 AD was found in Greenland. A stone version was also found at Vatnahverfi, Greenland. By looking at the place where the shadow from the rod falls on a carved curve, a navigator is able to sail along a line of latitude. Both gnomon curve devices show the curve for 60° north very prominently. This was the approximate latitude that the Vikings would have sailed along to get to Greenland from Scandinavia. The wooden device also has north marked and had 32 arrow heads around the edge that may be the points of a compass. Other lines are interpreted as the solstice and equinox curves. The device was tested successfully, as a sun compass, during a 1984 reenactment when a longship sailed across the North Atlantic. It was accurate to within $\pm 5^\circ$.^[15]

9.3.2 Propulsion

The longships had two methods of propulsion: oars and sail. At sea, the sail enabled longships to travel faster than by oar and to cover long distances overseas with far less manual effort. Sails could be raised or lowered quickly. In a modern facsimile the mast can be lowered in 90 seconds. Oars were used when near the coast or in a river, to gain speed quickly, and when there was an adverse (or insufficient) wind. In combat, the variability of wind power made rowing the chief means of propulsion. The ship was steered by a vertical flat blade with a short round handle, at right angles, mounted over the starboard side of the aft gunwale.

Longships were not fitted with benches. When rowing, the crew sat on sea chests (chests containing their personal possessions) that would otherwise take up space. The chests were made the same size and were the perfect height for a Viking to sit on and row. Longships had hooks for oars to fit into, but smaller oars were also used, with crooks or bends to be used as oarlocks. If there were no holes then a loop of rope kept the oars in place.

An innovation that improved the sail’s performance was the *beitass*, or stretching pole – a wooden spar stiffening the sail. The windward performance of the ship was poor by modern standards as there was no centreboard, deep keel or leeboard. To assist in tacking the *beitass* kept the luff taut. Bracing lines were attached to the luff and lead through holes on the forward gunwale. Such holes were often reinforced with short sections of timber about 500 to 700 mm (1.6 to 2.3 feet) long on the outside of the hull.

9.4 Legacy

The Vikings were major contributors to the shipbuilding technology of their day. Their shipbuilding methods spread through extensive contact with other cultures, and ships from the 11th and 12th centuries are known to borrow many of the longships’ design features, despite the passing of many centuries. The *Lancha Poveira*, a boat from *Póvoa de Varzim, Portugal* is one of the last remnants from the longship, keeping all the longboat features but without a long stern and bow, and with a *lateen sail*. It was used until the 1950s. Today there is just one boat: *Fé em Deus*.

Many historians, archaeologists and adventurers have reconstructed longships in an attempt to understand how they worked.^[17] These re-creators have been able to identify many of the advances that the Vikings implemented in order to make the longship a superior vessel.

The longship was a master of all trades. It was wide and stable, yet light, fast, and nimble. With all these qualities combined in one ship, the longship was unrivaled for centuries, until the arrival of the great *cog*.

In Scandinavia, the longship was the usual vessel for war even with the introduction of cogs in the 12th–13th centuries. Leidang fleet-levy laws remained in place for most of the Middle Ages, demanding that the freemen should build, man and furnish ships for war if demanded by the king—ships with at least 20 or 25 oar-pairs (40–50+ rowers).



Image from the Bayeux Tapestry showing Harold Godwinson's ship approaching a beach, probably in the Somme Estuary.^[16]

However, by the late 14th century, these low-boarded vessels were at a disadvantage against newer, taller vessels – when the **Victual Brothers**, in the employ of the **Hansa**, attacked **Bergen** in the autumn of 1393, the “great ships” of the pirates could not be boarded by the Norwegian levy ships called out by **Margaret I of Denmark** and the raiders were able to sack the town with impunity. While earlier times had seen larger and taller longships in service, by this time the authorities had also gone over to other types of ships for warfare. The last Viking longship was defeated in 1429.

9.5 Notable longships

- The **Oseberg** ship and the **Gokstad** ship – both from Vestfold in Norway.
- The **Ormen Lange** (“*The Long Serpent*”) was the most famous longship of Norwegian king **Olaf Tryggvason**.
- The **Mora** was the ship given to **William the Conqueror** by his wife, **Matilda**, and used as the flagship in the **Norman conquest of England**.
- The **Sea Stallion** is the second largest Viking ship replica ever made, is an almost new 30 m (98 feet) replica of the **Skuldelev 2**. **Skuldelev 2** was originally built near Dublin around 1042, but was rediscovered in Roskilde, Denmark in 1962. The **Sea Stallion** sailed from Roskilde to Dublin in summer 2007, to commemorate the voyage of the original.^[17] In the winter 2007/2008 The **Sea Stallion** was exhibited outside the National Museum in Dublin. In the summer 2008 the **Sea Stallion** returned to Roskilde on a route going south of England.
- The **Nydam** ship (c. 350–400) is a burial ship from Denmark. This vessel is 24 m (80 feet) long and may have had its mast and sail removed for burial. The ship shows a combination of building styles and was propelled by oars.

- Dragon Harald Fairhair, is the largest replica longship ever built. The ship was built in Haugesund, Norway and launched in 2012. Equipped with 50 oars, it is 35 m (115 feet) long.
- The Íslendingur (Icelander) is a 22 m (72 feet) replica of the Gokstad ship that was built, using traditional building techniques. In 2000, it was used to sail from Iceland to the L'Anse aux Meadows in Newfoundland, to participate in the 1000 year anniversary of Leif Ericson's discovery of America.^[18]
- *Munin* is a half-sized replica of the Gokstad ship. Berthed at the Vancouver Maritime Museum, she was built at the Scandinavian Centre, Burnaby, British Columbia and launched in 2001.

9.6 See also

- Birlinn
- Dragon Harald Fairhair (ship)
- Hugin (longship)
- Knarr
- Leidang
- Medieval ships
- Nordland (boat)
- Viking ship
- Viking ship replicas

9.7 Notes

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- [3] M Magnusson. *The Vikings*. P 71 Tempus. 2003.
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- [5] History World
- [6] NOVA
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- [15] Cultural Atlas of the Viking World. Ed. J Graham Campbell et al. Andromeda. 1994.
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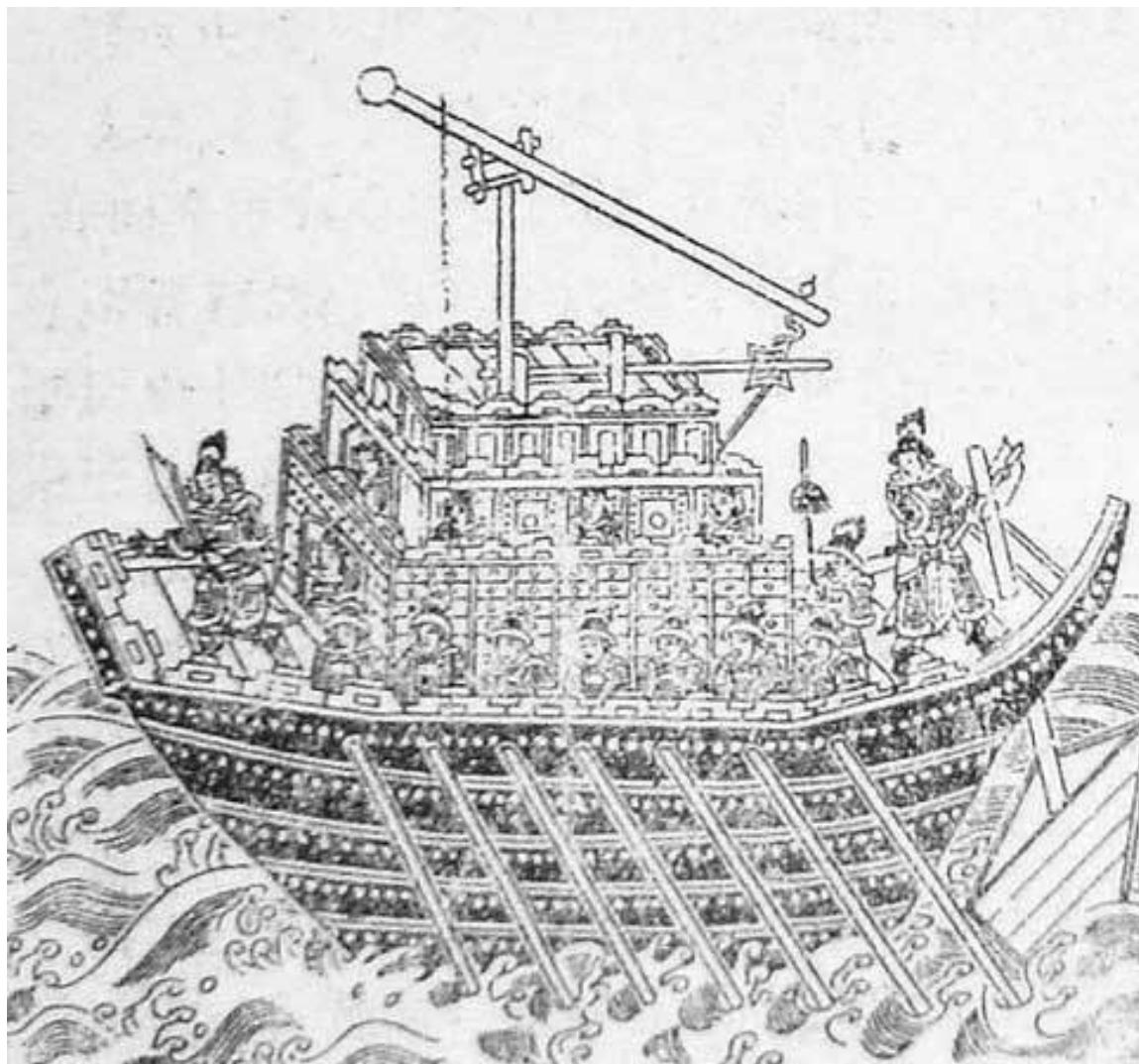
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9.9 External links

- The Viking Ship Museum in Roskilde
- The Viking Ship Museum in Oslo
- The *Ormen Friske* disaster – a warning against construction errors in Viking ship replicas
- The *Ormen Friske* disaster in 1950 investigated
- Viking ships and traditional Norse wooden boats
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Chapter 10

Louchuan



A Song dynasty louchuan with a trebuchet, depicted in the Wujing Zongyao

Louchuan (楼船, lit. *tower ships*) were a type of naval vessel, primarily a floating fortress, which has seen use in China since the Han Dynasty. Meant to be a central vessel in the fleet, the louchuan was equipped for boarding and attacking enemy vessels, as well as with siege weapons including traction trebuchets for ranged combat.

10.1 Description

Historical records relating to the louchuan are found in sources such as the *Wujing Zongyao*, written during the Song Dynasty, and the *Taibai Yijing* from the Tang Dynasty. From the latter (as translated by Joseph Needham), the tower ships were described as:

Tower ships (lou chuan); these ships have three decks equipped with bulwarks for the fighting lines, and flags and pennants flying from the masts. There are ports and openings for crossbows and lances [and at the sides there is provided felt leather to protect against fire], while (on the topmost deck) there are trebuchets for hurling stones, set up (in appropriate places). And there are also (arrangements for making) molten iron (for throwing in containers from these catapults). (The whole broadside) gives the appearance of a city wall. In the Jin period the Prancing-Dragon Admiral, Wang Jun, invading Wu, built a great ship 200 paces (1000 ft.) in length, and on it set flying rafters and hanging galleries on which chariots and horses could go. But if [all of a sudden] a violent wind is encountered, (such ships are likely to) get out of human control, so they were judged inconvenient in practice [for warlike action]. But the fleet cannot fail to be furnished with such ships, in order that its overawing might be perfected.^[1]

The use of such ships in riverine warfare, especially along the Chang Jiang, stretches back to the late Han Dynasty, and perhaps even earlier.

10.2 References

[1] Needham, Joseph (translated by), *Taibai Yijing*, Volume 4, Part 2, pg. 685.

10.3 See also

- Naval history of China

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10.4.1 Text

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