



## READING | What Was Needed to Link Continents? – World History For Us All — Dr. Anne Chapman

### SHIPS

#### Keeping afloat, carrying cargo, and moving across seas

In the 12th Century, the Atlantic was crossed on an open balsa raft and in a rowboat. But both were unsuitable for reliable, regular crossings, especially with cargo.

In the 15th Century, Europe had two main kinds of ships in general use. The northern tradition developed in the countries bordering the Baltic and the North seas, the southern in countries bordering the Mediterranean. Within these two traditions, there were many different designs tailored for particular purposes.

The northern design's hull (the body of the ship) was clinker built. That meant the planks making up the outer "skin" of the ship overlapped each other, and they were nailed so that each nail passed through both planks and into the internal frame as well. This made for strength and reasonable water tightness without much caulking. The narrow Viking ships with side-mounted steering oars, no decks, and little cargo-capacity that occasionally crossed the Atlantic to America around 1000 CE were clinker-built. In the early 13th Century, the more efficient rudder, mounted at the center of the stern, replaced the steering oar.

One version of clinker-built ships developed in the north by the early 14th Century was broad-beamed (wide from one side to the other at the midpoint of the ship), stable, and equipped with a massive keel. (The keel is a structural part of a ship in the center of the hull bottom and extending from stem to stern, sometimes protruding from the hull to provide stability.) It could carry heavy cargos. When used in warfare, temporary "castles" were raised on this type of ship front

and back to make boarding enemy ships easier and to give archers and musketeers an elevated position to shoot from. But the design limited the ship's size, since planks had to be rounded at front and back, and joining them became too difficult over 100 feet. Their rigidity was a disadvantage if the ship ran aground.

Northern ship's sails were square and fixed to horizontal yards mounted on each of the masts. This allowed a large area of canvas to be carried safely and with ease of handling. But unless the wind came from dead astern (from behind the ship), or nearly so, these ships made excess leeway, that is, a sideways movement that resulted in getting off course. A headwind simply kept them in harbor.

The southern design's hull was carvel-built. Its planks were fitted edge to edge rather than overlapping, each plank fastened with pegs or nails only to the permanent skeleton or frame, which was built first. It took considerable caulking of the joins, regularly repeated, to keep the ship watertight. But these ships could be built to any length and had more flexibility than clinker-built vessels. Early examples, carvel-built ships called caravels, had low sides and a shallow draft so that they could be used close inshore. At the start of the 14th Century, they adopted the center-mounted stern rudder of the northern design. By the late 14th Century, sides and stern were raised to prevent swamping, the beam was broadened, and the hull often covered with a deck. By the mid-15th Century, caravels usually had a quarterdeck (an additional deck, like a second story, raised over that part of the deck behind the mainmast), and a small permanent



stern castle. Sometime in that century, the tiller that moved the rudder was made to project inboard, giving better leverage. The caravels built to this design carried sails influenced by the lateen sails of the dhows, which Muslim mariners sailed across the Indian Ocean as far as China. These vessels were carvel-built, their planks fastened together with coir ropes passed through holes drilled at close intervals. Spun from coconut fibers, coir was highly durable, unaffected by seawater and rot. Its use made the dhow flexible, resistant to break-up on reefs or shoals, and easy to repair. Dhows were typically without decks.

Lateen sails appeared in the Mediterranean about the 13th Century. They were triangular, or nearly so, and the wooden yards that held them stiff to the wind were fixed more or less vertically to the longest edge of the triangle. They allowed sailing with maximum efficiency against a headwind, and they were simple to adjust to various wind conditions. However, the length of the main yard was tailored to the length of the ship. This limited the ship's size, since with increased length the yard became too heavy and hard to handle.

Around the start of the 16th Century, carracks developed from the caravels. They were bigger, bulkier, more rounded, and had more complicated rigging. Some had four masts and carried two or three square sails above each other on the foremast. They had lateen sails on the main and mizzen masts, though the distribution of sails on them varied. The result was increased speed, the ability to sail under different wind conditions, and easier steering. Late in the century, a topsail was added above the main sail. Carracks had permanent castles both fore and after that had room for a large crew and lots of provisions. That structure, however, made them prone to topple in strong winds. Their decks were stable and served as gun platforms.

The Chinese voyages in the 15th Century took place in ships, or "junks" that represented an altogether different design tradition, some of which were adapted to European ships. The most outstanding among these vessels were the "treasure ships," which were some 300 to 400 feet long and plied the Indian Ocean in the 15th Century and earlier. They had multiple decks, a hull with watertight compartments to minimize flooding in case of damage, and pumps to get rid of any water or to fight fires. They also had a stern-mounted rudder that could be adjusted to the depth of the water. They were mounted with multiple masts spread with slightly curved sails with horizontal bamboo battens to stiffen and strengthen them. These sails were easy to handle, needed few ropes, and could be adjusted to winds from different directions. The crew of a large Chinese "junk" ran to the hundreds, and naval artillery was sometimes placed on the decks.

## WINDS

### Getting from here to there

Sailing ships depended on wind to make them move. Fastest and easiest to handle on ships with square sails were winds that blew from directly behind when the vessel pointed in the direction it needed to go. But for a return trip, those winds could pose problems because a square sail might be "taken aback." That is, the wind might push the sail back against the mast. If the ship had one or more fore- and-aft sails, it could sail closer to the wind. That is, the ship could advance even if the wind were coming across the beam (the side of the vessel). By tacking, or following a zigzag steering pattern, along with proper adjustment of sails, the ship could progress against a contrary wind.

Knowledge of the global wind systems gave mariners greater confidence to sail out of sight of land. The monsoon blows in the Indian Ocean and China Seas region. In the



Atlantic and Pacific oceans the trade winds, westerlies, and easterlies blow. Monsoons are winds that reverse direction seasonally. In Asia, the winter monsoon blows reliably (though the exact dates on which it starts and ends vary year to year and in different locations) from the southwest from April to October, and from the northeast from November to March. In summer, monsoons bring torrential rains; in winter they bring sunny and dry weather.

The trade winds blow very steadily, almost continuously at about 11 to 13 miles per hour in both the Atlantic and Pacific oceans. They occur in two wide bands: one from about 5 to 30 degrees north of the equator, and the other from 5 to 30 south of it. The trade winds have a tendency to curl in towards the equator, blowing from the east to the west/southwest in the northern hemisphere and to the west/northwest in the southern hemisphere.

Winds called the westerlies blow from the southwest in the northern hemisphere and from the northwest in the southern hemisphere towards the east, between the latitudes of about 35 and 60 degrees. These have bursts of especially strong winds and storms, particularly in the latitudes called “the roaring forties.” Their speed is quite variable in both the north Atlantic and the north Pacific and less so in the southern hemisphere.

## MAPS

### Knowing where you are relative to the rest of the world

In the 15th Century, educated people regarded a round earth as common knowledge, despite popular tales about a flat earth. Venetian, Florentine, and Genoese mariners had since the Middle Ages sailed regularly across the Mediterranean, Black, and Baltic seas, as well as the coastal waters of the northeastern Atlantic. The most frequented coastlines

of these seas, including natural features and ports, were mapped in detail and quite accurately on charts, each one showing a limited area. These portolan charts, as they were known, represented the cumulative experience of mariners, summarized for the benefit of other seafarers. They could be relied on for navigating fairly short passages but were no use for fixing the position of a ship out of sight of land.

From the Mediterranean region, many Muslims and some Christian Europeans (mostly Italians) made their way in the thirteenth and fourteenth centuries overland to Inner Eurasia, India, Indonesia, and China. Many were merchants in search of products such as spices and silk unavailable at home. Other travelers included diplomats, scholars, and missionaries. Ibn Battuta and Marco Polo were only the best known among many other journeyers. The Mongol empires ensured safe routes. Some travelers left descriptions, not always accurate or full, of their routes and the places they visited.

In about 1410, two geographical works appeared that heavily influenced European views of the world. One, called *Image of the World*, was written by a cardinal of the Roman Catholic Church. It drew on the Bible, legends, travelers’ accounts, and classical writers, on whose authority the cardinal affirmed the possibility of reaching the Indies by sailing west. He exaggerated the east-west stretch of Asia and the proportion of land to sea in the area of the globe. Columbus is known to have studied this book. His own calculations made the distance from Europe to Japan less than 3,000 nautical miles. The actual great circle distance is 10,600.

The other work was a Latin translation of the *Geography* by the 2nd Century CE author Ptolemy. It described the world of Ptolemy’s time. It gave a fairly accurate picture of the Roman empire and its neighboring countries. But beyond the area of his knowledge, Ptolemy used guesswork instead of evidence. ►



He described a huge southern continent, attached at one end to Africa and the other to China, making the Indian Ocean a land-locked sea. He stated that navigation was impossible anywhere in the southern hemisphere because of the excessive heat there. And he contradicted the near-to-accurate estimate of the earth's circumference by an earlier classical author, his own being an underestimate by as much as one-sixth, thus shrinking the size of oceans. Ptolemy continued to have influence on geographical writing into early modern times.

European cartographers from about 1400 CE to 1550 CE usually underestimated the circumference of the earth by about 6,000 miles. Until the late 16th Century, some of them continued to believe that America was just an extension of Asia. Others thought that Asia lay just barely beyond the lands they had so newly found and that the westward route was therefore much shorter than the one around Africa.

By the 14th Century, Chinese maps gave a generally accurate view of the relationships and main features, though not the relative sizes, of the entire area from Korea to the Atlantic edge of Europe. At least two Chinese world maps from the 1300s are known but have not survived except as sources for the Korean world map of 1402 CE. The Kangnido Korean map, drawing on two earlier Chinese maps, shows India at the center combined with a heavily swollen China. Correctly positioned are Korea, Arabia, and the Red Sea. Korea is depicted as about the same size as Africa with an open sea at its tip. Europe is somewhat squashed on the left but shows the Mediterranean and Black seas and names many European countries, including "Alumangia," an attempt at Alemania, the Latin name for Germany.

Pilot guides and navigational literature by Muslim writers describing features of seas and shores from the Persian Gulf and the Red Sea to the Asian edges of the Pacific circulated

in the fifteenth and sixteenth centuries. European seafarers both East and West in the fifteenth and sixteenth centuries tried hard to find and persuade local pilots to help them navigate.

## NAVIGATION

### Finding your way from here to there

A map showed the location of starting place and intended destination. Knowing the location of one's ship when between the two and out of sight of land could be a big problem. Two methods helped:

- Experience, based on knowledge by observation of wind and wave patterns, currents, depth of water, color of the sea, kinds of seaweeds, types of fish, clouds, the flight and kinds of birds, and, as often as possible, sightings of known landmarks. In unknown waters and very far from land, these methods were less than satisfactory.
- Fixing location by finding the latitude (the east-west line giving the distance north or south of the equator) based on measuring the altitude (height above the horizon) of the Pole Star, or North Star. At the North Pole, the star is directly overhead at an altitude of 90 degrees, and the location on earth is at ninety degrees latitude. At the equator, the star is right at the horizon, at 0 degrees latitude. In between, the angle of the star above the horizon gives altitude and latitude. For navigation, a pilot would measure the star's angle before leaving the home port. On the return voyage, the ship would sail north or south until the Pole Star appeared at the same angle as at the home port, then "sail down the latitude" keeping the star at a constant angle. Other stars could be used similarly.

In the 1480s, when Portuguese mariners first approached and then crossed the equator, they found that the Pole Star disappeared below the horizon. A conference called by the king recommended using the sun's altitude as replacement, ►



and scholars translated from the Hebrew information about the sun's seasonal movements that made this possible.

Arab mariners had long sailed open seas by the stars and knew how to observe heavenly bodies to help fix their position. Their knowledge and instruments of observation had filtered into Western Europe, often through Jewish intermediaries. The compass, invented in China and passed westward through the Muslim lands, was also quickly adopted. By the mid-15th Century, celestial observation was still not commonplace, though fairly widely known.

## GUNS

### Protection and aggression

With its shot weighing ounces rather than pounds, the cannons mounted on Iberian ships in the 15th Century were more useful for killing people than sinking vessels. Placed on deck along the railing or on the castles, ships' guns could be mounted without major design changes. They had efficient uses against unarmed craft that Iberian mariners met in African and South Asian waters.

Large, heavy cannons were already used on land. By the end of the 1400s, naval technicians attempted to adapt these to ships and use them to breach fortifications on shore. These experts solved several problems. They cut down cannon length, tapering the barrels, and casting them from bronze or brass instead of forging them from separate pieces of iron. This saved weight, but the guns retained enough strength to throw stone, iron, or lead balls weighing from five to sixty pounds. Because of their formidable recoil, these guns could not be perched on ship castles. Therefore, they were moved down to the waist of the ship and fired through round holes cut in the gunwales, their recoil controlled with ropes.

Europeans who went overseas often had to fight. The Portuguese set up fortified commercial bases protected with cannon. In the Indian Ocean region, trained soldiers transported from Portugal served alongside men who were recruited locally. Auxiliaries from the armies of friendly rulers were also used. In preparing for his third expedition to America, Columbus asked the Spanish government for 100 muskets and 100 crossbows for 1200 soldiers, sailors, and settlers, whom he hoped to take with him. Cortés took a few light ship cannons with him when he invaded Mexico. He had thirteen muskets for his several hundred men, and he found swords, dogs, and horses the most effective weapons. He and other conquistadors also relied heavily on native allies.

In both the Americas and the Indian Ocean, the Iberians had a chronic problem of maintaining sufficient numbers of troops. Their own populations were small: about a million in Portugal, and eight times that in Spain. In Asia and America, Iberian forces were almost always overwhelmingly outnumbered. In addition, mortality among Europeans who went overseas was consistently high. During long voyages, they died from hunger, cold, unsanitary conditions, shipwreck, and deficiency diseases like scurvy. On shore, they faced fighting and tropical diseases.

*Source:*

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