



The Viking Longship

Long, narrow ships packed with warriors helped to make the Vikings the dominant power in Europe for three centuries, beginning in about A.D. 800

by [John R. Hale](#)

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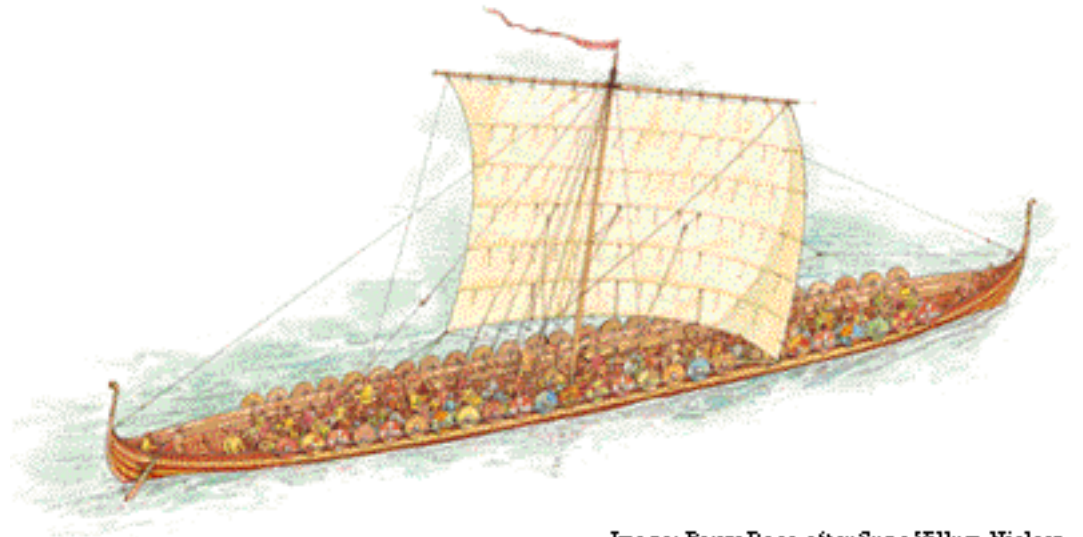


Image: Barry Ross, after Sune Villum Nielsen

In September 1997 Danish archaeologists discovered a Viking longship in the mud of [Roskilde harbor](#), 40 kilometers (25 miles) west of Copenhagen. The discovery was the kind of serendipitous event that earned Viking [Leif Eriksson](#) the appellation "Leif the Lucky." Lying unsuspected next to the world-renowned [Viking Ship Museum](#) at Roskilde, the longship came to light during dredging operations to expand the harbor for the museum's fleet of historic ship replicas

According to [Ole Crumlin-Pedersen](#), former head of the museum, the longship

must have been sunk by a storm centuries ago, then hidden by silt. Tree-ring dating of its oak planks showed that the ship had been built about A.D. 1025 during the reign of [King Canute the Great](#) who united Denmark, Norway, southern Sweden and England in a Viking empire.

With its immense length of 35 meters, the Roskilde longship surpasses all previous [longship finds](#). By doing so, the ship also refuted skeptical modern scholars who judged these leviathans, described in Norse sagas, to be as mythical as the dragon whose name they bore. (Longships became known generally as dragons.) The sagas had been accurate in their accounts of "great ships," the largest class of Viking warship.

The passage of a millennium has not dimmed the pride Scandinavians feel for the Viking longships. Their vital role in seaborne raiding, which is the meaning of the Norse term *viking*, assures them a prominent place in medieval history. Fleets of these long, narrow ships attacked coasts from Northumberland to North Africa, carried pioneers to the British Isles and Normandy, and made the Vikings the dominant sea power in Europe from about A.D. 800 to 1100, the Viking Age.

Although [finds of various Viking ships](#) and boats have been made since 1751--most spectacularly in the royal burial mounds at [Gokstad](#) and [Oseberg](#) in Norway--the classic longship itself proved elusive until 1935, when Danish archaeologists excavated a chieftain's burial mound at [Ladby](#). Only the shadow of a ship remained, with dark-stained soil revealing the form of the hull. Iron spirals marked the crest of the dragon's head at the prow, and seven long rows of iron rivets on either side still followed the lines of the vanished planks. The Ladby ship was much narrower than the celebrated Norwegian ships and looked quite unseaworthy: 20.6 meters long, only 3.2 wide amidships and a mere meter from the keel to the top plank. Critics dismissed as implausible the accounts in the sagas of much larger longships with the same extreme proportions.



[REALM OF THE LONGSHIP](#)

Actual timbers of a longship were located in 1953 in [Hedeby harbor](#), site of a prosperous Viking emporium on the German border. Although the ship was not raised, public interest ran so high that the diver who discovered it made a radio broadcast underwater; his fascinated audience included 18-year-old [Ole Crumlin-Pederson](#). By age 22, he had embarked on a series of finds that exploded the timid theories of the skeptics and ultimately involved him in the [retrieval](#) and study of every longship discovered since Ladby.

Peaceful burial mounds had yielded prior finds, but Crumlin-Pedersen specialized in disaster sites. Between 1957 and 1962 he was co-director of the team that recovered two longships and three other Viking ships from a blockade in a channel near Skuldelev, where desperate Danish townsfolk in the 11th century had deliberately sunk the ships to create a barricade against invaders. The bigger of the two Skuldelev longships, measuring 29 meters, met its end after making at least one successful voyage across the North Sea: its wood was Irish oak, cut about 1060 near the Viking stronghold of [Dublin](#). Both ships in fact showed many seasons of wear, evidence that longships were more seaworthy than some scholars had thought.

In 1979 Crumlin-Pedersen fulfilled a dream of his youth by leading the excavation of the Hedeby longship. It proved to have perished as a fire ship, a vessel intentionally set ablaze as an offensive weapon, during an attack on the town in about 1000. Here, too, the wood was remarkable: local oak cut from 300-year-old trees in lengths exceeding 10 meters without a knot or blemish.

An Evolved Design

The five longships discovered since 1935 show the full range of the species. Small levy vessels of up to 20 rowing benches (Ladby and the little Skuldelev warship) were maintained by local communities for royal service, to answer the call whenever the king sent around the symbolic war arrow. Standard longships of up to 30 rowing benches (Hedeby and the big Skuldelev warship) were the pride of Viking earls and kings, displaying craftsmanship of superb quality. The "great ships" of more than 30 rowing benches (Roskilde) appear only in the dynastic wars of the late Viking Age.

These finds reveal that Viking shipwrights, in quest of the ultimate raiding machine, created the most extreme of all traditional ship designs. The length-to-breadth ratio, greater than 6:1 and a rapierlike 11.4:1 in the Hedeby longship, combined with the shallow draft to allow longships to land on any beach and penetrate virtually any waterway in Europe. With speed as a goal, whether under oars or sail, expert shipwrights achieved strength through resilience and lightness. They pared the planking to a thickness of two centimeters--a finger's breadth--and trimmed every sliver of excess wood from the rib frames. Yet this drive for technical perfection produced a masterpiece of beauty as well, above all in the noble curves of stem and stern. A court bard sang the praises of King Harald Hardruler's dragon: "As Norsemen row the serpent, the [riveted \[ship\]](#), down the icy stream, it is like a sight of eagle's wings." Plato may have denied the existence of ideal forms in this world, but Plato never saw a Viking ship.

The longship's perfect mating of design, structure and material derives neither from a single creative genius nor even a single age. Rather these vessels represent the culmination of 6,000 years of technical evolution.

The primeval ancestors appear to be Stone Age [dugout canoes](#), the earliest dating to about 5000 B.C., which have been found at many coastal sites in Denmark. Using flint tools, boatwrights sculpted logs of soft, durable linden wood to an even thickness of two centimeters. As in all dugouts, the shell itself provided structural integrity, a true exoskeleton. The canoes reached lengths of 10 meters and seem to have been paddled out to sea for cod fishing, whaling and raiding expeditions. Some canoes later served as coffins. The creators of dugouts bequeathed to their successors the ideal of light, open vessels with shallow draft and a [long, narrow hull](#).

About 3000 B.C., boatbuilders along the âmose River in Denmark began to bore a row of holes along the upper edges of their dugout canoes. They could then secure the lower edge of a plank, with matching holes, to the top of the dugout with cords of sinew or fiber. The resulting overlap marked the birth of the distinctive northern European [construction](#) technique known as lapstrake, a strake being a line of planking. The added plank improved seaworthiness by increasing the extended dugout's "freeboard," the distance between the waterline and the hull's top. Axes of Danish flint found far to the north in Norway and Sweden bear witness to the adventures of these Stone Age voyagers.

During the [Bronze Age](#) (2000 to 500 B.C.), the watercraft of Scandinavia took on some of the appearance of the future Viking ship, including high posts at each end crowned with spirals or animal heads. Some of these heads are certainly serpents or dragons, and dragons are depicted hovering over boats in Bronze Age art. The warriors manning these boats often wore the horned helmets that have come to symbolize the caricature Viking of opera or cartoons. In fact, such headgear was quite out of fashion by the true Viking Age.

The designs on Bronze Age metalwork and rock carvings show boats with a beak at the prow. Although unfamiliar in European watercraft, the same structure could be found in the early 20th century on extended dugouts with sewn plank sides in Siberia, central Africa and the South Pacific. The beak was in fact the projecting tip of the dugout underbody. With a curved branch attached, it acted as a cutwater to protect the vulnerable stem where the planking closed off the forepart of the hull. Eventually, the wooden cutwater of the Bronze Age Scandinavian design would coalesce with the ornamented end post to form the great curved prow of the Viking ship.

The beak became the prominent feature of war canoes at the beginning of the Iron Age (500 B.C. to A.D. 400), a time of severe climatic and economic stress in northern Europe. Too high and too flimsy to serve as a ram, the beak must have been preserved by boatbuilders because it protected and stabilized the



[LONGSHIP ANCESTORS](#)

hull. Shipwrights deemed the beak valuable enough to include it at both ends, creating, in the Iron Age, the first truly double-ended design.

A bog near Hjortspring, Denmark, yielded an early [Iron Age canoe](#)--complete with paddles, weapons and other gear--built in about 350 B.C. With its symmetric beaks and large steering paddles at each end, the Hjortspring boat could have reversed directions without turning. Such adaptability might mean the difference between life and death when encountering enemies in a narrow fjord or pushing off after a raid on a hostile shore. For the next 1,500 years, all Scandinavian warships would maintain the double-ended design of the Hjortspring boat, even after the fixing of rudder, mast and sails had irrevocably distinguished the bow from the stern. The trait was unique: even the Romans, who left little commentary on Scandinavia, felt compelled to mention the double-ended boats.

Some Stone Age features still survived in the Hjortspring boat, such as the use of linden for the hull and the stitching of the lapstrake planks with [fiber cords](#). But the dugout underbody almost disappeared, trimmed down to a narrow bottom plank bent in a gentle curve--a step toward the Viking keel. The elevated ends kept the vessel drier as it breasted oncoming waves, whereas the deeper midsection improved handling during turns. (Future shipwrights inherited this curve. Viking ships had keels 30 centimeters [deeper amidships](#) than at the ends, a refinement almost as subtle as the entasis of the Parthenon's columns but adopted for function rather than appearance.)

The 20 warriors who paddled the Hjortspring canoe sat in pairs on intricate frames of linden, ash and hazel. The 90-centimeter interval between frames allowed each paddler ample room. As this spacing became standardized, Scandinavians began to compute the length of a vessel by counting the "rooms" between its frames or benches. Coupled with the narrow bottom plank, the widely spaced frames allowed the hull remarkable flexibility; as in the ancestral dugout, the shell, rather than any rib structures, conferred strength. The lithe hull enabled the Hjortspring canoe, like later Viking ships, to snake its way through the water like a living creature.

Innovations in Design

In the later Iron Age, thanks to an act of technological crossbreeding, the complicated end structures of the Hjortspring canoe dropped out of the evolutionary line in favor of a far more elegant and simple solution to the problem of closing off the end of a hull. According to Crumlin-Pedersen, the innovation came from the expanded dugout canoe, a type that appears for the first time in Iron Age graves on the Danish island of [Bornholm](#). Worldwide, makers of dugout canoes at times have been confronted with tree trunks too slender for a simple dugout. Independently, they worked out techniques for making a tubelike hollow in the log with an open slit on top, hewing the wood as thin as possible and then gradually expanding the sides by applying heat and

inserting longer and longer stretchers. As the sides flared outward, the ends would draw upward into symmetric, curved points: the inspiration for the graceful design of the future Viking ship.

A vessel found at [Nydam](#), north of Hedeby, is the earliest surviving offspring of the cross between the design of the expanded dugout and the lapstrake construction of the Hjortspring canoe. The late Iron Age Nydam vessel, built about A.D. 300, marks a fresh start on many counts. The planks, ribs and end posts were oak; clenched iron nails supplanted the stitches of earlier times; and the crew sat backward and propelled the vessel with long oars looped to rowlocks on the top strake. Most important, the five broad strakes on each side extended all the way to the low curving stem posts and stern posts, thus establishing the classic Viking prow structure.



LONGSHIP FUNCTIONALITY

An even more revolutionary change appeared about 700, just a century before the first important Viking raids. A ship from Kvalsund in western Norway sported an embryonic keel; the ever narrowing bottom plank finally acquired verticality with a T-shaped cross section. A fixed side rudder, the descendant of the steering paddle held over the side of earlier canoes, further stabilized the ship by projecting below the hull to prevent side slipping, like a modern centerboard. Thinner strakes, now eight in number, would make possible the more complex curves of the longships. The hardy Scandinavians stoically accepted the extra leaking around all these new seams. A Norse law regarded a boat unseaworthy if it needed bailing thrice in two days. (The crew could still choose to assume the risk.)

The Kvalsund ship's keel and side rudder heralded the arrival of leading performers in the drama of ship evolution that remained mysteriously in the wings until the dawn of the Viking Age: the mast and sail. Gravestone art on the Swedish island of [Gotland](#) began to depict ships with sails by 700, although the earliest physical remains of a mast come from a [royal ship](#) built in about 815 and buried at Oseberg in about 835. By then, the sail had been evolving for over four millennia, and Celtic sailing ships had been plying the seas near Scandinavia since the time of Caesar. Norwegian archaeologist [Arne Emil Christensen](#), the greatest authority on early Viking ships and the introduction of the sail, speculates that resistance to sailing may have been less technical than cultural: tough men row. Elder Vikings at the time "must have scorned the young," Christensen writes. He imagines them deriding their sons, "who were too lazy to row as we did, and want to be blown across the sea." In the long run, however, the advantages offered by the sail prevailed.

A pole, or spar, on the deck connected to a lower corner of the sail. Moving the spar angled the sail, which allowed the ship to tack into the wind. Rowing had carried the immediate ancestors of the Vikings east to Russia and west as far as the British Isles, but with the sail, the [explosive career](#) of the Vikings truly started. And the sail dictated most of the final steps of Viking ship evolution, including deeper keels, broader hulls and higher sides. The Viking longships, the direct descendants of the Stone Age canoes, soon found themselves surrounded by a family of related ship types that took advantage of the evolutionary potential to be found in the mast and sail. New designs proliferated, like Darwin's finches in the Galápagos, to fill every available environmental niche. Many of the newcomers were specialized sailing ships built for trade, exploration and colonization, such as the famous knorrs--stout ships with deep holds that carried Vikings across the Atlantic to [America](#). As funeral vessels, these various ships and boats transported pagan Vikings on their [final voyage](#); where ships could not go, in this world or the next, Vikings did not venture.

Small boats of Viking design would persist for centuries as cargo craft or church boats in such remote regions as the isles of western Norway or the Swedish lakes. But after 1100, the humble, flat-bottomed Hanseatic cog became the forebear of the next great line of sailing ships, including even the flagships of Scandinavian monarchs. The Viking longship, designed for raiding, could not compete in a world of fortified port cities, organized naval warfare and kings who demanded the pomp and comfort of a cabin when on board. The last naval levy of Viking warships was called out in 1429 and defeated by seven cogs. The dragon had retreated into the realm of legend.



CROSS SECTION OF LONGSHIP

Replicating the Design

From Captain Magnus Andersen's *Viking* of 1893 (a replica of the Gokstad ship from Norway), a long line of [reconstructions](#) has shown the astounding seaworthiness and resilience of Viking trading ships and sailing ships. Could replicas do the same for the longship?

In 1963 Danish boy scouts built a replica of the Ladby ship. Observing that the warships depicted on the 11th-century [Bayeux tapestry](#) were used as [horse transports](#), the young mariners wanted to see if horses could really clamber on board from a beach. Such a capability would have provided a motive for retaining the low freeboard throughout the Viking Age. The sea trials of the Ladby ship were a complete success, with horses, scouts and hull all performing well. The ship proved surprisingly swift and handy on the open sea, again vindicating the skill and ingenuity of the Viking shipwrights.

After the recovery of the Skuldelev ships in 1962, the Viking Ship Museum was built at Roskilde to house the remains and provide a center for study and reconstruction. In 1991 the Roskilde team built [Helge Ask](#), an exact replica of the smaller (17-meter) Skuldelev longship and saw its predatory power in action. Even with only half the crew of 24 at the oars, the ship easily outrowed a replica of the smaller, broader trading ship, also found at Skuldelev (*Roar Ege*). The longship also outsailed the trader, with a working speed approaching eight knots.

Although the trading ship performed better tacking into the wind, *Helge Ask's* crew could make up the difference by quickly lowering sail and rowing. Crumlin-Pedersen calculates that the longship could overtake its prey in any conditions short of an outright gale. The sagas include an account of this capability: A Viking named Gauti Tófason overtook four Danish knorrs in his longship. He was on the verge of capturing a fifth when a storm blew up, allowing his prey to escape.

In the past century more than 30 Viking ships have been reconstructed, and a host of [neo-Vikings](#) maintains and operates many of these replicas. At Roskilde, the guild of the *Helge Ask* takes the ship on sea trials and cruises in summer, hauls it overland to test portage accounts, repairs it during winter--and reports it all on the [World Wide Web](#). A millennium after the building of the original longships, the rough, expansive vigor of the Vikings is seaborne again.

Join host Alan Alda for a cruise on board the Helge Ask on this month's [Scientific American Frontiers](#). For time and channel, check local listings.

Related Links

[Viking Heritage Server & Database](#)

[Nordic Underwater Archaeology](#) a comprehensive site about the recovery of Nordic ships and underwater archeology.

[Danish National Museum](#) (mostly in Danish)

[Swedish National Maritime Museum](#) (mostly Swedish but the museum hosts Sweden's largest UW archaeology library, photo archive, and the national wreck register)

[Photodraw](#) A method for producing drawings of archaeological artifacts

["The History of Norway"](#) by Tor Dagle, editor emeritus, Nytt fra Norge

["The Vikings"](#) by Arne Emil Christensen, Chief Curator at the University Museum of National Antiquities in Oslo

[History and Archaeology of the Ship](#) online notes for a course at University of Wales, Bangor on the development of the methods and techniques of wooden shipbuilding from the Solar Ship of the Pharaoh Cheops (2600 BC) to the late 16th century AD

[The Viking Network Web](#)

Further Reading

THE VIKING SHIPS. A. W. Brøgger and Haakon Shetelig. Twayne Publishers, New York, 1971, and C. Hurst, London, 1971.

PLANK-BUILT IN THE BRONZE AGE. John R. Hale in *Antiquity*, Vol. 54, No. 211, pages 118-126; 1980.

SAILING INTO THE PAST: PROCEEDINGS OF THE INTERNATIONAL SEMINAR ON REPLICAS OF ANCIENT AND MEDIEVAL VESSELS. Edited by Ole Crumlin-Pedersen and Max Vinner. Viking Ship Museum, Roskilde, 1986.

THE EARLIEST SHIPS: THE EVOLUTION OF BOATS INTO SHIPS. Edited by Robert Gardiner and Arne Emil Christensen. Naval Institute Press, Annapolis, 1996.

VIKING-AGE SHIPS AND SHIPBUILDING IN HEDEBY/HAITHABU AND SCHLESWIG. Ole Crumlin-Pedersen. Viking Ship Museum, Roskilde and Provincial Museum of Archaeology, Schleswig, 1997.

The Author

JOHN R. HALE, archaeologist and director of Liberal Studies at the University of Louisville, has conducted fieldwork in Scandinavia, Britain, Portugal, Greece and the Ohio River Valley. In the course of his doctoral research at the University of Cambridge, he studied boat designs found in Bronze Age Scandinavian art. He recognized that the vessels, commonly thought to be skin boats, were in fact wooden craft directly ancestral to the Viking longships. An oarsman himself, Hale has also reconstructed the rowing techniques used on the ancient Greek trireme (see the author's article in *Scientific American*, May 1996).