5 SHIPS AND NAVIGATION

BY ARNE EMIL CHRISTENSEN

SHIP AT SEA, JONSBOK

AT THE BEGINNING OF THE VIKING era, around A.D.800, shipwrights in Scandinavia were working in a shipbuilding tradition that can be traced to before the birth of Christ and is still being practiced by rural boatbuilders all over Scandinavia. In western and northern Norway, the tradition has changed so little over the centuries that it is possible to ask a living boatbuilder questions about vessels made more than a thousand years ago and get relevant answers. There is a clear continuity in basic techniques, use of materials, detail solutions, terminology, and even some of the hand tools (fig. 5.16). This rare repository of knowledge that extends back a millennium, along with the large number of boat-related finds spread over Denmark, Sweden, and Norway (figs. 5.3, 5.4), has given Scandinavian archaeologists a unique opportunity for understanding and interpreting the technology and art of Viking shipbuilding.

The Vikings sunk ships and boats as gifts to the gods in holy lakes that have turned into bogs, preserving the wood to this day. Before the Christian era, some Vikings were buried in vessels, and in a few lucky cases wood has been preserved. Usually only the iron nails and rivets are left (fig. 5.6), but they are sometimes found in undisturbed rows, permitting a reconstruction of the lines of the lost vessel. With the adoption of Christianity around .D. 1000 this practice, and thus this source of ships, disappears. Archaeologists have also recovered ships from the end of the Viking Age and early Middle Ages that were used to block harbors and wrecks, which are valuable for the study of a continuing shipbuilding tradition. Norse poems and sagas, written down in the early medieval period when ships had not changed much since the Viking Age, provide valuable sources, as do the pictures of ships that were carved on wood or bone or cut into stone.

The basic principle used by shipbuilders was to shape a watertight shell of overlapping planks, fastened together at the overlaps (fig. 5.1). When the builder had finished the shell, he stabilized the shape and added some stiffness to the construction by inserting ribs inside the planking. This technique, named shell building, was the only way ships were built in northern Europe until the late Middle Ages, when a new method was adopted from the Mediterranean. In the new southern technique, a skeleton of keel, stems, and ribs was erected first, and then covered with planks that did not overlap and were fastened not to one another, but only to the ribs.

The oldest Norse vessel built of planks in the shell technique is a third-century .. boat from Hjortspring, Denmark. A broad bottom plank, which is curved both across and along the hull, forms the backbone of the vessel. Two side planks and two top planks (or sheerstrakes) were sewn to ribs to form the shell. Heavy blocks of wood standing on the bottom plank close the hull

5.1 VIKING SHIPBUILDING
The Bayeux Tapestry, which commemorates the Norman invasion of England by William the Conqueror in 1066 and was completed about 1077 for the consecration of the cathedral in Bayeux, contains the only contemporaneous illustration of Viking ship construction. Carpenters are seen felling trees, trimming timbers, and building up the hulls of two vessels that were destined for the Norman invasion fleet.

5.2 *SAGA SIGLAR* AT SEA
Much has been learned about sailing characteristics of Viking ships by using replicas such as the *Saga Siglar* (Saga Sailor) modeled after archaeological finds. Surprising results of these sailing tests show that oceangoing Viking ships could sail within 70 degrees of the wind.

at both ends, giving the boat a profile that closely resembles ships seen in Bronze Age and early Iron Age Scandinavian rock art. The Hjortspring boat is built of lime, a light and soft wood that is easy to work, while Viking shipbuilding is based on stronger, heavier, and more sturdy woods such as oak and pine. Pine dominates the northern parts of Scandinavia, where oak does not grow, but the Viking finds indicate that oak was the preferred wood for shipbuilding in those parts of Scandinavia where it was available. Lacking oarlocks, the Hjortspring boat was propelled by about twenty men who paddled rather than rowed.

From the beginning of the third century A.D. some boatbuilders started to use iron rivets instead of lashing the planks together. A third-century ship sacrificed in a bog at Nydam in southern Jutland (near the present-day border between the Danish peninsula and Germany), has many of the characteristics still found in Norse clinker vessels, whose planks overlap like clapboard on a house (Crumlin-Pedersen and Rieck 1993). On the Nydam vessel, sturdy curved stems have replaced the end blocks of the Hjortspring ship. The ribs are made from naturally curved timbers instead of thin bent rods, and the fastenings in the planking are of iron (fig. 5.6). The boat is built on a sturdy bottom plank and has five planks of enormous size on each side. Thirty men were needed to row the nearly ninety-foot (twenty-three-meter) ship. Its oars rested in hook-shaped oarlocks of a type still used in Scandinavia. The earliest example of such oarlocks, which were found in a bog at Mangersnes in western Norway, are a few centuries older than the Nydam ship; this suggests that the change from paddling to rowing took place around the birth of Christ.

Scandinavians were surprisingly late in adopting the sail (fig. 5.5). Although the sources are admittedly limited, they strongly indicate that until around 700, ships were rowed. The early seventh-century vessel from Sutton Hoo in East Anglia, part of a Saxon-style princely burial that was preserved only as an impression in the sand, and the early eighth-century Kvalsund ship from western Norway, may both have set a sail (Shetelig and Johannessen 1929). Their hull shapes indicate, however, that they can only have been efficient when sailing downwind.

Scandinavians may have been so late in adopting sails, which had been in use for centuries in waters as close as the English

5.3 Bronze Weathervane
Illustrations of Viking ships on picture stones and on a scrap of wood from Bergen show some ships carrying a triangular vane at the prow. This decoration in the eleventh-century Urnes style is made of gilded copper. Such vanes may have functioned as wind indicators in Viking times, but their elaborate design suggests they also had social and ritual meaning.

5.4 Viking Fleet Graffiti (replica)
A remarkable piece of casual Viking art was recovered during the excavation of medieval Bryggen Harbor in Bergen, Norway. The memory of Viking ships and perhaps tales of the great battles that raged between rival Viking kings in early times may have inspired this elegant bit of graffiti showing fleets of Viking ships in receding perspective.

Channel, because the Nordic type of hull was not well developed and strong enough to withstand the stresses set up by sail and rigging until around 800. It is tempting to suppose that the Viking Age did not start until the sail was in use and sailors had mastered this new invention (fig. 5.3).

Boat Graves

Viking Age belief, which was based on older Germanic and circumpolar beliefs, called for well-equipped graves. The nature and quantity of what was deposited in the grave differs within Scandinavia, but most Viking Age graves contain some grave goods, with much of the same equipment used by the living interred for the next life after death. A rich burial probably raised the prestige of the heirs as well as that of the dead person. Along the coast and inland waterways, boats are often part of the burial. This may reflect a belief that the land of the dead lay across water. Another theory is that the boats indicate that the dead person was active in the cult of the fertility god Frey, who was associated with transportation themes. Other scholars argue that the presence of a boat, which was a necessary tool for living life in the other world, suggests that ancient people expected life in the other world to resemble that of the living. The custom of burying a boat in a grave mound precedes the Viking Age by many centuries, but the use of really large ships is extremely rare before around 800. We know of two instances, one at Sutton Hoo in East Anglia, England, which is based on the Germanic Saxon model, and one at Karmøy in western Norway. The use of boat graves continued in northern Russian and Baltic countries into the nineteenth century and is still practiced by some Siberian peoples today.

In most cases only lines of iron rivets indicate that a ship or boat was part of the funerary equipment. Some burials are cremations, in others all wood has rotted. In the outer Oslo Fjord area, where the subsoil is blue clay, the clay formed a hermetic seal on a few grave mounds (fig. 5.8a), including those at Gokstad, Oseberg, and Tune and preserved wood, textiles, and leather remarkably well (fig. 5.9). The ships found at Oseberg and Gokstad are nearly complete, that from Tune is less well preserved (Bonde and Christensen 1993; Brögger and Shetelig 1951; Nicolaysen 1882; Shetelig 1917 a,b). In all three graves, rich equipment was loaded on board the ship for the funeral, but the graves were later robbed. The wood, leather, and textiles did not interest the robbers, but fine arms and jewelry that were probably part of the grave goods are gone (fig. 5.10). Very little was left in the Tune ship (fig. 5.7), whose condition was originally as good as the two other ships. The ships were dated to the ninth century by comparing the wood carvings of Oseberg and Gokstad with other Viking art. Recently, the year-rings of the wood have been studied and more precise dendrochronological dates have been established. The Oseberg ship (fig. 5.11) was built around 815–820 and those found at Gokstad (fig. 5.12) and Tune shortly before 900. In the case of Oseberg, timbers from the burial chamber had the outermost year-ring intact, giving a remarkably precise date for the burial (fig. 5.8b).

5.5 Viking Warships Underway
This scene from the Bayeux Tapestry shows Viking ships and armed warriors under full sail. The tapered sails are likely an artistic convention: Viking sails were square and were made of oiled woolen cloth. The steering oar *(styri)* was mounted on the right-hand *(styrbord)* side of the vessel, and this term has persisted into modern nautical language, as starboard.

The logs were cut in the summer of 834, and as timber was certainly used straight from the forest, this dates the burial to that year.

The three ships are housed in the Viking Ship Museum in Oslo, together with the rich equipment found in the graves. The oak of the ships was so well preserved that slow drying and several coats of linseed oil was the only conservation necessary. After 1,100 years buried in clay, the oak is brittle but has still retained enough strength for the ships to carry their own weight with sufficient support. Other finds from Oseberg, made of less-durable wood than oak, had to undergo lengthy conservation after the excavation in 1904. The Gokstad ship was less damaged than that found at Oseberg and could be taken out of the mound in two large fragments when excavated in 1880. It was exhibited for nearly fifty years with no restoration. After being moved to its present location in 1929, the ship was dismantled and rebuilt, using the technique developed for Oseberg. Not enough was left of the Tune ship for a complete and certain reconstruction, and stands as it came from the burial mound in 1867.

All three ships are of the same general type, and it is believed that they are the personal traveling ships of royal owners. Men were buried in the graves at Gokstad and Tune, but the fragmentary skeletons of two women were found at Oseberg, the richest Viking grave ever recovered. The amount and quantity of equipment included in the grave is a strong indicator of the high status of women in Viking Age society.

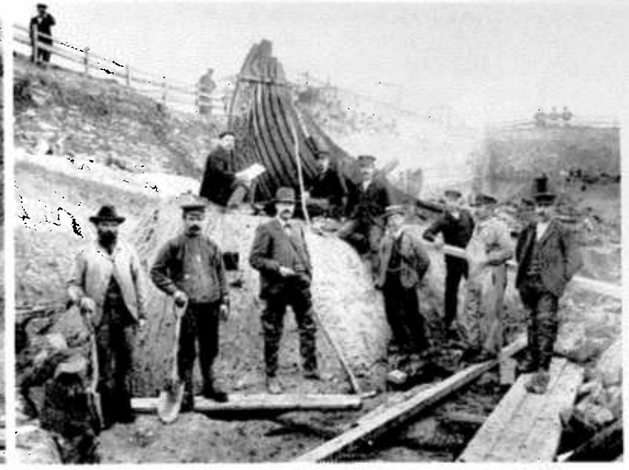
The Oseberg ship is the earliest sailing vessel found in Scandinavia (figs. 5.11, 5.13). Many improvements to the rowing vessels of earlier centuries have been introduced: the bottom plank has developed into a true keel; the seats of the oarsmen have changed function and become crossbeams, firmly fixed to an extra strong strake at the waterline. The beams form transverse braces that can withstand the stresses set up by wind pressure in the rigging. The ship's sides are higher, supported by knees on the crossbeams. In order to set the oars at the optimal distance above the water, oar holes have been cut in the top strake instead of using oarlocks. The mast is stepped in a keelson, a longitudinal oak structure resting on the keel, and additional support is given by a "mast partner," a sturdy block of oak resting on the crossbeams. The mast partner has a long opening facing aft, so the mast could be lowered and raised at sea by the crew. In contemporary pictures the mast is shown supported by ropes.

Earlier ships had rounded bottoms while the bottom of the Oseberg ship has a pronounced V-shape. Together with the deeper keel, this gives the hull better sailing qualities, especially when beating against the wind. The planking is about one inch (2.5 centimeters) thick, not much for a ship eighty-five feet (twenty-two meters) in length. The light planking and the lashing holding them to the ribs make a light, flexible hull. The woodworkers of the Viking Age did not use saws (fig. 5.1). Huge oak logs were converted to planking by splitting the log in first two, then four, then eight, and finally sixteen wedge-shaped planks, which were axed to shape and finished with scraping tools. Before the planks were riveted together, a tarred string of wool was placed in the overlap to ensure that the hull did not leak. It is difficult to split long trees, so each

5.6 Skip Riveys
Lapstrake or shell-type hull construction did not require heavy framing; the strakes were both skeleton and shell, making for lightweight boats. Planks were riveted outboard of the plank below, producing a vessel that "rode up" in the water, reduced spray, and could be assembled rapidly. This form exposed iron fastenings to saltwater, so they rusted quickly and needed to be replaced frequently.

5.8 a

5.8 b

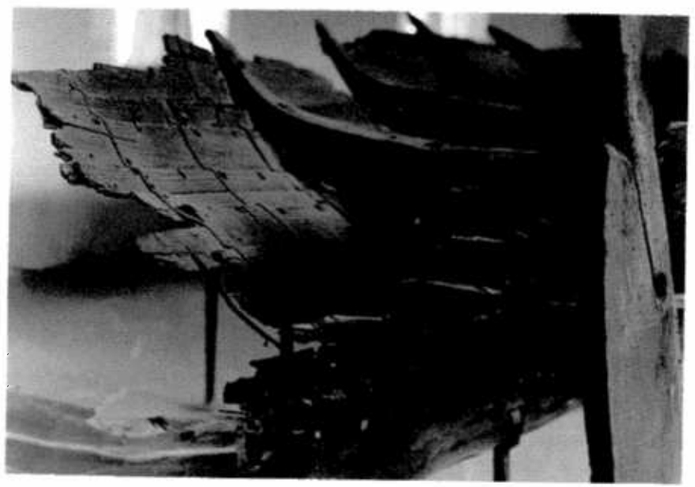


5.9

5.8 a, b Oseberg Burial Mound
The famous Oseberg ship burial was excavated from this mound in the Oslo Fjord. The blue clay of the burial site, impermeable to air, preserved the vessel and its contents for more than one thousand years (fig. 5.8 b). The local place-name of the site, Oseberg ("Aasa's mounds"), suggests linguistic continuity from Viking times, for this is thought to be the final resting place of Viking Queen Aasa.

5.9 The Oseberg Excavation
This photograph, taken in 1904 while the Oseberg excavation was underway, speaks eloquently about the social context of archaeology in Norway at the turn of the century: the all-male crew is attired in fine dress and standing at the bottom of a clay pit. Dendrochronology has revealed that the ship was built in 815–820 and was last repaired in 834, probably for the burial.

5.7 The Tune Burial
Unlike the Oseberg and Gokstad vessels, the vessel recovered from Tune in 1867 was poorly preserved and has not been completely restored. This was the first Viking ship to be excavated from a burial mound in Oslo Fjord, and it is presented in the Viking Ship Museum exactly as it came out of the ground.



plank was scarfed (joined) from several pieces to make up the length of the hull. The two fitting pieces had their ends worked to a feather edge and were then riveted together. To avoid leaks and damage to the thin edge, all scarfs open aft; this rule is so universal that it can be used to decide whether a fragment of planking belongs to the starboard or port side of a ship.

Axes seem to have been the primary tool for working wood, but the shipwrights needed large and small augers for boring holes, scrapers for finishing and making decorative moldings along the planks, and a hammer for riveting. The repetition of certain measurements in preserved vessels indicates that an "ell," a measuring tool of about 18 to 21 inches (47 or 55 centimeters), may have been used in Norway. The ells are known from medieval sources, and the 55-centimeter ell is still used for building small boats in western Norway.

Viking Sailing Ships

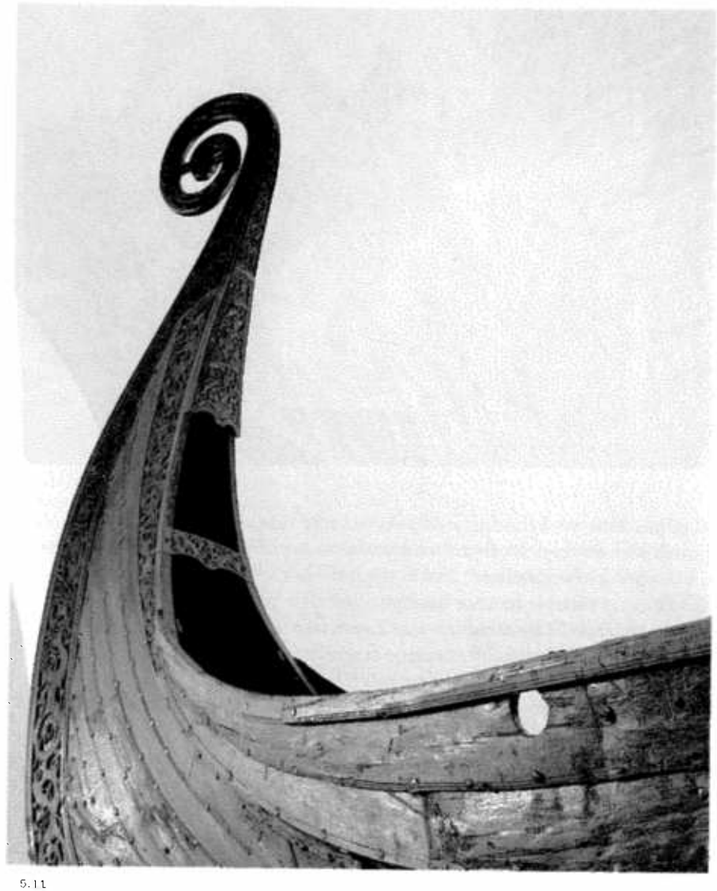
The Oseberg ship was probably a royal yacht for inshore use because it is less seaworthy than the more utilitarian ships found at Gokstad and Tune. The year-ring dates suggest another reason for the differences in design, which had become more sophisticated as the result of three generations of intense shipbuilding activity on the North Sea. Oseberg is the oldest true Viking ship found to date and is probably typical of the vessels used for the early Viking raids around 800. Certain design elements of a sailing ship are still rather undeveloped: the Oseberg ship could have been sailed successfully from Norway to Britain or Ireland in summer, but she is a much less seaworthy ship than the younger vessels (fig. 5.15). Many vessels were lost during the early period of sailing ships, and some crews must have barely reached home after narrow escapes. The Gokstad vessel has a hull shape that is much more seaworthy than Oseberg, with a higher freeboard and sturdier support for the mast.

At that time, the art of sailing was not old in Scandinavia, but the sailing ship, even in its early form, must have been a tool that gave the Norsemen a tactical advantage over Anglo-Saxon, Frankish, and Irish opponents, who did not use sailing ships. One reason for their success is that the crew of a sailing ship would have arrived in much better fighting shape than a crew tired from rowing; another is that because the Viking ships had shallow drafts they could land on any suitable beach, well away from defended harbors. The ships' ability to tack against the wind gave the Vikings a third tactical advantage: it was possible to make a quick raid and get away before a defense could be organized, even if the wind was not blowing away from the land.

The development of sailing ships did not do away with rowing all together: the Gokstad ship has oar holes for thirty-two crew-members and the Oseberg ship for thirty. Oar-ports seem to have been standard equipment for as long as Viking-type vessels were used for warfare. All Viking ships have a side rudder or steering oar mounted on the right side aft. The Old Norse name for a rudder is *styri*, and that side of the ship where the rudder was fastened hundreds of years ago is still *stýrabord* in the Scandinavian languages and starboard in English.

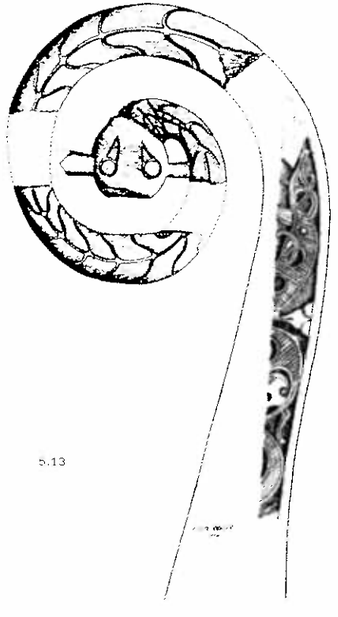
5.10 Oseberg Sleds
The burial ritual at Oseberg included elaborate preparations for transport to the afterlife. In addition to an ornate cart (fig. 4.16), several highly decorated sleds were found. Such carving would not have been done simply for prestige or aesthetic reasons. The Oseberg art probably played a role in protecting the deceased from harm in the unpredictable journey ahead.

Experiments with replicas of Viking ships in recent years show that they are remarkably fast and tack well against the wind (fig. 5.2). We know little of the ships of the Irish, Franks, or Anglo-Saxons. Irish seafaring seems to have been based on skin-covered curraghs, which must have been easy prey for the larger wooden ships of the Norsemen. When Alfred of Wessex established a navy to counter the Viking attacks around 890, the chronicle states that he did not build ships on either the Norse or the Frisian model, but as the king himself thought they would be most efficient. This report suggests that there was no obvious Anglo-Saxon model for building warships. The Carolingian empire had a navy, but it seems to have played a minor role in the defense against the Vikings. The Viking ships were troop transports rather than warships. The ram, a favorite naval weapon in classical Mediterranean ships, was not used in the north, and sea battles were fought with infantry tactics, generally by lashing several ships together to make stable fighting platforms. The maritime supremacy of the Vikings is probably best demonstrated by the fact that, as far as we know, no attempt was ever made by Franks or Anglo-Saxons at striking back across the sea. There are no sources indicating that Frankish or Anglo-Saxon troops ever sailed north across the sea to plunder the coasts of the Viking homelands in revenge.



5.11

5.11, 5.12
Viking Ship Design
The Oseberg vessel, with its low sweeping hull and soaring prow scroll, has few rivals for simplicity and elegance of nautical design (fig. 5.11). Those inclined toward open ocean sailing find more nautical security in the Gokstad ship's lines (fig. 5.12), with its greater beam and deeper hull. The beauty of both ships is matched by their display in the Viking Ship Museum.



5.13 Oseberg Prow
Parts of the Oseberg prow did not survive one thousand years of burial. However, fragments of the terminal scroll bearing the image of a serpentine beast were drawn for the scientific record, and later the drawings were used to reconstruct the vessel for public exhibition.

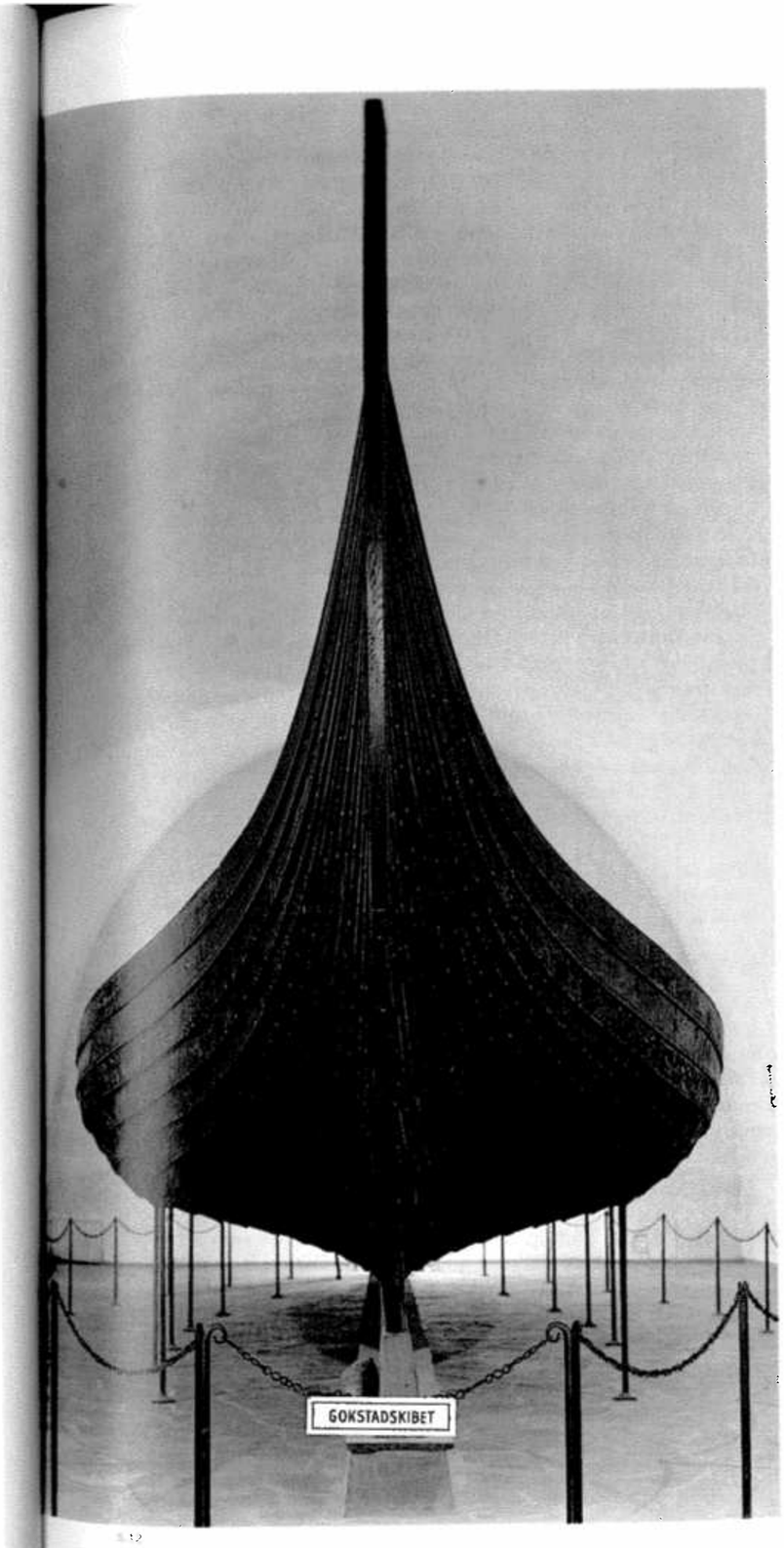
5.13

Diversity for War and Trade

During the tenth century, society in the Viking homelands changed. Central kingdoms became more powerful, and trading centers developed into towns. About this time the old all-purpose vessels like that found at Gokstad were developed along two lines (fig. 5.14). Long, slender warships, propelled by sail and oars and intended only to carry men and arms, were built for the king and chieftains. People who traded to the towns or went abroad to find new land used the broader-beamed sailing ships, which were seaworthy and capable of carrying more cargo.

Twice in the eleventh century the channel leading to the town of Roskilde in Denmark was blocked to prevent enemy ships from entering. Old ships, stripped of all equipment, were filled with stones and sunk. A large-scale excavation in 1962 rescued the ships, which have been restored and are exhibited in the Viking Ship Museum, Roskilde (Olsen and Crumlin-Pedersen 1968). While the museum was being enlarged in 1997, more ships came to light in the old harbor of Roskilde.

The preserved material of recovered ships is so small that they do not document for certain when more specialized ships for war and trade were developed, but the tenth century is the most likely period. The eleventh-century find from Skuldelev in Roskilde Fjord shows that the two subtypes had become firmly established. Warships are long and slender, extremely so, judging from the cases of the fragmentary ships found in the harbors of Hedeby and Roskilde. They retain the oar-ports all along the side, in part because warships were staffed with a large crew to row the ship in a calm or contrary wind, and the narrow ships had high potential for speed. The Skuldelev wreck 5 (fig. 5.14b) is a small warship, much repaired and built with some planks recycled from an older ship. The excavator Ole Crumlin-Pedersen has suggested that this was one of the ships that farmers along the coast were obliged to build for defense purposes and which the king could commandeer for military purposes. The other warship (fig. 5.14a)—originally believed to be two ships because of its length—has been shown to have been built from Irish oak, but in all probability it is the work of a Norse shipwright working in Dublin. To take a ship as slender and low on the water as this one across the Irish and North

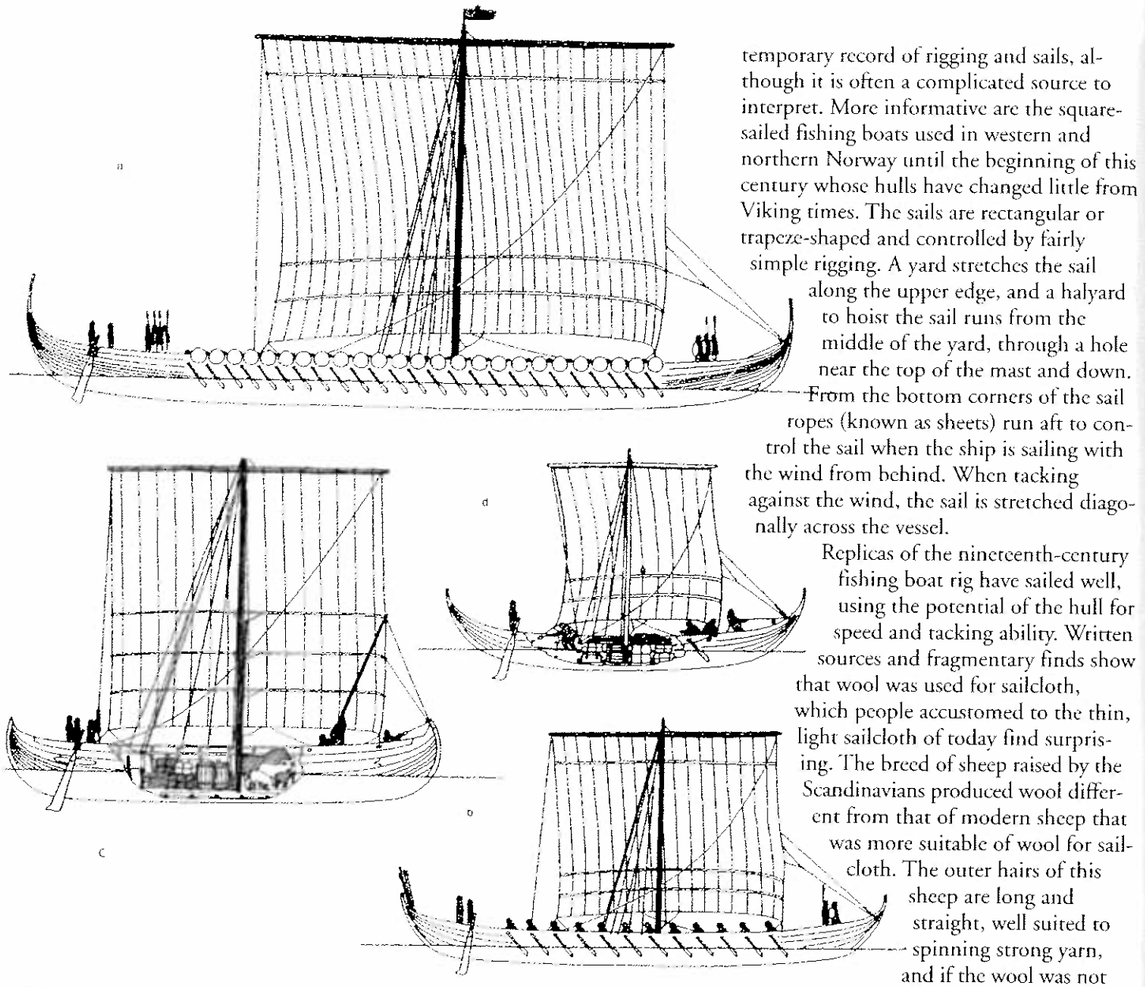


5.12

seas, even in summer, is a feat for daring and clever sailors.

The merchant ships—Skuldelev wrecks 1 and 3 and the small freighter wreck 6—show another picture. Wreck 3 is built of oak and shows many similarities to the small warship (fig. 5.14d). They may both have been built near Roskilde. Wreck 3 is a small coaster, less slender than the warships, but with elegant lines and good workmanship. It has an open hold amidships for cargo and small decks fore and aft for working the ship. It can carry about 4.5 tons of cargo and can be sailed by five men. In and out of the harbor, or in a calm, a few oars can be used fore and aft. The large merchantman, wreck 1, and the small freighter or fishing vessel 6 are both built of pine from western Norway. There was no lumber trade at that time, as far as we know, so these ships must have been built in western Norway. Wreck 1 is a sturdy, broad vessel, well suited to the rough seas of the North Atlantic (fig. 5.14c). It has the same open hold amidships and small decks fore and aft as number 3, but the cargo capacity is much larger, about twenty-four tons. Five to six men can sail the ship, but in the Viking Age, no sensible merchant would risk his cargo with so small a crew, because pirates might wait behind the next island. A few rich men of the upper class might have goods to fill such a ship, but the general trading pattern was probably the one described in the Norwegian medieval laws, where it is stated that when a shipowner wants to travel to a market, he should make his intention known. People with goods to sell would then hire space for their wares by working as crew members. The possibility of overloading is regulated, and "a ship which requires bailing three times in twenty-four hours will be declared seaworthy for all kinds of travel; but if they so wish, the crew can entrust themselves to a ship which requires more frequent bailing." The *Grágás*, or Icelandic lawbook, even stipulates a plimsoll mark, a technical measurement of ship draft, which requires that two-fifths of the ship's height amidships be above water.

In comparing the Oseberg, Gokstad, and Tune ships on one hand with the Skuldelev ships on the other, we see that hull shape and technical solutions have changed somewhat. The Norwegian ships still have the traditional solutions of ribs



5.14 Viking Ships Diversity

During the past twenty years several well-preserved late Viking boats recovered from the mud of Roskilde Fjord in Denmark have given Viking ship experts new information. Reconstructions revealed large (a) and small (b) warships (Skuldelev 4 and 5), an oceangoing vessel (c) (Skuldelev 1), and a coastal merchant vessel (d) (Skuldelev 3). One had the construction of the oceangoing vessels that sailed the North Atlantic, its higher sides, second deck, and extra trusses could withstand heavy seas and provided minimal shelter for cargo, animals, and crew.

temporary record of rigging and sails, although it is often a complicated source to interpret. More informative are the square-sailed fishing boats used in western and northern Norway until the beginning of this century whose hulls have changed little from Viking times. The sails are rectangular or trapeze-shaped and controlled by fairly simple rigging. A yard stretches the sail along the upper edge, and a halyard to hoist the sail runs from the middle of the yard, through a hole near the top of the mast and down. From the bottom corners of the sail ropes (known as sheets) run aft to control the sail when the ship is sailing with the wind from behind. When tacking against the wind, the sail is stretched diagonally across the vessel.

Replicas of the nineteenth-century fishing boat rig have sailed well, using the potential of the hull for speed and tacking ability. Written sources and fragmentary finds show that wool was used for sailcloth, which people accustomed to the thin, light sailcloth of today find surprising. The breed of sheep raised by the Scandinavians produced wool different from that of modern sheep that was more suitable of wool for sailcloth. The outer hairs of this sheep are long and straight, well suited to spinning strong yarn, and if the wool was not washed, as the custom is today, it contains sufficient lanolin to be water repellent. In the Viking Age, spinning was done with a spindle, a much slower process than using a spinning wheel. Weaving was done on an upright loom where the warp was stretched by clay or stone loomweights. The weavers worked standing, beating the weft up. The effort used to collect and sort wool and spinning and weaving sailcloth must have been equal to that of building the ship. More than 930 square feet (one hundred square meters) of cloth was needed to make a sail for the Gokstad ship, enough to make a set of clothes for a crew of about forty. Textile work was clearly a female responsibility, so a Viking shipmaster must have had the support of women to sail.

Much Viking seafaring took place within sight of land, and the pilots' knowledge of good landmarks was important. The rocky coasts of Norway and parts of the Baltic have an abundance of natural landmarks that were often enhanced by stone cairns (piles). The low coasts of Denmark may have given navigators problems, and this is where some of the oldest man-made landmarks were built in the Middle Ages. In Norway the landmarks, mainly characteristic mountains, are featured in fairy tales that explain them as petrified trolls and giants, who in the old days had their quarrels and friendships. The stories told on board not only passed the time but instructed young crewmen in the art of navigation: such tales helped the sailors remember the landmarks.

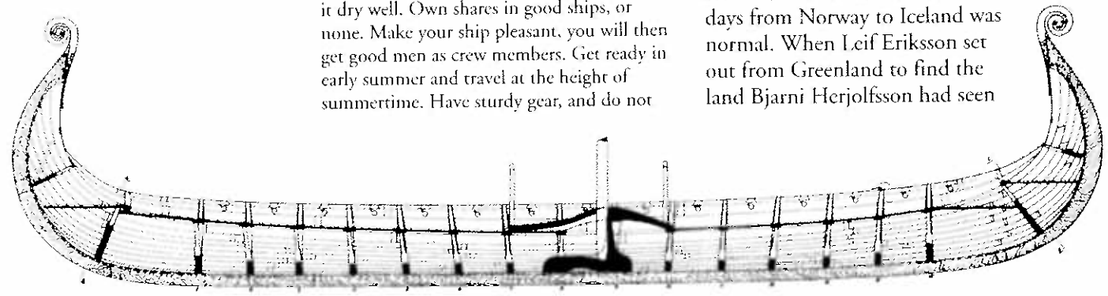
On the high seas ships sailed day and night. The Old Norse name of Polaris, the north star, *Leiðarstjarna*, clearly indicates that its position was known and probably used. In summer the northern skies of the North Atlantic are too light for stars to be seen, but early and late in the sailing season stars may have been used for navigating. Few people sailed in open water during winter when the best fishing often occurs, but inshore fishery probably took place also in winter. Around 1230 a father in Norway wrote a book of instructions for his son, including this advice about the life of a merchant:

> If you prepare for trade across the sea and own your ship, tar it well in the autumn and let it stay tarred over the winter, if possible. But if your ship is beached so late in autumn that it cannot be tarred, tar it early in spring and let it dry well. Own shares in good ships, or none. Make your ship pleasant, you will then get good men as crew members. Get ready in early summer and travel at the height of summertime. Have sturdy gear, and do not stay at sea late in autumn, if possible. When setting out, take with you two to three hundred ells of wadmal suitable for mending sails, plenty of needles, twine, and rope for reefpoints. You need nails, axe, gouge, auger and all other tools for shipbuilding.

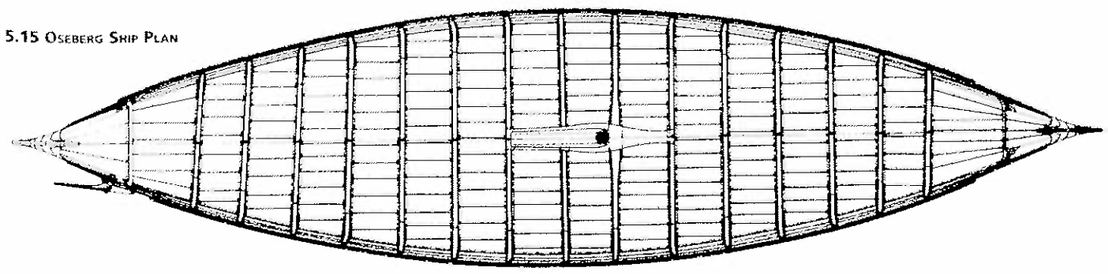
There is little reason to doubt that the Vikings followed similar rules.

Navigating the Open Sea

The techniques of coastal sailing are fairly well understood, but there has been much debate about how people navigated in the Viking Age when they were out of sight of land. The *Hauksbók* (an Icelandic manuscript) gives directions for sailing from Norway to Greenland. The starting point is Hernar, on the coast north of Bergen, with a course set to the west. On a clear day the Shetland Islands would be visible; the next landmark is the Faeroe Islands. The sailor would meet whales and see seabirds south of Iceland, but never sight the land before arriving at the southern tip of Greenland. This description is highly instructive because it adapts coastal sailing techniques—moving from landmark to landmark—to the high seas. Including start and landfall, it identifies five landmarks to navigate across the North Atlantic Ocean. No landmark on Greenland is mentioned, but later medieval sources tell of a characteristic snow-clad mountain that could be seen from far out at sea. The same source gives sailing time between important places in Norway, Iceland, and Ireland: four to five days from Norway to Iceland was normal. When Leif Eriksson set out from Greenland to find the land Bjarni Herjolfsson had seen



5.15 Oseberg Ship Plan



when he was blown off course while voyaging from Iceland to Greenland, a set of landmarks were described for him to find his way. The question is, was there really nothing else to help sailors cross the ocean?

Traveling from Denmark, ships could have contact with the coast all the way to Gibraltar and into the Mediterranean. When going to England from northern Denmark or eastern Norway, a course set *útsuð* would cross the North Sea in two to three days. The traffic from western Norway to Scotland or the Irish Sea probably went by the Shetland and Orkney islands, so the stretches of open sea would be fairly short. The Baltic and the Russian rivers could be sailed by landmarks. Only the voyages from Norway or Ireland to Iceland and Greenland called for sailing out of sight of land for many days. In the description of the voyage from Norway to Greenland no mention of tools used for navigation can be found in the text; apparently the sailor had to learn how to use nature as a guide.

Some researchers, many of them navigators and sailors, have maintained that Viking Age navigation was very advanced and based on a sophisticated knowledge of astronomy. Most of the written sources are Icelandic and date well after the Viking Age. Some of the Icelandic sagas tell of men who were knowledgeable about stars. About a century after the Viking Age, a gifted astronomer known as Star-Oddi lived in northern Iceland. It is not known if he was literate himself, but some of his astronomic observations have been written down and preserved. He seems to have had no connection with the astronomy practiced by the church, which was mainly aimed at establishing the right dates for moveable feasts. Oddi used the diameter of the sun as his measuring unit and seems to have been ignorant of degrees. We do not know if he used instruments. Although his work has been cited as evidence for astronomic navigation in the Viking Age, in the opinion of this writer, he was an astronomer on land, not a navigator at sea, and when he lived, the Viking Age was already history.

Some men of the church took the interest in astronomy further than what was necessary for establishing feast days. Another Icelander, bishop Nicolas of Tverá, went on a pilgrimage to Jerusalem around 1150. He reports that when he lay on his back near the river Jordan, bent his knee, and placed his fist on the knee with outstretched thumb, the polestar "rested" on the thumb. This clearly proves that the bishop knew that different latitudes could be deduced by the height of stars above the horizon, knowledge that was necessary for "latitude" sailing.

One possible latitude observation is described in the *Greenlander's Saga*. It notes that on a certain day, the sun set at a named point on the horizon, which showed that Vinland was far south of Greenland. Neither the day nor the point on the horizon can be identified with full certainty, however, and the observation has been used to place Vinland in widely different places on the east coast of North America. The observation was made on land and offers no proof that similar observations were used for navigation at sea.

In the light northern summer nights, stars are not visible for use as navigational aids. Polaris was known and could be used to find north when it could be seen. On clear days, the sun would help in establishing directions, but the combination of fog and calm caused problems. The condition was known as *hafvilla* in Old Norse, meaning to lose your way at sea. One saga tells of a long debate in the ship's council on where to set a course when the sun was again visible after some foggy days.

There is general agreement that the magnetic compass was not known in northern Europe in the Viking Age. The sea chart and the log are also later inventions. The *St. Olaf's Saga* includes a story of a man who claims to know the cardinal points even when the sun is not visible. The king checks this out on a snowy winter day with the help of his "sunstone." Some readers assert that the saga passage is a reference to a feldspar, a crystalline mineral that polarizes light and shows where the sun is, even when it is below the horizon. Although the double-refractive feldspar found in Iceland has this property, no such stone has been found in a Viking Age context. Such crystals may have been the prized secret of a few people, but it is highly doubtful that it was a common navigation tool.

One much-discussed artifact is a fragmentary disc of wood found in the ruins of a Norse farm in Greenland. This has been interpreted as a bearing dial, or a kind of shadow compass, which uses the sun for orientation(fig. 20.5). It is a fragment, a little more than half a circular disc of pine with a diameter of two and one-half inches (seventy to seventy-two millimeters). Triangular

5.16 Vittangi Boat
Viking ship construction continues today in Scandinavia, including production of Viking replicas, small homemade utility vessels, and vessels used by native Saami such as the one shown here from Vittangi in northernmost Sweden. Perhaps someday it will be shown that the design of Viking ships did not originate in the southern Baltic and Europe, but from boatbuilding traditions of the northern boreal forests, which also survive today.

notches are cut around the edge, and several straight and curved lines mark the surface; in the middle is a hole. The first to identify it as a navigation instrument was the maritime historian and navigator Carl V. Sølver (1954), who built a reconstruction as a bearing dial with a central sighting pin, a pointer, and thirty-two points, like an old-fashioned marine compass. The reconstruction came under heavy criticism as idealized mainly because triangles on the points of the original are far less evenly spaced than the reconstruction. The object has later been reinterpreted not as a bearing dial, but as a sun compass (Vebæk and Thirslund 1992). The shadow from a central pin would be measured against the lines scratched on the surface: on a westerly course, a shadow that was too long would indicate that the ship was too far north; too short a shadow meant the ship was too far south. Although modern computer-calculated shadow compasses do work, the lack of precision in the points around the edge makes this interpretation just as doubtful as the bearing dial theory. Again, there is no proof that either instrument was known or used by the Vikings.

Understanding the prevailing wind and wave systems of the North Atlantic may have been important to navigation; recognizing flight patterns of birds, the migration of whales in coastal waters, and the tendency of clouds to form over land could also have assisted sailors in establishing bearings. The first man who settled in Iceland is said to have brought ravens with him on board the ship. When they were let loose, one of them rose to a great height before flying straight ahead; the ship followed and found land. This method of finding land is possible, but the legend is probably a literary loan from the Old Testament and the story of Noah's dove. Shipwreck was far more common than it is today. When Erik the Red set out to colonize Greenland, less than half of the ships reached their destination, and the rest were driven back to Iceland or wrecked.

From the early-ninth-century Oseberg ship to the mid-eleventh-century Skuldelev wreck 1, we see great changes in the hull shape of the Viking ships. The basic concept of a fairly light and flexible clinker-built shell with no permanent deck is unchanged, but there is more weight on seaworthiness and sailing ability. Generations of experience in sailing the North Atlantic ocean produced ships capable of reaching Iceland, Greenland, and North America. The Viking expansion, in Europe as well as across the North Atlantic, was possible first and foremost because of superb shipbuilding.