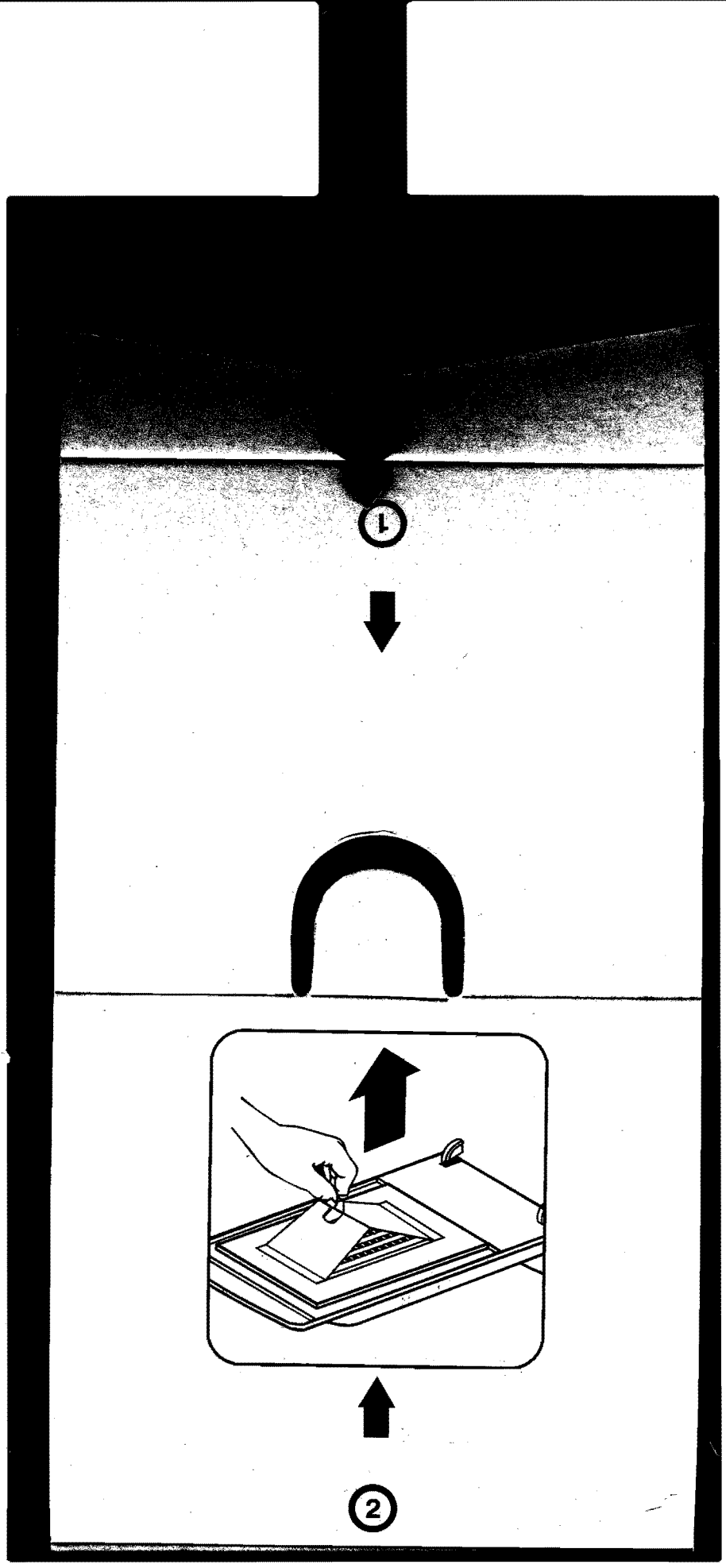
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SEAFARING FROM THE EARLIEST TIMES TO CHISTOPHER COLUMBUS

Prof. Dr. Dr. h.c. Erno Wiebeck

Summary

When Columbus had crossed the Atlantic he discovered the New World for Europe. However long before Columbus bold seafarers were braving the vast Oceans on both sides of our globe. The considerations of this paper are confined to the Atlantic Ocean and to the Pacific.

A brief analysis and evaluation of the sea-craft of Polynesians and Vikings contributes to a better understanding of the adventures of these bold navigators.

In this context some basic criteria are defined, determening the seaworthiness of a seagoing ship/boat. Additionally the climatic conditions (e.g. prevailing winds, currents) are considered.

With reference to existing hypothesis and theories on transoceanic contacts prior to Columbus the seaworthiness of the sea-craft of these ages is investigated as an important precondition for early transoceanic voyages.

To support the evaluations the results of "experimental voyages" with replica of ancient sea-craft are considered.

1. Columbus discovers America

In the early hours of October 12, 1492, the outlook of the „Pinta" shouted „Tierra! Tierra!" (Land! Land!). The little fleet of Christopher Columbus, consisting of the ships „Santa Maria", „Pinta" and „Nina", had come over 3000 nautical miles of unknown and uncharted sea since leaving the Canaries. At the same day Columbus landed at the island of Guanahani, belonging to the Bahamas. Only at his third voyage on August 5, 1498, Columbus reached the shores of the American Continent. This voyage marked one of the most important events in the history of discoveries. It is, however, not the aim of this paper to evaluate the discoveries, but to give a brief survey of the seafaring activities in the scope of the great discoveries.

The ships of Columbus' little fleet were with lengths between 18 and 25 metres according to modern standards (lengths usually between 120 and 250 metres) really small ships. „Santa Maria" probably reached a maximum speed of

only 9 knots, whereas the maximum speed of the „Pinta" and „Nina" amounted to 11 knots. It is important for our further considerations to note, that Columbus (intentional or/and unconscious ?) made use of main currents and prevailing winds, when crossing the Atlantic Ocean. Figure 1 shows the routes of his first voyage.

Figure 2 depicts a reconstruction of the flagship „Santa Maria", since the exact particulars of the ship have not been passed on. Based on this design the first replica of the „Santa Maria" was built and sailed in 1893 across the Atlantic Ocean to the world fair in Chicago. The so far last replica of the „Santa Maria" was built in 1992 on the occasion of the 500th anniversary of the discovery of America by Columbus.

However, was Christofer Columbus really the first to cross the Atlantic Ocean or had he any predecessors ? Pining and Pothorst (1471 - 1473) reached the American mainland before Columbus. But they in turn can not claim to have discovered the New World. Pining and Pothorst sailed almost exactly on the searoutes of the Vikings (s. figure 3), who set foot on Americas shores half a millenium prior to Columbus.

2. The Vikings

The Vikings originate from Scandinavia, more precise from Norway. According to the saga, the Vikings stormdriven with their undecked boats first reached Iceland around 860 AD. In 982 AD they landed in Greenland. Probably in 986 AD the Vikings first sighted the east coast of America and about 14 years later the Viking Leif Ericsson and his crew made their landfall on the coast of America.

There are reliable informations on their ships, because some of them, well preserved, have been excavated. The first replica, the „Viking", was built in 1893 exactly after the particulars of an excavated ship (see figure 4), using the same tools and constructionmethods, the Vikings had had at their disposal. The „Viking"crossed (like the replica of the „Santa Maria") the Atlantic Ocean on the occasion of the world fair in Chicago. Captain Andersen was in command. The particulars of the ship are given below:

* maximum length
23,3 m,
* breadth
5,3 m,
* depth
2,0 m,
* maximum speed
11 knots

Captain Andersen states, that the excavated ship had so fine and perfect lines, that even craftsmen of the 19th century could not do it better. The best merchantships under sail of Andersens days had practically the same lines of the underwater hull as the Viking-ships.

The maximum speed the „Viking" during her voyage was equal to that of the Columbus-ships „Nina" and „Pinta".

Another replica, the „Saga Siglar" (length only 16,5 m; breadth 4,6 m; depth 2,0 m), was built in 1984 and made a round the world voyage. This voyage proved, that Viking-ships could not only brave the waves and storms of the North Atlantic

but also match the challenges of any other ocean of the globe. It may be mentioned, that captain R. Thorseth, before setting sail for the great tour, performed extensive trials with the „Saga Siglar". They yielded so excellent results, that Thorseth decided to have his family during large parts of the world tour on board the ship.

The navigation of the Vikings was rather simple but nevertheless efficient. Based on observations of coastline, winds, waves etc. they had derived empirical rules for navigation and passed them on from generation to generation. As an aid for navigation the Vikings used birds. These birds (raven) were kept on board the ships during the voyages. When the crew lost orientation (e.g. in a storm) they sent out a raven. The bird took wing and when he saw a coastline he flew away in that direction and the ship could be steered on this course. Otherwise the bird returned to the ship[1].

3. The seaworthiness of a ship

The voyages with replika of Columbus-ships and Viking-ships have doubtless proved the seaworthiness of these vessels. Figure 5 shows a comparison between the largest known ship of the Vikings and the „Santa Maria". This comparison clearly indicates a considerable difference in the size of both ships. Nevertheless both are almost equal in seaworthiness and speed. This fact rises the question, wich kriteria are decisive for the seaworthiness of a ship/boat[2].

In 1956 the bold adventurer H. Lindberg crossed th Atlantic Ocean with a foldable boat of only 5,2 metres length [5]. Attached to the boat was a small outrigger. It took Lindberg under sail from the Canary Islands to the West Indies 72 days. This experiment indicates, that the size of a ship/boat and the number of crew members are no decisive kriteria for the seaworthiness of a seagoing vessel.

What are important criteria for seaworthiness?

* *Ability of the vessel to remain afloat during the voyage*
E.g. Thor Heyerdahl failed in his first attempt, to cross the Atlantic with an Egyptian papyrus boat (Ra I), due to omissions in the structural design of the ship and a missing pretreatment of the construction material. A similar fate had a replica of a Chinese junk (Tai Ki), that failed to cross the Pacific. The vessel lost its floatability because its planking was gradually destroyed by the ship worm (Teredo navalis) due to a missing protective coating.

* *Load-carrying capacity*
The ability to carry crew, food and cargo required for the journey.

* *Speed*
To reach the destination a minimum speed is required. The speed and thus the duration of the voyage in turn influence the load-carrying capacity.

* *Manoeuvring capability*
The property of a vessel to be steered to a prescribed destination.

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[1] Ancient Indian mariners also used raven or pigeon as navigation
[2] Boat: Undecked ship

* *Stability*
The ability of a vessel to return from an inclined position (due to wind, waves etc.) to the upright floating position.

* *Ability, experience and boldness of the crew*
Statistics indicate that ships often were lost due to human failures. This means the crew must be able to do the right things at the right time.

Besides the seaworthiness of ships the discoveries in ancient seafaring were largely influenced by currents and prevailing winds. It was already mentioned, that Columbus' voyages closely followed the currents and prevailing winds of the Atlantic Ocean. In figure 6 the main currents of the Atlantic are shown. The routes of the Vikings, Pining/Pothorst and Severin (compare figures 3 and 6) also follow closely the main currents of the North Atlantik. We will see later, that the same is also valid for the voyages of the explorers in the Pacific. The main currents work like great „conveyors" transporting the ship. The famous raft „Kon Tiki" sailed from Peru to the Tuamotu Islands in about 100 days. The distance amounted to 4000 nautical miles. The progress of the raft with reference to the water surface was only 1000 nautical miles whereas the current, acting as an „conveyor", carried the raft with reference to the ground over a distance of 3000 nautical miles.

4. Had Columbus still more predecessors ?

There is increasing speculation that bold seafarers were braving the Atlantic Ocean long before Columbus and even centuries before Leif Ericsson. Among them are supposed to be

* Irish monks,
* African seafarers,
* Phoenicians and
* Egyptians.

We will take a glance at the ships of these ages, to estimate, wether they might have been able to cross the Atlantic Ocean or not.

4.1 Irish footprints in North America ?

The „Navigatio Sancti Brendani Abbatis" (Voyage of Saint Brendan the Abbot), an Irish saga, written between 8th and 10th century, gives an account on Brendan the Abbot[3] and his 17 fellow monks sailing to the „land promised to the saints" somewhere beyond the far reaches of the Atlantic Ocean. Was this „promised land" America ? Neither history nor archaeology prove, that St. Brendan actually reached it.

The British scientist and explorer Timothy Severin [7] was fascinated by the Brendan story. It would give the Brendan story more significance, if a modern sailor would cross the Atlantic, sailing a boat, built of the same materials and using the same construction techniques St. Brendan had had at his disposal. The idea of the Brendan voyage was born. The voyage however only would prove, that such a long-ago voyage could have been made.

Based on more than two years of painstaking researches Severin designed

[3] Brendan was living from ca. 489 to 570 or

and built a boat of 12 metres length, the „Brendan", that corresponded with all informations of the „Navigatio". This vessel had frames and ribbands with 1600 intersectionpoints (see figure 7), tied together with leather strings (total length: 3000 metres). The skin of the boat consisted of 49 cowhides, stitched together with flaxyarn (length 37000 metres).
It seemed almost incredible, that such a fragile boat (see figure 8) would brave storms and adverse climate of the North Atlantic, but it did !

The bold adventure of Tim Severin brought one of the history's most intriguing tales a step closer to the realm of possibility. A 6th century leatherboat, manned with a experienced and bold crew, could have crossed the North Atlantic in Brendans days.

4.2 African Seafarers

H. G. Lawrence e.a. [8] claim that African seafarers set sail from Guinea Coast in the beginning of the 14. century and reached the American shores.

There are only meagre informations about ships of the African west coast in those days. Probably they used (like nowadays) dugouts. Only one source [9] reports, that early this century a boat shaped log raft was in use in Lotito Bay (Angola).

The adventurer H. Lindemann [5], mentioned earlier, crossed the Atlantik on the Columbus-route in 1955 with an African dugout (length 7,7 m). However Lindemann had made a number of manipulations, to make the dugout seaworthy (adding a keel consisting of lead, replacement of the traditional rig by a more efficient rig etc.). Despite of these manipulations Lindemann was still complaining about the unsufficient seakeeping behaviour of the dugout.

To come to a decisive conclusion regarding the seaworthiness of African sailing vessels further research work is indispensable. Based on the meagre facts, available at present, we can conclude: It is highly improbable, that these dugouts have crossed the Atlantik.

4.3 Phoenicians in the New world ?

Pharaoh Necho II of Egypt (609 - 594 BC) commissioned the intrepid mariners of Tyre and Sidon to circumnavigate Africa. These men set sail down the Red Sea on the pharaoh's mission and returned three years later to Egypt after passing the Pillars of Hercules. These bold mariners had sailed over a distance of nearly 37000 km.

When the Phoenician fleet sailed up the west coast of Africa it may well have happened, that a ship, separated from the fleet by storm and currents, was taken by the South Equatorial Current to the shores of South America (compare figure 6). There is however no evidence, that Phoenician sailors landed in America.

Based on the limited informations about Phoenician-ships it was shown in [10], that only one ship of the Phoenicians was suitable to brave the Atlantic Ocean. It is the hippoi (horse), a cargo-vessel. Figure

9 compares the side view of a Viking - ship[4] and a Phoenician cargoship[5].

At the first glance both ships appear to be quite similar. The similarities (particularely the upturned prows) result from the common aim of Vikings and Phoenicians, namely to make the ships seaworthy[6]. A comparison indicates, that the hight und probably also the freeboard of the Phoenician ships is larger. This contributes to some extent to seaworthiness and strength of the ships. The keel of the Viking-ships, considerably contributung to their strength, is missing in the Phoenitian ships. This drawback is however partly compensated by the larger hight. Both ships are undecked. The Viking-ships have obviously finer lines and thus they are considered to be faster.

This comparison of the Phoenician-ships with Viking-ships, despite of some drawbacks, indicates the seaworthiness of the Phoenician-ships.

4.4 Reedboat Ra II crosses the Atlantic

In 1970 the famous Norwegian Thor Heyerdahl and his international crew crossed in a 2nd attempt the Atlantic with the reed boat „Ra II" (length ca. 12 metres). They sailed almost the same route Columbus had taken on his 4th voyage using main currents and prevailing winds.

„Ra II" was constructed of papyrus reed after the fashion of the earliest boats of Ancient Egypt (3000 - 2000 BC). There were however a number of unceartainties. To some extent uncertain was the way these boats were designed and built. Moreover it was unknown, whether there had been seagoing reedboats in Ancient Egypt at all. Mainly due to these uncertainties the 1st adventure with „Ra I" had failed. A careful analysis of all deficiencies of „Ra I" led to modifications in design and construction of „Ra II" (see figure 10). The result was a boat capable of crossing the Atlantic.

Heyerdahl stated, that by this experiment he did not wont to prove anything. His aim was to find out if reedboats of Ancient Egypt were capable of sailing to the shores of America. And this question Heyerdahl has impressive answered.

5. Polynesian seafaring

Long before the Vikings ventured to cross the Atlantic on the other side of the globe bold seafarers, the proto-Polynesian, had already left their homeland somewhere in Southeast Asia and had spread over the Pacific. By 4500 BC they arrived at the Moluccas [12] and around 1300 BC [13] they discovered Tonga and Samoa Islands and thus had entered the great „Polynesian Triangle". From there they finally spread to Easter Island (400 AD) and Hawaiian Islands (ca. 500 AD) [13].

The Pacific is, like the Atlantic Ocean, dominated by main currents and prevailing winds (see figure 11). However on the route, the proto-Polynesian sailors sailed, they could not make use of the main currents as

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[4]Stonecarving, Stenkyrka-Stone, Gotland

[5]Relief from the palace of King Sargon at Khorsabad, Accyria , 8th century

[6]The structural design of both ships in quite

„conveyorbelts". In contrary on their route they were forced to sail against the currents. In the earlier stages of their migration however they sailed with the summer Asiatic monsoon (see figure 12). In the periods of their migration which followed they had unlimited to match the callenges of both countercurrents and adverse winds.

To meet these challenges the Polynesian seafarers had developed unike boatdesigns unparalled in the western hemisphere. The eldest type is the double canoe. By linking two dugouts with a plattform the stability of the vessel was increased considerable. (see figure 13 A). In the next phase of development the dugout was equipped with an outrigger (float) either to weather or to leeward (s. figures 13 B and 13 C). The latest development was the double outrigger canoe (fig. 13 D).

Figure 14 shows a Tongan double canoe and figure 15 the design of a single-outrigger.

Which are the main features of these unparalleled boats ?

1. High stability compared to monohull-boats, i.e. increased seaworthiness.

2. Due to high stability double canoes and outrigger canoes can carry more sail than monohull-boats and thus increase their speed. There are only a few informations regarding the speed of these vessels. A Fijian double canoe made 12 knots and for Gilbertese boats, called „flying proas", 17 knots are recorded. A Carolines canoe averaged 14 knots on a voyage from Guam to Manila [12].

3. All Pacific canoes can make good a course about 60° to 65° off the true wind and even better[7]. By sailing a zig-zag course, canoes can make good a course directly to windward.

Captain Eric de Bisschop 1937/38 set sail in Hawaii and voyaged with a Polynesian double canoe (length only 11,5 metres) via the Fidshi Islands, Java, Madagaskar, Cape of Good Hope to Europe. After 264 days the voyage ended in Cannes (France). De Bisschop with the little double canoe had circled more than half of the globe and had proved, that this vessel could not only match the challenges of the Pacific Ocean.

To sum it up: Polynesian and proto-polynesian canoes were exceptional and can favourable compare with sailingvessels designed and built centuries later in the western hemisphere of our globe.

6. Conveyorbelts of the Pacific Ocean

The main currents of the Pacific in west-east-direction are (see figure 11):

* North Pacific Current,
* Equatorial Counter Current,
* West Wind Drift

The experienced captain and explorer de Bisschop tried in 1939 to cross the Pacific in a Chinese junk, using the Equatorial Counter Current. It proved however unsufficient to work as conveyor because it is partly

[7]For comparison: Squareriggers of 19th century could make good about 67° off the true wind

superimposed by the counterrotating North and South Equatorial Currents. Moreover de Bisschop hat to sail against the trade-winds. After a tough fight against adverse conditions, lasting almost three years, he gave up. The Equatorial Counter Current had proved to be inadequate to function as conveyor for a west-east passage of traditional vessels.

6.1 Bamboo rafts on the west-east passage

Long after having failed in the Equatorial Counter Current de Bisschop made another attempt to cross the Pacific from west to east. He built the bamboo raft „Tahiti Nui" (length 12 m, breadth 4 m). Apart from double canoes and outriggers this type of water craft belonged to the sailing vessels of Polynesia. De Bisschop set sail in 1957 from Tahiti and went down to enter the West Wind Drift. After 180 days of stormy and cold weather the raft was 1000 nautical miles off the coast of South America and the crew unable to continue the voyage gave up. Again an attempt to cross the Pacific in west-east direchtion had failed.

36 years later Tim Severin [17] attempted to cross the Pacific in west-east direction also with a bamboo raft[8] using the North Pacific Current. He built the bamboo raft „Hsu Fu" (see figure 16; length 18,3 m, breadth 4,6 m) and set sail from Hongkong in May 1993. After a stressing voyage of 5500 miles the raft began to disintegrate. Like de Bisshop Tim Severin abandoned the bamboo raft 1000 miles off the shores of America.

[8]The earliest documentary reference to a bamboo raft in China is from 472 BC

Reasons for the failures in both de Bisshops and Severins expidition were the unsufficient speed of the rafts. The „Tahiti Nui" raft reached an average speed of
1 knot [18] and the „Hsu Fu" an estimated average speed of 1,0 to 1,2 knots. This results indicate, that these rafts because of their low speed (see chapter 3) had only a limited seaworthiness. Due to the low speed, the extremely limited manouevribility and the tendency to disintegrate on long distance voyages it is doubtfull whether bamboo raft have ever crossed the Pacific not to mention return voyages[9].

6.2 Planked ships in the North Pacific Current

Ch. Broocks [19] in his book, published 1882 reports, that within 73 years 53 Japanese ships after wrecking have been driven by northerly currents to the shores of America from Alasca down to Acapulco in .These statistics clearly indicate the significance of the northerly „conveyors", namely the North Pacific Current.

In 1974, i.e. about 20 years before the unsuccessfull attempt of Tim Severin with the bamboo raft „Hsu Fu" the Austrian Kuno Knöbl built in Hongkong the replica of a Chinese junk from the 1st century AD (see figure 17). The route he took was almost the same as that Severin took two decades later. The junk was

[9]It is recorded in Chinese sources, that the 1st Emperor of China in 218 BC sent out the scientist and navigator Hsu to explore the „Eastern Ocean". Hsu set sail and *returned* to report to the Emperor.

built according to the old technologies, using not a single iron nail.

The junk reached at short streches a speed variing from 3 to 6 knots. The average speed amounted to 2,5 knots, far above the speed of the bamboo rafts. The seakeeping of the dow was excellent. She braved waves of 10 metres and in a single case also a 20-metres-wave. Nevertheless the junk also failed before reaching the American coast. The reason was that the ship worm had gradually destroyed the planks of the junk. This mishappening however was avoidable, so that the 1st century jung can be classyfied as seaworthy also for long distance voyages, including ocean crossing.

6.3 Balsa rafts in the Pacific

1947 the famous Thor Heyerdahl with his balsa raft „Kon Tiki" crossed the Pacific from east to west. With this spectacular action Heyerdahl initiated the era of „experimental voyages".

Heyerdahl set sail from the Peruan port Callao and strandes after a voyage of about 100 days at the Raroia Reef (s. figure 18). The balsa raft was with an average speed of 1,7 knots not much faster than the bamboo rafts, but he was successfull. In the years to come in total 11 balsa rafts crossed the Pacific. Fife of them even reached the Australian coast. It was a process of learning how to inprove the navitation of these rafts. The average speed increased to sligktly above 2 knots. These voyages clearly indicate, that sefarers of antiquity could reach polynesia setting sail from the American mainland.

Zusammenfassung

Als Kolumbus den Atlantik überquerte, entdeckte er die Neue Welt für Europa. Aber schon lange vor Kolumbus wagten sich kühne Seefahrer in die Weiten der Ozeane unseres Planeten hinaus. Die in diesem Beitrag angestellten Betrachtungen beschränken sich auf den Atlantischen Ozean und den Pazifik.

Eine kurze Analyse und Bewertung der Wasserfahrzeuge der Polynesier und Wikinger soll zu einem besseren Verständnis ihrer herausragenden Leistungen als Seefahrer beitragen.

In diesem Zusammenhang werden auch Kriterien zur Beurteilung der Seefähigkeit eines Schiffes/Bootes zusammengestellt. Zusätlich werden noch die klimatischen Bedingungen (vorherrschende Winde, Strömungen etc.) berücksichtigt.

Ausgehend von Theorien und Hypothesen über transozeanische Kontakte von Seevölkern vor Kolumbus wird (soweit möglich) die Seefähigkeit der Wasserfahrzeuge jener Epochen abgeschätzt als wichtige Voraussetzung für die Überquerung von Ozeanen.

Um die getroffenen Aussagen zu unterstützen, werden auch die Ergebnisse von „Experimentalfahrten", die mit Nachbauten antiker Wasserfahrzeuge in neuerer Zeit ausgeführt wurden, berücksichtigt.

Figures

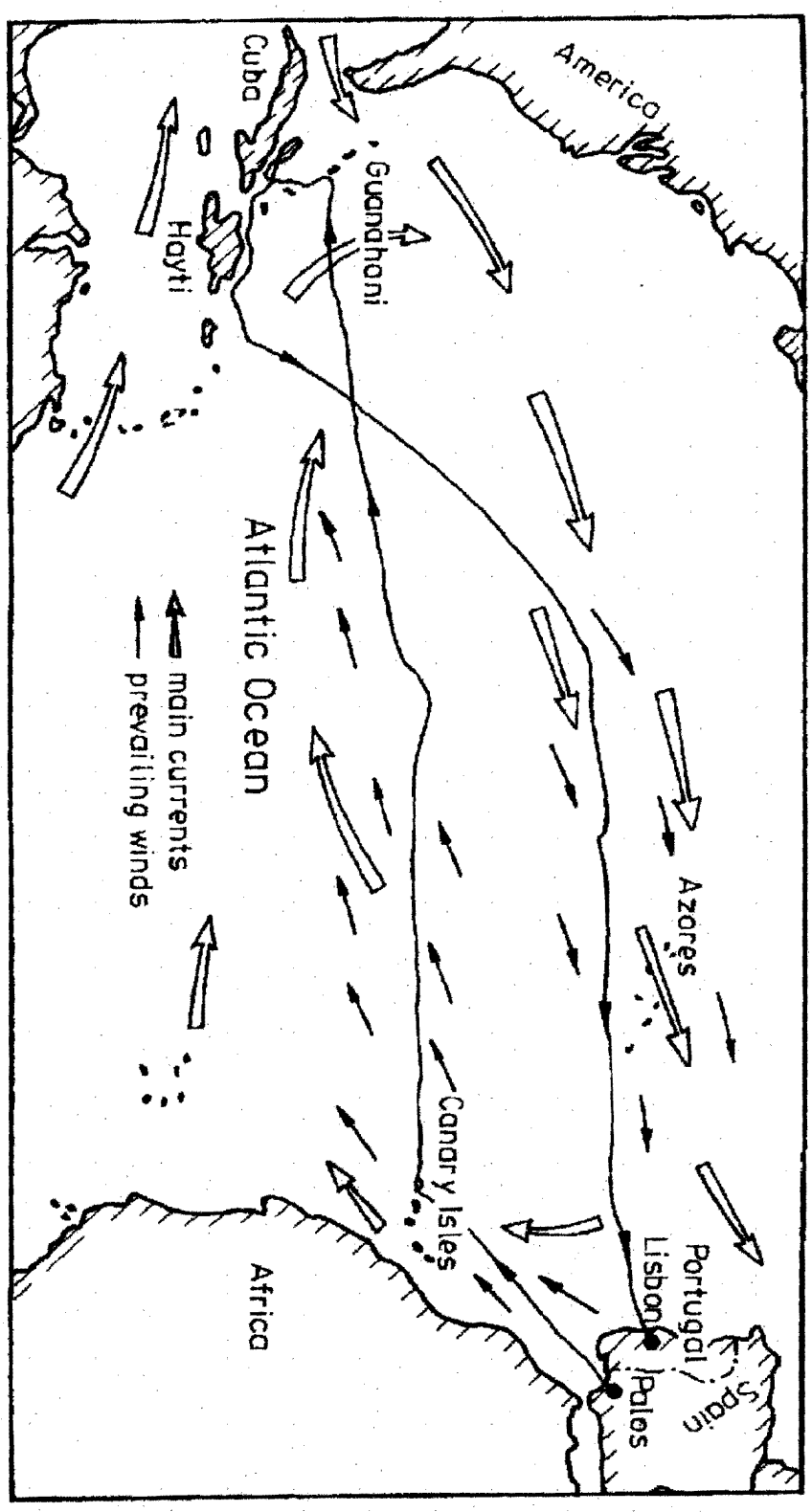
America
Cuba
Guanahani
Hayti
Atlantic Ocean
main currents
prevailing winds
Azores
Canary Isles
Africa
Portugal
Lisbon
Palos
Spain

FIGURE 1

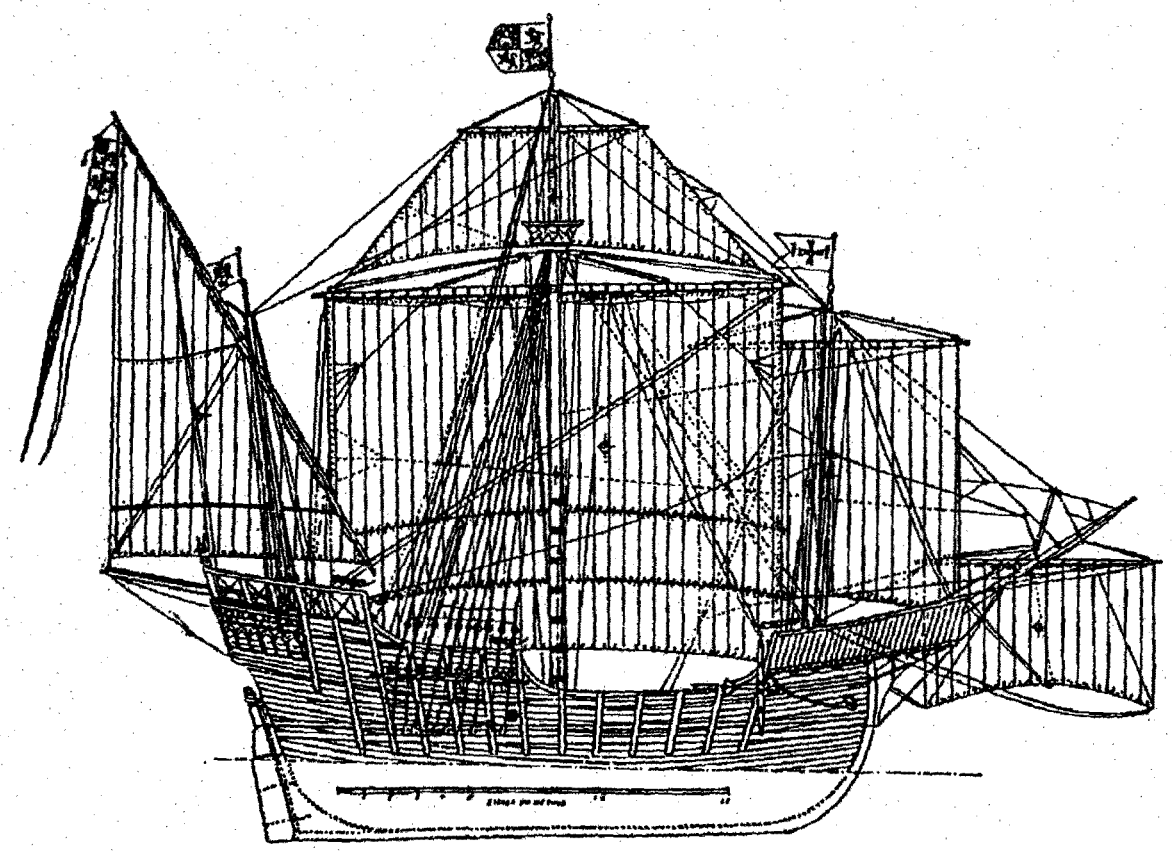

FIGURE 2

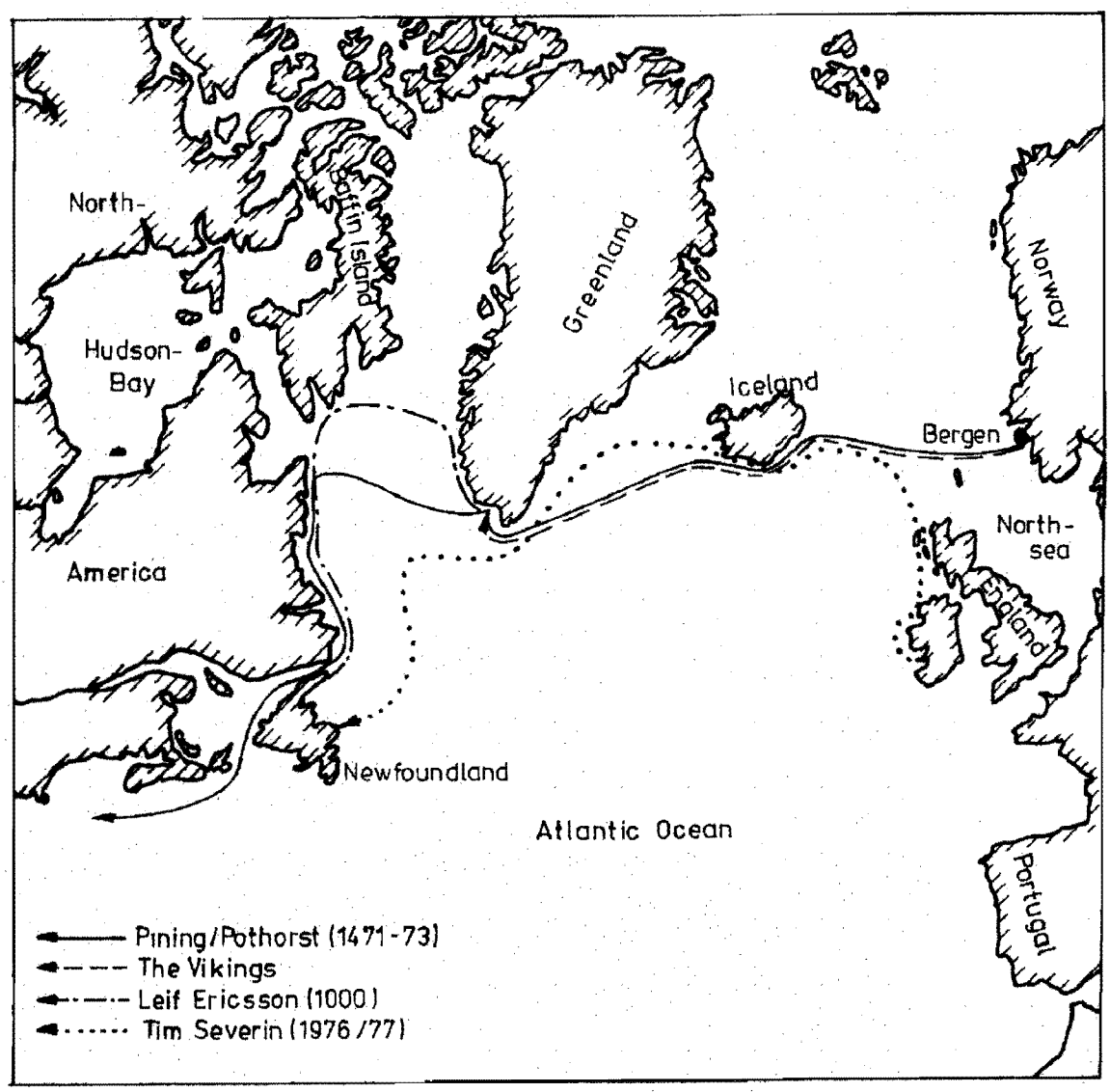
North-
Hudson-
Bay
America
Baffin Island
Greenland
Iceland
Norway
Bergen
North-
sea
England
Newfoundland
Atlantic Ocean
Portugal
Pining/Pothorst (1471-73)
The Vikings
Leif Ericsson (1000)
Tim Severin (1976/77)

FIGURE 3

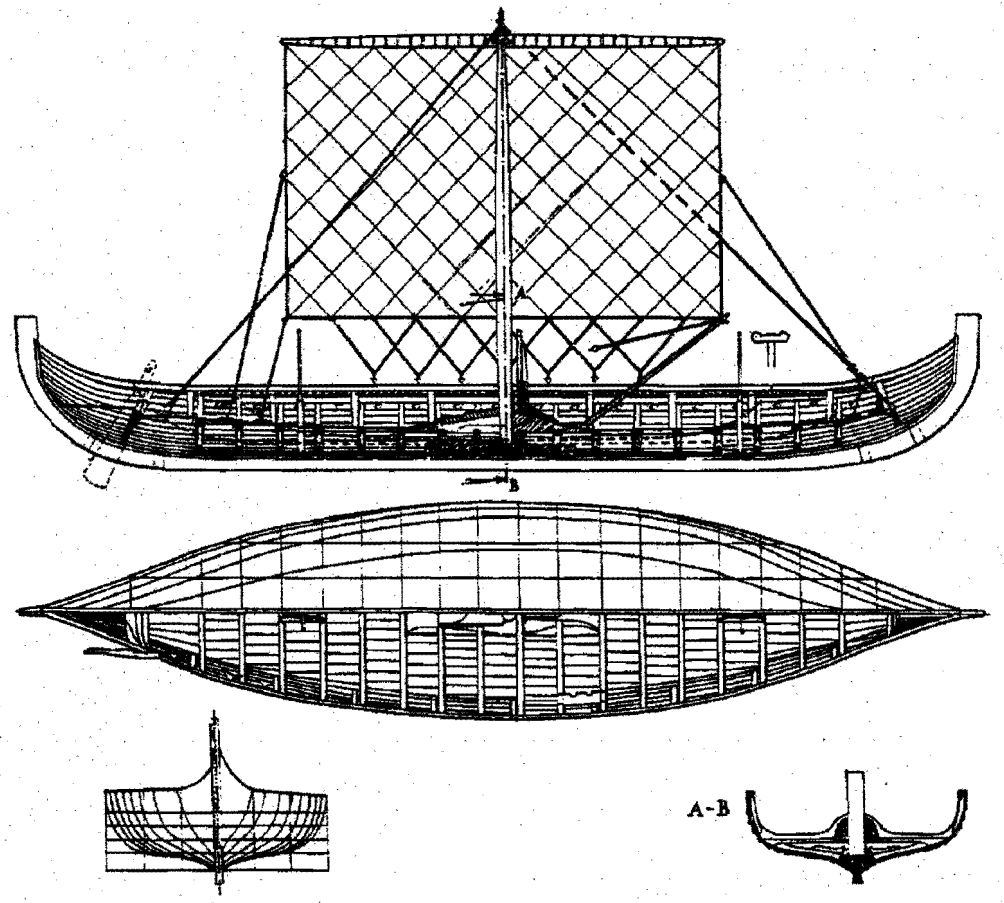

FIGURE 4

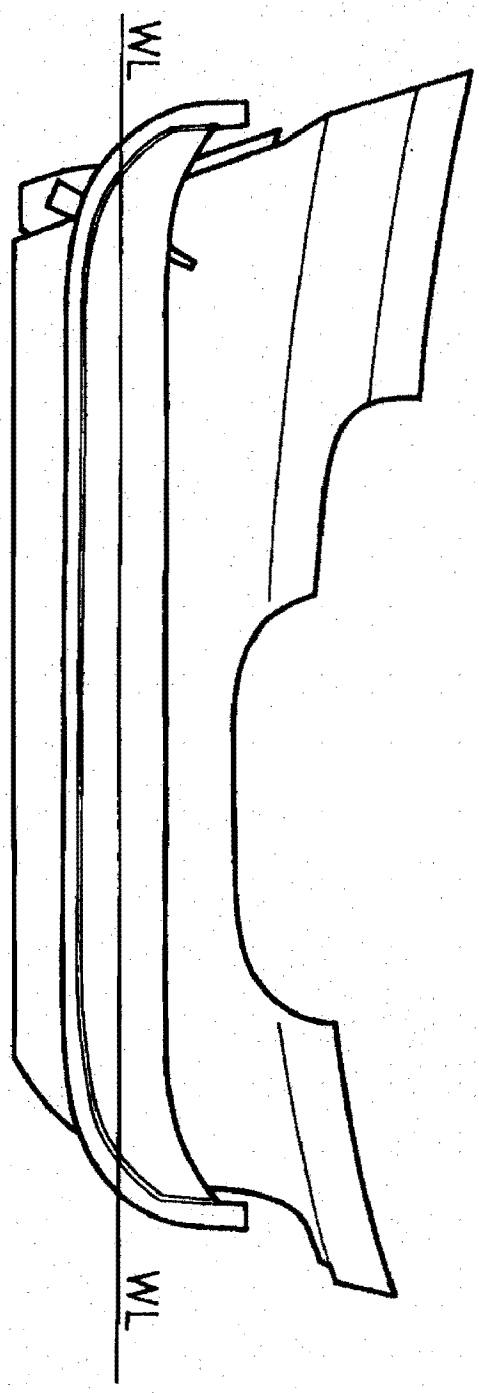

FIGURE 5

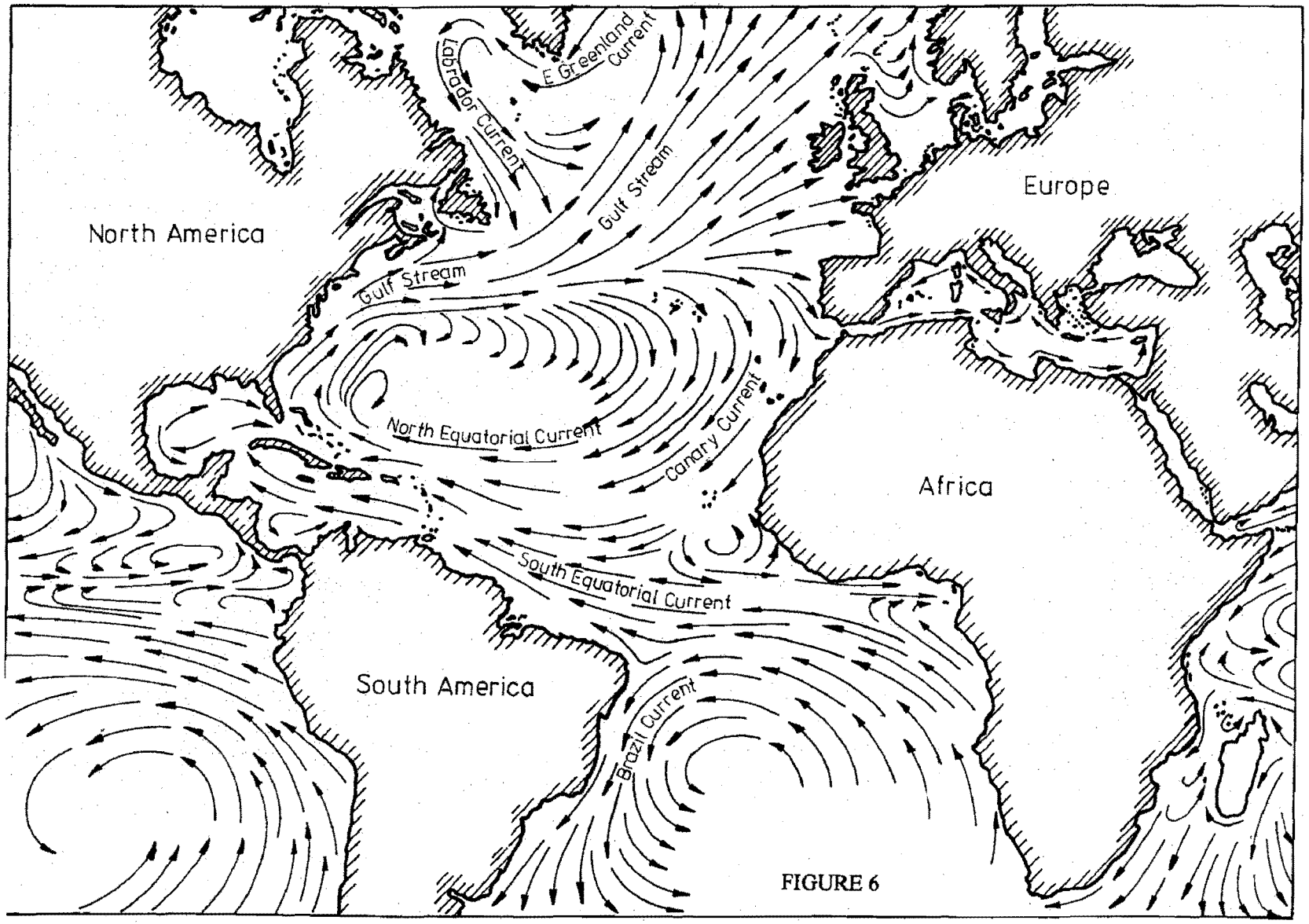
E Greenland Current
Labrador Current
Gulf Stream
Europe
North America
Gulf Stream
North Equatorial Current
Canary Current
Africa
South Equatorial Current
South America
Brazil Current

FIGURE 6

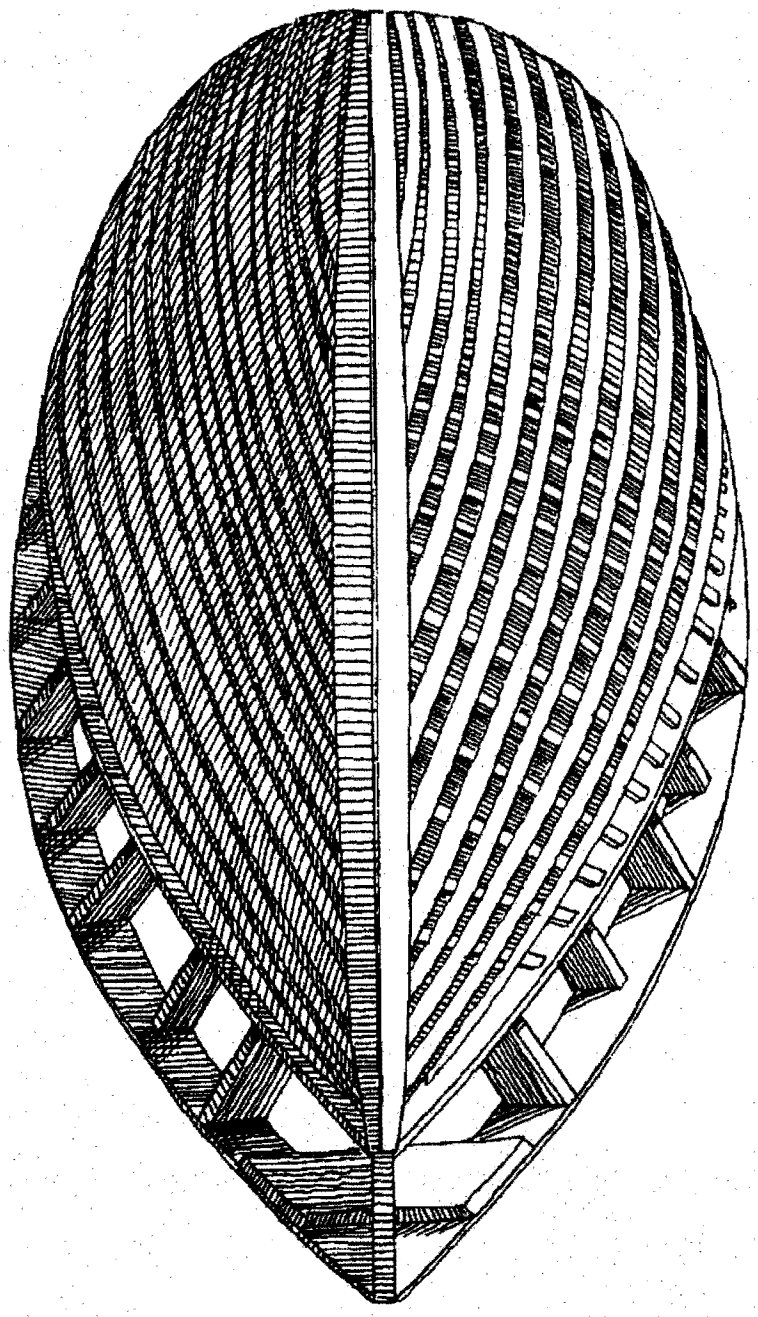

FIGURE 7

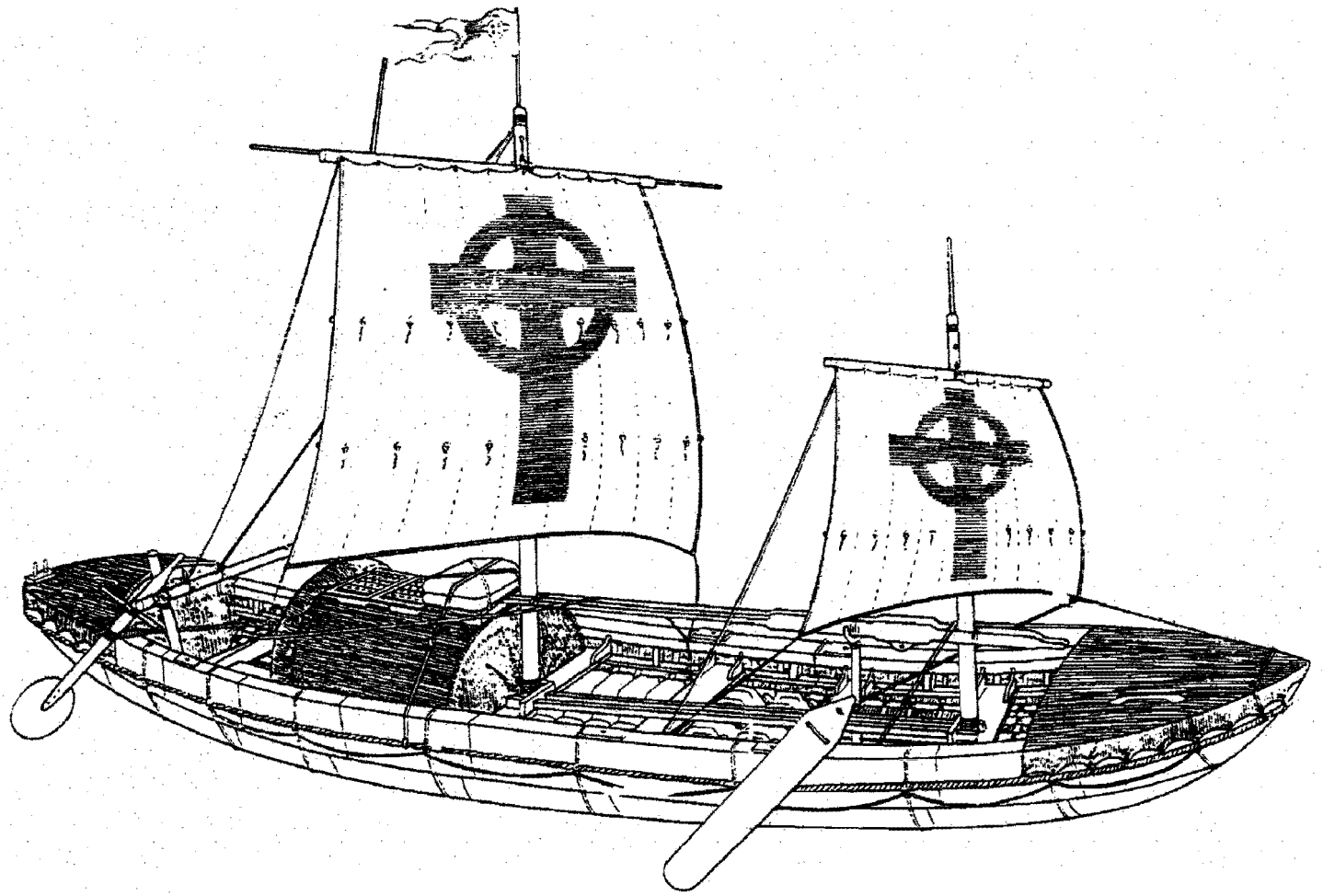

FIGURE 8

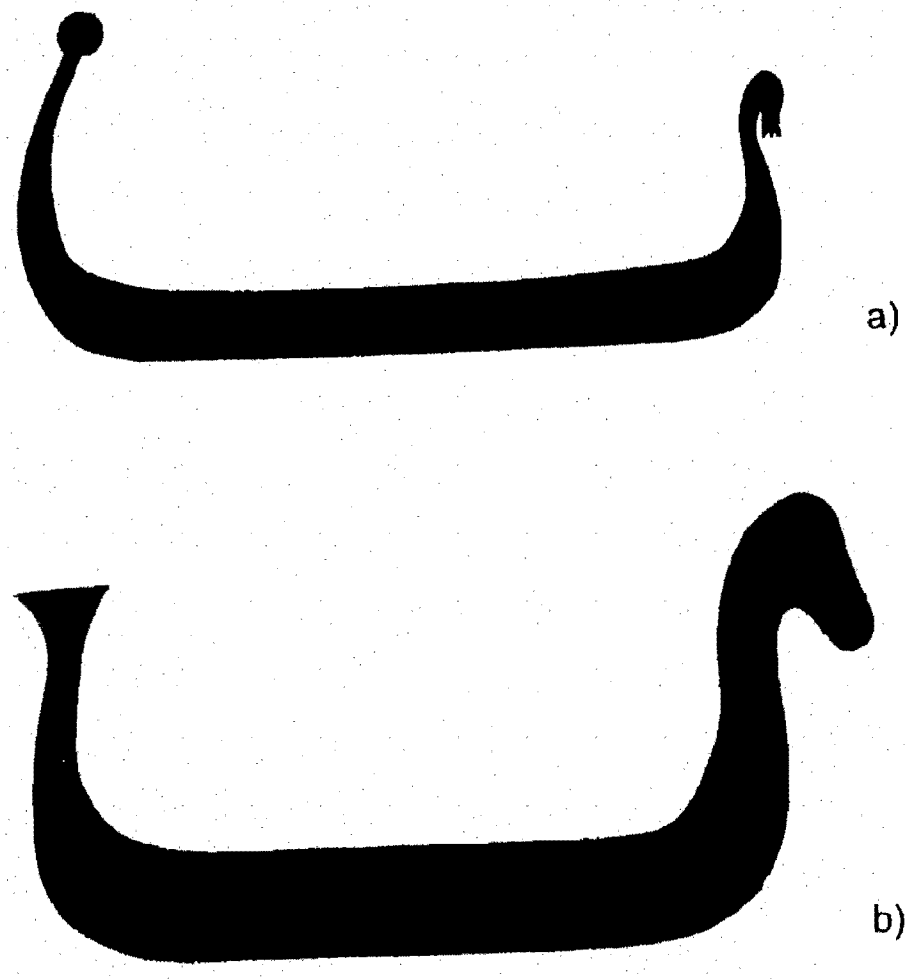

FIGURE 9

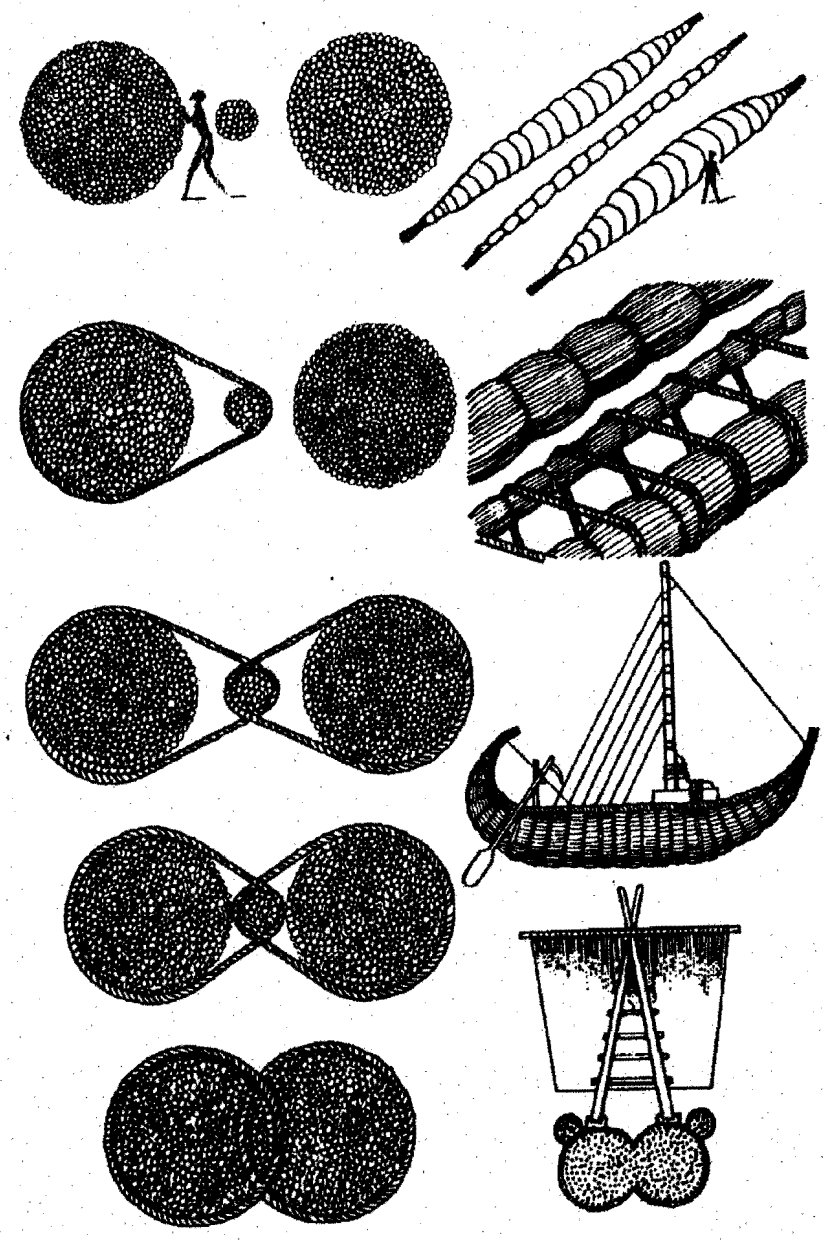

FIGURE 10

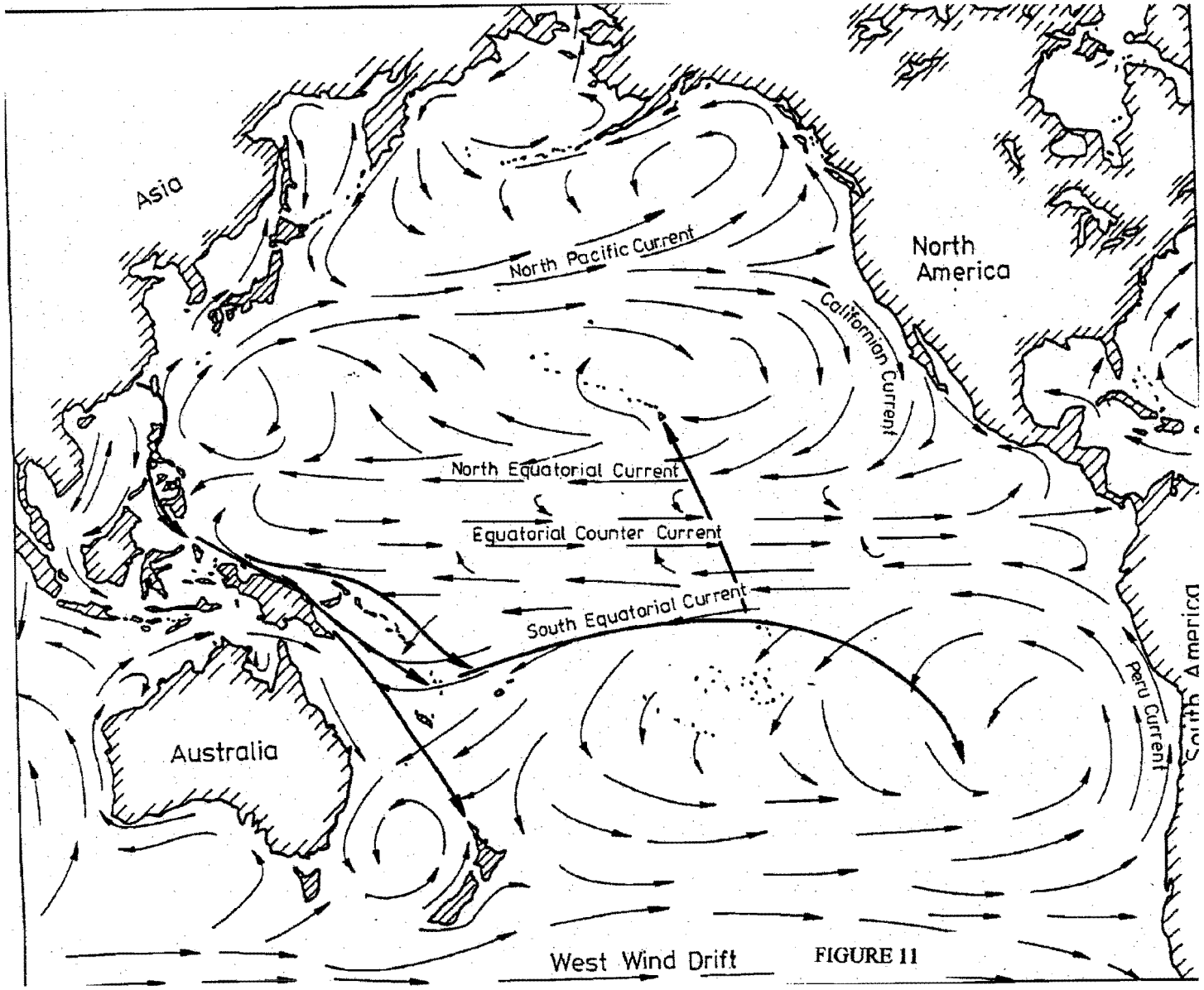
Asia
North Pacific Current
North America
Californian Current
North Equatorial Current
Equatorial Counter Current
South Equatorial Current
Australia
Peru Current
South America
West Wind Drift

FIGURE 11

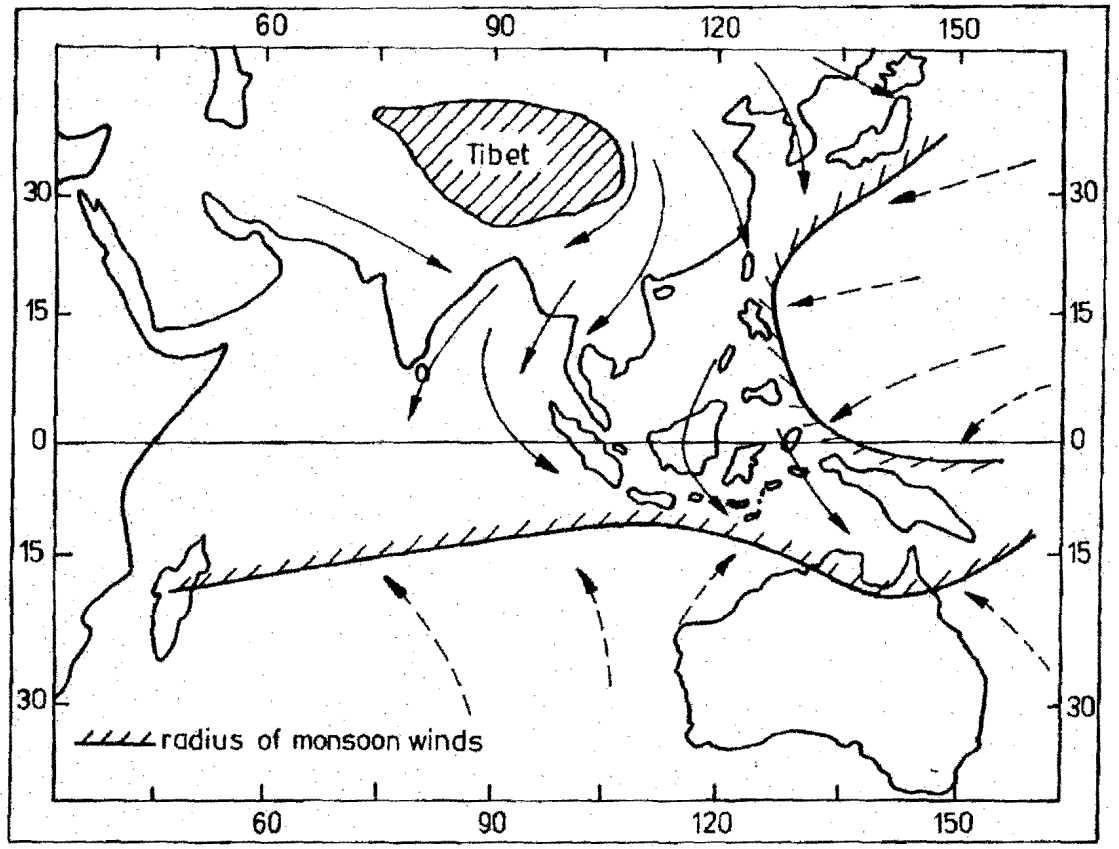

FIGURE 12

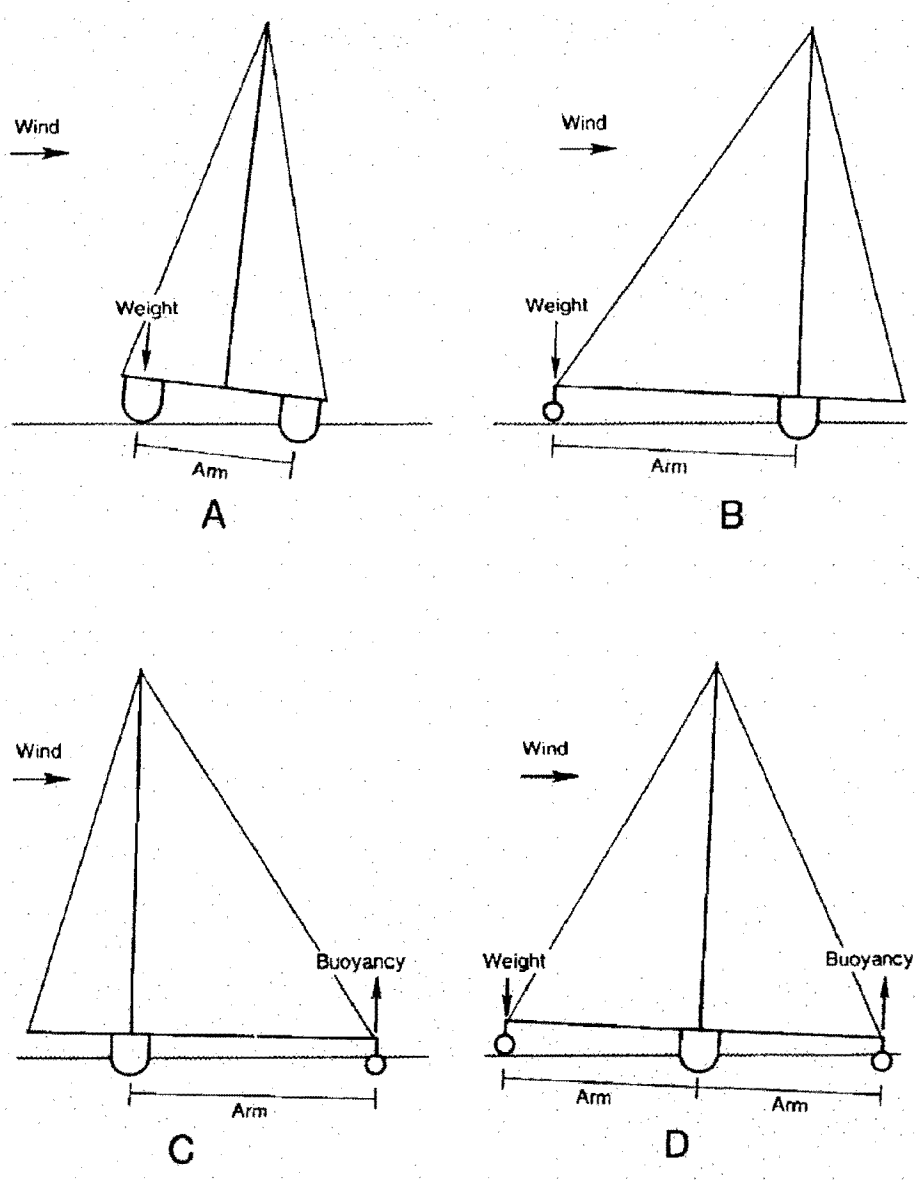
Wind
Weight
Arm
A
Wind
Weight
Arm
B
Wind
Buoyancy
Arm
C
Wind
Weight
Buoyancy
Arm
Arm
D

FIGURE 13

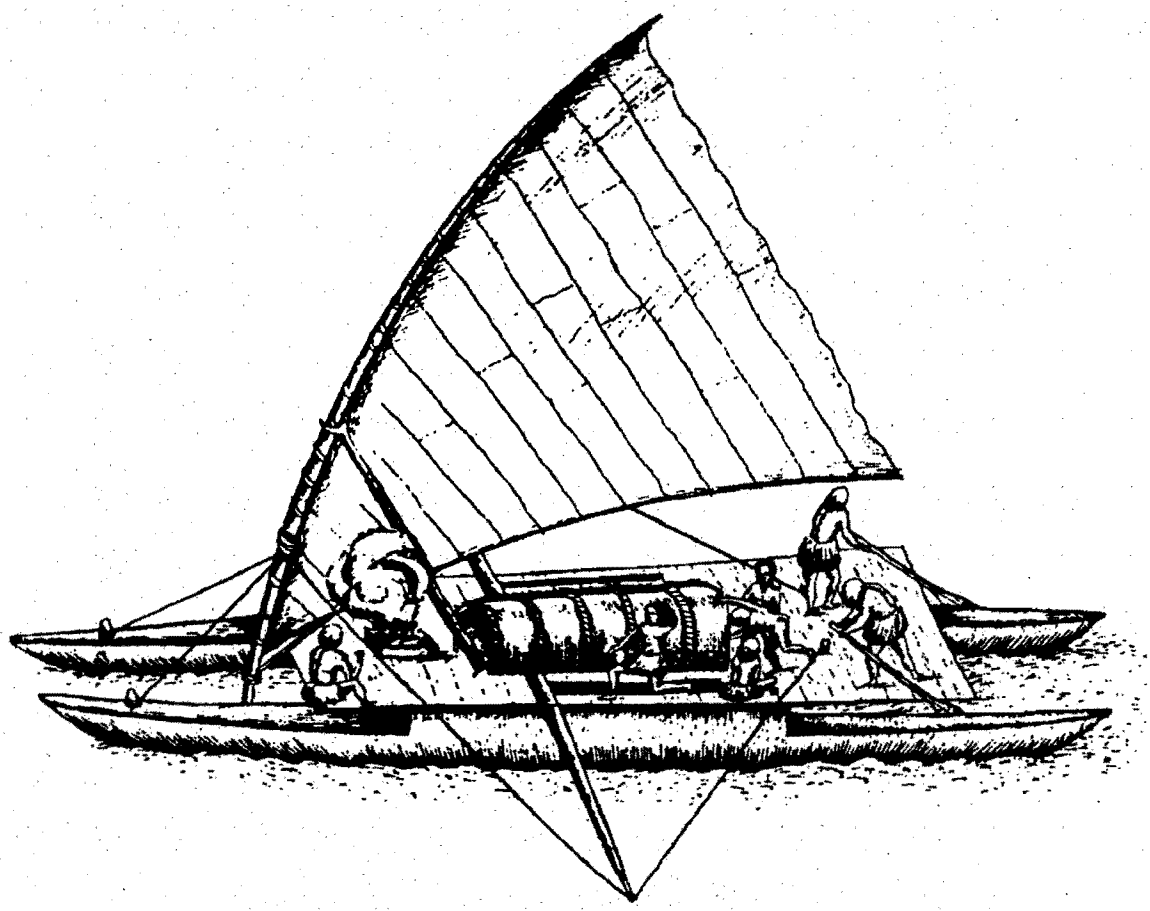

FIGURE 14

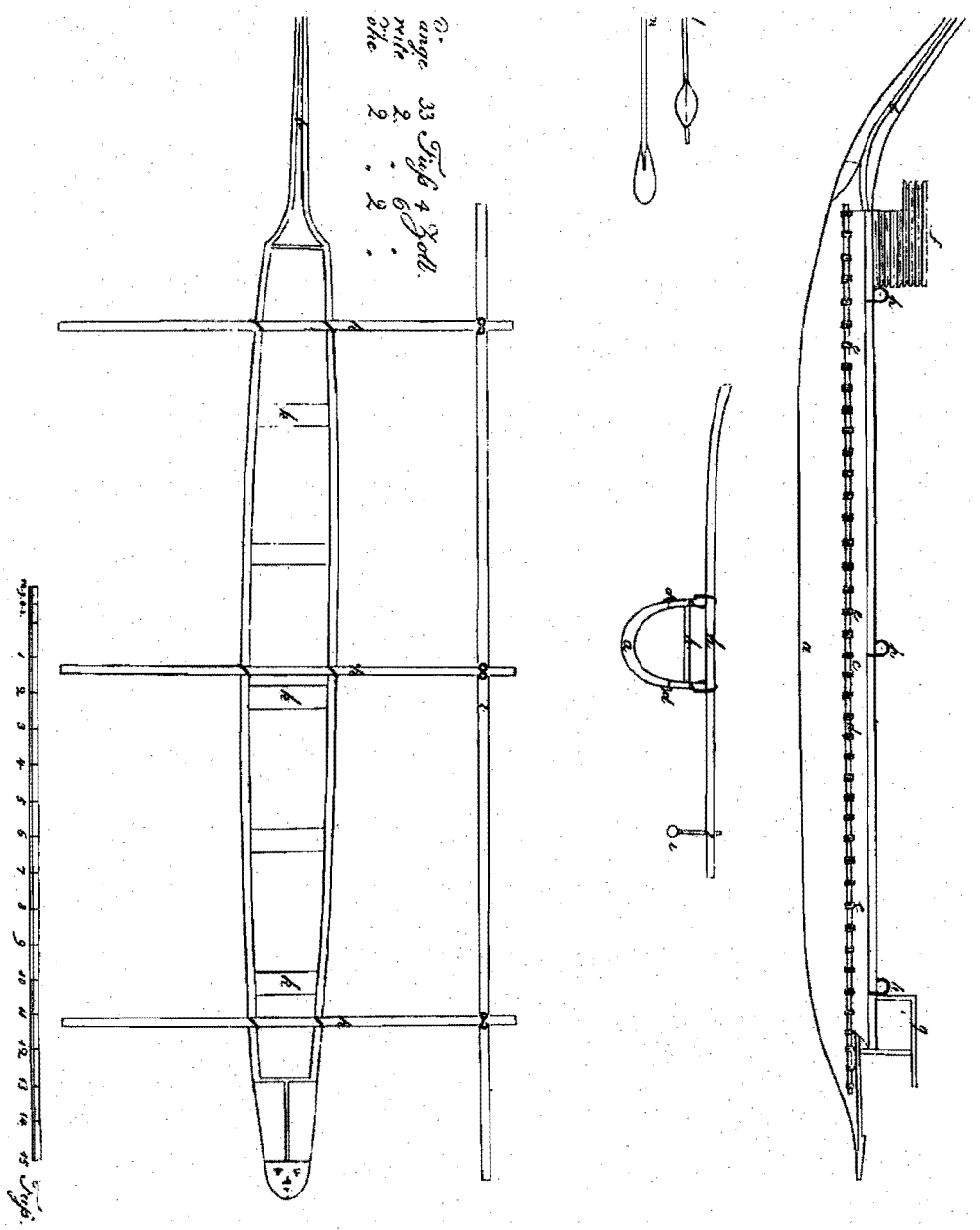

FIGURE 15

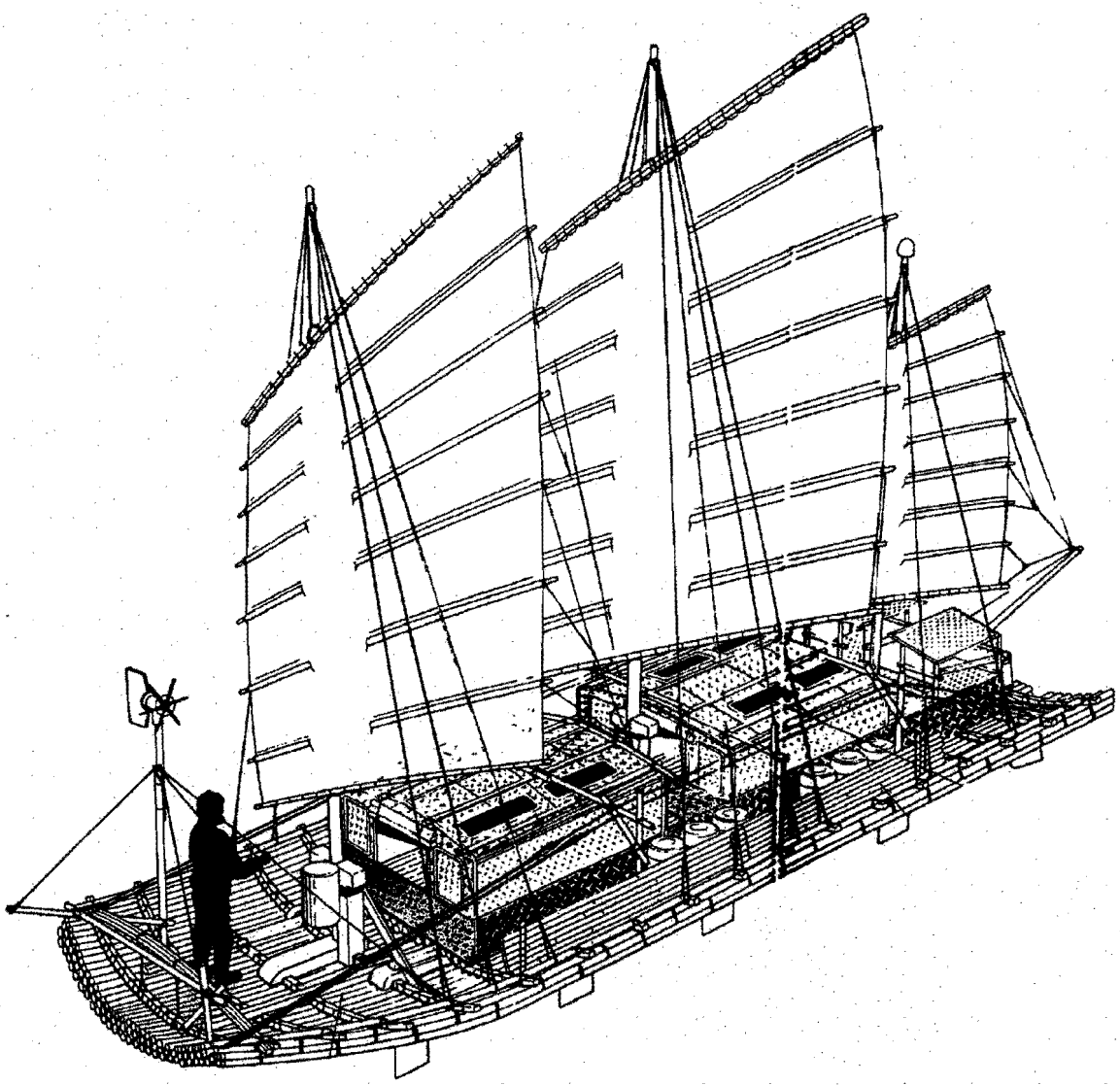

FIGURE 16

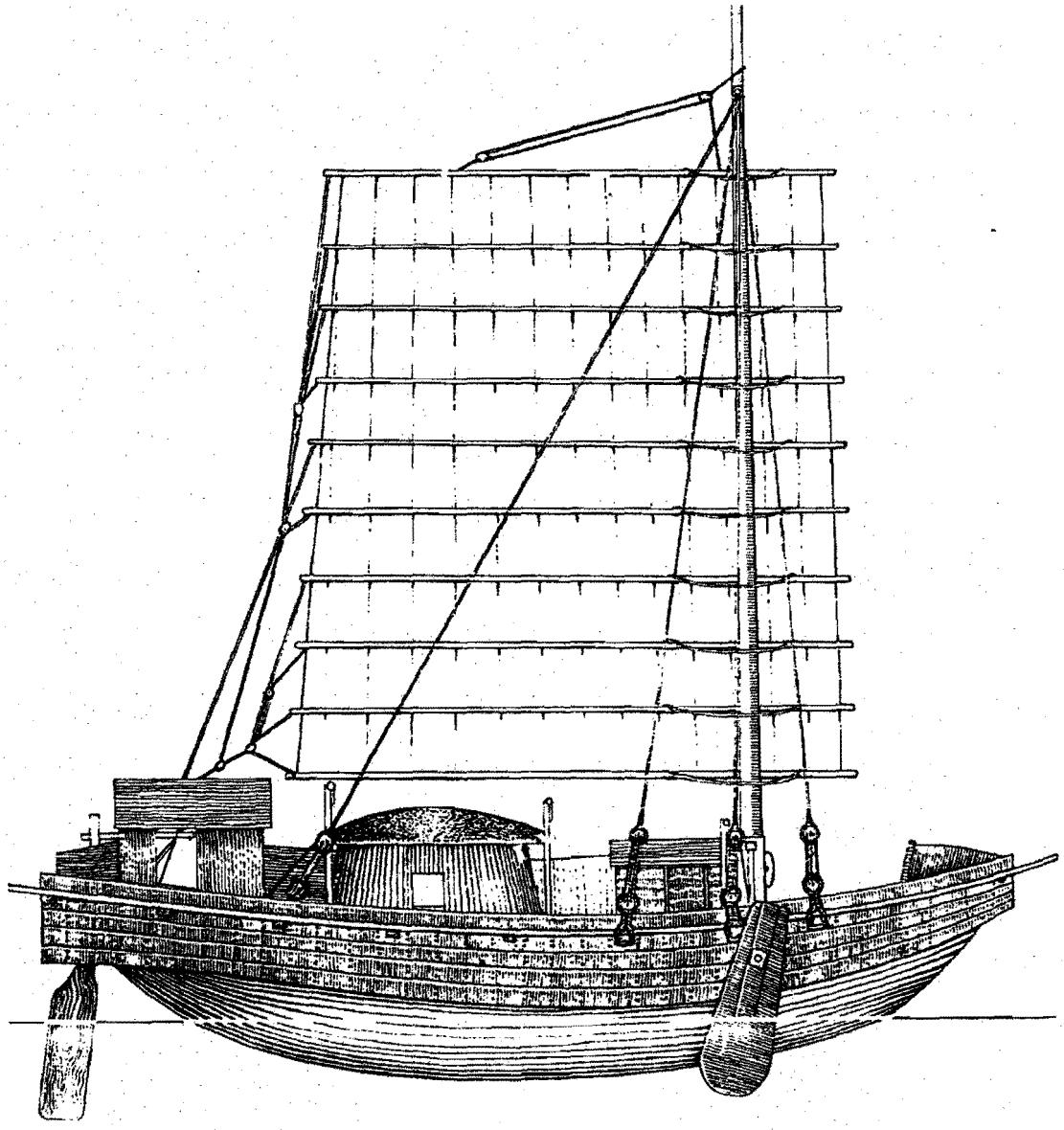

FIGURE 17

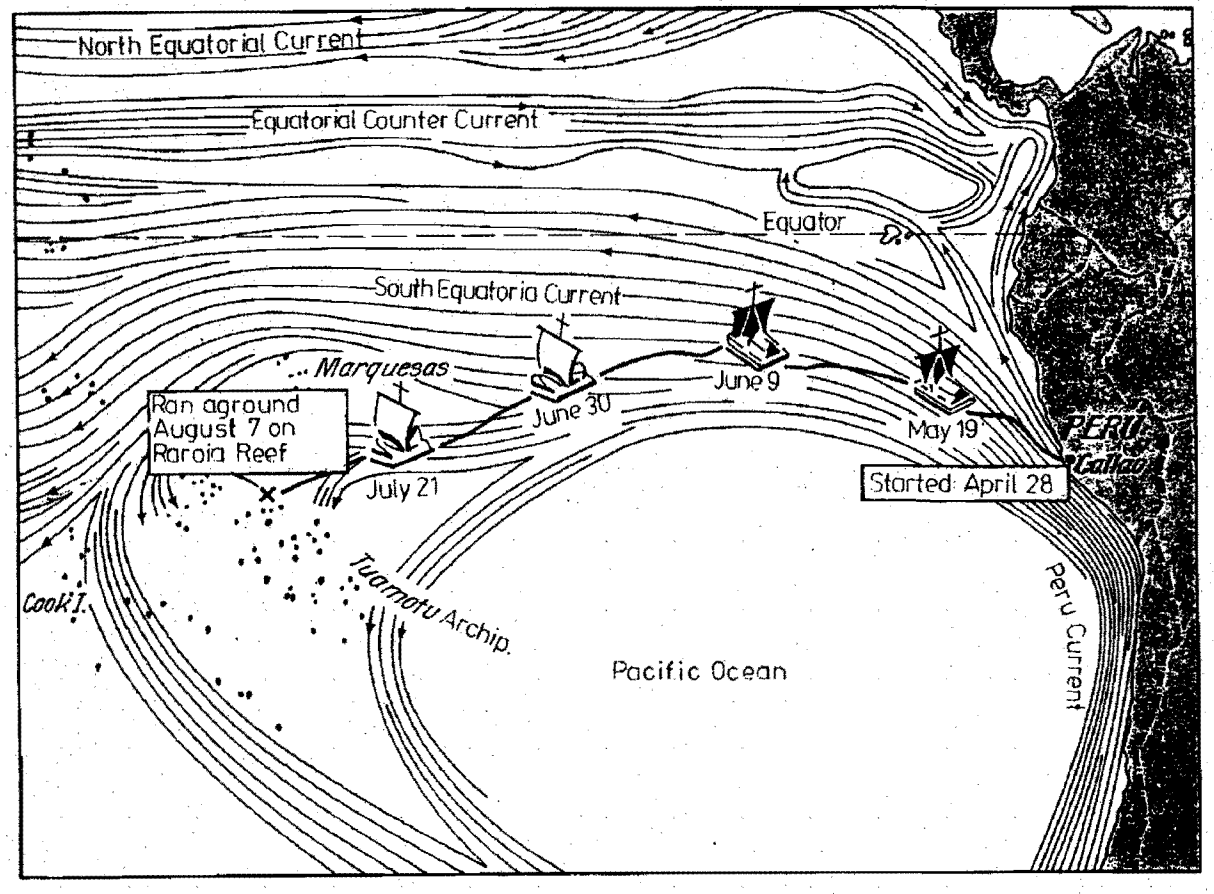
North Equatorial Current
Equatorial Counter Current
Equator
South Equatoria Current
Marquesas
Ran aground
August 7 on
Raroia Reef
June 30
June 9
May 19
July 21
Started: April 28
PERU
Callao
Cook I.
Tuamotu Archip.
Pacific Ocean
Peru Current

FIGURE 18

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