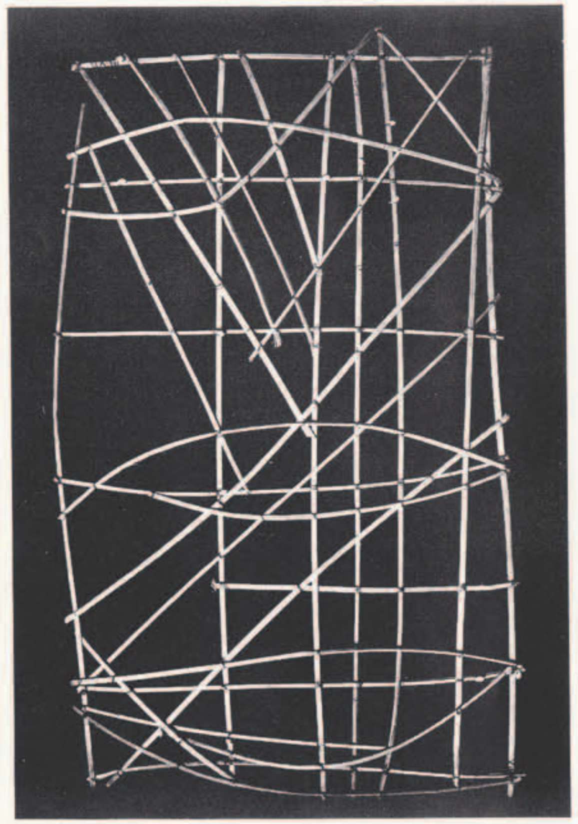
MARSHALL ISLANDS CARTOGRAPHY

By WILLIAM DAVENPORT

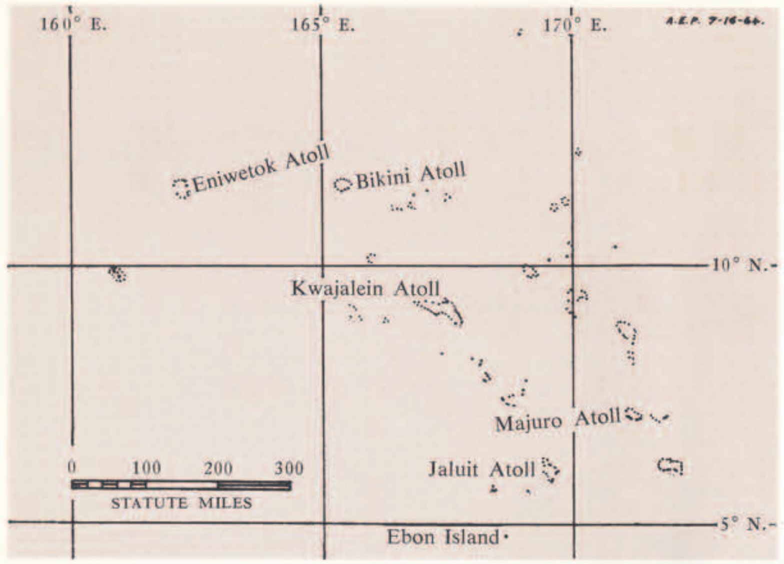


The University Museum's meddo *chart, collected by Robert Louis Stevenson. The straight sticks represent systems of swells rolling into the Marshall Islands. Shells tied to the framework represent islands of the group. The curved sticks depict refracted swells. Most of these kinds of charts represent only a few islands and their characteristic swell patterns, but this one covers nearly the entire Marshall group. 29 by 49 inches.*

Cartography is an invention that is seldom encountered among primitive, that is non-literate, peoples, for it seems to be a development closely allied with writing systems. One of the rare occurrences of map making in a primitive culture—and certainly the most sophisticated of them—is in the Marshall Islands of eastern Micronesia, Pacific Ocean. Before their first contact with European civilization in the 16th century the Marshallese had perfected both ocean-going canoes that were as maneuverable and swift as any small craft ever devised, even by an industrialized society, and a unique system of piloting that was graphically represented on a kind of chart.

The hulls of their canoes, constructed of handhewn planks that were tightly fitted and stitched together with coconut fiber cord, were knife-thin and kept stable in the water by a cantelevered outrigger float on one side. Driven by a lateen sail, the canoe could be easily tacked and sailed up very close to the wind, without making undue leeway, as well as sailed down wind with minimum drag in the water. With such seaworthy and manageable craft as these, regular communication among the 34 coral atolls of the Marshall Islands was possible, even though the tiny islands of this group are widely scattered and all are so low that none can be seen from more than a few miles at sea.

By acute observation of the sea, the Marshallese had accumulated a rich fund of accurate knowledge about the action of ocean swells, what happens to them as they approach and pass by land, and the characteristics of two or more swell patterns interacting with each other in the presence of an island. Much of this empirical knowledge was not so well known by scientific oceanographers of our society as it was by Marshallese seafarers until aerial photographs were available for studying wave and swell action. When oceanographers began to study ocean swells it was found that their action conformed to the laws of wave theory in the same ways as do light and sound. For example, when an ocean swell strikes a shore, part of it—its energy, that is—is reflected at an angle equal to the angle of its incidence. And when a swell approaches, strikes, and part of it moves past a small island, such as one of the Marshall Islands atolls, its line of movement is changed according to the angle of shoreline toward which it is advancing. The crestline of a swell approaching the shore of an island is bent and curved toward conformity with the shoreline. This occurs because the inshore portion of the wave is slowed down as it encounters shallow water, its energy is expended by breaking or peaking up the wave, thus slowing down the forward motion while the offshore portion in deep water continues advancing at a constant rate of speed. This is swell refraction. Finally, a turbulent shadow of a special kind, resembling a penumbra, is to be found extending out from the lee side of an island for several miles.

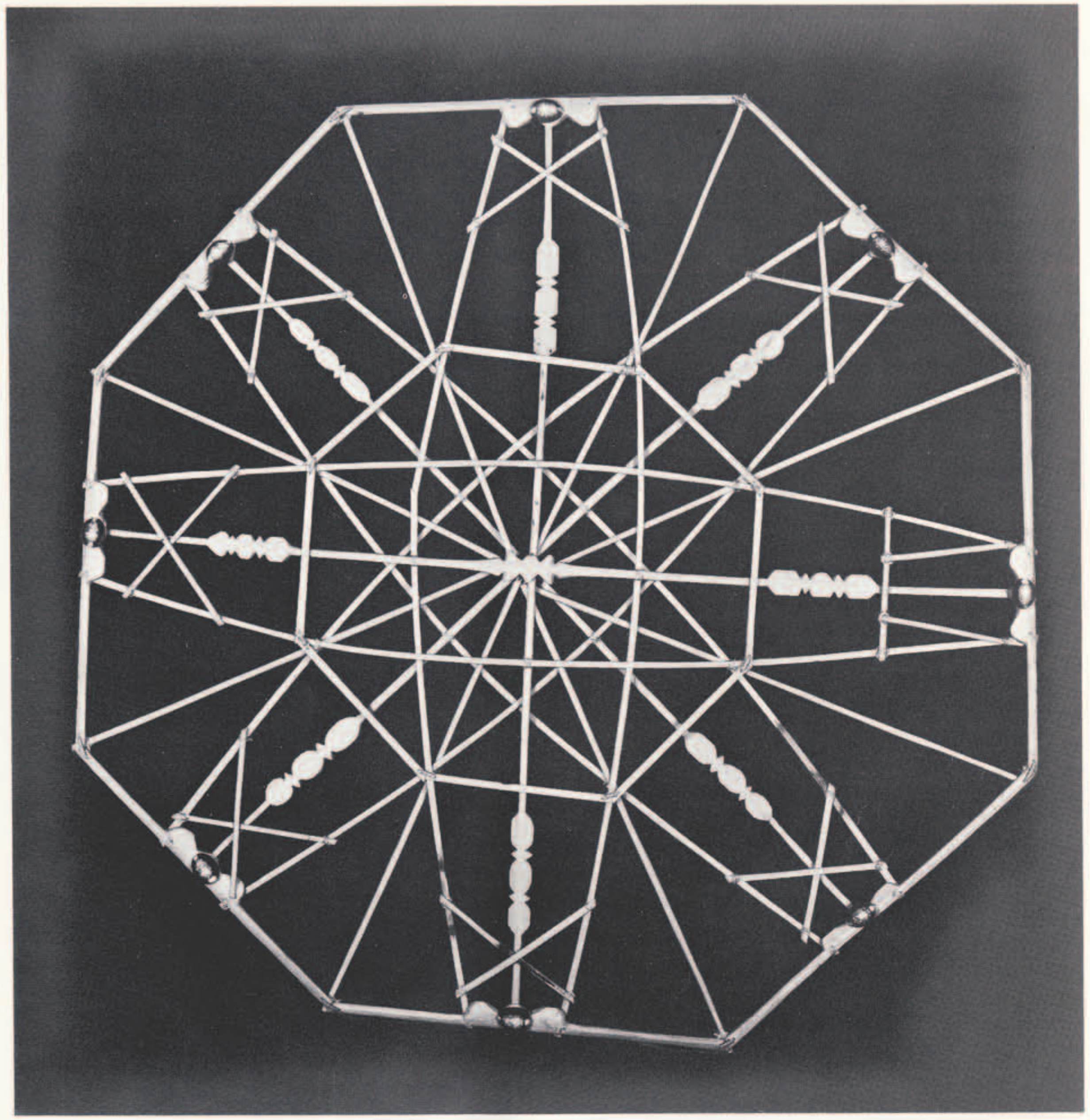


Inhabited by about 14,000 persons who are racially classed as Micronesians, the Marshall Islands are part of the Trust Territory of the Pacific Islands which are administered by the United States under a trusteeship from the United Nations.

Reflection, refraction, the shadow phenomenon, and several other ancillary wave actions were well understood by the Marshallese who studied them, not from the vantage point of aerial photographs where they can be observed with ease, but from the surface of the sea in their canoes and from the shores of their atolls which offer elevations never more than a few feet above sea level. They not only recognized these complex swell and wave patterns, they put this empirical science to practical use by developing a system of piloting and navigation from it. It is these oceanographic phenomena that are depicted on their charts. The charts are used by sailing masters to teach the principles of wave action and the use of them in fixing a canoe's position when it is near to but out of sight of land.

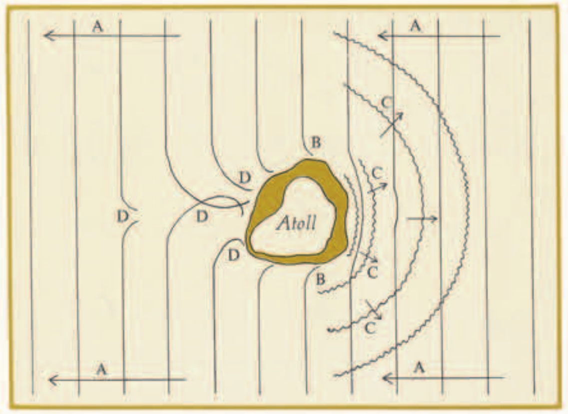
Marshallese charts are not drawn on flat sheets; they are models constructed of sticks. There are two types: the *mattang,* constructions that illustrate the abstract general concepts of swell movements and interactions in the vicinity of one or more small islands; and the *meddo* ("sea") constructions depicting particular islands in the Marshall group and their distinguishing wave characteristics. The former are, in effect, science models; the latter, piloting instructions. Neither kind was carried on board a voyaging canoe, for all the oceanographic erudition was stored inside the Marshallese navigator's head. And these navigators, even today, guard this information carefully and pass it on only to others who have been specially selected for the training. Only when the information is to be conveyed to an apprentice are the best charts—that is, those with complete information—constructed. One of the finest *meddo* type charts in any museum collection is the model collected by Robert Louis Stevenson and his wife when they were in the Marshall Islands in 1890. It is displayed in the Oceania Hall of the University Museum.

Another fine example of the *mattang* type was given to the writer by James Milne, a fully



A mattang*-type chart on which the principles of piloting by ocean swells are illustrated. The cardinal point is the side on which the two small sticks are not crossed. It is the sunrise or easterly quarter out of which the northeast tradewinds blow, bringing the dominant system of swells. The other swell systems depicted are those that are generated by winds in other parts of the Pacific Ocean and reach the Marshall Islands in different times of the year after travelling across thousands of miles of sea. 34 by 35 inches.*

trained Marshallese navigator, from Ebon Island in 1958. It is remarkable for on it are represented four (two is the usual number) different swell patterns, their reflections and refractions, as well as a number of possible interactions these may have with each other, depending upon the condition of the sea and the way in which the model is read. Each swell pattern is represented by a pair of opposed curved sticks, between which is laid a straight stick with a notched figure near each end. One straight stick has a third notched figure at the center. At all ends but one of the swell representations is a pair of shorter crossed sticks that represent the interaction of the two adjacent swell patterns on the one represented by that to which the short pair is lashed.



Reflection and refraction of ocean swells as they strike a small atoll. (A) Straight line of advance of a system of ocean swells. (B) Crestlines of the swells are bent or refracted as they strike land and conform to the contour of the shore. (C) Part of each swell is reflected back after striking the island. (D) Shadow of turbulence created by refracted portions of swells that curve around the island.

The odd end that has two uncrossed sticks represents the direction of sunrise, the cardinal direction for the Marshallese, from which come the tradewind and the dominant swell. All elements of the model are arranged into an octagonal composition. The eight marginal sticks forming the sides of the octagon and the undecorated straight sticks that connect the corners constitute the supporting frame only and represent nothing.

In reading this training model, the center can represent an island, and the bent sticks illustrate refractions of waves approaching it from many directions. The cowrie *(Cypraea* sp.) shells tied at the center point of each side can also represent islands, and the crossed sticks by them illustrate either interactions of other refracted waves or the turbulence that is found in the lee of an island as a swell is bent around it. In other words, some elements of the construction can be used to represent more than one principle of swell action. Combinations of island representations, either center and side or side and side, can be selected by the instructor to represent almost any pair of islands in the Marshalls in a variety of wave conditions.

The problem for the Marshallese pilot is to be able to sail up and down the whole chain out of sight of land and to know his position relative to the nearest islands all the time; knowing this he can correct his headings as needed in order to make accurate landfalls when currents, which cannot be observed, affect his traversed course. To do this he must know the relative geographic positions of all the islands in the group, the expected sailing distances between them under varying conditions of wind, and must be able to read the configurations of swells that identify each unseen island as he passes it. By lying on his back in the bilge of his canoe and sensing the motion of the canoe, the skilled pilot can "fix" his position at night even without looking at the sea, for the movement of the canoe alone will tell him what kinds of swells are acting on it.

Obviously, a certain amount of aesthetic license is to be found on some charts, and an instance of this can be seen on the *mattang* described here. Wave patterns rarely, if ever, occur in such perfectly symmetrical relationships as shown on this chart. And an added bit of appropriate symbolism is contained in the notched figures of the straight sticks laid between the curved pairs, for they are appropriately shaped in the same form as were masthead decorations on the old Marshallese sailing canoes. These creative liberties hardly can be attributed to the scientific naiveté of a tribal people; the trained technicians who construct the colored ball and wire models of the atom in order to illustrate principles of nuclear physics also seem to sacrifice some scientific accuracy for visual appeal.

SUGGESTED READING

Robert S. Arthur, "The Effect of Islands on Surface Waves," *Bulletin of the Scripps Institution of Oceanography of the University of California, La Jolla,* Vol. 6, No. 1. Berkeley, 1951.

Henry G. Bigelow and W. T. Edmondson, *Wind Waves at Sea, Breakers and Surf,* U. S. Navy Department, Hydrographic Office Publication No. 602. Washington, 1947.

William Davenport, "Marshall Islands Navigational Charts," *Imago Mundi,* Vol. 15. 1960.

WILLIAM DAVENPORT, Associate Curator of the Oceania Section of the University Museum and Associate Professor in the Anthropology Department of the University of Pennsylvania, has had a lifelong interest in boats, sailing, and navigation. During 1955 and 1956 he learned the Marshall Islands system of piloting by swells from a Marshall Islander who still uses it to navigate his small trading ship throughout the group. Dr. Davenport is currently engaged in ethnographic research among the Melanesian peoples of two islands, Owa Raha and Owa Riki, in the Eastern Solomons.