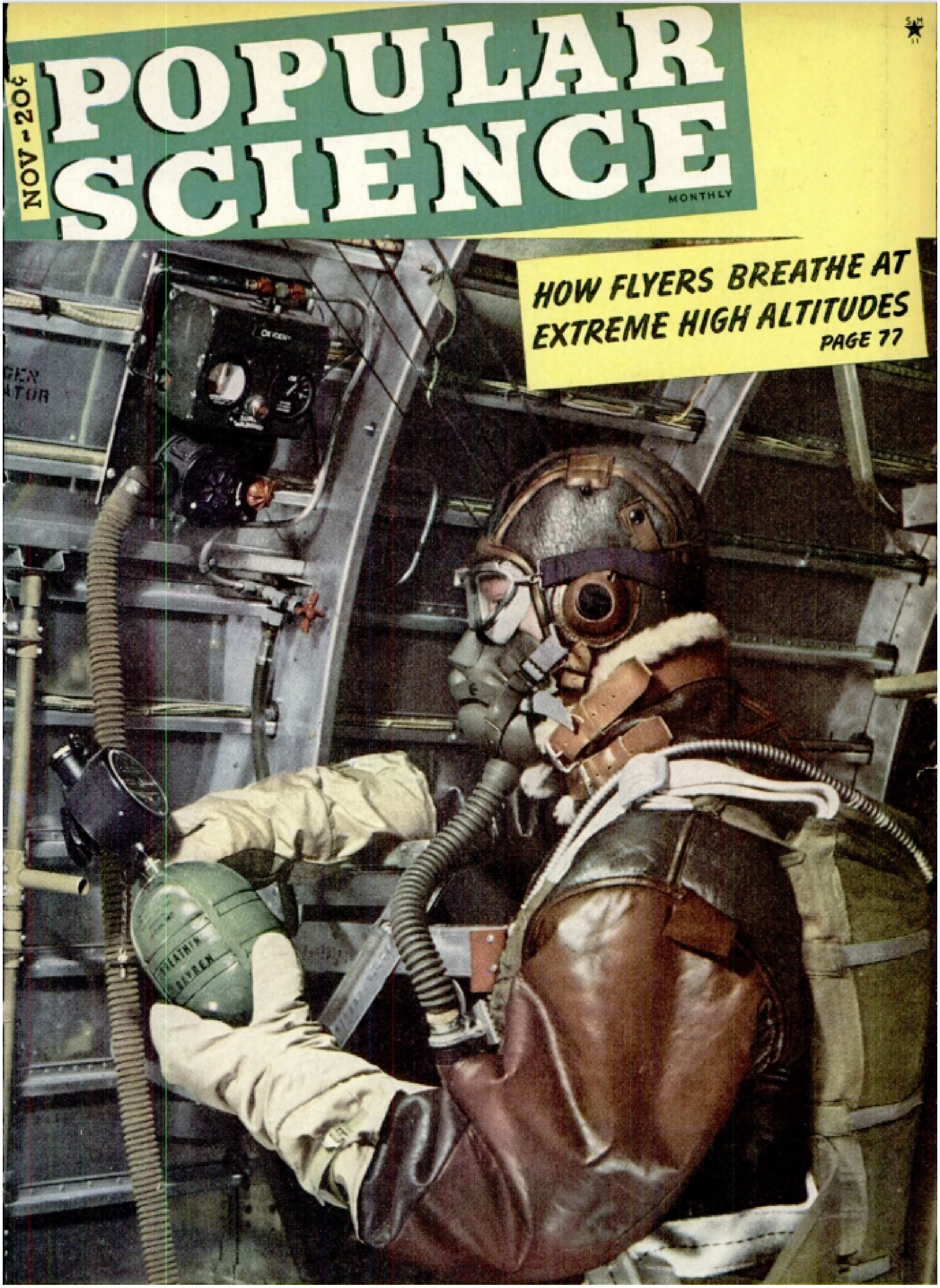

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PUTTING THE PRECISION IN PRECISION BOMBING

OUR bombardiers' boast that they can "hit a pickle barrel at 10,000 feet" is backed up by a mathematical and mechanical miracle. When a bomb is dropped from a plane traveling 200 miles an hour, miles above the earth, it is a job for an Einstein to figure just where it is going to land. Good as they are, our bombardiers are not expected to be mathematical wizards. Their amazing skill in picking off enemy factories, rail yards, and military installations is due to the wonderful tool with which they have been provided—the precision bombsight. You may have wondered how this Axis-beating instrument works. An article in our December issue will explain the complicated mathematical problems involved and the ingenious mechanism that solves them.

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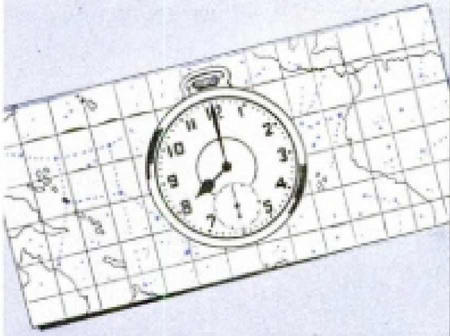
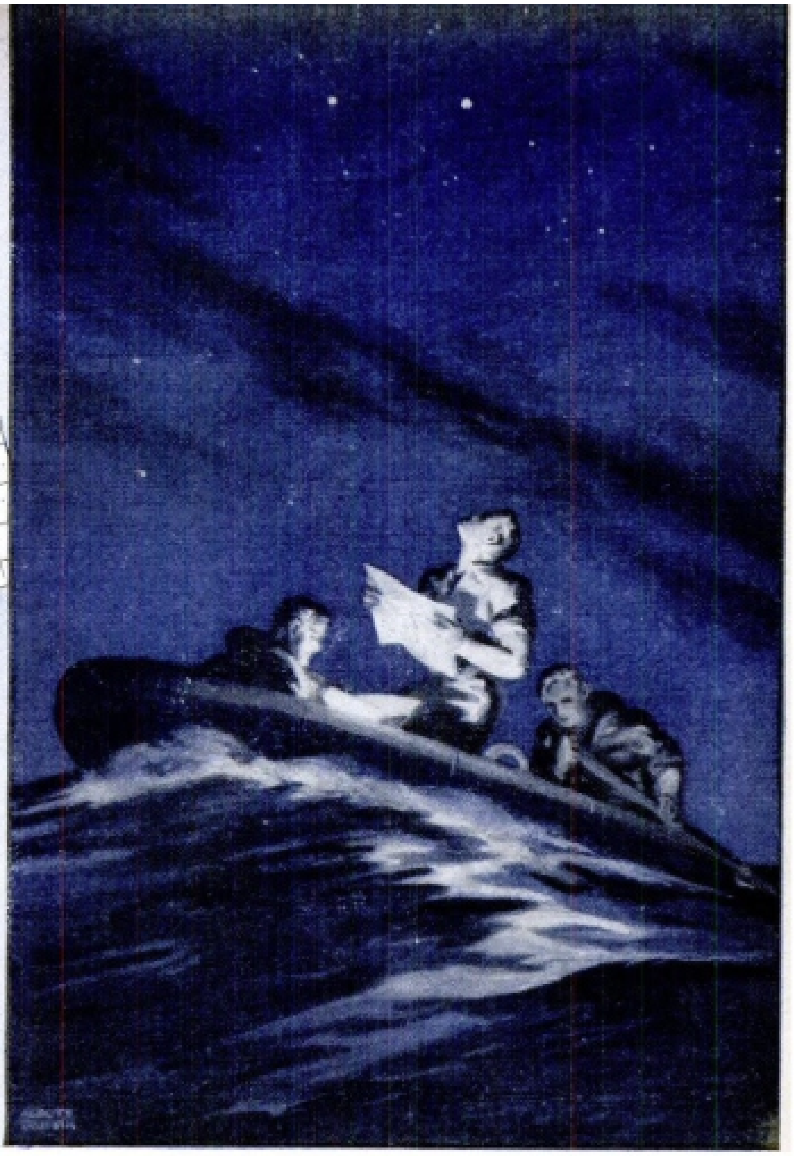
With a watch and two charts you can find your position anywhere in the world.



Aided by the brightly shining stars, these three men on a raft could be in the middle of the Pacific and still have a good chance of reaching the safety of shore. Currents, winds, clouds, reflections, birds, and sea life will help if they know how to read their meaning



How to Navigate a Raft

ANCIENT ART OF THE POLYNESIANS IS REDISCOVERED TO AID SEAMEN AND FLYERS ADRIFT FAR FROM LAND

By SEYMOUR FREIDIN

SUPPOSE you got tossed out on the ocean from a torpedoed ship or a plane that couldn't make it home after a bombing raid. Do you think you could find your way to land? You stand a good chance of doing just that if you have with you on your raft a watch in a waterproof case (or, better still, in a transparent, waterproof rubber sack that can be kept closed) and two charts, one of the heavens and one a navigational base chart of the world, and both drawn to the same scale.

Even without these basic implements, Polynesian travelers of some 600 years ago made long voyages over the trackless Pacific—the last of them a great colonization trip from Tahiti to New Zealand, a distance of 2,500 miles. Their navigators used simply their eyes, their sense of hearing and of smell, and a primitive knowledge of the heavens and the sea.

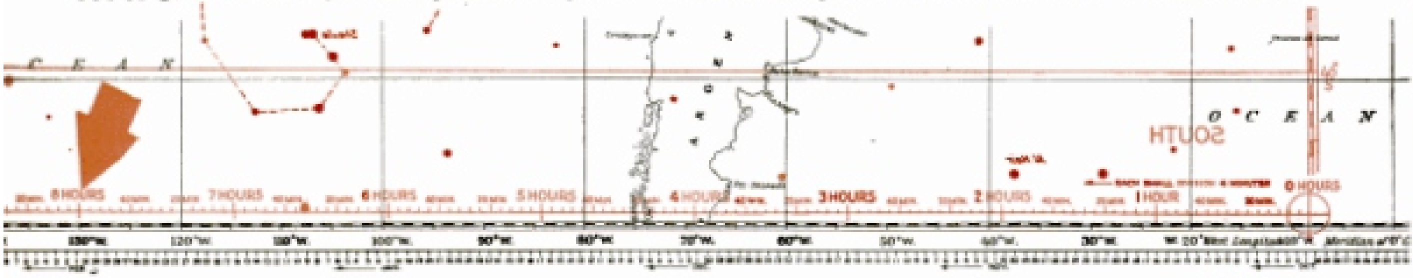
But their method of navigation has been buried these past six centuries in a maze of Polynesian song and legend—known only to their priests and wise men and transmitted by word of mouth from generation to generation since economic necessity and tribal differences no longer prompted these great sea migrations. Their secret has only recently come to light, and it is so remarkably simple that a system based on it opens the prospects of successful navigation to the most absolute landlubber.

Capt. Harold Gatty, who was Wiley Post's navigator on his first round-the-world flight and has passed most of his life in the South Pacific, has written "The Raft Book" (the George Grady Press, New York) based on extensive research in Polynesian legend. "The Raft Book" is intended as a guide for those lost anywhere on the world's oceans. Through the courtesy of Captain Gatty, Popular Science is able to present here some of its more important features.

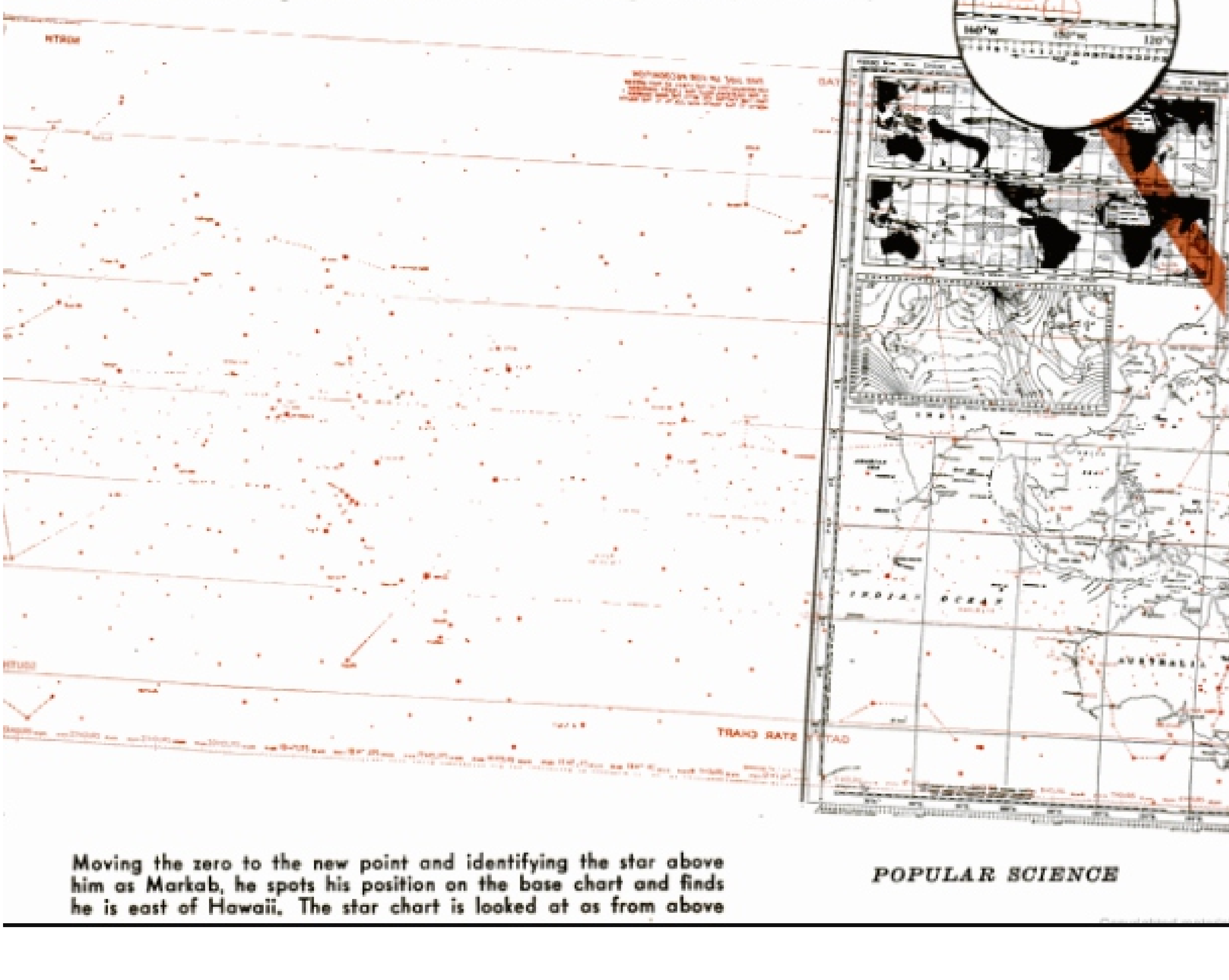
What value there is in following the stars, what various types of sea birds and fish indicate, how currents and winds may be used to advantage, what aid can be had from clouds and reflections in the sky—a knowledge of these things helped the Polynesians reach their destinations, and they will help the average man today as well, even if he is without training in navigation.

With neither charts nor watch, the Polynesians relied on a traditional lore of the stars, viewing them as moving bands of

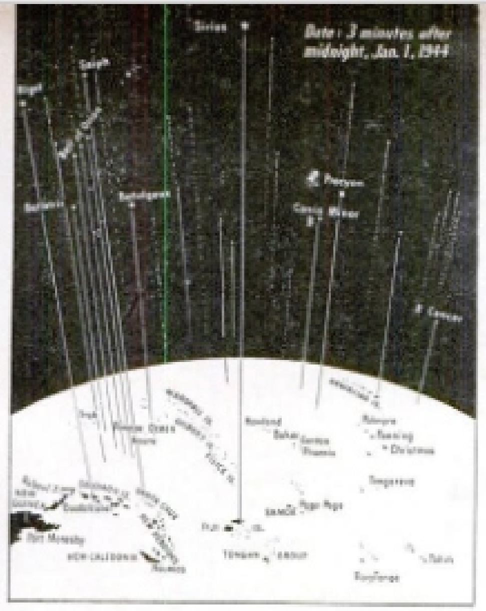
WATCH AND STAR CHART GIVE THE EXACT POSITION OF THE RAFT



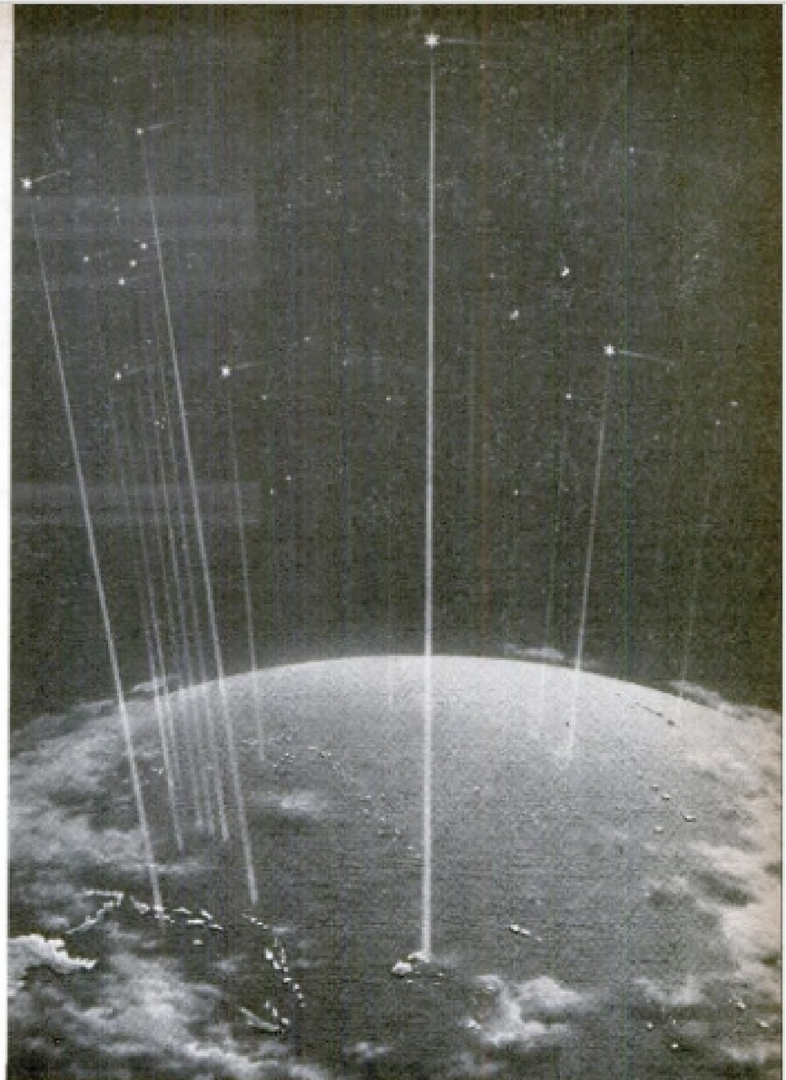
Out on a raft in the Pacific at 8 a.m. Greenwich time October 1, the amateur navigator takes his bearings. He matches the zero hour on his star chart with the date on the navigation base chart and marks off eight hours (at the arrow)

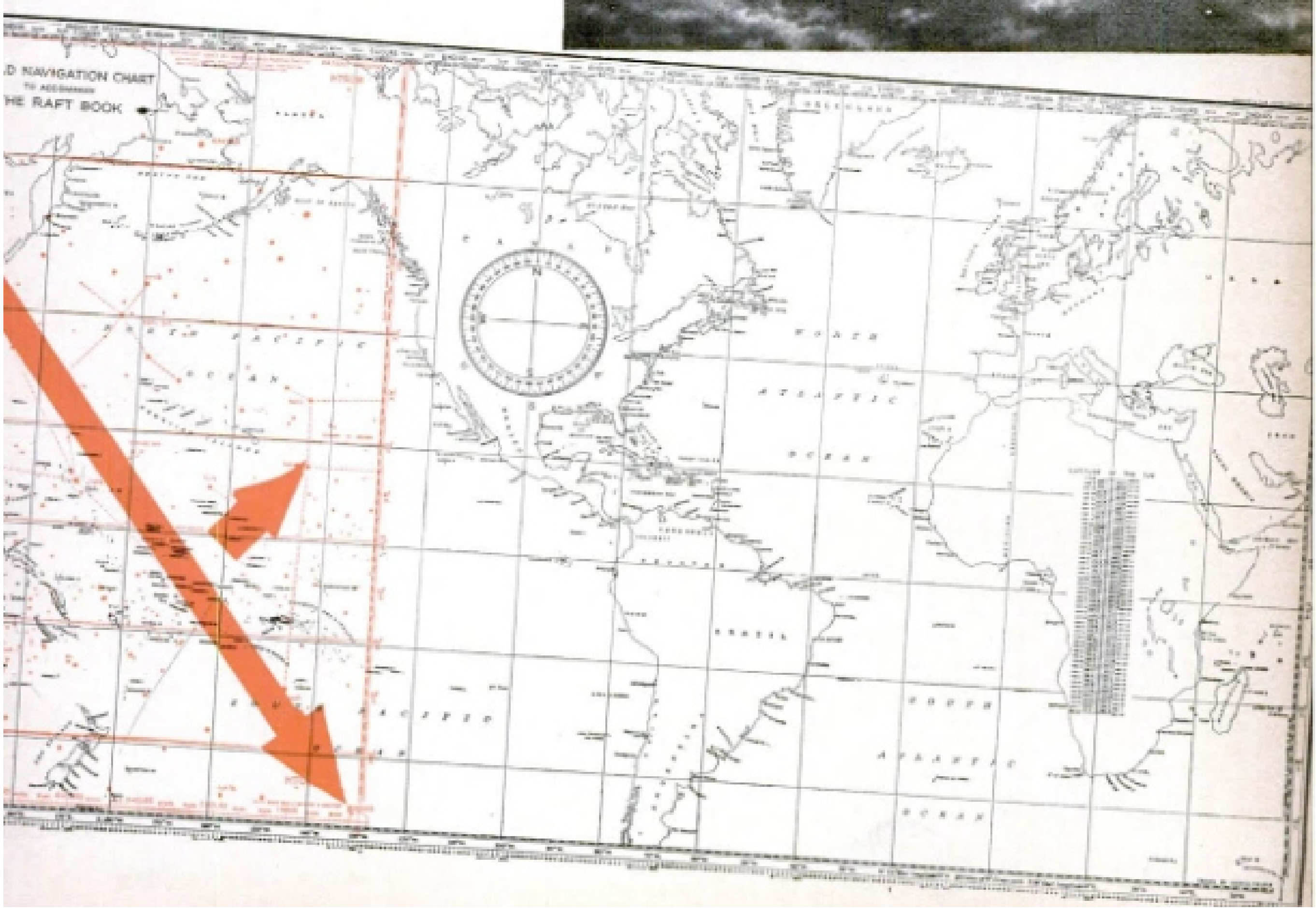


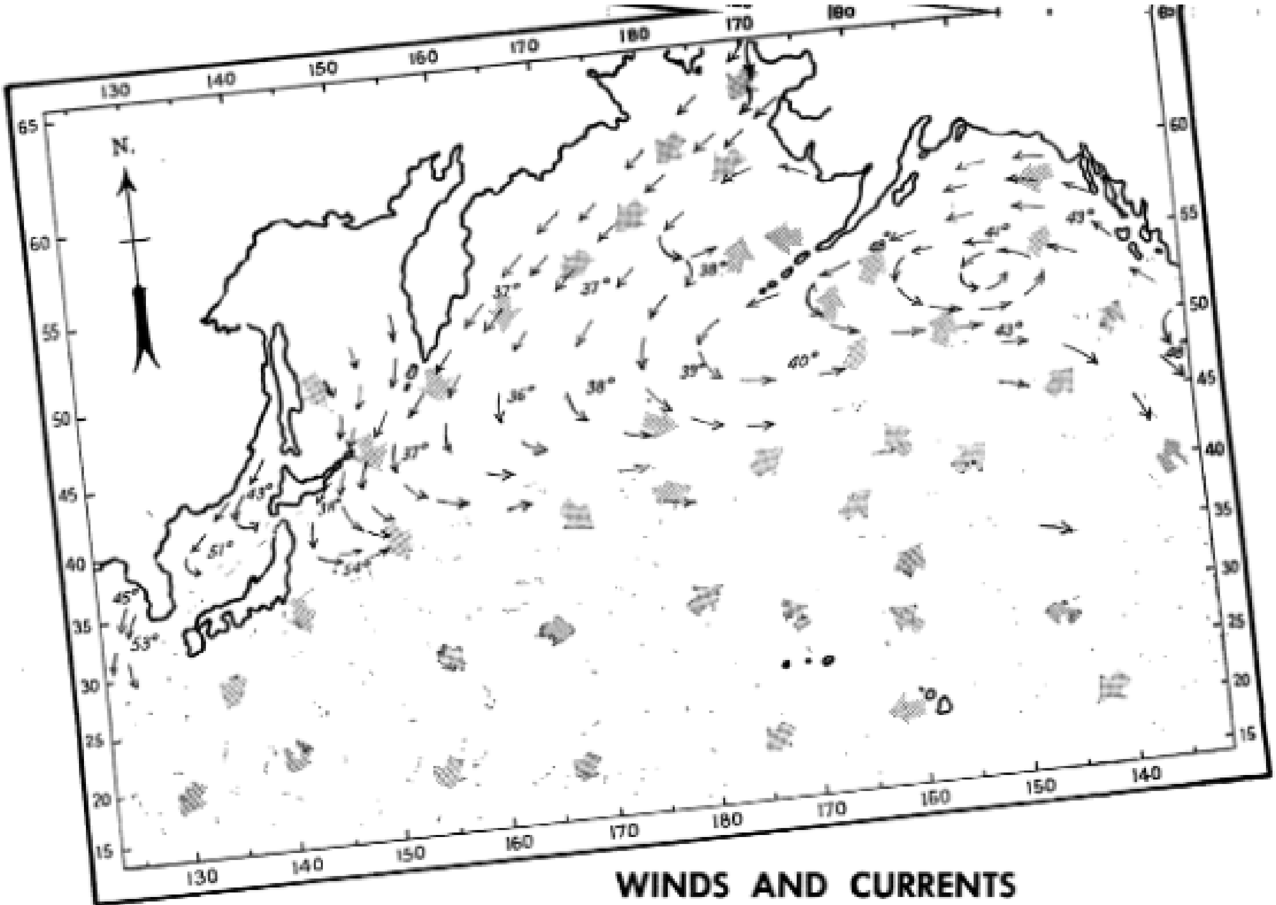
Moving the zero to the new point and identifying the star above him as Markab, he spots his position on the base chart and finds he is east of Hawaii. The star chart is looked at as from above



Stars were looked upon by the Polynesian navigators of six centuries ago as moving bands of light that passed over the same islands night after night. Those passing over particular islands were memorized and used as beacons to lead the Polynesians to their destination. At right and in the diagram above, Sirius is an overhead star for Vanua Levu in the Fiji Islands at three minutes past midnight on January 1, 1944. All the stars are shown in their actual position for this moment. On each succeeding night they will appear in the same positions about four minutes earlier







WINDS AND CURRENTS DICTATE DIRECTION OF TRAVEL

Next, the raft navigator turns to a chart of winds and currents in the area of the Hawaiian Islands and finds that if he uses a sail he may be blown far to the south, but that the current will carry him in. He can cast a sea anchor and drift with assurance

light. They knew all the stars of each band that passed over the islands in which they were interested, and knew what star would be over a given point at a given time. Then they simply set their course by this star. This required years of memorizing, however, and restricted the Polynesians to the stars passing over the islands with which their navigators were familiar.

Since stars and their positions in different seasons of the year cannot be memorized overnight, Captain Gatty simplifies this system of navigation by providing a chart of the stars with markings on the border in Greenwich time. If you are able to recognize a star overhead and identify it on the chart, it makes little difference whether you know its name.

One essential feature of Captain Gatty's star chart is that it is printed on transparent paper. Thus, with the stars visible from either side, the chart may be used both to check on the night sky and to find the position of given stars on the navigational base chart of the world. In checking on the stars overhead, the chart is looked at from one side; in locating them on the navigational chart, it is looked at from the other, as if you were yourself above the stars looking down on the ocean.

To complete the system of navigating by the stars, you must keep your watch running on Greenwich time or be able to make calculations from it in Greenwich time. This is necessary, since the transparent sheet is moved over the navigational chart in accordance with the time of day in Greenwich time and with the date.

Just as the Polynesians "chased the stars" to their destination, you can pick out a star on your course and follow it with equal assurance of success. The movement of your "guiding star" must be watched hourly, and your course set an increasing or decreasing amount to one side according to whether the star is moving away from your destination or toward it.

In weather when the stars are not discernible, there is a duration-of-the-day method of setting your course that will serve as well. This consists simply of measuring the length of time between sunrise and sunset, and using this knowledge along with the date to find latitude and longitude in hemisphere tables included on the navigational chart. Probably the only way to determine the duration of the day on a raft is the slow but sure one of taking readings from your watch at both sunrise and sunset.

Eyes and senses must also be brought to

bear to pick up and recognize signs that will help you guide your raft toward land. Use the winds and currents in propelling your craft, sailing if the wind is right, or using a sea anchor that will keep you drifting with the current. Before deciding which to try, however, decide whether the resultant winds—the sum total of the prevailing and the other winds—or the current will better serve you. You should know, too, that the winds may blow in one direction and the current may flow in one directly opposite. Captain Gatty has prepared winter and summer charts of the winds and both warm and cold currents covering all waters.

Birds can also be a big help in finding direction. The Polynesians saw land birds take off year after year in the same direction and knew that they could not rest on the ocean. In the great voyage to New Zealand, they followed the route of the long-tailed cuckoos after repeatedly observing the migration of these birds from Tahiti.

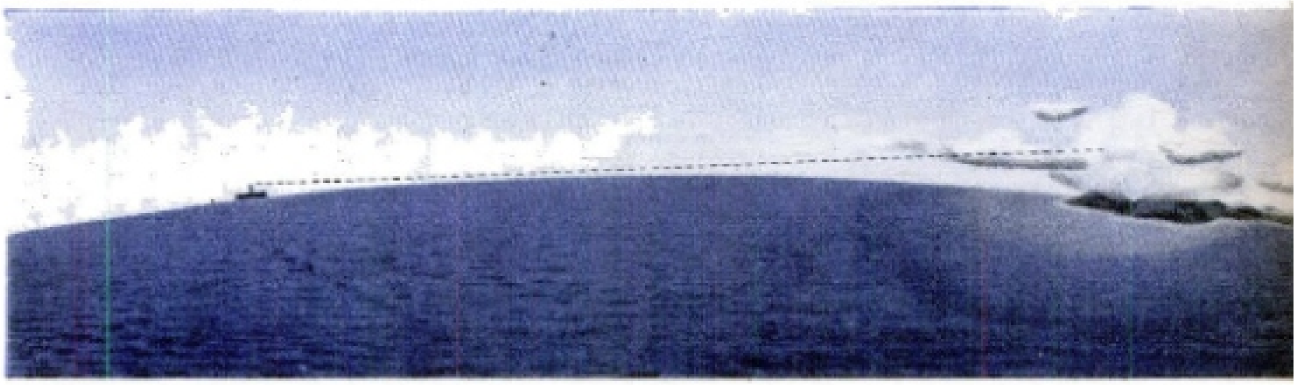
The Polynesians frequently carried frigate birds as an aid in sighting shore. Released, these birds would fly upward, spot land if any were to be seen, and go directly to it, or else, if land were not in sight, they would return to the boat, from which they could be set loose again later on. Pigeons could be used easily as substitutes.

Captain Gatty has prepared pictures of the main sea birds along with a list of their characteristic markings to help in identifying them. Noting their flight is one of the most important ways of telling when you are near land and in what direction it lies. The type found over any area of the ocean depends on the temperature, depth, and salinity, and the movement and kind of marine life present. Identifying the birds will often give additional information.

Most tropical sea birds do not range far from their breeding grounds on islands and coasts, and as a consequence they are not often seen far from land. All of them are edible, and they are easy to catch. You can bag an albatross or other hook-billed bird

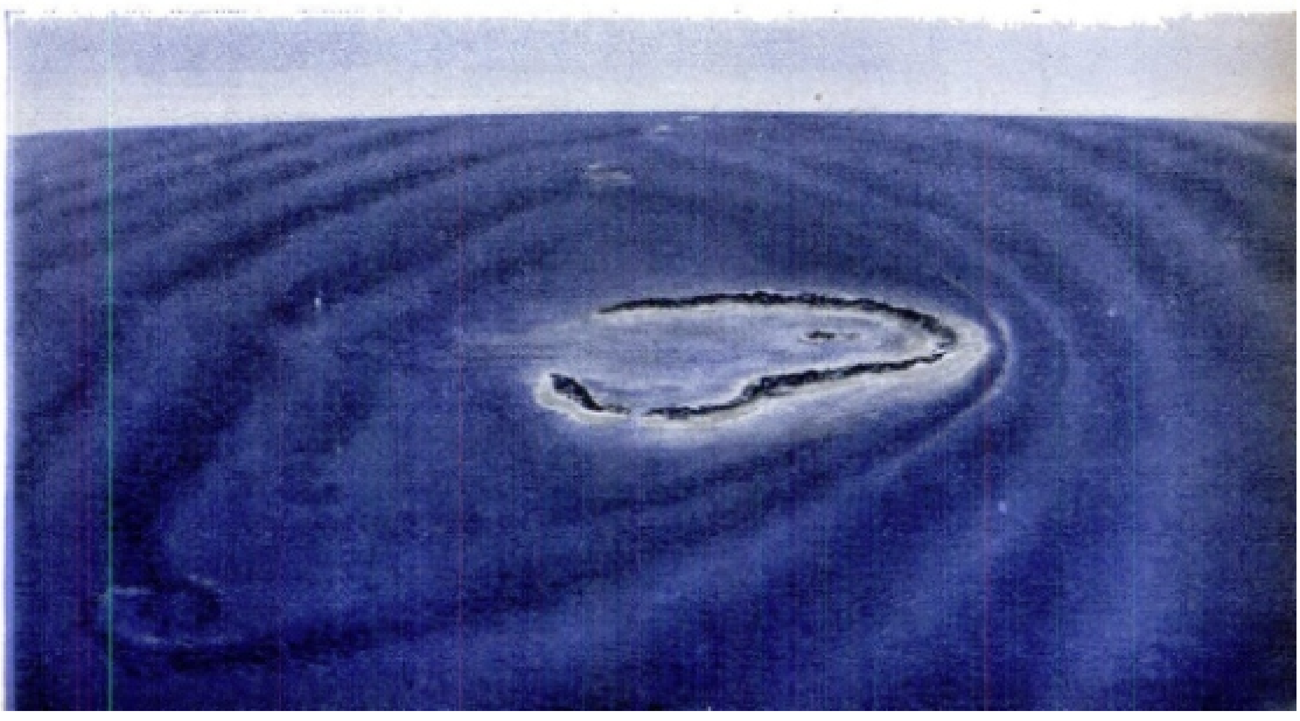
SMALL CLOUDS AND SWELLS DISCLOSE THE NEARNESS OF LAND

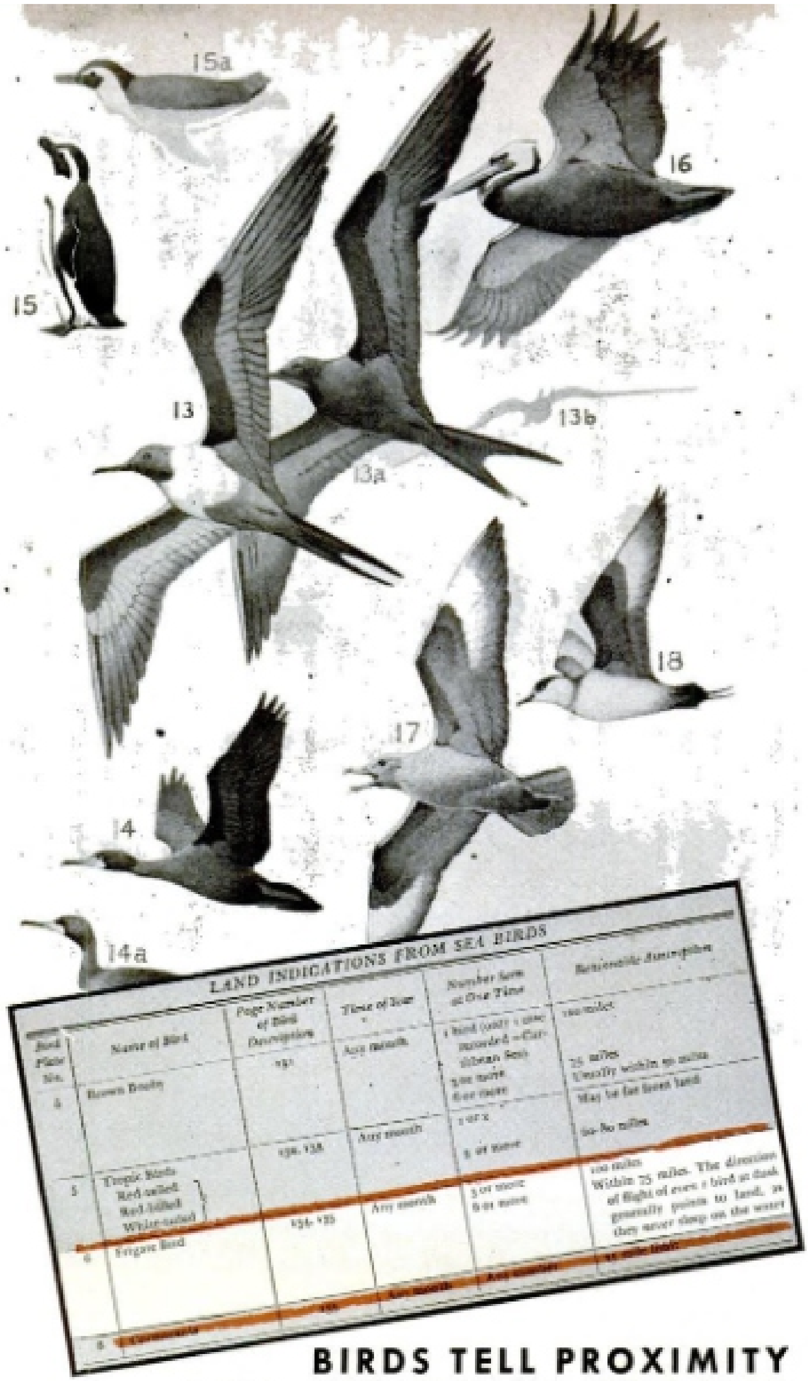
Note: In Captain Gatty's "The Raft Book," these illustrations appear in full color



↑ Because white sand reflects more heat than the sea, small clouds hover over all atolls

Parallel swells, curving to the shape of the land, are driven toward an island by the prevailing wind ↓





BIRDS TELL PROXIMITY AND DIRECTION OF LAND

Close watching of sea birds is a good guide to shore. These creatures cannot land on the ocean, and toward dusk they always fly back to the nesting grounds. Above are excerpts from Captain Gatty's book, giving pictures of sea birds and outlining their most helpful characteristics

with a shiny metal object tied to a string.

Keep a sharp lookout for fish and other surface life, bearing in mind that rich marine life occurs in quantity only relatively close to shore. Far out, there generally are whales, porpoises, large sunfish, and ocean bonitos.

Polynesian navigators watched the sky, knowing that small clouds hovered over atolls. This is because the white sands reflect more heat than the surface of the water and cause a difference of temperature above. The cloud over your atoll will be a little to the lee side, blown that way by the prevailing wind. You will be able to see on its underside a reflection of the bright turquoise lagoon long before the atoll appears over the horizon.

Deep water is a poor reflector, but lagoons and other shallow waters play their colors on a cloudless sky. In polar regions, this results in "water skies" and "ice blinks." The former, a sharply defined shadow in a bright sky, indicates open water in the midst of ice, and the latter, a patch of brightness in the gray, means floes or shore ice in open water.

Waves and swells tell their tale as well. The prevailing wind carries parallel swells toward an island, and they curve to the shape of the land as they near it. Those directly in front form waves that break on the reefs.

Sounds also can give you a good idea of how near shore may be. Gulls, with the exception of the kittiwake, are not found far out, and their cries in flight generally indicate near-by land. In fact, continued cries of sea birds from one direction usually signify a roosting place on the shore. There are such sounds, too, as breaking waves, fog whistles, and buoys. And, of course, if you hear a factory or train whistle, it's all over but the celebration.

But don't try to go head on into the shore when you actually sight it. It's usually dangerous to attempt a landing from the windward side of an island, and even on the lee side, heavy surf may make it hazardous. Don't risk everything by trying to fight your way in. If you have any doubts, remain outside the breakers and signal for help with any means at your disposal—a pistol shot, a flare, a distress flag, or a plain, lusty shout.

Navigating the high seas in a small boat is perfectly possible if you know how. The Polynesians did it—and so can you.