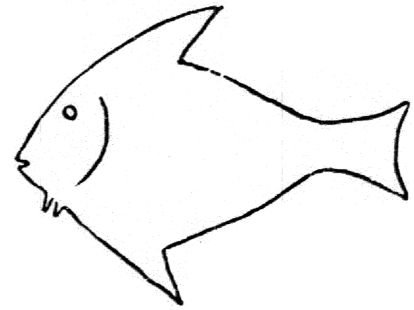


CHAPTER 8
ISLAND CURRENTS

We were sailing to the island of Sonsorol on the schooner *New World*. It was shortly before 2:00 A.M. on a quiet, moonless night. My watchmate was Mariano Carlos, a young Sonsorolese chief home from law school in the midwestern United States. The captain had told us to wake him at 2:00 A.M., having reckoned that we would be close to Sonsorol by then and would have to drop the sails and wait for daylight before making our approach.

Without any warning the boat began to shudder and shake. A few seconds later, and with equal suddenness, the shaking stopped.

"Sonsorol is just ahead," said Mariano matter-of-factly. "It's time to wake the captain."

"How can you tell?" I said. "And what just shook the boat?"

"A current that occurs close to the island," he said.

This startling encounter with rough water in the middle of a calm sea prompted me to ask fishermen on Sonsorol, Tobi, and Pulo Anna to describe the currents around their islands. The three sets of accounts they provided were almost identical, yet they involved current patterns different from any of which I had previously heard (figure 3).

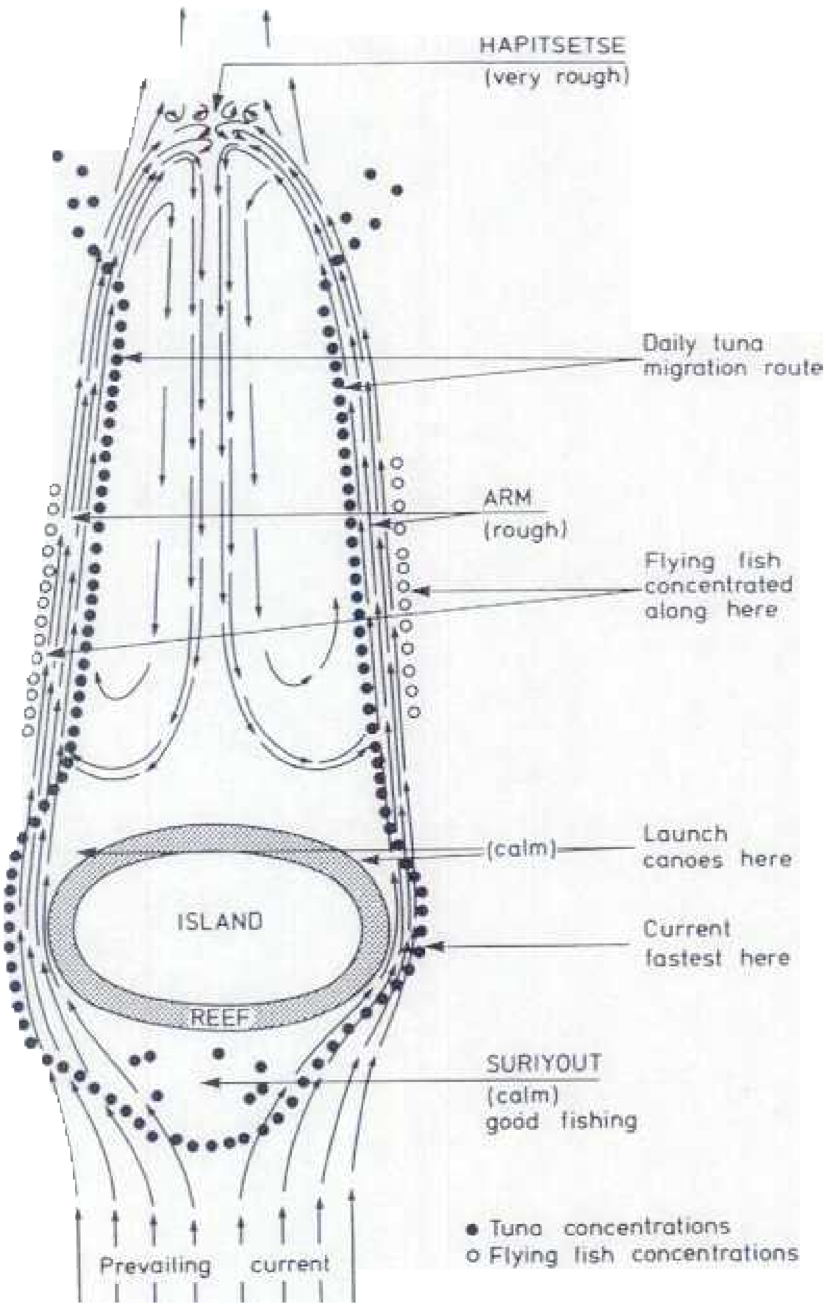


FIGURE 3. Idealized diagram of current patterns around Tobi.

On the upstream end of an island the current divides and is directed past the island on either side. Shoreward of the point where the current divides is an area of still, calm water with almost no current which Tobians call the *suriyout.*[1] Two narrow streams of turbulent water called *arm* extend downstream from the sides of the island, paralleling the prevailing current. Five to forty meters wide, each *arm* is sufficiently rough so that crossing it in a canoe can be hazardous. It was an *arm* that we had passed through near Sonsorol. These twin currents usually increase in width and decrease in turbulence with distance from the island. They extend downstream for a variable distance, sometimes to a point from which the island can no longer be seen, gradually curving toward each other. Ultimately they converge, creating an area of exceptionally rough water, called *hapitsetse.*[2] (If such a convergence can be found near Pulo Anna, fishermen there were unaware of it, although their description of the currents around their island coincided with those described for Tobi and Sonsorol in other details. Tobians said their *hapitsetse* disappears when the currents are weak.)

Leading back from the *hapitsetse* toward the island is a kind of backwash, or reverse current, running between the two *arm*. Patris explained it like this: "You know when you throw out a cigarette behind your canoe when you are sailing? Sometimes instead of being left behind it is sucked forward toward the stern. The same thing happens in the current directly behind Tobi. After we have been fishing downstream from the island we ride back to it easily on this current." Like fishermen, he said, turtles also tend to beach on the downstream side of the island, riding this backwash toward shore.

The wake current system as a whole is known on Tobi as the *hasetiho*. What did physical oceanographers have to say about such a current system, I wondered. Consulting the literature when I returned

1. Although parts of this chapter are based on information from Sonsorol, Tobian terminology is used throughout for the sake of clarity. Although inhabitants of the South West Islands all speak the same language, each island has a distinctive dialect. For example, *suriyout* is referred to as *doriyout* in the Sonsorolese dialect.

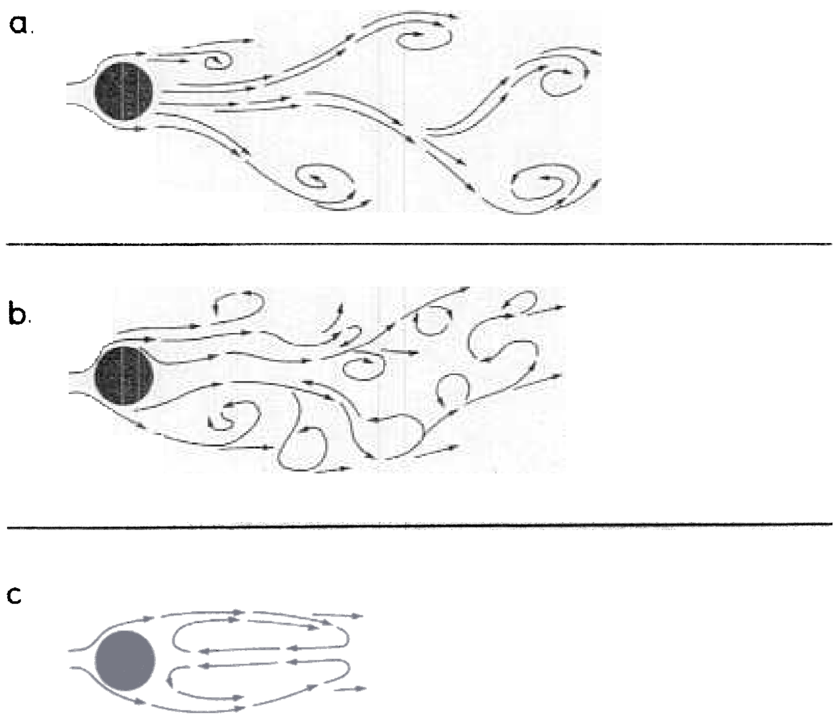
2. According to Mariano, a Japanese fisherman living on Sonsorol before World War II once approached the *hapitsetse* too closely in his canoe and was swept into a whirlpool. While clinging to the bow of his upended canoe as it revolved, he was spotted by a Sonsorolese fisherman who paddled his canoe as near as he dared. As the other man swung by he leaped from his canoe and grabbed the bow of his rescuer's boat. The Sonsorolese man back-paddled as hard as he could and the two men made it to safety.

Marine biologist John Miller (1973) described dye studies downstream of the islet of Molokini in Hawaii, the results of which indicated the existence of a pair of currents which converge in a manner similar to *arm*. Because of the exceptional turbulence at this spot, it is known to local boaters as The Washing Machine (Gene Helfman, pers. comm.).

to the United States I learned that they had reported two basic types of wakes downstream of oceanic islands (figure 4). One consists of a trail of more or less random turbulence. The other, called a von Karman vortex street, consists of a trail of eddies. The eddies form near both lateral edges of an island, enlarge as they drift downstream, and are shed laterally, first from one side of the wake, then from the other in a regular sequence. Neither of these wake types corresponded to what South West Island fishermen had described to me.

If no such current pattern existed, why had informants from islands separated by more than 100 miles of open sea been so uniform and explicit in their accounts of it, even possessing special words in their dialects for its features? Later, in a recently published thesis in anthropology, I found additional evidence for its existence. Fishermen from Linungan Island in the southern Philippines had

FIGURE 4. Current patterns caused by an obstruction such as an island in a prevailing current. (a) von Karman vortex trail; (b) Random turbulence; (c) Stable eddy pair.



described the same current pattern around their island. Like South West Islanders they had specific terms in their language for: (1) paired currents that form on either side of the island; (2) a region in which these currents converge downstream; and (3) a back current flowing toward the island from this convergence point (Randall, 1977).

Perplexed, I decided to look into the literature on hydrodynamics to see if laboratory studies threw any light on the problem. Here I found that considerable research had been done on the influence of obstructions on water currents in experimental streams and *three* basic types of wakes had been observed. Two of them corresponded with those described by physical oceanographers. The third wake type, known as a stable vortex pair, corresponded with the *hasetiho* (figure 5).

Hydrodynamic theory predicts that the form a wake will take is a function of the size of the obstruction and the velocity of the current. The South West Islands present obstructions to prevailing currents ranging from about one to three miles in effective width at the surface. Prevailing current speeds in the area range typically up to two knots (Sailing Directions for the Pacific Islands, 1964). Current speeds between one and two knots plus island widths of one to three miles should produce stable eddy pairs according to theory (Richard Barkeley, pers. comm.).[3]

The reports of South West Island fishermen could thus be reconciled with scientific observations after all. The islanders had discovered stable vortex pairs and used them in their fishing and navigation long before they were known to science.

An account of how these currents relate to fish behavior and fishing activities in the South West Islands requires a brief description of seasonal changes in weather and sea conditions. On Tobi the year is divided into two roughly equal seasons based on current strength and wave conditions. The "peaceful" season, *Neihahi*, extends from February to September. (For part of this time Tobi is in the doldrums and the winds are very light.) The rough season, *Niyafang*, occupies the rest of the year. During this time canoe fishing is more difficult.

Sonsorol is far enough north of the equator to be in the monsoon belt, experiencing easterly winds from November to April and westerly winds from May to October. Sonsorol also experiences

3. Hydrodynamic theory does not predict the existence of quite such narrow, discretely defined streams of turbulence as the *arm*. But I experienced one in the dark, as recounted above, and Peter Black tells me that he often saw them while out with Tobian fishermen. Differences of scale between hydrodynamic laboratory models and currents around ocean islands may account for differences in the details of their stable wake patterns.

stronger currents and higher waves than Tobi and fishing conditions there are more difficult and dangerous.

The *hasetiho* shifts around these islands seasonally in synchrony with shifts in the direction of the prevailing currents. These seasonal shifts are predictable, and the fishermen know them well because their fishing sites and canoe-launching sites must shift with them. Around Tobi the current direction usually shifts clockwise with the seasons. The seasonal shifting of the current around Sonsorol is more erratic. Around both islands, at some times of year, the prevailing current may also fluctuate significantly in direction and speed within the space of as little as an hour. Such short-term fluctuations are more common and of greater magnitude around Sonsorol.

Two factors determine local current strength according to fishermen. The most obvious of these is the speed of the prevailing current. As the local currents flowing past either side of the island increase in speed, the *arm* get wider, rougher, and longer and the *hapitsetse* gets larger and rougher and moves farther downstream. But the direction of the current is also important. The wider the obstacle, the greater the volume of water that is deflected and the stronger the current this creates. Thus when prevailing currents hit the broad side of an island they accelerate more as they pass it than when currents of the same strength pass the island parallel to its long axis.

Tobian accounts of seasonal changes in local currents compare well with published accounts of major ocean currents in the region (e.g., Hisard et al., 1969; Schott, 1939). During the northern spring the westward-flowing South Equatorial Current is deflected north of the equator by New Guinea and flows past Tobi. Later in the year this current retreats southward. During May, June, and July, Tobi is often located near the boundary between the South Equatorial Current and the Equatorial Counter Current, and currents around the island are weak and exhibit considerable day-to-day, as well as year-to-year, fluctuations in direction. (In about two out of three years the currents set predominantly to the southwest at this time, in the other years mainly to the northeast.) By fall Tobi comes under the influence of the eastward-setting Equatorial Counter Current.

Currents around Tobi are not synchronous with those of Sonsorol, 150 miles to the northeast. In the summer, for example, Sonsorol is near the center of the Equatorial Counter Current and the currents are stronger then they ever get at Tobi, according to fishermen who have lived on both islands. Drawing a picture of the central Pacific Ocean on the sand with a stick, I once explained the large-scale seasonal shifts in equatorial currents to some South West

TABLE 5. Seasonal Changes in Weather, Wave, Current, and Fishing Conditions around Tobi.

Month / Approx. Tobian Equivalent	January / Tahebor	February / Yahemaus	March / Tumuch	April / Masichik	May / Masirap	June / Tauta	July / Tukumar (Tirotamau)	August / Huh	September / Ur	October / Erir (Yoruyoru)	November / Mar	December / Iich
WINDS AND WEATHER	Northeasterly, weak		Easterly or no wind, thunder	Easterly, weak, clear			**Easterly, or no wind, rain, thunder**		**Northwesterly, moderate, dry**			
CURRENTS	Southeast, weakening	South, weak	Southwest, very weak	Currents weak and unstable, direction often changing with the tide			South to east strengthening		South to east, strong			
WAVE STATE	Diminishing	Low						Picking up	High			
SKIPJACK & YELLOWFIN TUNA	Mostly large yellowfin, feeding on squid and flying fish	Small yellowfin mixed with skipjack move offshore before dawn, spread out all around Tobi in shallow water, returning in early evening eating small fish					Remain in *Suryour* during day eating small fish, move offshore at night; Best tuna fishing season		Mostly large yellowfin, feeding on squid and flying fish			
JUVENILE REEF FISH		Particularly abundant		Abundant								
FLYING FISH AND NEEDLEFISH								Abundant, eggs appear in September. Spawning from October through June				
WAHOO			Very abundant, with eggs			Abundant						
GREEN TURTLES (Helen Reef)	Mating starts			Egg-laying. Numbers of eggs laid per nest decreases as the nesting season progresses, from 100-150 in April to around 70 in October								No turtles
SEABIRDS			Nesting: Brown noddy, black noddy, white tern						Lesser frigate birds common; no nesting (nests on Sonsorol)			
DRIFTING LOGS							Some logs		Best log months			

Island fishermen. They seemed as interested in this glimpse of the larger pattern as I was in the details of the local circulation they had taught me.

Fishermen of all three islands noted that in some years the prevailing currents behave atypically. For example, in Tobi the direction of the current occasionally shifts systematically counterclockwise for several months. Oceanographic observations in this region confirm that current patterns differ appreciably from the norm in some years (e.g., Inanami, 1941).

Prevailing currents around Tobi are weakest from April through February. Pelagic juvenile reef fish are also most abundant around the island during this time. (The apparent connection between these two phenomena is discussed in Chapter 3.) Tobians are particularly aware of seasonal changes in abundance of juvenile reef fish because of their importance as food for tuna. Few schools of small, surface-feeding tuna, and few seabirds, are present from September through January. The return to Tobi waters of large numbers of tuna and seabirds beginning in late February is believed by fishermen to be linked to the increased availability of pelagic juvenile reef fish. Egg-bearing *yar* or wahoo (*Acanthocybium solandri*) are also more abundant around all three South West Islands (and Palau) in the spring.

Mackerel tuna (kawa kawa) and dogtooth tuna remain near the islands at all times according to fishermen. But yellowfin tuna, skipjack tuna, and a large needlefish all make predictable daily migrations to and from the waters near the islands, and these migrations vary in character with the season. During January and early February at Tobi, for example, skipjack, yellowfin, and needlefish move offshore after midnight and return by mid-to late afternoon. Skipjack move offshore and return earlier than yellowfin. Needlefish tend to leave and return earlier than either of the tunas. The phase of the moon reportedly has some influence on the timing of these movements; fish are said to leave the island later during the dark nights around the new moon and return later.

These daily migrations take tuna and needlefish from the calm waters of the *suriyout* along the *arm* in the direction of the *hapitsetse*. Seabirds leaving the island at dawn to hunt for the small fish that the tuna drive to the surface also generally fly off in this direction. Both birds and fish also generally return from this direction.

From February through June the tuna move offshore before dawn and are found during the day spread out near the surface all around the island. During this period of weak prevailing currents around Tobi, the schools of small fishes on which the tuna feed are also spread out around the island. When the prevailing current picks up speed in July these forage fish tend to stay closer to the island and to the *arm* and form more compact schools. This, say the fishermen, causes the tuna to concentrate in these areas too. In July and August the tuna tend to concentrate in the *suriyout*[4] and stay there throughout the day, moving offshore at night. In the fall large yellowfin dominate the catch. They tend to stay in deep water, moving offshore about 3:00 A.M. and returning in the mid-afternoon. Large, deep-running trolling lures are designed for use at this time. Yellowfin are also caught by dropline fishing to depths of 100 meters or more in the reduced currents of the *suriyout* at this time.

Small species of needlefish and flying fish can be found in the *suriyout* throughout the year. Larger and more sought-after species of both types are found further offshore. Large flying fish are particularly abundant near the outer margin of the *arm*. Small yellowfin and skipjack tend to concentrate near the inner margins of the *arm* as they move to and from the island.

Similar patterns of movements of offshore–inshore movements were described to me by fishermen from Sonsorol, Pulo Anna, and outer islands in the Ponape district in the eastern Carolines and in Palau by Ngiraklang. The seasonal timing of these movements varies from island to island, presumably because of seasonal differences in current and wind conditions.

I searched the literature to find the extent to which scientific research might support the reports of the fishermen on daily tuna migrations. Much work has been published on long-distance seasonal migrations of tuna in the Pacific. But I could find only one paper that relates to daily, repetitive migrations near islands. Marine biologist Heeny Yuen (1970) fixed an ultrasonic tracking device to a skipjack tuna near Hawaii and monitored its movements. When returned to the water the fish rejoined its school. Each night the fish left the shallow bank where it was caught and traveled over deep water for distances of up to sixty-six miles before returning to the bank by dawn. The pattern of movement described by Yuen on the basis of observations on a single fish is the same as that described by fishermen for populations of fish of three different species. Their testimony indicates that these movements vary seasonally, are related to prevailing current strength and direction, and are not just a local Hawaii phenomenon.

4. Westenberg (1953) similarly notes that in Indonesia favored tuna-fishing spots are where "a prominent corner divides the approaching water masses of the surface current."