Socialisation of fishing knowledge: The emergence and transmission of new fishing technology and marine ecological knowledge in the Republic of Palau, Western Micronesia

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Abstract

Catch rates and access to fishing locations have changed in contemporary Pacific fishing owing to newly introduced technologies such as speedboats and dive gear. At the same time, fishermen have also acquired new ecological knowledge of the marine environment and have developed new fishing skills. In this article I provide ethnographic examples from the Republic of Palau, Micronesia on the emergence of marine environmental knowledge and the use of new fishing practices in three key fishing methods: speargun fishing, hand-held trolling, and trapping. Fishermen develop different knowledge and skills through their individual experiences of the sea, as well as through the collective and traditional understanding of the marine environment by elder fishermen. The transmission of this knowledge and the use of new skills are enacted through kinship, and fishermen are often motivated to acquire this knowledge and skill in order to achieve status and prestige, rather than to simply increase their catch. Thus, technological change in contemporary Pacific fishing does not always undermine the social and cultural elements of fishing; rather these elements may be reinforced or even augmented.

Introduction

To understand the marine ecological knowledge of fishermen in the contemporary Pacific, it is important to account for the effect of new technology on current fishing practices, however modest they may be in comparison with industrial fisheries. A few examples from my recent study on fishing in Palau, demonstrate the extent to which modern technological inputs in small-scale fishing in the Pacific region are used outside of the "traditional management system". In turn, they may have reduced the sustainable use of marine resources, although some knowledge is transmitted through specific social networks of fishermen, which are governed by chieftainship and kinship structure.

In *Words of the Lagoon*, the landmark ethnographic account of Palauan fishing, Johannes (1981) showed that fishermen in Palau possessed detailed ecological knowledge of the marine environment, accumulated through generations of fishermen; but that this knowledge was fading away because the youth no longer fished as frequently as the elders. Johannes also found that some types of marine ecological knowledge were increasing because of new technologies. For example, fishermen had gained a greater understanding about fish behaviour by using dive masks, and learned more about the various marine environments because of speedboats, which allowed access to more fishing areas.

Similarly, significant changes in the amount and depth of fishermen's marine ecological knowledge have been reported from elsewhere in the Pacific. Some authors refer to these changes as simply the "erosion" of traditional fishing skills (Donner 1995), whereas other researchers take the view that fishermen are collecting new kinds of knowledge in order to fulfil the "wealth of ideas" (Carucci 1995). Overall, the scientific literature suggests that either the possession or the process of acquiring fishing knowledge continues to add important elements to people's social lives and identity, despite changes in the form and depth of the knowledge. Nonetheless, many ethnographic details remain to be investigated about the use and transmission of this knowledge, particularly knowledge that is highly specialised and has emerged from the adoption of new technologies (Hviding 1995; Feinberg 1995; Howard 1995).

Focusing on the ethnographic details of newly emerged knowledge and skills, this article provides some of those details by describing three different types of marine ecological knowledge attached to three different fishing methods. These

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are speargun fishing, fish trapping, and hand-held trolling from a boat with large outboard engines. Understanding the details of new fishing technology and fishermen's knowledge of the sea contributes significantly to the discussion of marine conservation, because the transmission of such knowledge is an indicator of the social control over fishing grounds. Hence, in this the article I emphasize the importance of comprehending the socialisation of new fishing technology — which takes place in the process of fishers' acquisition of marine ecological knowledge — and the application of this knowledge to actual fishing practices.

Contemporary practices of different fishing methods in Palau

Palau (Fig. 1) is known for its rich marine-based culture and the intricate ecological knowledge of traditional fishermen (Masse 1989; Kubary Kramer 1927; Johannes 1981; Parmentier 1987. In the late 1970s, however, Johannes (1981) pointed out that many youth had abandoned village life, and so fishing knowledge was no longer being transmitted by "traditional means", namely through direct experience and through the collective knowledge provided by elder fishermen. At the same time, he also reported (Johannes 1981:15) that some fishing knowledge was expanding because of the arrival of "modern technology", including speedboats with outboard engines, and underwater diving equipment. Johannes (1981) observed that eight fishing methods were in regular use at the time of his research: daytime and night-time speargun fishing, hand-spear fishing, barrier net fishing, line fishing, trolling, portable trap fishing and dynamite fishing. Except for the use of dynamite, which is legally banned, the other seven methods were still widely used at the time of my fieldwork in 2001. I examined the extent to which each of these fishing methods were used, along with the social and cultural occasions for which each method was practiced. I also recorded the catch size from each method (Ota 2006a, b).

Between the 1970s and 2001 the most significant technological change in Palauan fishing practices was reportedly the increased use of "speedboats" for inshore fishing; the approximate number registered in 2001 was 1450, of which more than 300 were considered to be used for inshore fishing (JICA 2001). During my interviews, fishermen said specifically that boat numbers increased rapidly in the late 1990s — several years after the country's independence in 1994 — because of increased cash flow into the country.

Johannes (1981) pointed out that the increased use of speedboats increased fishermen's access to hitherto unknown fishing grounds, which enabled them to expand their ecological marine knowledge. However, my ethnographic data suggest that the process of knowledge acquisition and the application of this knowledge to actual fishing practices involves more than a simple mechanistic response to technological advancement. Hviding (1995) points out the importance of understanding the depth of this knowledge, as it can be either general

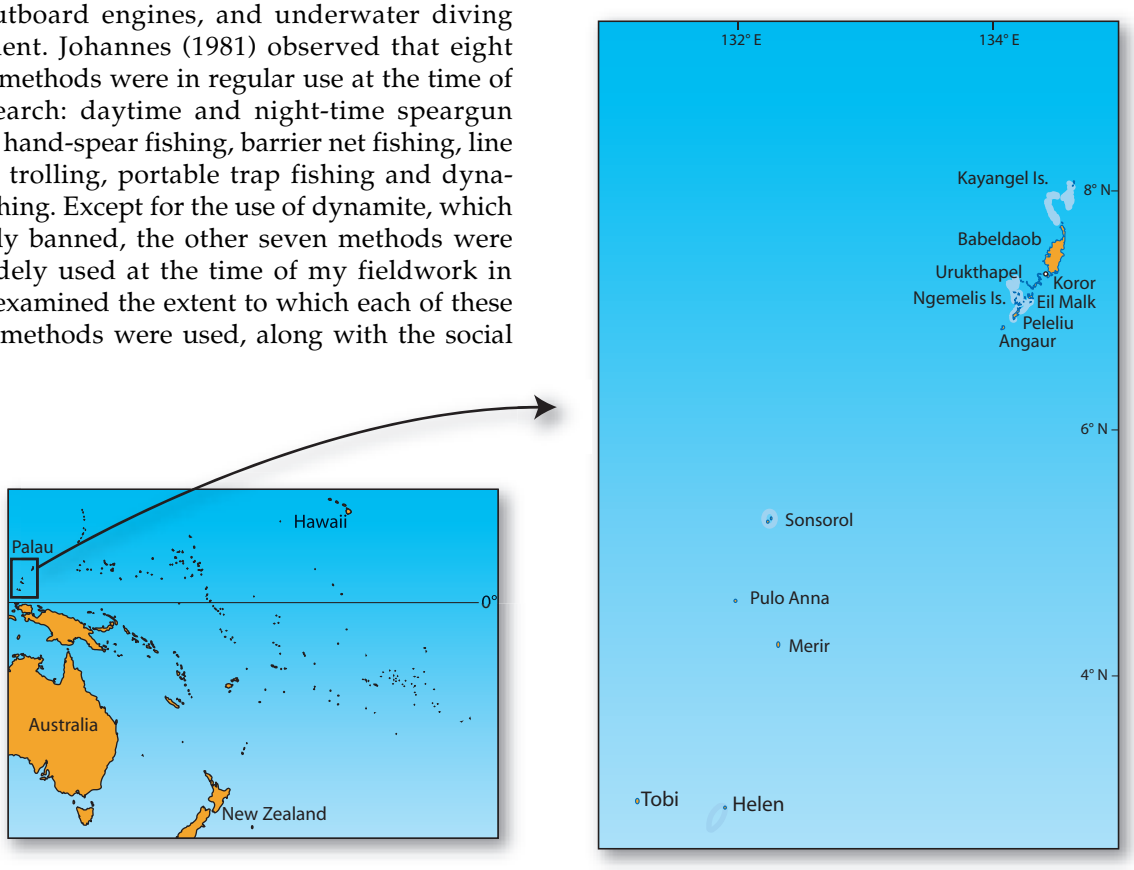

Figure 1. Palau

or specialised, and that this difference determines the emergence and transmission of knowledge in the Marovo communities of the Solomon Islands. Differences in knowledge regarding the Palauan marine ecosystem is apparent; some aspects of marine knowledge are known to many fishermen, while other aspects are known to only a few fishermen, and even fewer can successfully use this knowledge for fishing. It is this specialist knowledge that is my concern. In my view, the specialist knowledge that emerges from the application of newly introduced technology often requires appropriate social and cultural contexts, such as kinship structure or hereditary status.

Underwater speargun fishing and the division between reefs

In Palau, spearguns are locally made using mainly foreign materials, and they are used in conjunction with imported dive masks and flippers. Fishermen who practise speargun fishing collect their oceanographic knowledge by both individual quests to new areas, and by repeated visits to familiar reefs. In Koror, the capital of Palau (2002)[2] where more than half of the population lives, most fishermen use speedboats to access their fishing grounds. They travel some 10–30 minutes each day to reach reefs appropriate for daylong diving. Speagun fishing is done exclusively by men, and is currently the most popular method of providing fish for household consumption, even though the community's lifestyle is no longer based on subsistence. However, fishing is essential for the maintenance of tradition because fish is still used for customary gift exchanges and served at feasts and ritual gatherings. Moreover, the practice itself contributes to the formation of a strong sense of masculine identity, since it is the traditional obligation of men to provide female kin with the catch (Ota 2003, 2006c).

In the Palauan language, the sea is generally called *daob* and is in opposition to *beluu*, the land. These two structurally opposed foci are often depicted as constituting the balanced cosmos of the Palauan world conception (Ferreira 1987; Force 1960; Barnett 1960). These two geographic terms, however, do not apply when one refers to going to the ocean in order to fish. Then the word *chei* is used instead of *daob*. *Ak mora chei*, the general expression in Palauan "to go fishing", refers to the first person singular, "I", and "*mora*" means to go. *Chei* is often translated as the area between the shore and the edge of the reef, the common area for local fishing (Josephs 1990). Johannes (1981) explains that the word *chei* probably suggests a specifically located area of the sea (i.e. the lagoon), as opposed to *daob*, which refers to the sea in general. However, this distinction was not explicitly explained by fishermen during my fieldwork, because they rarely use the word *chei* on its own. Rather, the word was always used as part of the sentence, *Ak mora chei*: I am going fishing. If one goes fishing in the area near the shore, a person would say, *Ak mora kmeed*, referring to the nearshore. If one goes farther away from the reef, then a person says, *Ak mora chei cheroid*. The word, *cheroid* means far, and can be used outside the context of fishing. Moreover, the term *chei*, which is used to describe lagoon, should be understood as "the place they can go fishing" as opposed to *daob*, which refers to the sea, since fishermen say that "wherever you go to fish is the place called *chei*. Because *chei* is used by a Palauan fisherman to announce his will to go out fishing, saying *A mora chei*, other fishermen would then ask where the fisherman is heading to, *Komo ra*? In response to this question, the fisherman may provide an anonymous answer, (*Ak mora*) *basho*: I'm going to the place. In the context of fishing, *basho* refers to an anonymous fishing spot, known only by a limited number of fishermen. Using *basho* requires more detailed comprehension about the oceanographic settings of the reef, because fishing practices involve learning about winds, current directions, and other weather conditions and combinations of geographical variations.

For underwater speargun fishing, two types of *basho* are selected for diving: the lagoon edge and inside the lagoon. Fishing near the edge of the lagoon, near the reef dropoff, increases the risk and difficulty because of the relatively deep water (for skindiving: between 10 m and 25 m) and strong currents. Access can be further limited by weather conditions. Nevertheless, fishermen prefer to dive in such areas, which yield larger fish and a greater total catch. In contrast, fishing areas inside the lagoon and in saltwater lakes created by the extensive protected lagoon — which contains a great number of limestone islands (locally called Rock Islands) — are relatively safe. This is partly because currents within the area circulate inwardly, whereas in areas near the lagoon edge the strong current could easily carry a fisherman out to sea. But within the reef, the water is calm because the limestone islands and reefs shelter the area from external climatic influences. These nearshore areas are used mostly for short fishing periods, say an hour or two in the evening (nonetheless fishermen still use a speedboat to reach their *basho*). The only disadvantage is that catches tend to be smaller, due to the shallower water depth.

Besides of these oceanographic differences, the two areas are also distinguished from one another by

2. The capital was changed from Koror to Melekeok in October 2006.

the level of skill and knowledge required to dive and catch fish successfully. In the first location in particular, which is near the edge of the lagoon, fishing is restricted because of the strong currents; fishermen diving here must have a good understanding of the complex water flow. Therefore fishing here demands specialised knowledge of sea conditions, particularly currents, in order to carefully plan a diving route[3].

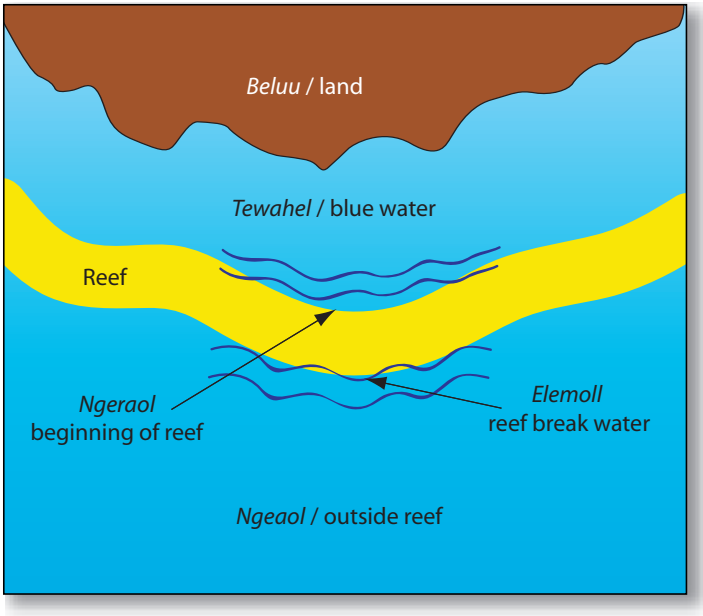

Figure 2. Sea map for underwater speargun fishing

Because of the need for specific marine knowledge about currents and appropriate diving routes, speargun fishermen have an understanding of reef gradation, from the shore to the deep water, including the seabed and fish distribution. To explain the general structure of the lagoon, a fisherman draws a map of the lagoon water emphasizing the line where the reef starts and ends (Fig. 2). In this map, waves are considered only as an indicator for the fishing point between the reefs, since the wave-break is an obvious visible seamark in the lagoon. Fishermen stress that those lines indicate the change of the seabed as the division imposed between reefs and the outside reef, which fishermen divide into three areas: *ngeraol*/beginning of the reef, *elemoll*/reef break water, and *ngeaol*/outside reef. However, this general map of the lagoon does not contain enough practical knowledge for successful fishing in the area known as *elemoll* — the reef break near the outside reef.

More intricate knowledge is required for diving. Fishermen must have a general understanding of the lagoon structure and, more specifically, about dive routes through areas with strong currents. Such practical knowledge is acquired not simply by visually observing target fish and the underwater topography of the reef while diving, but is also transmitted between individual fishermen as they fish together. Hence, at the beginning of their fishing experience, younger unskilled fishermen are taken only to the Rock Islands (limestone islands near the shore), which are surrounded by patch reefs. As the young fishermen's skill levels and physical strength increase, they are taken to the area near *ngeaol* (outside the reef) to be taught current movements. Knowing the basic seascape of the fishing area has no practical application to actual fishing, because the direction of the current and the routes to avoid must be learned from other fishermen.

This ethnographic observation on underwater speargun fishing presents a different view from Johannes (1981), who describes the expansion of marine ecological knowledge through the use of dive gear; having an ecological comprehension of fish habitat derived from direct visual observation of the underwater world. The intricate knowledge of underwater currents that is required for successful and safe diving is acquired through both lessons from other fishermen and through the direct experience of diving and swimming through the complex water flows.

Since the introduction of speedboats, however, the distinction between these two fishing areas has been slightly obscured. Some fishermen are now accompanied by another person who controls the boat while the fisherman fishes underwater. A fisherman no longer has to swim against a current going back to the boat after diving for fish; he can now let the current take him as he continues fishing and then the waiting boat will pick him up. Nonetheless, fishermen do not neglect learning the direction of the current and the condition of the reef, because they must carefully design the route for fishing, knowing the distance between the starting and ending points, since it is difficult for the boat operator to follow the underwater movement of a fishermen when there are strong waves accompanied by wind. In other words, using speedboats has not rendered obsolete fishermen's skills and knowledge. The difficulty of diving through the area near the outside reef still conveys the cachet of

3. However, wind direction is not considered because it does not affect underwater conditions in such small-scale environments (This is quite unlike other fishing methods, such as handheld trolling).

being a "skilled fisherman" and it subsequently brings a limitation of access to such areas. Thus, in the practice of underwater speargun fishing, both individual skill and knowledge socially institutionalises the distribution of fishing grounds.

Trap fishing and underwater oceanographic setting

The combination of individual input and given knowledge is also seen in more passive fishing methods, which do not come with direct physical risks and challenges. Contemporary fishermen have modified the design of fishing traps to make it more suitable for the oceanographic conditions of their local fishing grounds. In this case, knowledge comes more from the individual fisherman, rather than to the development of personal skills and a relationship with more experienced fishermen. However, the ability to use the newly invented design — in terms of fishing rights — is considered through the fisherman's social status, namely chieftainship and kinship relationships.

The practice of trap fishing depends directly on a fisherman's knowledge about the habitat and migratory movement of fish. Therefore, knowledge about the fishing spot and the way the fisherman sets the trap is considered as an essential and intricate skill. This intricacy is also transferred to the technological modification of fishing gear, particularly for the design of trap entrances. The design is adapted to the specific environmental settings of a particular area, taking into account oceanographic conditions and fish behaviour because the success of trap fishing depends largely on how much fish are led towards the entrance of the trap, following their usual movements through the water.

The significance of the correlation between profound oceanographic knowledge and the design of the fishing trap is observed in the use and setting of *beng*, which is made of iron wire mesh, is about 30–50 cm long, and is attached to the entrance of the trap as a kind of wing device. This device is employed mainly on the east coast of Babeldoab Island, in traps used for catching mid-sized reef fish. As a fisherman explained to me, *beng* works as the "arms" to the trap entrance, which leads fish inside only when the curved shape is set appropriately. In other words, the opening direction of *beng* needs to be arranged in accordance with the direction of water flow, calculating the swimming route of fish that is determined largely by the current movement.

An area in Melekeok district provides an example (Fig. 3). At a point near the channel, parallel to the district's shoreline, there is a strong surface current that runs from the south side to a point slightly north. Between the southern and northern points there is a steep dropoff as the shallow seaweed bed at the south point inclines to a deep reef. This results in a strong surface current in that direction (current A). There are also tidal currents coming from the direction of the shore, which is east of the south point, to the deeper water, which is west of the south point (current B). The current simply moves from deep water to the shallows as the tide floods, and runs in the opposite direction as the tide ebbs. Taking both current movements and fish following those movements into account, the fisherman sets the fish trap at the position near the dropoff between the south and north point, and faces the trap entrance slightly towards the shore. In this way the entrance faces the south point so that it opens to the fish following the current from the south point to the deeper north point. To maximise the catch, the fisherman attaches two *beng* to the entrance of the trap, luring not only the fish coming from the direction of the shore, but also those following the tidal currents from the deeper water.

Most other fishermen share his same knowledge of current movements and seabed conditions, including the location of the steep dropoff. One fishermen said to me, however, that his father set the specific position of the trap, but that he then continually modifies new traps for the same location, although the specific design was passed on to him from his father. As a result, he realised that by attaching the *beng*, the trap enabled him to attract fish that moved from both current directions. The fisherman credits his oceanographic knowledge to his father, but

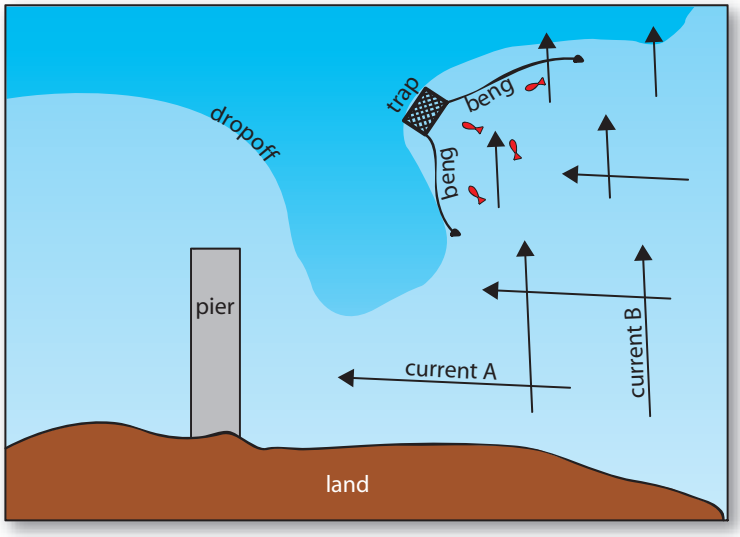

Figure 3. *Beng* setting in relation to current movements.

attributes the success of his trap with the attachment of *beng* to his continuous trials and modifications, readjusting both the length and the curve of the *beng* until it worked successfully.

Although the use of traps has declined, owing to a decline of traditional practices or the weakening of general community ethics, trap fishing for mangrove crabs has developed in recent years. This has been stimulated in part by the increased commercial value of crabs (by the tourist sector), and also by modifications to the trap design, which has improved its efficiency and has increased catches. The change resulted from altering the design of a fishing trap used elsewhere, and which did not originally target mangrove crabs.

Mangrove crabs are predominantly found around the large mangrove tracts in Ngatpang district, located on the south part of the east coast of Babeldaob Island. At the time of my fieldwork, seven groups of fishermen specialised in this trap fishing. Among them, an elderly fisherman worked alone by setting about 100 traps; the chief of the nearby village set more than 30, and each of the rest of the five groups, local youth trying to earn pocket money, set 20 traps.

Fishing changed recently because the chief of the district began using a new box type fishing trap with a small square fish net, instead of the circular crab net that needs to be constantly pulled out of the water. The chief, the inventor of the method, explained that the idea of using the small box type fish trap evolved from the fishing he did near Melekeok district, where these traps were quite common. After he moved to the N district he applied this standard fish trap to catch mangrove crabs, by modifying the size of the trap and other details. He explained that the most significant difference between the previous trap and his is the reduced effort required to check the catch, since it is no longer necessary to check the traps as frequently as every half day or more, because crabs can be kept for a day in the new trap. However, although the newly "invented" trap reduces fishing effort, only the chief and the elderly fisherman, the chief's brother-in-law use the new type. This has enabled the chief's family to capitalise on the regional stock of mangrove crabs, while his right to conduct this fishing was provided by his title and his generous attitude toward the community. (For example, he always supports both materially and financially to ritual gatherings from the region held within the family residence.) Several residents from the region clarify this link between the chiefly title and the use of the new device by saying that this chief circumvents complaints about his family's monopoly over the skill and the catch of crabs because he uses the money gained for the district. Thus, although the fishing knowledge is not "traditional", the way the chief exercises his social institution to access the fishing ground and evade other's concern and blame over the monopoly of this fishing is traditional to the extent that he uses his position to make it possible to do so.

Handheld trolling and wave movements

This example shows that a combination of previously collected knowledge given to a fisherman and the fisherman's own modification and improvement of it with new technology has produced not only a profound understanding of a complex oceanographic setting, but also the skill and knowledge to handle new equipment efficiently. However, the fisherman's motive for this learning and knowing is not simply economical, based on catching fish or simply exploring new fishing locations, but also satisfies his pride to possess the highly specialised knowledge.

In general, except sports fishing for tourists, only a few elderly fishermen are known to be skilful and knowledgeable at handheld trolling. This is in direct contrast to those who conduct sports fishing and who are technologically well-endowed with various types of equipment and who spend excessive amounts on fuel. Instead, these knowledgeable fishermen had a propensity for economising their fishing cost as well as for seeking new fishing locations. Their knowledge about exact wave movements serves a dual purpose: using oceanographic dynamics to move their boat and gaining access to locations without using a powerful outboard engine. My fishing experience with an elderly fisherman and an anecdote from him reveal his ability to observe and develop oceanographic knowledge about particularly perplexing fishing locations.

The purpose of the trip with the elderly fisherman was to troll for barracuda. The location of the fishing spot was only about 70 m offshore, on the east coast of Babeldaob Island. He drove his boat along the line of the dropoff, the point where the shallow reef drops down and the deepwater begins. We reached the point slightly before sunset, so the surface of the water was still visible. The fisherman pointed to the water surface closer to the shore and explained that there were three different currents and waves moving in different directions. He told me that he could see the change in the current and waves, as they reflect light differently on the surface of the seawater. At the fishing location, the waves and wind were moving towards the shore near the coastline, while they changed direction slightly diagonally towards the coast a little farther from the coastline. At the place where he situated his boat, the directions of wave and current altered completely from the area near the coastline; they stopped facing against the coastal line and instead

ran parallel to it. The fisherman explained that he knew from long experience that it was in this current that the barracuda would be found (Fig. 4).

This same fisherman explained to me his more profound knowledge of the sea environment concerning the reef between Angaur and Peleliu, the two southern islands of the Palau Archipelago. The narrative of his fishing experience and his knowledge of the reef begins with the general rule that the wave movement changes as a result of hitting the shore; as it hits land, a wave made by strong wind would create another smaller wave moving in a 45-degree angle (Fig. 5). He then explained that it is commonly known that the area around Angaur Island has no extensive lagoon as in other areas in Palau, and this oceanographic setting causes high waves in the area. Hence, any fishing activities in the area with a small boat and outboard engine with limited horsepower are considered a high-risk activity.

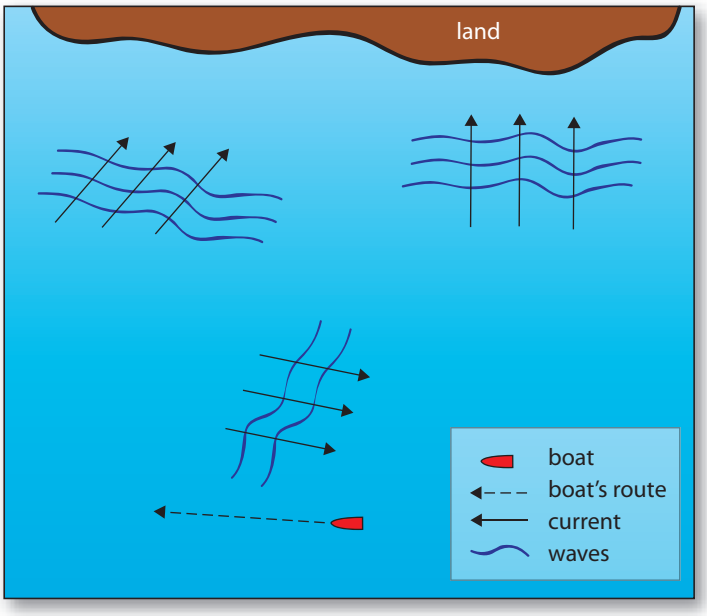

Figure 4. Currents and waves for handheld trolling.

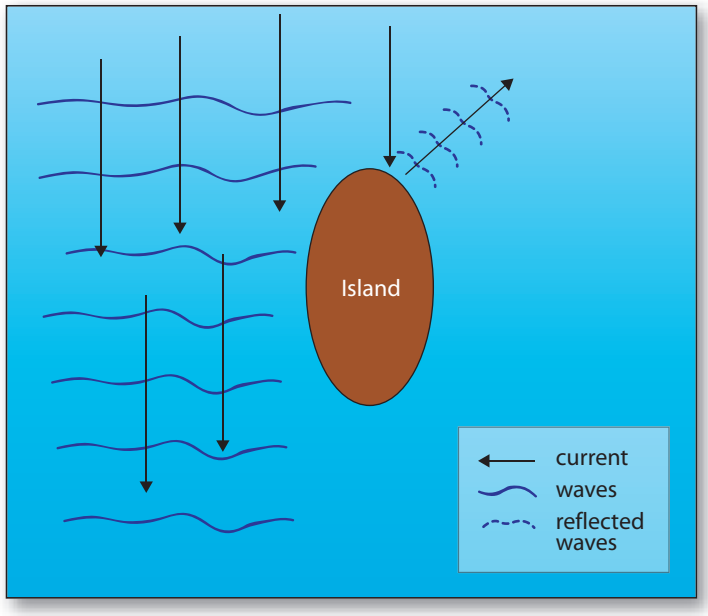

Figure 5. Current and wave reflection in relation to an island.

According to the fisherman, two different winds blow from the direction of Peleliu Island. One blows from east to west, striking the bottom end of Peleliu Island; then as it hits the island it curves and blows in the direction of Angaur Island. Another wind comes from the southern end of Peleliu directly to the north of Angaur Island. The first wind is not powerful enough to create strong waves, whereas the second can move boats in the direction of the shore of Angaur. As he trolled in the area, the fisherman let his boat be taken by the second wind to reach a point a couple of hundred metres from the shore, a similar distance from the shore to the fishing point where he fished for barracuda on the east coast of Babeldaob Island. The high waves and strong wind made it risky to be at the point so close to the cliff. But redirecting the boat is easily done by riding on the reflected wave, which goes slightly west in the opposite direction to the strong wave at this particular point. He explained that he was required to move the position of the boat slightly west across the strong wave, using minimum engine power (since it would have been impossible to move against the wave with that size of engine). Then, as the boat moved towards the west, the returning wave supported it in reaching the middle of the area between the two islands, where two waves — one produced as it is returned from the shore of Angaur and the other from Peleliu — crashed into each other, creating a high and rough ocean surface. At this middle point, the peculiar wave movement is not difficult to avoid since the meeting of the waves is based on only a moderate current running under the sea surface (Fig. 6).

The elderly fisherman told me that he was given some basic knowledge about this complex oceano-

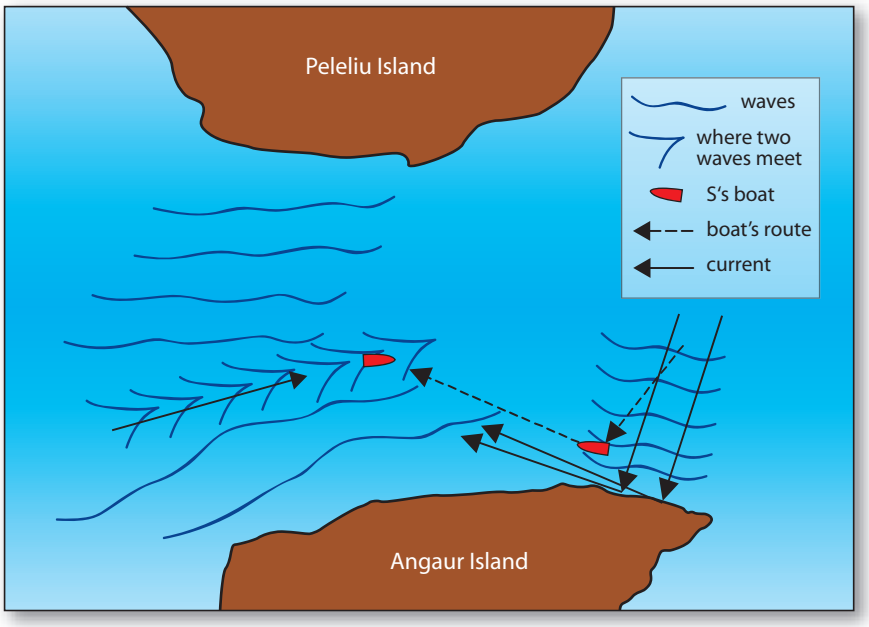

Figure 6. Sea map of different current and wave directions between Angaur and Peleliu islands.

graphic setting by his wife's "uncle" (she has her genealogical association with the region). As he relayed the initial source of this information, he proudly noted that it was only possible to ask this uncle about the fishing location because he was related to him and knew what he needed to ask specifically about the reef. Then he emphasized that the complexity of the location and the intricacy of the oceanographic setting were known to him ultimately through his own challenging trials during his own fishing activities.

Conclusion

Four main ethnographic findings emerge from these three ethnographic examples about marine ecological knowledge of Palauan fishermen.

1. A profound understanding of marine environments is not enhanced simply by the use of new technologies, such as speedboats or diving equipment or newly designed fishing traps;
2. The knowledge and skills used in contemporary Pacific fishing are partly acquired through the transmission from other fishermen, but are also largely supported by fishermen's actual experiences;
3. What fishermen understand and know about complex marine environments, including the movement of currents, reefs and waves, is attained through their active and individual investigation and contrivance of fishing skills and equipment, but the use of this knowledge can be socially limited; and
4. Some knowledge emerges from extremely challenging experiences, which can cause serious physical harm to fishermen; nonetheless, the challenge does not directly result in increased catch. Fishing remains difficult but the knowledge becomes a symbol of the fisherman's prestigious skill.

These findings offer new perspectives for the study of the emergence and transmission of contemporary marine environmental knowledge in Pacific Island small-scale fishing communities. These findings suggest that all fishermen do not easily apply the acquisition of the knowledge; hence, the use of their skills and knowledge is limited. Moreover, in practice, the use of this knowledge and these skills is restricted by the fishermen's social network and therefore, the acquisition of this body of knowledge does not necessarily lead to an increase in catch, but it may relate more to the socioeconomic elements of fishing, such as the social prestige of a fisherman. Although it is true that a fisherman's profound understanding of the oceanographic settings is coupled with his versatile attitude in searching for applications of new technology in contemporary Pacific Island fishing, nonetheless the emergence of new knowledge and skill does not always undermine either social and cultural elements of fishing, nor their relevance in conservation and use of marine resources, particularly when the knowledge is specialised. And the knowledge must always be specialised if a fisherman wants to apply it beneficially.

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