

FISHING-GLEANING ACTIVITIES ON REEF FLATS AND/OR REEF MARGINS IN THE CORAL ECOSYSTEM IN YAP, FEDERATED STATES OF MICRONESIA (FSM)

Jun TAKEDA

Introduction

Fishing-gleaning activities on reef flats and reef margins in coral ecosystem and on tidal flats in the ecosystem have been very important in the history of human evolution and/or survival of coast-dwelling people (TAKEDA, 1994a, 1994b ; TAKEDA and OHYAMA, 1994 ; TAKEDA et al., 1998 ; LEE and TAKEDA, 1999 ; TAKEDA, LEE and CHO, 2001). These activities have been carried out on a daily basis by women, children and even the aged using non-specialized technologies. Not much diving, spearing or harpooning was required, and nothing very large was taken. It is necessary to re-examine small-scale fishing-gleaning activities and the detailed ecological relationship between marine species habitats and fishing-gleaning techniques used by non-specialized coast-dwelling people. The accumulation of these data on coastal communities will give us some means of reconsidering the role of food-foraging activities in the process of human evolution, not only of the coastal dwellers, but also in the foraging societies of the tropical and subtropical regions.

This study is based on the information collected by direct observations done in October to November, 1999 accompanied with questionnaire methods, and other works cited in the text.

Related Backgrounds

Yap is one of four states which constitute the Federated States of Micronesia (FSM) (Fig. 1). It is situated in the Western Caroline Islands. Mainland Yap is composed of four high islands (Yap, Maap, Rumung and Gagil-Tamil islands) with an extensive fringing reef 31 km in length and 12 km in width, and 15 low coralline atolls and islands. The combined area of the four main islands is 95 km² with 174 m above sea level at the highest point. The reef extension is 200 m at the narrowest, with 2.5 km on the north end and 3.5 km on the south in width. The lagoonal holes are a major feature of Yap's lagoons. They are highly irregular and vary from 10 m to 1.5 km in diameter with depth ranging from 3 to 22 m. The fringing reef flat has an average depth of 2-3m at high tide (FALANRUW, 1994b). A considerable portion of the shoreline is fringed by mangrove forests. Because of the irregular shape of complex of islands, mainland Yap has one of the longest coastlines in the Federated States of Micronesia (FALANRUW, 1994b).

The outer islands are composed of 3 raised coral line islands and 12 atolls, with 2 inhabited raised islands and 9 atolls. The total land area of the outer islands is only 18.7 km².

Yap has a warm tropical climate with mean annual temperature at around 27 °C and a very little seasonal variation. There is on average about 1 °C variation between the warmest and coolest months, whereas mean diurnal variation is about 7 °C. Yap lies within the area affected by the Asian monsoon, thus having a wet climate with irregular dry seasons. From July to October the islands are under the influence of the Intertropical Convergence Zone (ICZ). During this period

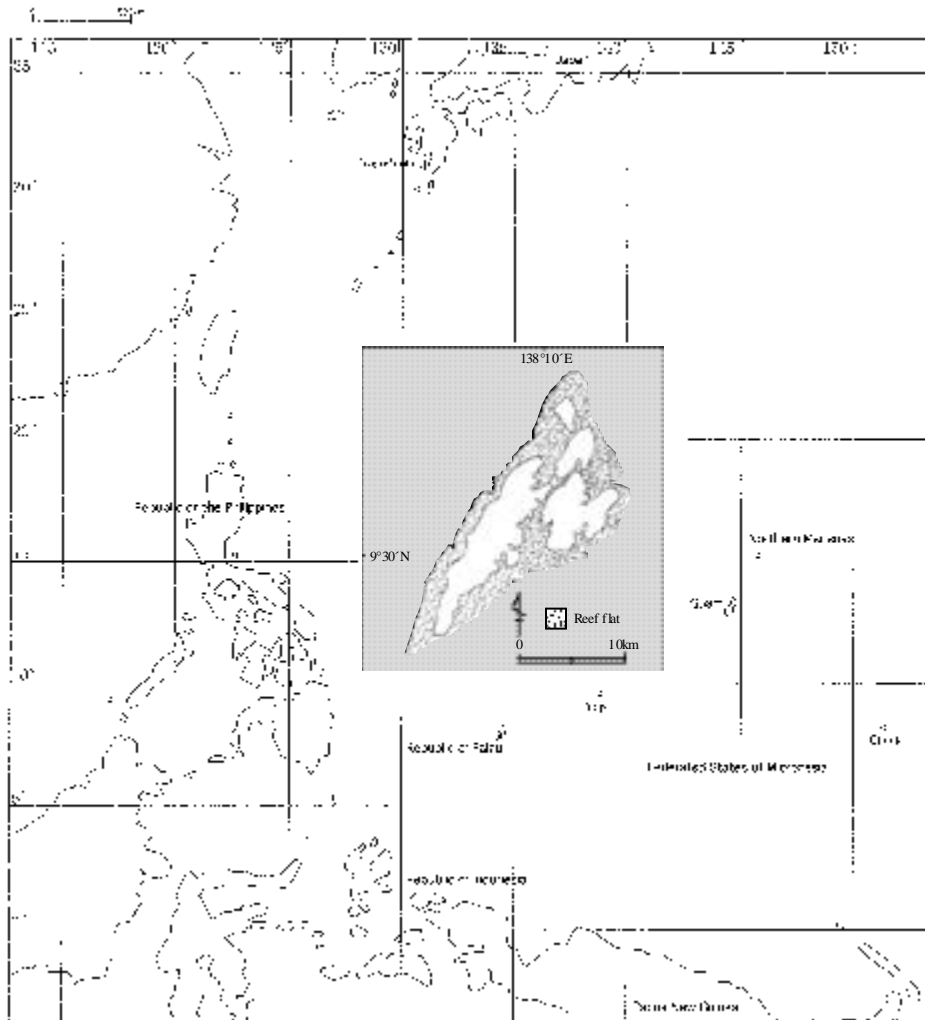


Fig. 1. Mainland Yap.

there is the south-westerly prevailing wind, which is also the wettest season with precipitation of about 33 cm/month. The average annual rainfall was 3,023 mm for the period 1949-1992 with a standard deviation of 17.7 mm. Thunderstorms are relatively infrequent and most cyclones pass north and north-westward of the area. Between November and June the area is under the influence of the north-east Trade Winds, and the driest part of the year is between February and April when precipitation is about 18 cm/month (US DEPARTMENT OF AGRICULTURE, 1983).

According to the 1987 census, the population of mainland Yap was about 6,650 and the outer islands' population was 3,489. The pre-Western contact population was estimated to range from 26,000 (HUNTER-ANDERSON, 1983) to 40,000 (UNDERWOOD, 1969). After contact with outsiders there was a drastic drop in population that continued through World War II to the end of the Japanese occupation when the population was estimated at 2,400 (USEEM, 1946).

Subsistence on Yap depends on agriculture. Aroids, yams, breadfruits, bananas, Polynesian chestnuts, cassava and coconuts are grown, but the major cultivated crop is giant swamp taro (*Cyrtosperma chamissonis*) (DODSON and INTOH, 1999). Yams (*Dioscorea* spp.) are also important in Yap (BARRAU, 1976). Five species and many varieties of yams are grown in intermittent mixed gardens (FALANRUW, 1994a). The ceremonial significance has been stressed by USHIJIMA (1987) to indicate a long established position in Yapese society. At least 31 different varieties of yam have been distinguished among traditional village societies.

Marine Resources

The relatively shallow lagoon is filled with seagrass meadows and sand flats, and it is pocketed with deep holes and dissected by a number of channels (FALANRUW, 1994b). Marine species on Yap are listed (AMESBURY et al., 1977; TSUDA, 1978). Mangroves make up 12 per-cent of the vegetation (FALANRUW et al., 1987), and extensive seagrass meadows have at least 7 species of seagrass. Ninety-nine species of algae have been reported as well as 168 species of hard corals and numerous other invertebrates, 426 species of fish (TSUDA, 1978) and 4 species of sea turtles including a few captures of leather-backed turtles (FALANRUW, 1994b). A dugong was captured about 20 years ago, and porpoises and whales found offshore. At least 5 whales have been stranded in the last 30 years, with a 40-foot sperm whale in June 1992 as the most recent case.

Sea turtles can be found in the outer islands and in the deep holes of Yap's reef. Turtles are considered as a delicacy, but there are strict traditional regulations about the catching and eating of turtle which limits the numbers of turtles killed.

The Yapese do not catch turtles for their shells, but they do make handicrafts and jewelry out of the shells of turtles that have been caught for consumption.

Fishing-gleaning Activities

All fishing activities in Yap are done by men. Yap's taboo has prohibited Yapese females not to fish, although women are engaged in seashell gleaning.

There is a lack of small-scale commercial fishing in the neighboring islands of the type that occurs on Yap proper. This is partly due to the lack of opportunities, and it is also caused by a fear that commercial fishing will not leave enough reef fish for subsistence purposes. There have been a number of positive management actions in many of the neighboring islands, highlighting the responsibility shown by traditional authorities towards marine management issues. Although paddling and sailing canoes are permitted, the use of boats and outboard motors have been banned by the chiefs in Ifik atoll. This is, in part, to contribute to control the level of marine resources exploitation and to help maintain the traditional skills.

Yapese canoes, made of bamboo, are used to go fishing, but some people fish without canoes. Boats and rafts are also used. As it has no deep keel in the water, the raft is very good for fishing at a low tide.

Many of the neighboring islands have banned the use of monofilament gill nets. When this type of net was first introduced to the islands, it was quickly recognized as to be very efficient and likely to result in over-fishing. It also changed the way net fishing could be conducted from communal fishing to one that could be done by a few individuals. Spearfishing with flashlights (*dengki*) was also recognized by the chiefs and elders as a method that would allow the reef fish resources to be easily over-harvested. Accordingly flashlight spearfishing has also been banned in many of the neighboring islands.

Bayoch, underwater spearfishing at daytime, was traditionally done in the past, and still done now. One of more recent introductions of fishing equipment into Yap is the speargun. It was brought in about 1950 by some Palauans, and underwater spearfishing with flashlight at night, called *dengki*, is secretly done in mainland Yap, although it is prohibited because of the conservation of marine resources.

Dynamite fishing is also not allowed, since it could cause bad damage to marine resources and natural habitats.

Fish traps such as *etch*, *sagel*, *yinup*, and *ulung* are some of the methods controlled and used by families or individuals, and they apparently have provided the bulk of a family's day-to-day needs.

Major Traditional Fishing-gleaning Methods

1. Fish poisons

An important complement to the sophisticated fishing gear used by subsistence coastal societies in Oceania has been fish poisons or stupificants; 11 species of plants used for this purpose (THAMAN, 1994). The most commonly used species are *Barringtonia asiatica*, *Derris trifoliata*, *Pittosporum* spp. and *Tephrosia purpurea*, which reportedly suffocate without affecting the flesh (MERRILL, 1943).

Roots of *yub* or *yuub* plants (*Derris elliptica*) are pounded on the rocks before use in the Solomon Islands. Squeezed plants are put in a place where fish stay, and all the fish will become paralyzed. Numbed fish are easily caught by hand and/or speared.

Pounded roots of another *gabach* vine (unidentified) are also poisonous and used to stupefy fish.

Some other plants were also used to stupefy fish in rivers in mainland Japan and in tide pools in reef flats in the Ryukyu Archipelago (TAKEDA, 1994a, 1994b)

2. FAD (Fish-Aggregation Devices)

This fish-aggregating device is called *pipi fafat*, using a bamboo raft while spear fishing.

Since the advent of goggles, fishermen have noticed that fish stay under a floating object. This led to the evolution of this method where a bamboo raft is pushed ahead of the spear fisherman. Fish are attracted to this miniature fish-aggregation device (FAD; TAKEDA, 1992, 1993c), and, as they pause under it and turn briefly sideways, they are easier to spear.

Such artificial fish-aggregation devices are available nationwide in Japan, especially used in the prefectures along the Black Japan current called *kuroshio*.

3. Flyingfish fishing

This fishing method is called *magal* or *magal gog* for catching flyingfish at night, using sailing canoes and hand nets.

About four or six men are engaged to catch flyingfish outside the reef, using big canoes. They carry tied bundles of braided or twisted coconut leaves or coconut frond, which will be used as a torch. The best time to start *magal* fishing is when the sunset has disappeared and the constellation which the Yapese call *magirgir* (Pleiades) is in the middle of the sky, and the prevailing wind is from the east.

It is the same with the Palau islanders where the constellation is very important to decide the fishing activities properly (TAKEDA and MAD, 1996).

When the sun is almost set, the men sail to the outside of the reef. They stay there until it is completely dark. Then they fold the sail to make the canoe go slowly. Then they begin to light a torch. The light of the torch makes the flyingfish come near the canoe. Everyone takes his dipper net called *chew* except the bailer on the canoe, the paddler and the torchbearer. Flyingfish are captured with hand nets in the air and/or in the water while standing in the sailing canoes.

Participants isolated themselves at the men's house before and after the fishing expeditions.

The Yapese use a fine net to catch small-sized fish for bait, but the net is not so fine in times of catching flyingfish.

4. Line, hook and net fishing

The original lines were made of fibers of beach hibiscus (*Hibiscus tiliaceus*) or *Pipturus argenteus*, with leaders made of fibers from the local variety of pineapple (FALANRUW, 1994b). The bast fiber from *Ficus* spp., *Hibiscus tiliaceus*, *Pandanus tectorius*, and *Pipturus argenteus* are commonly used by Pacific coastal people (THAMAN, 1994).

Nets are made with hibiscus fibers and bamboo and tied with coconut twine. An especially fine net is also made of seagrass fibers (*Enhalus acoroides*) (FALANRUW, 1992a).

Hooks were made of sticks, coconut shell, hawksbill turtle shell, combinations of pearl shell and turtle shell, and hardwood.

Long ago the people made their nets, called *nug* from coconut fiber, but today they make their nets from twine. Stones were used as their sinkers in former times, but they are now substituted by leads.

When the men are going to fish with a new net they have to stay in the men's house for four or five days. They have to fish every day until that number of days is over, then they can go home. After that they can fish with the net anywhere in the ocean or on the reef without staying in the men's house for four or five days.

Net fishing (*nug*) and net casting (*talada*) are usually done by males at any time all year round, although *talada* net-casting has been newly introduced to Yap Islands.

Nets may be also used with V-shaped stone fish weirs.

Seap fishing is done to catch fish at low tide at small shallow pathways from within the reef, crossing to the outside of the reef with a dipper net called *chew* or in June and July when the low tide is big.

5. Butterfly nets

This fishing method is called *kef* (Fig. 2). The nets are composed of an L-shaped frame with an elongated deep net pocket on the arm of the frame held perpendicular to the fisherman. Fishermen employ different sized and proportioned *kef* net in different habitats and depths, usually used in shallow water. Both individuals and groups use *kef* net. Nets are used in connection with rock piles, and with fish traps. They are used to surround and concentrate fish into a small area, to be speared or scooped up with hand nets or captured with the nets.

Nets are made with hibiscus fibers and bamboo, and tied with coconut twine.

6. Leaf sweeps

The traditional movable leaf sweep is called *ruol* or *ruwol*, although it is called *ruul* in Palau (JOHANNES, 1992; TAKEDA and MAD, 1996). The net made of cotton twine is used for a cod net. Both wing nets are composed of coconut leaves and the stem of *gabach* vine.

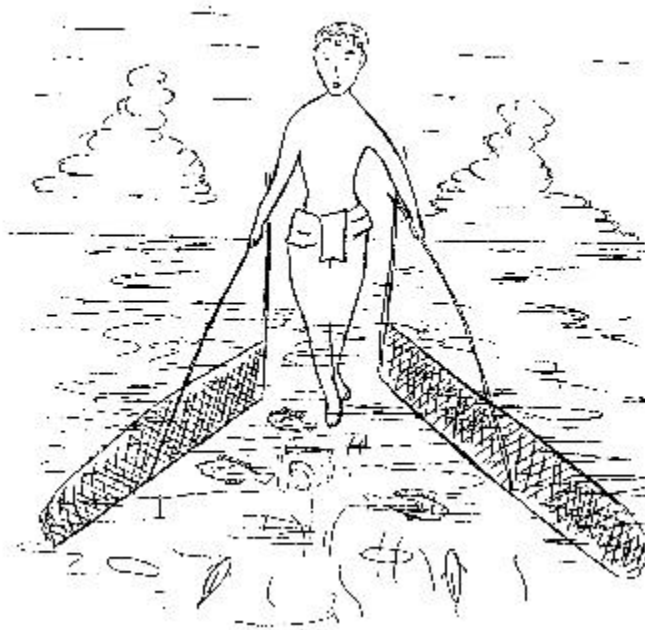


Fig. 2. Butterfly net (*kef*) (by courtesy of Yap Our Island, 1966).

The men make a circle in the net, then they take the *ruol* about one hundred feet away and push it down in the water to keep the fish from going under it. They bring it toward the cod net slowly to chase the fish into the net.

These methods are done inside the reef when the tide is high, and/or near the reef in places where the water is about five feet deep.

7. Portable fish trap

It is a small portable fish trap, called *yanup* or *yinup* made of bamboo, which is operated individually. When they bury this fish trap made from bamboo and pieces of wood in the deep ocean, they put it on the sand or mud and put stones on it. They cover it so that if the fish see it they may think that it is coral and they would like to live under it. Then the fish will swim into the trap. After the men have buried the *yanup* they wait for two days or about every three days before they go to see if there are fish inside it.

This kind of fish trap lasts only about three months.

This fishing method is done only by males at any time throughout the year at high and low tides.

8. Fish weirs

Sagel is a large fish trap made from bamboo panels and mangrove. It lasts about six months.

Etch, ach or *aech* is another stone tidal weir which is artificially made of stones on the shallow reef flat, and similar to *sagel* in placement and design. It is the only permanent kind of fish trap ever made. It is based on the idea that fish will flow into the V-shaped enclosures of the *etch*

and be trapped as the tide recedes.

These stone weirs are used at low tide by males only throughout the year.

Nets may be used with V-shaped stone fish weirs.

The largest weir consists of arrow-shaped walls of stone, with chambers formed between parallel walls of the diagonal arms of the tip of the arrow. A chamber is often subdivided into smaller compartments separated by one-way entrance of decreasing size. This retains bigger fish in the first chambers while smaller fish end up in the last chambers.

When these weirs are in use, bamboo traps are placed in the deeper areas within or adjacent to them to catch and contain the fish directed into them as the tide recedes. When they are not in use, the weirs do not continue to trap fish because the fish can escape through the openings; fish can also escape during high tide when the weir is submerged.

Ulung is another fish trap. It is built with a pile of stone or coral in a small artificial reef, later encircled with a net and then taken apart to catch the fish.

These fishing methods are done at any time all year round by males.

A more detailed description of the stationary stone tidal weirs in Japan can be found in TAKEDA (1993a, 1994a, 1994b).

Invertebrates-gleaning

Several species of seagrasses such as Caulerpaceae (*Caulerpa racemosa*) and Gracilaria (*Gracilaria salicornia*) and so on are growing in large quantities on reef flats in Yap, but only a few species are utilized as foods among the people on a daily basis. Information on other usage such as medicinal use or other purposes were not available at all. Some Yapese have begun to eat *Caulerpa racemosa*. This new food habit was influenced by the people from the Philippines or the immigrants from Palau. Gracilaria and Eucheuma seagrasses are available in the markets in the Philippines as foods (OHBA, personal communication).

Caulerpa spp., *Eucheuma* spp., *Gracilaria* spp., and other seagrass are now consumed by the people in Okinawa, Japan (TAKEDA, 1993b, 1994a, 1994b). These are especially consumed by the old. Some species of Gracilaria are essentially important to be offered to the gods in Okinawa.

Some women who gathered seashells called locally *gutay* (*Asaphis violasens*, Psammobiidae) were observed near Ganir Bridge in the center of Colonia, the capital of Yap, for domestic use, digging them by knife or other tools according to the time when the tide is at ebb. They took good care not to gather small-sized ones at that time. It is one of their sustainability-integrated wisdoms for maintaining marine resources, although they are daily available near the sea.

The palolo worm (*Palolo siliensis*), a coral reef delicacy, is preferred in Samoa and Fiji. The reproductive swarms occur in Rarotonga (the Cook Islands), the Solomon Islands, Kiribati, Vanuatu and Tonga Islands in the South Pacific, too. The swarms always occur on the evenings of the last quarter moon of spring or early summer. This occurs seven days after the full moon of October and November in Samoa and seven days after the full moon of November and December in Fiji. Swarming will occur for two or three consecutive evenings with the second night usually having the strongest showing. In Samoa, palolo worms will usually appear in October, sometimes in November or sometimes during both months (TAKEDA, 2000). No information on palolo worms was available in mainland Yap.

Conclusion

Fishing-gleaning activities in fringing reefs and/or atolls in small islands in the Pacific Ocean have endowed the people with various kinds of marine resources available for food or other uses. Although some species have only seasonal availability, fish, seashell and other marine resources have been captured throughout the year without specialized skills or laborious technologies.

Such ecosystems with coral reef or tidal flats have also afforded women, children and even the aged chances to catch diverse species all year round, which has given them daily-basis self-sufficient livelihoods and affluent marine resources.

Before the introduction of motorized boats, monofilament gillnets, and flashlights, Yap's fishermen employed a much greater variety of fishing methods than at present (MARINE RESOURCES MANAGEMENT DIVISION, 1991). It is possible that one reason for employing so many methods may have been that no single method was much more efficient than any other, and thus many were used to target relatively narrow niches of the fishery, according to species, reef area, and temporal cycles.

However, many villages had nets at their disposal, such as the huge nets used for *athing* fishing in the channels, which provided many large fish when used. *Athing* is a high-ranking fishing method done in the reef channels that requires a large net and lots of manpower (MARINE RESOURCES MANAGEMENT DIVISION, 1991).

The number of nets was relatively few, and they were used rarely, perhaps fewer than five times per year by a given village (MARINE RESOURCES MANAGEMENT DIVISION, 1991).

They were used only for community needs such as community events and obligations to other villages, and their use was strictly controlled by a few individuals. Restrictions on the use of those efficient gears may or may not have been an intentional conservation measure, but the result appears to force greater use of other non-net methods.

Over 700 large fish weirs such as *ach* have been mapped and described in an ongoing project (FALANRUW, 1992b).

One day I observed three women digging *gutay* shellfish in Colonia. In order to consume them as side dishes, they gave the activity careful consideration not to target small-sized shellfish, although they are endowed with rich marine resources.

These factors imply that Yapese traditional technologies have tended to be nature-intensive, making use of the natural energy of tides and the habits of fish.

However, a big-scaled ice box is also put under the eaves of houses which face the roadways in Yap which lead to Colonia, and fish and shellfish are domestically sold. It is partly sometimes turned for domestic consumption, but delicate fish and seashells are usually exported from Yap by air to Palau and/or Saipan by air cargo, most of which will be served to Japanese tourists.

The purchase of a ship outboard engine and FRP (fiberglass reinforced plastic) for vessels has become very easy. A freezing refrigerator and the use of the ice manufacture are also popularized, and methods are moving from fishing-gleaning form to a commercial base at a drastic rate.

Such traditional fishing-gleaning subsistence has been becoming minor in Yap proper, apart from the islands far from Yap where large technical assistance and political projects are under way on a large scale from foreign countries for Yap.

However, it is essentially important to accumulate data on the traditional fishing-gleaning activities done throughout Oceania in terms of ecological anthropology, which will make a basic effort to elucidate human adaptabilities in the process of the human evolution and survival strategies in coral ecosystems.

Acknowledgements

I am greatly thankful to Mr. HENRY WORSWICK, Jr., Mr. IMEONG LUCKY and their wives for their warm-hearted hospitality and giving me valuable information on Yapese traditional fishing-gleaning activities during my stay in Colonia even though they were very busy. I am also grateful to Ms TERRIE FANAPIN, worker at Nature Way under Ms MITSUE YASUI for teaching me fishing-gleaning methods in Rumung Island and to Mr. TSUTOMU IGARASHI, Associate Professor of Saga University for drawing a figure in the text.

References

- AMESBURY, S.S., R.T. TSUDA., R.H. RANDALL and C.E. BIRKELAND. 1977. *Marine Biological Survey of the Proposed Dock Site at Colonia, Yap*. Univ. Guam Marine Lab. Tech. Report 35.
- BARRAU, J. 1976. *Subsistence agriculture in Polynesia and Micronesia*. B.P. Bishop Museum Bulletin, Vol. 223. Bishop Museum Press, Honolulu.
- DODSON, J.R. and M. INTOH. 1999. Prehistory and palaeoecology of Yap, Federated States of Micronesia. *Quaternary International* 59:17-26.
- FALANRUW, M.C. 1992a. Seagrass nets. *Atoll Research Bulletin* No. 364, Smithsonian Institution, Washington D. C.
- FALANRUW, M.C. 1992b. Traditional use of the marine environment on Yap. Paper presented at the Science of Pacific Island Peoples Conference, Suva, Fiji.
- FALANRUW, M.C. 1994a. Food production and ecosystem management on Yap. *A Journal of Micronesian Studies*, 2(1): 5-22.
- FALANRUW, M.C. 1994b. Traditional fishing on Yap. In: MORRISON, J., P. GERAGHTY, and L. CROWL (eds.) *Ocean and Coastal Studies: Science of Pacific Island People* Volume 1, pp.41-58. Institute of Pacific Studies, The University of the South Pacific.
- FALANRUW, M.C., C.D. WHITESELL, T.C. COLE, C.D. MACCLEAN, and A.H. AMBACHER. 1987. *Vegetation survey of Yap, Federated States of Micronesia*. USDA Forest Service, Resource Bulletin PSW-21.
- HUNTER-ANDERSON, R.L. 1983. *Yapese settlement patterns: an ethnoarchaeological approach*. Pacific Studies Institute, Guam.
- JOHANNES, R.E. 1992. *Words of the lagoon: Fishing and marine lore in the Palau district of Micronesia*. University of California Press, Berkeley and Los Angeles, California.
- 李應喆, 武田淳 1999. 干潟の水産資源 (第2報) 韓国・西海岸咸平湾における伝統的漁撈と採捕活動. 佐賀大学農学部彙報 第84号, pp.11-27. [LEE, E.C. and J.TAKEDA. 1999. Marine resources on tidal flats. Part 2: The traditional fishing-gleaning activities in Hampyong Bay, South Korea. *Bulletin of the Faculty of Agriculture, Saga University* No. 84: 11-27.]
- MARINE RESOURCES MANAGEMENT DIVISION. 1991. *Reef Fisheries in Yap Proper: Status of the Traditional Authority Environment and Implications for Management*. Marine Resources Management Division, Department of Resources and Development, Yap State, Federated

States of Micronesia.

- MERILL, E. D. 1943. *Emergency food plants and poisonous plants of the Pacific*. Technical monograph 10-420, United States Printing Office, Washington D.C.
- TAKEDA, J. 1992. Seasonality and change in traditional fishing patterns in Minatogawa, Japan. *South Pacific Study* 13 (1): 107-129.
- 武田 淳 1993. 海からの捧げもの：伝統的漁法「石干見」, 潮騒 9:48-51. [TAKEDA, J. 1993. Stone tidal weirs: Japanese traditional fishing methods, *Shiosai* 9: 48-51.]
- TAKEDA, J. 1993b. The Ikei Islanders: Fishing practices in an Okinawan coral ecosystem. *South Pacific Study* 13 (2): 211-234.
- TAKEDA, J. 1993c. Seasonality and change in traditional fishing patterns in Japan. *Annals of Human Biology* 20 (1): 95-96.
- 武田 淳 1994a. イノエの採捕経済：サンゴ礁海域における伝統漁法の多様性, 地域文化の均質化, pp. 51-68, 九学会連合「地域文化の均質化編集委員会」(編), 平凡社. [TAKEDA, J. 1994a. Foraging economy on reef flats: traditional diversity of foraging activities in the coast-dwelling people of the Ryukyu Archipelago. In: Council of Nine Learned Sciences (ed.), *Cultural Homogenization of Japanese Communities*, Heibonsha: Tokyo, 51-68.]
- TAKEDA, J. 1994b. Plant phenology, animal behaviour and food-gathering by the coastal people of the Ryukyu Archipelago. *Humans and Nature* 3: 117-137.
- TAKEDA, J. and S. OHYAMA 1994. Man and crabs in Yaeyama folk song: Crab-species identification and folkzoological background. *Humans and Nature* 4: 99-124.
- TAKEDA, J. and P. K. MAD. 1996. Traditional Palauan lunar calendar and the fishing-gleaning activities on reef flats and/or in lagoons in the western Caroline Islands, Micronesia. *Kagoshima Univ. Res. Center S. Pac.*, Occasional Papers No.30: 91-106.
- 武田 淳, 五十嵐 勉, 趙慶萬, 李應喆 1998. 干潟の水産資源 (第一報): 有明海における伝統的採捕技術と多様性. 佐賀大学農学部彙報 第83:79-97. [TAKEDA, J., T. IGARASHI, K.M. CHO and E.C. LEE, 1998. Marine resources on tidal flats. Part 1: The traditional fishing-gleaning strategies and diversity in the Ariake Sea. *Bulletin of the Faculty of Agriculture, Saga University* No.83: 79-98.]
- 武田 淳 2000. ある南海の珍味「太平洋パロロ」～生物季節と採捕～. 3号館フィールド年報, Vol. 2, 104-105. [TAKEDA, J. 2000. A coral reef delicacy of the South Sea: Pacific palolo sea-worm: its phenology and the gleaning activities. *Annual Report of Fieldworks* 2: 104-105.]
- TAKEDA, J., E.C. LEE and K.M. CHO. 2001. The anthropological and ecological importance of tidal flats to Japan and Korea with special reference to oyster-gathering activities. *Lowland Technology International* 3(1): 57-69.
- THAMAN, R.R. 1994. Ethnobotany of Pacific island coastal plants. In: MORRISON, J., P. GERAGHTY, and L. CROWL (eds.) *Fauna, Flora, Food and Medicine. Science of Pacific Island People* Volume III, pp. 147-184. Institute of Pacific Studies, The University of the South Pacific.
- TSUDA, R.T. 1978. *Marine biological survey of Yap lagoon*. Univ. Guam Marine Lab. Tech. Reports 45.
- UNDERWOOD, J.H. 1969. Preliminary investigations of demographic features and ecological variables of a Micronesian population. *Micronesia* 5(1): 1-24
- USEEM, J. 1946. *Economic and human resources, Yap and Palau, West Carolines*. United States

Commercial Company Economic Survey, Honolulu.

牛島巖 1987. ヤップ島の社会と交換, 弘文堂. [USHIJIMA, I. 1987. *Society and the exchange system of Yap Island*. Kobundo, Tokyo.]

YAP DISTRICT DEPARTMENT. 1966. *Yap Our Island by 9th Grade Intermediate School*. Publications Office, Saipan, Mariana Islands.