

## Dietary Patterns and Food Consumption Survey in the Federated States of Micronesia: A Case Study in Pingelap Island, Pohnpei State

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**Abstract** Before the 1950s, the population of the Federated States of Micronesia (FSM) consumed a traditional diet based on starch staple crops and marine resources. This began to be replaced by a modern food in the 1960s and this phenomenon accelerated after a Compact of Free Association was signed between the FSM and the United States in 1986. Previous researches on dietary patterns in the FSM were undertaken only for a very short-period and they did not indicate the dietaries for the whole year. Therefore, a detailed study of household food consumption for every meal over a period of 18 months was conducted to understand the dietary patterns of the inhabitants of Pingelap Island, Pohnpei State, the FSM. Inhabitants of Pingelap Island were partially dependent on imported rice, but they all consumed banana, breadfruit, *mweiang* (*Cyrtosperma merkusii*; giant swamp taro), and fish obtained locally at a high frequency. Breadfruit was available seasonally, so the frequency of its consumption fluctuated, and consumption of banana and *mweiang* increased depending on the availability of breadfruit. The consumption frequencies of imported fresh meat, canned fish, and canned meat were very low. These observations suggest that the dietary patterns on Pingelap Island resemble traditional diets, with a reliance on food available locally and favorable for food security.

**Key words:** Banana, Breadfruit, *Cyrtosperma merkusii*, Ethnobotany, Food security, Traditional food

### Introduction

The Federated States of Micronesia (FSM) consists of four states: Yap, Chuuk, Pohnpei, and Kosrae, from west to east. The FSM is composed of approximately 600 small islands, lying just above the equator in the western Pacific Ocean. The total land area is 700 km<sup>2</sup>, occupying more than 2,600,000 km<sup>2</sup> of the Pacific Ocean and spanning approximately 2,500 km. The FSM has a tropical climate, with relatively warm temperatures (the average annual temperature is 26-27°C; Galbraith *et al.*, 2000) and typically plentiful rainfall throughout the year.

Before the 1950s, the population relied on a traditional diet based on starch staple crops (e.g., breadfruit, root and tuber crops, banana) and marine resources (e.g., fish, octopus, clams, turtles). By the 1960s, the traditional diet was being replaced by a modern diet consisting of rice, flour, sugar, fatty foods, and various imported and processed foods after the United States Department of Agriculture initiated a supplementary feeding program (Englberger *et al.*, 2003). This phenomenon was accelerated by the Migration, Remittance, Aid

and Bureaucracy (MIRAB) economy, a cash economy mainly consisting of migrated workers' remittance and salary of bureaucratic workers funded by aid from the United States. A Compact of Free Association agreement was signed between the FSM and the United States in 1986 (Hezel, 2004). Since then, the FSM has faced serious public health problems, such as obesity, diabetes mellitus, hypertension, cardiac disease, and vitamin A deficiency, due to the modern diet and other lifestyle changes (Yamamura *et al.*, 2004; Nomura *et al.*, 2005; Matsumoto *et al.*, 2012). In response, the government, non-governmental organizations, and researchers have attempted to promote a return to local foods because of their higher contents of carotenoids and vitamins compared to modern foods (Englberger *et al.*, 2009), but the outlook for this program is still bleak.

Murai (1954) conducted a dietary survey of one household for eight days on Udot Island, Chuuk Atoll, in 1951, and concluded that "the diets of the people are influenced by the seasonal fruits and vegetables available," and thus any such studies have limited meaning unless they are conducted over an entire year. Since then, some dietary surveys have been conducted in Micronesia, but for a short period of time. For example, in 1981 and 1986, studies in Saipan were conducted for one week per study during January to March (Denman and Dewey, 1989). Other studies have included the seven-

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Communicated by M. Onjo

Received Jan. 26, 2015

Accepted Jun. 17, 2015

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day Food Frequency Questionnaire (the 7-day FFQ) on Pohnpei Island from January to March 2004 (Corsi *et al.*, 2008), others in 2005 and 2007 (Kaufer, 2008), and still another that Pohnpei Island plus Mokil and Pingelap islands in September 2008 (Kawai *et al.*, 2010). Long-term studies are necessary to understand dietary habits in Micronesia, whether they are traditional or modern. In the present study, we conducted a detailed evaluation of household food consumption at every meal over a period of 18 months on Pingelap Island, Pohnpei State.

### Study Site and Data Collection

Pohnpei State consists of the main island of Pohnpei Island, the center of Pohnpei State and home of the capital city Kolonia, and eight smaller outer islands including Pingelap Atoll located approximately 250 km southeast of Pohnpei Island (Fig. 1). Pingelap Atoll has three islets, Pingelap Island, Deke Island, and Sukoru Island, which make up an area of 1.8 km<sup>2</sup>. Among these, only Pingelap Island is inhabited (Office of the Governor, Statistics Section, Pohnpei State Government, 1996: 25).

Access to Pingelap Atoll was very limited. Villagers mentioned that a public ship operated by the government (approximately USD 12 per person from Pohnpei Island to Pingelap Island) came to Pingelap Island only twice from August 2012 to August 2013. There was a 300 m airstrip on Pingelap Island, and Caroline Islands Air flew light aircraft (for eight passengers) to the island, but flight schedules were irregular and the price of a one-way ticket was USD 190. The cost of shipping parcels

from Pingelap Island, via Caroline Islands Air, was USD 0.75 per pound, which was considered prohibitive.

According to our preliminary survey, the population was 239, represented by 58 households in August 2012. The average income per household was USD 59.1 (roughly USD 3,000/year). There has been a slight decline in the population and number of households since 2000, but the average income has remained almost constant since 2002 (Table 1; Pohnpei Branch Statistics Office, 2002).

The inhabitable area of Pingelap Island extends from the shoreline to a patch of *mweiang* (*Cyrtosperma merkusii*) at the center of the island (Fig. 1). This area was divided into 154 sites based on traditional land classification and/or land ownership, including sites with no inhabitants at the time of our survey. Edible plants were documented at each site in August 2013 to understand the frequencies of crops and other useful plants in home gardens. The frequencies of each edible plant was calculated as: frequency (%) = (total site number of appearances of each useful plant / 154 sites) × 100. It is known that people obtain crops from home gardens and fields (uninhabited area) in the island or the atoll (Damas, 1994).

Two households were selected to survey dietary patterns, based on the average family size (median value 4) and income (median value USD 32.8) according to our preliminary survey. Detailed information of household A (HH-A) and household B (HH-B) is presented in Table 2. Questionnaires were distributed to explore the

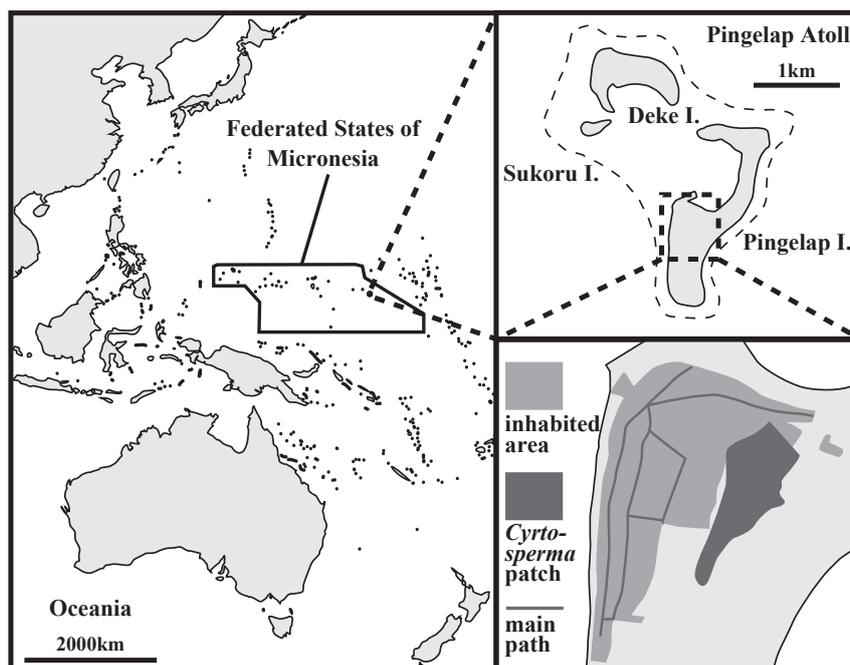


Fig. 1. Study sites in Pingelap Atoll, Pohnpei State, the Federated States of Micronesia.

Table 1. Population, number of households, and median income on Pingelap Island from 1920 to 2000 (Pohnpei Branch Statistics Office, 2002).

	1920	1925	1930	1935	1958	1967	1970	1973	1980	1985	1994	2000
Population	601	601	638	694	627	647	661	641	375	737	518	438
Number of households	—	—	—	—	—	—	—	—	—	—	87	83
Median Income per year in U.S. Dollars	—	—	—	—	—	—	—	—	—	—	1500	3000

Table 2. Detailed information on two households selected for a dietary survey (data collected in August 2012).

Household number	Sex	Age					Total	Income within last 7 days
		0-9	10-19	20-29	30-39	40-49		
Household A (HH-A)	Male	1	1* <sup>1</sup>	0	0	1	3	USD 32.5
	Female	0	2+1* <sup>1</sup>	0	0	1	4	(31st / 58 households)
Household A (HH-B)	Male	1	0	0	1	0	2	USD 30.0
	Female	2	2* <sup>1</sup>	0	1	0	5	(33rd / 58 households)

\*1: They are students and they came back to Pingelap Island for the summer vacation; they usually stay in Pohnpei Island.

foods consumed at every meal, as follows: starch staples (e.g., rice, breadfruit, *mweiang*, banana, flours), marine resources (e.g., fresh fish, dried fish, canned fish), meat (fresh, canned), and miscellaneous items such as instant noodles, coconut juice, vegetables, and fruit. All the items were asked by local food (obtained from home gardens, a patch of *mweiang*, and other crop fields in the island and/or the atoll) or imported food. These items were selected based on a preliminary survey in 2010 (Yamamoto, 2011). The frequencies per month of each item were calculated using the following formula: frequency (%) = (total number of appearances of each item / total number of meals) × 100. Food consumption data were collected from August 2012 to January 2014, for a total of 18 months.

## Results and Discussion

### *Edible plants and their frequencies in home gardens*

More than 25 species of edible plants were observed in home gardens (Table 3). *Cocos nucifera* was present at the highest frequency (82.8%), followed by *Musa* spp. (79.0%), *Pandanus* spp. (66.9%), *Artocarpus* spp. (52.9%), and *Carica papaya* (44.6%). These crops were consumed, or used in other ways on a daily basis, as starch staples, fruit, drink, food wrapping material, handicrafts, canoes, or as construction material. The frequencies of root and tuber crops were low. They included *C. merkusii* (8.3%), *Dioscorea* spp. (7.0%), *Xanthosoma sagittifolium* (6.4%), *Colocasia esculenta* (1.9%), and *Ipomoea batatas* (1.3%). This is partly because there is a big patch of *C. merkusii* on the island and it is difficult to cultivate some crops, e.g., *Dioscorea* spp. which are one of the most important crops in Pohnpei Island, due to alkali soil derived from coral (Onjo, 2010). *Alocasia macrorrhizos* (12.1%) and

*Tacca leontopetaloides* (1.9%), which were regarded by villagers as famine food, were found in home gardens as both cultivated and spontaneous forms. *Citrus* spp. (28.7%) and *Capsicum* spp. (28.7%) were very important condiments, thus they were grown frequently. However, the frequencies of other fruit trees, vegetables, and spices were low, except for *Alternanthera sissou* (12.7%) and *Cnidocolus chayamansa* (10.8%), which are native to the Americas and consumed as vegetables.

Cultivars of some crops on Pingelap Island are shown in Table 4. The Pingelap Island inhabitants tended to name cultivars after the originators of the cultivars or the locations of cultivar derivation. The numbers of cultivars per crop were not very different from the numbers reported in a previous study during 1975-1983 (Damas, 1994). However, many of the names of the cultivars have changed since then, suggesting that some cultivars have been lost and others have been introduced in the past 30 years.

### *Imported food*

The frequencies of food consumption of HH-A and HH-B are shown in Tables 5 and Table 6, respectively. Rice consumption of HH-A (65.7%, 18-month average, the same hereinafter) was higher than that of HH-B (33.2%), as the head of HH-A was a municipal employee and his income was stable. HH-B rarely ate rice in May, June, July, and November 2013 due to the unstable income of the head of the household based on the interview survey. A low frequency of rice consumption of both households in September 2012 was due to lack of imported rice on the island. Compared to rice, flour was rarely used in either household (HH-A: 12.4%, HH-B: 7.9%). The frequencies of canned fish and meat consumption were

Table 3. Edible plants on Pingelap Island and their frequencies in home gardens.

Scientific name* <sup>1</sup>	Local name	Frequency* <sup>2</sup>
<u>Starchy staples</u>		
<i>Musa</i> spp.	<i>wis</i>	79.0%
<i>Artocarpus altilis</i> , <i>A. mariannensis</i>	<i>mei</i>	52.9%
<i>Alocasia macrorrhizos</i>	<i>wod</i>	12.1%
<i>Cyrtosperma merkusii</i>	<i>mweiang</i>	8.3%
<i>Dioscorea</i> spp.	<i>kehþ</i>	7.0%
<i>Xanthosoma sagittifolium</i>	<i>sewa seipan</i>	6.4%
<i>Colocasia esculenta</i>	<i>sewa</i>	1.9%
<i>Tacca leontopetaloides</i>	<i>mwekemwek</i>	1.9%
<i>Ipomoea batatas</i>	<i>pidehde</i>	1.3%
<u>Fruits etc.</u>		
<i>Cocos nucifera</i>	<i>ni</i>	82.8%
<i>Pandanus</i> spp.	<i>kipar</i>	66.9%
<i>Carica papaya</i>	<i>keiniap</i>	44.6%
<i>Citrus</i> spp.	<i>karer</i>	28.7%
<i>Saccharum officinarum</i>	<i>sew</i>	8.9%
<i>Terminalia catappa</i>	<i>dipwopw</i>	2.5%
<i>Syzygium</i> spp.	<i>apol</i>	2.0%
<i>Ficus tinctoria</i>	<i>nin</i>	0.6%
<u>Vegetables, spices and herbs</u>		
<i>Capsicum annuum</i> , <i>C. frutescens</i>	<i>sele</i>	28.7%
<i>Alternanthera sissoo</i>	<i>sipinach</i>	12.7%
<i>Cnidioscolus chayamansa</i>	<i>chaia</i>	10.8%
<i>Cucurbita</i> sp.	<i>pwengkin</i>	3.2%
<i>Brassica</i> sp.	-	0.6%
<i>Ocimum tenuiflorum</i>	<i>kadiring</i>	0.6%

\*1: Scientific names following Balick (2009).

\*2: Frequency in 154 sites privately owned (including sites with no inhabitants at the time of our survey).

Table 4. Vernacular names for cultivars of some crops on Pingelap Island.

Scientific name	Number of cultivars	Cultivar names
<i>Artocarpus altilis</i> , <i>A. mariannensis</i>	6	Seeded type: <i>mei pa</i> , <i>mei si</i> ; Seedless type (all named after a place name): <i>mei in Mokil</i> (Mokil), <i>mei Sapwerek</i> (Pohnpei), <i>mei in We</i> (Pohnpei), <i>mei Samoa</i> (Samoa)
<i>Citrus</i> spp.	2	<i>karer mototo</i> , <i>karer rei</i>
<i>Cocos nucifera</i>	4	<i>ni mau</i> (=between green and red), <i>ni sol</i> (=black), <i>ni weisahsa</i> (=red), <i>ni Kosrae</i> (Kosrae)
<i>Colocasia esculenta</i> and/or <i>Xanthosoma sagittifolium</i>	3	<i>sewa Pingelap</i> , <i>sewa Seipan</i> (Saipan), <i>sewa wai</i> (=from abroad, nowadays meaning mainly USA)
<i>Cyrtosperma merkusii</i>	10	Someone's name: <i>Aikem</i> , <i>Dison</i> , <i>Iken</i> , <i>Jerria</i> ( <i>Serria</i> ), <i>Piseþ</i> , <i>Sehn</i> , <i>Simihden</i> , <i>Wais</i> ; Place name: <i>Ngatik</i> ; Others: <i>sounpwong wonou</i> (=six months)
<i>Musa</i> spp.	12	Someone's name: <i>Aro wis</i> , <i>Ezra</i> , <i>Inek wis</i> ; Place name: <i>Fiji</i> (Fiji), <i>Lekedan</i> (Pohnpei), <i>Lokoi</i> (Pohnpei), <i>Taiwan</i> (Taiwan), <i>wis in wai</i> ; Others: <i>dukuru</i> , <i>eke dahn</i> , <i>þihsi</i> , <i>wis keras</i>
<i>Pandanus</i> spp.	10	Place name: <i>Mwasel</i> (Marshall); Others: <i>aspwihrek</i> , <i>eisesoul</i> , <i>esies</i> , <i>ezero</i> , <i>kaparin mwahsez</i> , <i>makesokosok</i> , <i>mwisamwis</i> , <i>ne-nekehsak</i> , <i>sohn meneia</i> , <i>suwaiþwehpwe</i>
<i>Saccharum officinarum</i>	4	<i>seni</i> , <i>sew sol</i> , <i>sew weisahsa</i> , <i>kelai</i>

very low (canned fish: HH-A 2.8%, HH-B 1.0%; canned meat: HH-A 1.4%, HH-B 0.5%). These percentages indicate that both households consumed canned food less than 1-2 times/month. HH-A ate imported turkey tail only twice in 18 months. Instant noodles, however, were

sometimes consumed in both households (HH-A: 22.5%, HH-B: 9.9%).

Kaufer (2008) reported that imported rice and flour (including instant noodles) were consumed 6.8 days/week and 4.1 days/week, respectively, in 2005, and 6.1

Table 5. Frequency (%) of food consumption of household A (HH-A) during 2012-2014 on Pingelap Island.\*1

	2012												2013				2014		18-month average
	Aug. n=60	Sep. n=90	Oct. n=93	Nov. n=90	Dec. n=93	Jan. n=93	Feb. n=84	Mar. n=93	Apr. n=90	May n=93	Jun. n=90	Jul. n=93	Aug. n=93	Sep. n=87	Oct. n=93	Nov. n=90	Dec. n=93	Jan. n=93	
<b>Starchy staples</b>																			
Rice	43.3	11.1	81.7	71.1	86.0	68.8	61.9	63.4	70.0	76.3	77.8	61.3	72.0	73.6	72.0	56.7	57.0	78.5	65.7
Breadfruit	35.0	54.4	3.2	1.1	4.3	0.0	15.5	28.0	21.1	24.7	30.0	47.3	31.2	21.8	31.2	14.4	12.9	7.5	20.4
Mweiang	26.7	7.8	19.4	16.7	7.5	21.5	15.5	12.9	15.6	15.1	26.7	11.8	18.3	14.9	18.3	27.8	43.0	28.0	18.7
Banana	80.0	66.7	25.8	51.1	45.2	35.5	51.2	35.5	48.9	30.1	30.0	29.0	25.8	37.9	25.8	38.9	18.3	40.9	41.2
Flour	0.0	0.0	11.8	18.9	19.4	20.4	15.5	17.2	14.4	8.6	10.0	5.4	6.5	8.0	6.5	21.1	16.1	15.1	12.4
Others	10.0	24.4	4.3	18.9	2.2	0.0	1.2	0.0	3.3	19.4	2.2	2.2	2.2	0.0	2.2	1.1	0.0	0.0	5.2
<b>Marine resources</b>																			
Fresh fish	76.7	84.4	45.2	55.6	51.6	66.7	71.4	67.7	67.8	80.6	73.3	79.6	75.3	71.3	75.3	66.7	60.2	54.8	67.4
Dried fish	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.2
Canned fish	10.0	1.1	1.1	0.0	1.1	8.6	6.0	2.2	4.4	1.1	0.0	0.0	0.0	0.0	0.0	1.1	2.2	1.1	2.8
Others	0.0	13.3	0.0	5.6	0.0	0.0	1.2	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
<b>Meat</b>																			
Fresh	8.3	0.0	17.2	4.4	23.7	5.4	0.0	0.0	4.4	2.2	11.1	0.0	0.0	0.0	0.0	4.4	8.6	5.4	5.4
Canned	0.0	4.4	9.7	0.0	4.3	0.0	1.2	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	1.4
Others																			
Noodle	31.7	7.8	18.3	15.6	16.1	32.3	14.3	12.9	31.1	9.7	11.1	31.2	15.1	16.1	15.1	35.6	40.9	41.9	22.5
Coconut	46.7	76.7	17.2	32.2	14.0	23.7	32.1	30.1	33.3	45.2	38.9	61.3	21.5	34.5	21.5	35.6	40.9	22.6	36.3
Vegetable	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	3.2	1.1	0.0	0.0	0.0	0.0	1.1	0.0	2.2	1.2
Fruit	13.3	21.1	3.2	14.4	16.1	32.3	73.8	43.0	20.0	46.2	45.6	32.3	23.7	21.8	23.7	23.3	20.4	10.8	27.7

\*1: Frequency (%) = (total number of appearances of each item / total number of meals) × 100.

Table 6. Frequency (%) of food consumption of household B (HH-B) during 2012-2014 on Pingelap Island.\*1

	2012												2013			2014		18-month average	
	Aug. n=63	Sep. n=90	Oct. n=93	Nov. n=90	Dec. n=93	Jan. n=93	Feb. n=84	Mar. n=93	Apr. n=87	May n=87	Jun. n=90	Jul. n=93	Aug. n=93	Sep. n=90	Oct. n=93	Nov. n=90	Dec. n=93		Jan. n=93
<b>Starchy staples</b>																			
Rice	20.6	5.6	34.4	33.3	51.6	57.0	65.5	49.5	39.1	4.6	0.0	7.5	53.8	40.0	37.6	0.0	35.5	61.3	33.2
Breadfruit	30.2	3.3	3.2	33.3	19.4	21.5	17.9	5.4	5.7	8.0	14.4	31.2	11.8	14.4	6.5	20.0	0.0	0.0	13.7
Mweiang	36.5	46.7	37.6	10.0	3.2	5.4	2.4	0.0	13.8	39.1	12.2	0.0	5.4	12.2	23.7	33.3	19.4	0.0	16.7
Banana	15.9	50.0	18.3	22.2	11.8	8.6	6.0	16.1	28.7	39.1	55.6	21.5	4.3	11.1	26.9	42.2	25.8	1.1	22.5
Flour	0.0	0.0	4.3	0.0	6.5	4.3	1.2	22.6	26.4	2.3	0.0	2.2	15.1	16.7	1.1	0.0	8.6	31.2	7.9
Others	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	2.3	4.4	9.7	0.0	0.0	0.0	0.0	0.0	0.0	1.5
<b>Marine resources</b>																			
Fresh fish	85.7	54.4	60.2	61.1	52.7	80.6	70.2	47.3	43.7	65.5	56.7	41.9	21.5	26.7	62.4	76.7	36.6	44.1	54.9
Dried fish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.1
Canned fish	1.6	0.0	3.2	0.0	3.2	3.2	0.0	3.2	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	2.2	0.0	1.0
Others	9.5	44.4	8.6	0.0	0.0	0.0	0.0	0.0	0.0	6.9	10.0	0.0	0.0	1.1	3.2	0.0	0.0	0.0	4.7
<b>Meat</b>																			
Fresh	3.2	0.0	0.0	0.0	0.0	0.0	0.0	1.1	5.7	0.0	0.0	3.2	15.1	4.4	6.5	0.0	0.0	9.7	2.7
Canned	0.0	0.0	1.1	0.0	0.0	0.0	0.0	3.2	2.3	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.5
Others																			
Noodle	3.2	0.0	10.8	12.2	31.2	9.7	9.5	9.7	4.6	0.0	0.0	1.1	18.3	4.4	9.7	0.0	29.0	24.7	9.9
Coconut	44.4	58.9	31.2	20.0	20.4	7.5	2.4	7.5	4.6	50.6	56.7	30.1	5.4	0.0	0.0	6.7	0.0	2.2	19.4
Vegetable	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Fruit	28.6	48.9	15.1	0.0	0.0	0.0	2.4	17.2	9.2	25.3	16.7	9.7	0.0	2.2	0.0	0.0	0.0	0.0	9.7

\*1: Frequency (%) = (total number of appearances of each item / total number of meals) × 100.

days/week and 5.0 days/week, respectively, in 2007, on Pohnpei Island (the 7-day FFQ, 1 count/day). Corsi *et al.* (2008) reported similar results (the 7-day FFQ, 1 count/day) on Pohnpei Island. They reported that consumption of imported rice and wheat flour products (including instant noodles) in 2004 were  $6.5 \pm 1.4$  days/week and  $3.5 \pm 2.6$  days/week, respectively. Although it is very difficult to compare these results to our results, as they did not survey every meal, consumption of rice was somewhat greater on Pohnpei Island than Pingelap Island because HH-A and HH-B were precluded from consuming rice and wheat flour products during some months.

Consumption of imported fish (probably canned fish) and meat (probably canned meat and imported chicken) on Pohnpei Island was  $2.4 \pm 1.9$  days/week and  $1.9 \pm 2.1$  days/week, respectively, in 2004 (Corsi *et al.*, 2008), 2.4 days/week and 1.7 days/week in 2005, and 2.7 days/week and 2.6 days/week in 2007 (Kaufert, 2008). Pohnpei Island inhabitants consumed considerably more imported fish and meat than those of Pingelap Island, which is consistent with the results of Kawai *et al.* (2010). These results suggest that it was much easier to access imported food on Pohnpei Island than on Pingelap Island, as the former island had better transportation and higher income (Pohnpei: USD 6,631, Pingelap: USD 3,000 in year 2000 census).

#### Local food

Among the starch staples, the frequency of banana consumption was the highest, followed by breadfruit and *mweiang* (*C. merkusii*) (banana: HH-A 41.2%, HH-B 22.5%; breadfruit: HH-A 20.4%, HH-B 13.7%; *mweiang*: HH-A 18.7%, HH-B 16.7%). Breadfruit availability fluctuated (harvest time is mainly May to September, but it depends on cultivars [Fownes and Raynor, 1993]; people in Pingelap Island also eat preserved breadfruit called “mar” during the off-season [Damas, 1994: 54]). When breadfruit consumption was low, consumption of banana and *mweiang* tended to increase. Only HH-A consumed yam, but its usage was very limited (Table 7).

Figure 2 shows the additional value of frequencies of local starchy crop consumption (breadfruit, banana, *mweiang*, and others). The additional value for HH-A each month was close to 80-100%, which means that HH-A consumed local starch crops once per meal. HH-A tended to eat rice or flour, and at least one local starch crop, per meal. On the contrary, the additional value for HH-B fluctuated greatly. HH-B tended to eat only one starch crop (e.g., rice, breadfruit) at every meal.

Compared to the results of Kaufert (2008) and Corsi *et al.* (2008), banana and *mweiang*, in particular, seemed to be more highly consumed on Pingelap Island than on Pohnpei Island. Kawai *et al.* (2010) also pointed out that daily consumption of *mweiang* was significantly higher on Pingelap Island than on Pohnpei Island in September 2008.

HH-A and HH-B sometimes ate land crab, coconut crab, sea turtle, and squid (Table 7), but a primary marine resource was fresh fish (HH-A: 67.4%, HH-B: 54.9%). They ate fresh fish as low (*sashimi*), soup, grilled, and fried, but they rarely consumed dried fish (HH-A: 0.2%, HH-B: 0.1%). The frequencies of local meat consumption were low (HH-A: 5.4%, HH-B: 2.7%). Pigs were usually eaten on ceremonial occasions. HH-A consumed pork during this survey, but local chicken was eaten infrequently (Table 7). Based on previous research, consumption of local fish and meat on Pohnpei Island was  $4.8 \pm 2.3$  days/week and  $1.3 \pm 1.6$  days/week, respectively, in 2004 (Corsi *et al.*, 2008), 3.9 days/week and 1.5 days/week in 2005, and 4.2 days/week and 1.1 days/week in 2007 (Kaufert, 2008). Compared to Pohnpei Island, people on Pingelap Island seemed to consume more local fish and less local meat because it was easier to catch fish in the lagoon and more difficult to feed large quantities of pigs and chickens on the small island. These results agree with results presented by Kawai *et al.* (2010), indicating that daily consumption of fresh fish on Pingelap Island was twice as high as on Pohnpei Island.

Vegetables were rarely eaten by either household during this 18-month survey (HH-A: 1.2%, HH-B: 0.1%), suggesting that people on Pingelap Island are not accustomed to eating green (or leafy) vegetables. This has made it difficult to introduce new vegetables via programs that promote healthy diets. For example, it was observed that some people on Pingelap cultivated cucumber introduced by a certain project on a preliminary survey in 2010, but its cultivation was not observed until 2012. See weeds were not consumed in this survey.

Compared to vegetables, the frequencies of fruit consumption were relatively higher (HH-A: 27.7%, HH-B: 9.7%). Fruits, including ripe banana, ripe *Pandanus* spp., ripe papaya, and *Syzygium* spp., were eaten by island inhabitants (Table 7). Coconut was consumed as a drink by HH-A (36.3%) and HH-B (19.4%). They also ate a sponge-like endosperm of mature coconuts (not a solid endosperm for coconut milk) as either *uhmw par*, which is cooked in an earth oven, or *daloak*, in which the endosperm is pulverized and mixed with sugar (Table 7). Fruits were eaten at regular meals and also on vari-

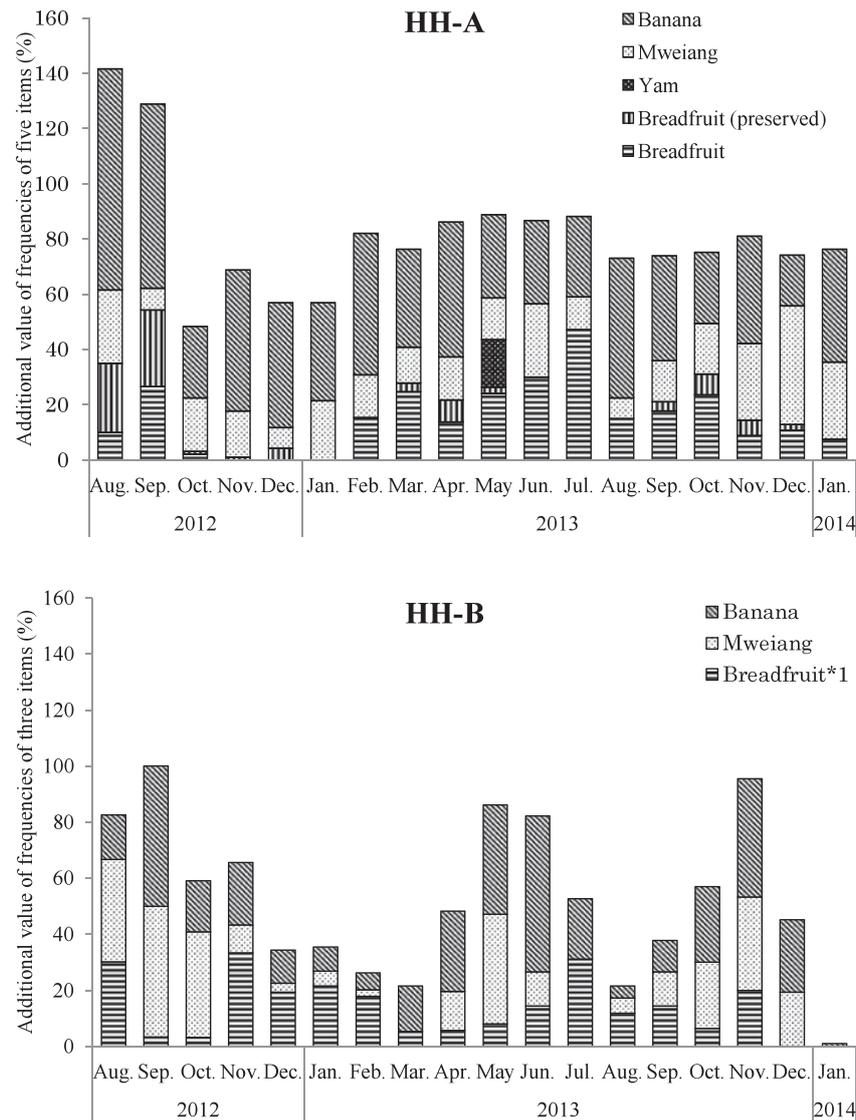


Fig. 2. Additional frequencies of starch crops obtained on Pingelap Island (\*1: breadfruit including both preserved and non-preserved fruits).

ous special occasions, such as agricultural and fishery practice, meetings, etc., therefore, the real situation of these consumption would be higher.

### Conclusions

Inhabitants of Pingelap Island were somewhat dependent on imported rice, but also consumed crops and marine resources obtained locally at a high frequency. The frequencies of consumption of imported fresh meat, canned fish, and canned meat were very low. Recently, the amount of aid from the United States has decreased. The steep rise in crude oil prices has caused an increase in the prices of transportation and a corresponding reduction of traffic. It is anticipated that, in the future, fewer imported goods will be sent to remote islands of the FSM. The dietary patterns on Pingelap Island are

rather traditional, so food consumption there is still in good situation from the view of food security. However, *mweiang* was recently damaged by seawater contamination. Moreover, the younger generation has never eaten famine food such *A. macrorrhizos* and *T. leontopetaloides*, and as a result does not know how to prepare that food. It is clearly necessary to pass to the next generation traditional knowledge of these plants as a precaution for food shortages.

### Acknowledgments

We are very grateful to all villagers on Pingelap Island for their great hospitality, kindness, and openness. We wish to thank the following people for arranging and helping our survey on Pingelap Island: Makir Keller, Elizabeth Keller, Ipraim Capelle, Kapilly Capelle, Charly

Table 7. Number of occurrences of each item in starch staple crops, marine resources, meat, and fruit during 2012-2014 on Pingelap Island.

	HH-A	HH-B
<u>Starchy staples (others)</u>	n=82	n=23
Yam	15	0
Uhmw par* <sup>1</sup>	53	12
Daloak* <sup>2</sup>	6	8
Nutrition biscuit	8	3
Pancit	1	0
<u>Marine resources (others)</u>	n=19	n=73
Land crab	11	43
Coconut crab	7	29
Sea turtle	1	1
Squid	1	0
<u>Meat</u>	n=87	n=44
Pork	77	n.a.* <sup>3</sup>
Chicken	10	n.a.* <sup>3</sup>
Turkey tail	2	n.a.* <sup>3</sup>
<u>Fruit</u>	n=447	n=150
Ripe banana	227	80
Ripe pandanus	172	37
Ripe papaya	32	33
<i>Syzygium</i> spp.	16	1

\*1: A sponge-like endosperm of mature coconuts (not a solid endosperm for coconut milk) called “*par*” is cooked in an earth oven.

\*2: “*Par*” is pulverized and mixed with sugar.

\*3: HH-B sometimes wrote only “meat”, therefore we could not clarify what kind of meat in this study.

Aiseam, Pernes Pernas, Smith Ezra, Ohnio Soswehl, Kodaro Soaz, and Kensly Kenneth. We could not have conducted an efficient survey without their warmhearted and persevering help. This work was partly supported by the Japan Society for the Promotion of Science (Project code: No. 24402006).

## References

- Balick, M. (ed.) 2009. *Ethnobotany of Pohnpei: Plants, People, and Island Culture*. University of Hawaii Press (Honolulu) p. 585.
- Corsi A., L. Englberger, R. Flores, A. Lorens, and M. H. Fitzgerald 2008. A participatory assessment of dietary patterns and food behavior in Pohnpei, Federated States of Micronesia. *Asia Pac. J. Clin. Nutr.* **17**: 309-316.
- Damas, D. 1994. *Bountiful Island: A Study of Land Tenure on a Micronesian Atoll*. Wilfrid Laurier University Press (Waterloo) p. 272.
- Denman, V. M. and K. G. Dewey 1989. Food self-sufficiency in Micronesia: Effects of a nutrition assistance program on food-consumption. *Food Policy* **14**: 330-346.
- Englberger, L., G. C. Marks, and M. H. Fitzgerald 2003. Insights on food and nutrition in the Federated States of Micronesia: A review of the literature. *Public Health Nutr.* **61**: 5-17.
- Englberger, L., J. Schierle, P. Hofmann, A. Lorens, K. Albert, A. Levendusky, Y. Paul, E. Lickaneth, A. Elymore, M. Maddison, I. Debrum, J. Nemra, J. Alfred, N. Vander Velde, and K. Kraemer 2009. Carotenoid and vitamin content of Micronesian atoll foods: Pandanus (*Pandanus tectorius*) and garlic pear (*Crataeva speciosa*) fruit. *J. Food Compos. Anal.* **22**: 1-8.
- Fownes, J. H. and W. C. Raynor 1993. Seasonality and yield of breadfruit cultivars in the indigenous agroforestry system of Pohnpei, Federated States of Micronesia. *Trop. Agric.* **70**: 103-109.
- Galbraith, K., G. Bendure, and N. Friary 2000. *Micronesia 4th Edition*, Lonely Planet Publications (Hawthorn) p. 368.
- Hezel, F. X. 2004. Health in Micronesia: Over the Years. *Micronesian Counselor Issue 53*. *Micronesian Seminar (Pohnpei)* p. 15.
- Kaufner, L. 2008. *Evaluation of a Traditional Food for Health Intervention in Pohnpei, Federated States of Micronesia*. Thesis, McGill University p. 116.
- Kawai, K., S. Kuwahara, M. Onjo, S. Noda, A. Nishimura, S. Tominaga, and S. Nagashima 2010. The influence of environmental changes on the Micronesian area: A case study of islands in Pohnpei State, Federated States of Micronesia. *South Pac. Stud.* **30**(2): 23-43.
- Matsumoto, K., H. Seguchi, H. Taniguchi, S. Hada, T. Seguchi, M. Nishida, K. Suastika, A. A. Gde Budhiarta, and N. Kajiwarra 2012. Health and nutritional status in the village of island of Pohnpei, Federated States of Micronesia: Preliminary survey in 2009. *Bull. Fac. Health&Welfare Kobe Women's Univ.* **4**: 47-55. (in Japanese with English summary)
- Murai, M. 1954. Nutrition study in Micronesia. *Atoll Res. Bull.* **27**: 1-239.
- Nomura, S., T. Shingu, A. Nakata, K. Chayama, G. Itoh, and Y. Itoh 2005. The prevalence of obesity and diabetes mellitus is high in Chuukese island population: A study of medical checkups during 2002-2004. *J. Hiroshima Med. Ass.* **58**: 562-565. (in Japanese)
- Office of the Governor, Statistics Section, Pohnpei State Government 1996. *1994 FSM Census of Population and Housing: Pohnpei State Census Report*. Office of the Governor, Statistics Section, Pohnpei State Government (Pohnpei) p. 207.
- Onjo, M. 2010. Case of cultivated crops and its utilization in Federated States of Micronesia. *Bull. Exp. Farm Fac. Agr. Kagoshima Univ.* **32**: 27-30. (in Japanese)
- Pohnpei Branch Statistics Office 2002. *2000 FSM Census of Population and Housing: Pohnpei State Census Report*. Pohnpei Branch Statistics Office, Division of Statistics, Department of Economic Affairs, National Government (Pohnpei) p. 176.
- Yamamoto, S. 2011. Use of *Capsicum frutescens* in Pohnpei Island, Mokil Atoll, and Pingelap Atoll, Federated States of Micronesia. *People and Cult. Ocean.* **27**: 87-104.
- Yamamura, C. M., K. M. Sullivan, F. van der Haar, S. B. Auerbach, and K. K. Iohp 2004. Risk factors for vitamin A deficiency among preschool aged children in Pohnpei, Federated States of Micronesia. *J. Trop. Pediatr.* **50**: 16-19.