

ISSN 1345-0411

南太平洋海域調査研究報告 No. 53 (2013年2月)
OCCASIONAL PAPERS No. 53 (February 2013)

**Research on the Influence of Globalization and Global
Warming on Life in Chuuk Atoll**

Edited by KAWAI Kei and KUWAHARA Sueo

鹿児島大学国際島嶼教育研究センター
KAGOSHIMA UNIVERSITY RESEARCH CENTER
FOR THE PACIFIC ISLANDS

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KAGOSHIMA UNIVERSITY RESEARCH CENTER
FOR THE PACIFIC ISLANDS
KAGOSHIMA, JAPAN

Preface

Globalization and global warming are affecting people's lives on this planet in many significant ways. Because of their small size and delicate ecology, islands are especially affected by these fundamental climate changes taking place globally. For example, substantial existing scientific evidence predicts a rise in sea levels due to global warming. Low-lying lands are particularly vulnerable to a rise in sea level, and atolls in the Pacific are especially at risk because of a total lack of high ground. To be prepared for possible disasters, it is particularly important to learn the specific details of the threat facing a particular island or atoll and the perception of people regarding their predicament.

We conducted interdisciplinary research in the Weno, Piis, and Romanum Islands, Federated States of Micronesia, in August 2011. This is a research report that examines the possible effects of globalization and global warming on the life and the environment on the Chuuk Atoll.

We are grateful to Mr. Meison and to member in governments of the Chuuk States and the Federated States of Micronesia for their support.

KAWAI Kei

KUWAHARA Sueo

Editors

KURCPI

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The foraminifera of the Chuuk lagoon, and its value as teaching materials

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Abstract

Analysis of the recent foraminifera, which is distributed to the Chuuk lagoon in the Federated States of Micronesia Chuuk state, and its practical use as teaching materials in education were considered.

Keyword: Chuuk lagoon, Recent foraminifera, teaching materials

The outline of investigation

Recent foraminifera in the Chuuk lagoon was studied with the cooperation of staff of the College of Micronesia (COM) in Chuuk. The obtained samples were treated to distinguish living material from emptiness material with rose bengal, and dried samples were taken out. The foraminifera was separated and judged at the laboratory of Kagoshima University.

Track lagoon extraction point

The sample was extracted around three islands, Piis, Romanum, and Ueno Island of the Chuuk lagoon island. Next, a sampling day, a place, the number of samples, and the depth of sample are shown.

- | | |
|-----------|--|
| 2011-8-5 | One sample from near a guesthouse, near the shore of the northeast part of Piis Island (1 m depth) |
| 2011-8-6 | Northeast of Island (From land to near reef) 1-4 (1 m depth) |
| 2011-8-7 | East of Island (From land to near reef) 1-4 (1 m depth) |
| 2011-8-7 | To Romanum Island |
| 2011-8-8 | From near shore of a guesthouse to near reef 1-3(1 m depth) |
| 2011-8-9 | In mangrove near a guesthouse 1-2 (1 m depth) |
| 2011-8-10 | From near shore to near reef 1-5 (1 m depth) |
| 2011-8-11 | To Ueno Island |
| 2011-8-11 | From near TrukStop Hotel of Ueno Island 1-5, Depth of No.1 is 2m, No.5 include much mud |
| 2011-8-12 | Beach sand near Blue Lagoon Hotel |

Foraminifera

The extracted foraminifers were taken photo with the biological microscope and the clear pictures of the foraminifera were created by multi-in-focus image processing technical software. Next, an extraction place and the feature of extracted foraminifera are shown by photo.

Figure 1 shows sea grass in shore of Piis Island.

Figure 2 is showing growth of beach rock in Piis Island. The materials of beach rock are dead coral and foraminifers.

Figure 3 shows the foraminifera which can check existence with the naked eye (*Amphisorus* & *Homotorema*).

Figure 4-a shows *Amphisorus hemprichii* with scale of a ball-point pen and its size is 5.5mm.

Figure 4-b shows dry specimen. Figure 4-c is showing lateral side of *A. hemprichii*.

Amphisorus hemprichii Ehrenberg is showing the double row of drop shaped apertures and several additional openings in the lateral side.

Figure 5-a, b, and c are showing *Baculogypsina sphaerulata*, *Poroeponides lateralis*, and *Cymbaloporella squammosa*.

Baculogypsina sphaerulata (Parker & Jones) was reported from the tropical Pacific region. *Poroeponides lateralis* (Terquem) is very similar to *Eponides repandus* (Fichtel & Moll), but the distribution of supplementary apertures extends and the primary spiral umbilical canal is less distinct than that of *Eponides repandus*.

Cymbaloporella squammosa (d'Orbigny) is characterized in having a vaulted dorsal apex, in many cases colored purplish brown.

Figure 6-a, b, and c are showing *Cymbaloporella plana*, *C. Plana* with a balloon chamber, and *Quinqueloculina* spp.

Cymbaloporella plana (Cushman) differs in having a longer trochospiral portion and an annular series of fewer chambers per whorl at the immature stage. A balloon chamber grown at the mature stage of gamont generation.

Figure 7-a, b, and c are showing *Peneroplis planatus*, *Spirolina acicularis*, and *Gaudryina* sp.

Peneroplis planatus (Fichtel & Moll) distinguish with the flattened specimens from *P. pertusus*.

Spirolina acicularis (Batsch) is completely involute at the early stage and the chambers change from compressed to round in transverse section.

Practical use of the teaching materials in education

I introduce and propose to use foraminifera in biological education and environmental education with a clear picture of the foraminifera in this paper.

Moreover, I would like to propose to researchers and the staff of the College of Micronesia (COM) about the construction of the simple breeding environment of living foraminifera, and if possible, I would like to propose practice of the environmental education through breeding and observation of recent foraminifera of the Chuuk lagoon in the Federated States of Micronesia.

Acknowledgment

I have to thank the staff of the Research Center for the South Pacific of Kagoshima University and the cooperation of Ms Yvonne Pangeliyan of the Micronesia college (COM) Chuuk state.



Fig. 1. Coast of a Piis island, sea grass stock.



Fig. 2. Formation of a beach lock.

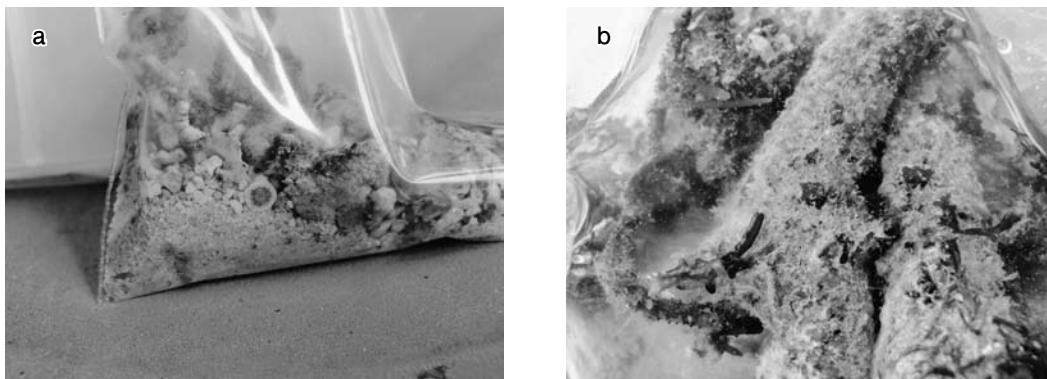


Fig. 3. Foraminifera which can check existence with the naked eye (*Amphisorus*(a) & *Homotorema*(b)).

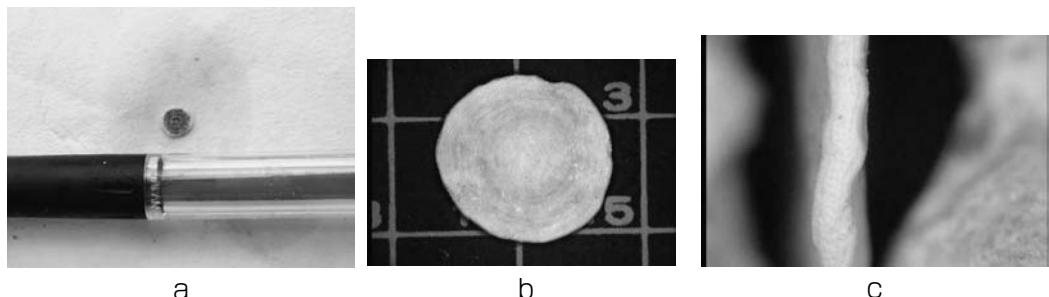


Fig. 4. *Amphisorus hemprichii* size=5.5mm (With scale of a ball-point pen (a); Dry specimen (b); Lateral side(c)).

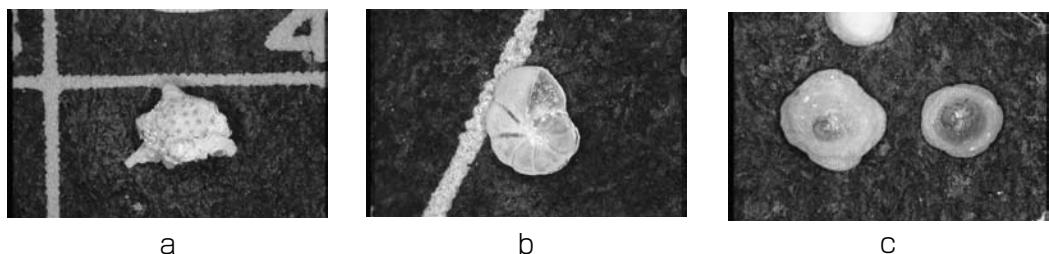


Fig. 5. *Baculogypsina sphaerulata* (a), *Poroeponides lateralis* (b), *Cymbaloporetta squammosa* (c).

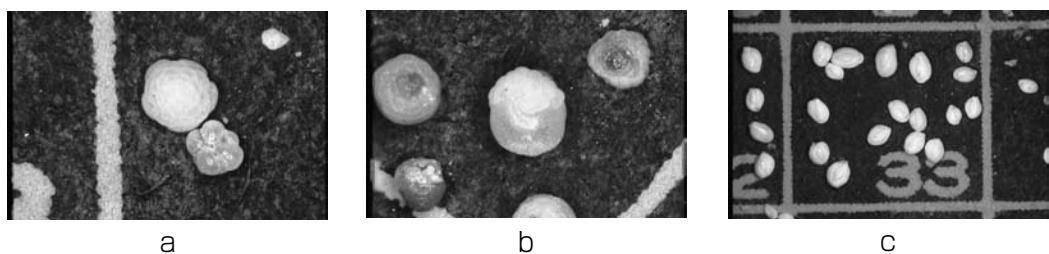


Fig. 6. *Cymbaloporetta plana*(a), *C. Plana* with a balloon chamber(b), *Quinqueloculina* spp.(c).

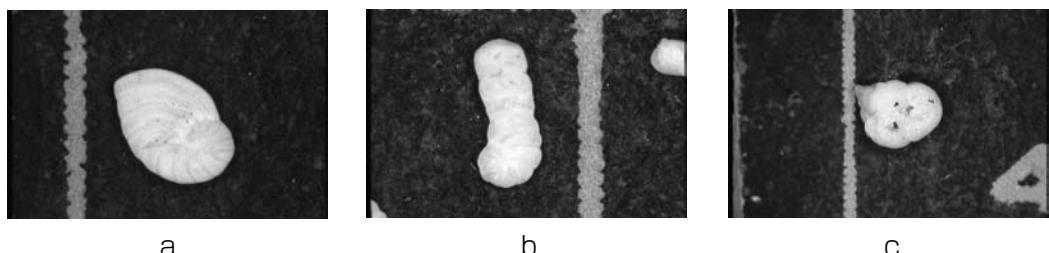


Fig. 7. *Peneroplis planatus*(a), *Spirolina acicularis*(b), *Gaudryina* sp.(c).

References

- HATTA A. and UJIIE Hiroshi (1992): Benthic Foraminifera from Coral Seas between Ishigaki and Iriomote Islands, Southern Ryukyu Island Arc, Northwestern Pacific. Bull. College of Science, Univ. Ryukyus, No. 53, p.49-119, No. 54, p.163-287.
- HOHENECKER J. (2011): Large Foraminifera -Greenhouse constructions and gardeners in the oceanic microcosm. Kagoshima Univ. Museum, Bull. No. 5, 81pp., 257 photographs, 8 figs.

Floristic composition and distribution pattern of coastal vegetation in Chuuk island, Federated States of Micronesia

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Abstract

The distribution pattern of the coastal vegetation that is closely related to the plant diversity of the islands was surveyed in Chuuk islands, Micronesia. In consequence of TWINSPLAN, which is the classification method of plant communities, six communities were classified as 1) Mangrove, 2) *Vigna marina* - *Bidens pilosa* var. *radiata* community, 3) *Scaevola taccada* - *Heliotropium foertherianum* community, 4) *Thespesia populnea* - *Pandanus* community, 5) *Hibiscus tiliaceus* - *Derris trifoliolate* community, 6) *Enhalus acoroides* (Sea grass) community. Mangrove forest was mainly established on a salty swamp located on the small river mouth or coastline. *V. marina* - *B. pilosa* var. *radiata* community, *S. taccada* - *H. foertherianum* community, and *T. populnea* - *Pandanus*. community established on the sandy seashore. And, the *H. tiliaceus* - *D. trifoliolate* community was observed around the rocky coast. Vegetation patterns on an island differ among three islands. Mangrove and *H. tiliaceus* - *D. trifoliolate* community established in Weno and Romanum island, but not in Piis. This pattern seems to be the effect of the geology of the island, i.e., base-rock type may relate to habitat formation in the coastal area. On the other hand, *V. marina* - *B. pilosa* var. *radiata* community that includes many invader plants was established only around the town in Weno island. This community may depend on the industrial human activity. To recognize the mechanisms of formation of vegetation on islands, we need to clarify several environment factors related to geology, sociology, and economy.

Keywords: coastal vegetation, invader species, mangrove, plant community, species richness

Introduction

The coastal vegetation that is established in the boundary between the sea and land is one of the major elements of island landscape. In general, the growth of many kinds of plants is restricted in the coastal environment i.e. high salinity, poor soil, wind damage and ground instability. Therefore, the species composition of the coastal plant community often is very simple. On the other hand, the species composition and structure of the coastal plant communities vary among the topographical or geographical conditions. Therefore, the distribution pattern of the coastal vegetation would be closely related to the plant diversity of the islands.

Muller-Dombois & Fosberg (1998) reported ten categories of vegetation in Micronesia, 1: Mangrove vegetation, 2: Strand vegetation, 3: Vegetation on the coral

atolls and low coral islands, 4: Vegetation on raised coral or elevated limestone, 5: Vegetation on coastal plains, including swamp forests, 6: Lowland rain forests, 7: Montane rain forests and cloud forest, 8: Dwarf vegetation on open crests, 9: Vegetation on open crests, 9: Vegetation of rough lava flows, 10: "Savanna," or grassland, vegetation.

The general vegetation of the Caroline Islands consists of natural broad-leaved evergreen trees and planted trees (e.g. coconuts, breadfruits, and mango). Micronesian Economic surveys in 1946 reported that the coconut (*Cocos nucifera*) and bread fruits (*Artocarpus incisus*) were planted broadly on coral islands and coastal strips of volcanic islands (Muller-Dombois & Fosberg 1998). In the Chuuk islands, the forests on the gentle slope were mostly cut, and coconuts and bread-fruits were planted broadly in the cultivated site (Kanehira 1933). Like above, there are some reports of vegetation in Micronesia. However, the vegetation pattern of small coral islands or small volcanic islands in one atoll has not been shown. I will compare the species composition of the coastal plants in the Chuuk islands, and discuss the ecological character and the diversity of the coastal vegetation.

Study site

We surveyed a series of neighboring plant communities along a coastline in Chuuk states, Federated States of Micronesia. The study site was located in the three islands in Chuuk atoll, i.e. Piis, Romanum and Weno (Fig.1).

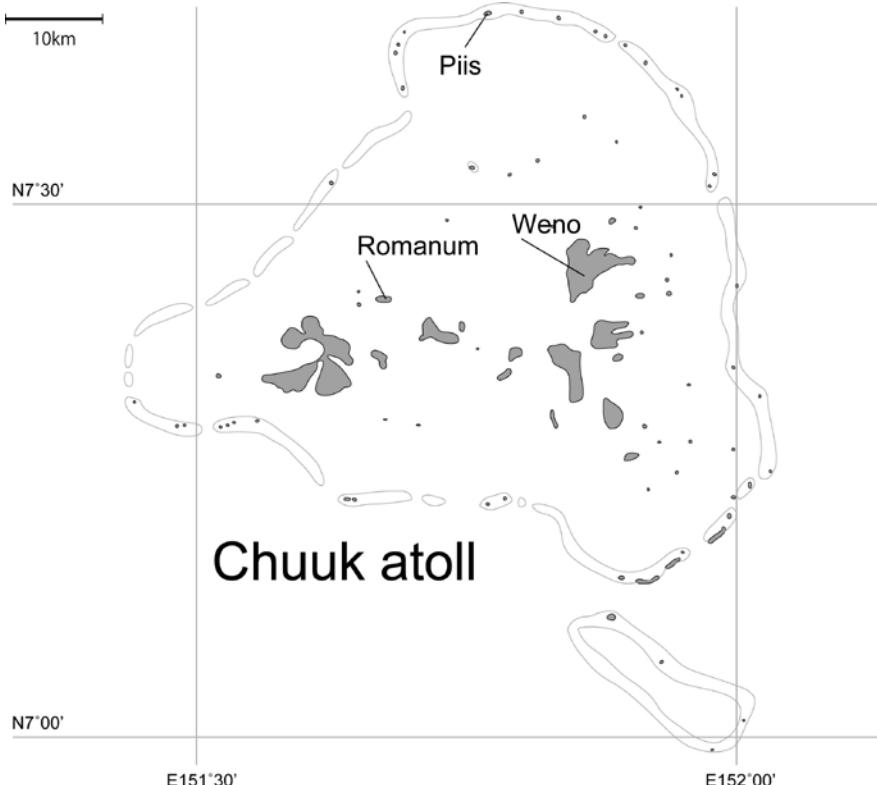


Fig. 1 Map of Chuuk atoll and studied island, Weno, Romanum, and Piis.

Weno is the capital and commercial center of Chuuk. This volcanic island has an area of over 18 km², and a high mountain (Mt. Tonoken, 370 m a.s.l) in the center of the island. Coastal habitats on the west side of the island are mostly changed by industrial activity, because relatively large towns are on the north-west side of the island (Galbraith et al. 2000). In contrast, Piis is a very small and flat coral island on the atoll. The length of the island is about 1km. Romanum is also a small island of about 1.5 km in length. The terrace-like ground surface with sedimentary rock was observed on the north-side of the island. On the other hand, the low-land at the south-side of island is plain of coral sand with swamp.

Methods

In this study, the vegetation on the coast line was comprehended. The habitat types on the coastline include sandy seashore, rocky coast, and salty swamp, and small sea wall.

We obtained vegetational data (43 plot) using the phytosociological method (Braun-Blanquet 1964), to recognize the species composition of the vascular plants in the coastal vegetation of the island. The surveys were conducted in August 2011. The plot area ranged from 20 m² (2 × 10m) to 100 m² (10 × 10m) because the study plot be set to correspond to the width of the habitat. The location of the individual plot was a typical point of the vegetation type. The community types were classified by TWINSPAN (two-way indicator analysis) using a computer program PC-ORD ver.5 (MJM software design).

To recognize the correspondence among the habitat types and the coastal vegetation, ground conditions were surveyed at each plot during a vegetation survey. Micro-landform, sediment (or base rock), and artificial structures were recorded by visual observation in each quadrat.

Results and discussion

1. Plant community type

TWINSPAN classification (Fig. 2) showed strong divisions forming at the first level (eigenvalues = 1.000), a group B with *Enhalus acoroides* as an indicator species containing plots characterized by sea grass species, and another large group A include the various community types.

At a second level of division (eigenvalues = 0.8069), the plots that have the indicator species *Rhizophora mucronata* and *Sonneratia alba* (A1) were separated from the others (A2) characterized by *Vigna marina* and *Thespesia populnea*. The former group was composed by the plot of Mangrove forest. On the other hand, the latter groups include the various seashore vegetation.

At a third level of division (eigenvalues = 0.5869) the plots containing the indicator species of *Derris trifoliata* (A22) were separated from the others.

At a fourth level of division (eigenvalues = 0.4809), the plots with the indicator species *Ipomoea pes-caprae* and *Leucaena leucocephala* (A21-1) were separated from the other groups (A21-2) containing two groups derived from the final division, characterized by *Scaevola taccada* (A21-21) and *Thespesia populnea* and *Phymatosorus*

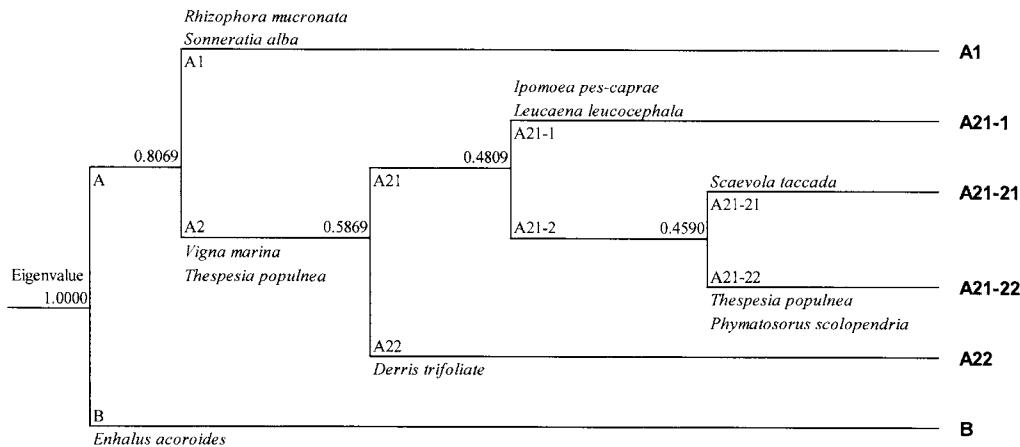


Fig. 2 TWINSPAN classification for 43 plots of coastal vegetation in Chuuk island. Species name shown in dendrogram is indicator species of each division level.

scolopendria (A21-22).

In consequence of TWINSPAN as above mentioned, six communities were classified and are named as follows:

- 1) Mangrove (A1)
- 2) *Vigna marina* - *Bidens pilosa* var. *radiata* community (A21-1)
- 3) *Scaevola taccada* - *Heliotropium foertherianum* community (A21-21)
- 4) *Thespesia populnea* - *Pandanus* community (A21-22)
- 5) *Hibiscus tiliaceus* - *Derris trifoliolate* community (A22)
- 6) *Enhalus acoroides* (Sea grass) community (B)

Floristic composition and occurrence of these communities are shown in Table 1 and 2, respectively.

1) Mangrove

This community is mainly established on the salty swamp located on the small river mouth or coastline of the large volcanic islands such as Weno and Romanum but not in Piis island (Fig. 3, Table 2). This community mainly consists of Rhizophoraceae trees (*Rhizophora mucronata*, *Bruguiera gymnorhiza*, *Rhizophora apiculata*), and *Sonneratia alba*, *Excoecaria agallocha* (Species group A1, Table 1). Species diversity would be relatively low because many species such as *Avicennia marina*, *Xylocarpus granatum*, and *Lumnitzera littorea* that occur in well-developed Mangrove vegetation in Micronesia (Muller-Dombois & Fosberg 1998) were absent in the study site.

The canopy height of mangrove forest in the study area did not reach 10m high in every site although mature forests reach the 30-40m high like in the Pohnpei Island (Cole et al. 1999). The mangrove forests on both islands seem affected by strong human activity.

Table 1 Vegetation table of coastal vegetation in Weno, Romanum, and Piis island. Six community types are derived from TWINSPAN (see Fig. 2). The value of each species are frequency of appearance and range of dominance-scale in parentheses.

A1 : Mangrove

A22 : *Hibiscus tiliaceus* - *Derris trifoliata* community

A21-1 : *Vigna marina* - *Bidens pilosa* var. *radiata* community

B : *Enhalus acoroides* community

A21-21 : *Scaevola taccada* - *Heliotropium foertherianum* community

A21-22 : *Thespesia populnea* - *Pandanus* community

	A1	A21-1	A21-21	A21-22	A22	B
Number of stands	9	4	11	6	8	5
Mean coverage (%)	67.8	72.5	61.8	63.3	76.3	72.0
Mean community height (m)	9.3	4.8	7.1	11.5	9.2	6.0
Species group A1						
<i>Cassytha filiformis</i>	11 (1)	-	9 (1)	-	22 (1-2)	-
<i>Clerodendrum inerme</i>	44 (1-2)	-	-	-	44 (1-4)	-
<i>Bruguiera gymnorhiza</i>	22 (2-3)	-	-	-	-	-
<i>Rhizophora apiculata</i>	33 (2-3)	-	-	-	-	-
<i>Vitaceae</i> sp.	11 (1)	25 (1)	-	-	11 (1)	-
<i>Davallia solida</i>	11 (1)	-	-	17 (+)	-	-
<i>Excoecaria agallocha</i>	11 (2)	-	-	17 (2)	-	-
<i>Rhizophora mucronata</i>	78 (1-5)	25 (+)	-	17 (+)	-	-
<i>Sonneratia alba</i>	67 (1-4)	-	-	-	-	-
Species group A2						
<i>Cocos nucifera</i>	11 (+)	25 (1)	64 (+-4)	83 (1-2)	33 (2-3)	-
<i>Nephrolepis</i> sp.	-	-	-	33 (1-2)	11 (+)	-
<i>Thespesia populnea</i>	11 (1)	75 (2)	18 (+-1)	100 (+-3)	67 (1-3)	-
<i>Guettarda speciosa</i>	-	-	18 (1)	33 (1)	11 (2)	-
<i>Phymatosorus scolopendria</i>	-	25 (+)	9 (+)	83 (+-1)	33 (+-1)	-
<i>Sida rhombifolia</i>	-	75 (+-1)	-	-	11 (1)	-
<i>Wedelia trilobata</i>	-	50 (1-2)	-	-	11 (1)	-
<i>Digitaria</i> sp.	-	25 (2)	-	-	11 (+)	-
<i>Desmodium umbellatum</i>	-	25 (1)	-	33 (1-2)	11 (1)	-
<i>Ipomoea pes-caprae</i>	-	75 (1-3)	-	-	11 (1)	-
<i>Premna serratifolia</i>	-	50 (1)	18 (+-1)	50 (1)	11 (1)	-
<i>Hernandia nympheafolia</i>	-	-	18 (1)	50 (2-3)	11 (2)	-
Species group A21						
<i>Cenchrus echinatus</i>	-	25 (1)	18 (+)	-	-	-
<i>Cordia subcordata</i>	-	50 (2)	27 (2)	-	-	-
<i>Fimbristylis cymosa</i>	-	25 (+)	27 (+-1)	17 (+)	-	-
<i>Lepturus repens</i>	-	50 (1)	64 (+-3)	17 (2)	11 (1)	-
<i>Pemphis acidula</i>	-	25 (1)	9 (2)	33 (1)	-	-
<i>Vigna marina</i>	-	100 (1-4)	82 (+-3)	50 (+-2)	-	-
Species group A21-1						
<i>Bidens pilosa</i> var. <i>radiata</i>	-	50 (1)	-	-	-	-
<i>Ipomoea littoralis</i>	-	25 (+)	-	-	-	-
<i>Panicum maximum</i>	-	50 (1)	-	-	-	-
<i>Polygala paniculata</i>	-	25 (+)	-	17 (+)	-	-
<i>Senna occidentalis</i>	-	25 (1)	-	-	-	-
<i>Stachytarpheta jamaicensis</i>	-	75 (+-1)	-	-	-	-
<i>Vernonia cinerea</i>	-	25 (+)	-	-	-	-
<i>Solanum</i> sp.	-	25 (1)	-	-	-	-
<i>Cyperus</i> sp.	-	25 (+)	-	-	-	-
Species group A21-21						
<i>Canavalia cathartica</i>	-	-	27 (1-3)	-	-	-
<i>Chamaesyce atoto</i>	-	-	36 (+-1)	-	-	-
<i>Heliotropium foertherianum</i>	-	-	64 (1-3)	17 (1)	-	-
<i>Psidium guajava</i>	-	-	9 (+)	-	-	-
<i>Scaevola taccada</i>	-	25 (1)	82 (+-4)	33 (+-2)	-	-
<i>Terminalia samoensis</i>	-	-	36 (+-1)	-	-	-
<i>Thuarea involuta</i>	-	-	27 (1-2)	-	-	-
<i>Triumfetta procumbens</i>	-	-	36 (+-2)	-	-	-
<i>Garcinia</i> sp.	-	-	9 (1)	-	-	-
<i>Crinum</i> sp.	-	-	36 (+-2)	17 (+)	-	-

Species group A21-22						
<i>Carica papaya</i>	-	-	-	17 (1)	-	-
<i>Ficus</i> sp.	-	-	-	17 (1)	-	-
<i>Ficus tinctoria</i>	-	-	-	17 (1)	-	-
<i>Pandanus</i> sp.	-	-	45 (+3)	100 (+2)	11 (1)	-
<i>Terminalia catappa</i>	-	-	-	33 (+2)	-	-
<i>Zoysia</i> sp.	-	-	-	17 (3)	-	-
Euphorbiaceae sp.	-	-	-	17 (1)	-	-
Sapindaceae sp.1	-	-	9 (+)	50 (+2)	-	-
<i>Psilotum nudum</i>	-	-	-	17 (+)	-	-
<i>Paspalum</i> sp.	-	-	18 (+2)	17 (3)	-	-
Sapindaceae sp.2	-	-	18 (1)	17 (1)	-	-
Species group A22						
<i>Acrostichum aureum</i>	-	-	-	-	11 (+)	-
<i>Allophylus ternatus</i>	-	-	-	-	11 (+)	-
<i>Barringtonia asiatica</i>	-	-	9 (1)	17 (1)	33 (1-2)	-
<i>Derris trifoliata</i>	-	-	-	-	89 (+2)	-
<i>Dioscorea bulbifera</i>	-	-	-	-	11 (1)	-
<i>Heritiera littoralis</i>	-	-	-	-	11 (3)	-
<i>Hibiscus tiliaceus</i>	-	-	-	-	56 (1-4)	-
<i>Macaranga carolinensis</i>	-	-	-	-	11 (3)	-
<i>Melanthera biflora</i>	-	-	9 (1)	-	11 (3)	-
<i>Nephrolepis</i> sp.2	-	-	-	-	11 (1)	-
<i>Procris pedunculata</i>	-	-	-	-	22 (1)	-
Gramineae sp.	-	-	9 (+)	-	11 (1)	-
<i>Asplenium</i> sp.	-	-	-	17 (+)	22 (1)	-
unknown	-	-	-	-	11 (1)	-
<i>Paliurus</i> sp.	-	-	-	-	33 (1-2)	-
Convolvulaceae sp.	-	-	-	-	11 (1)	-
<i>Leucaena leucocephala</i>	-	75 (2-4)	-	-	33 (1-3)	-
<i>Musa</i> sp.	-	-	-	-	22 (1-2)	-
Leguminosae sp.	-	50 (+)	-	-	11 (3)	-
Species group B						
<i>Enhalus acoroides</i>	-	-	-	-	100 (3-5)	
<i>Zostera</i> sp.	-	-	-	-	20 (1)	

Table 2 Existence pattern of costal vegetation in Weno, Romanum, and Piis island. Community types are derived from TWINSPLAN (see Fig. 2). Existence of the community type are shown as *.

	Piis	Romanum	Weno
Mangrove		*	*
<i>Vigna marina</i> - <i>Bidens pilosa</i> var. <i>radiata</i> com.			*
<i>Scaevola taccada</i> - <i>Heliotropium foertherianum</i> com.	*	*	
<i>Thespesia populnea</i> - <i>Pandanus</i> com.	*	*	*
<i>Hibiscus tiliaceus</i> - <i>Derris trifoliata</i> com.		*	*
<i>Enhalus acoroides</i> com.	*	*	*

A2 type communities (A21-1, A21-21, A21-22, and A22) distributed on the terrestrial habitat along the coastline and characterized by *Cocos nucifera*, *Hernandia nymphaeifolia*, *Phymatosorus scolopendria* and so on. The community type of A21 (A21-1, A21-21, A21-22) and A22 were characterized by species group A21 (e.g. *Vigna marina*, *Lepturus repens*, *Pemphis acidula*), and the species group A22 (e.g. *Barringtonia asiatica*,



Fig. 3 Mangrove forest (Romanum island).

Derris trifoliata, *Hibiscus tiliaceus*) respectively. The former communities established on the sandy seashore of three islands. The latter was observed on the rocky coast of Romanum and Weno Island.

2) *Vigna marina* - *Bidens pilosa* var. *radiata* community

This is occupied by a shrub (e.g. *Leucaena leucocephala*, *Thespesia populnea*) and vine (*Vigna marina*, *Ipomoea pes-caprae*) and many herbaceous plants. This community is mainly established on the artificial coast on Weno island (Fig. 4), and includes many invader species, such as *Bidens pilosa* var. *radiata*, *Ipomoea littoralis*, *Panicum maximum*, *Polygala paniculata*, *Senna occidentalis*, *Stachytarpheta jamaicensis*, *Vernonia cinerea*, *Cenchrus echinatus* (Space et al. 2000).



Fig. 4 *Vigna marina* - *Bidens pilosa* var. *radiata* community (Weno island). Left: *Leucaena leucocephala* and *Ipomoea pes-caprae* dominated type. Right: *Vigna marina* and *Panicum maximum* dominated type.

3) *Scaevola taccada - Heliotropium foertherianum* community

This would be one of the natural vegetations on the sandy seashore in Chuuk (Fig. 5). Some shrub species such as *Heliotropium foertherianum*, *Scaevola taccada*, *Terminalia samoensis* with vines; *Canavalia cathartica*, *Vigna marina*, *Triumfetta procumbens* distribute to the front side of the *Cocos* plantation. In addition, coastal herbs *Chamaesyce atoto*, *Thuarea involute*, and *Crinum* sp. were observed in this community characteristically.



Fig. 5 *Scaevola taccada - Heliotropium foertherianum* community (Piis island).

4) *Thespesia populnea - Pandanus* community (A21-22)

This community was established on the similar habitat of *Scaevola taccada - Heliotropium foertherianum* community (Fig. 6). Large trees such as *Thespesia populnea*, *Hernandia nymphaeifolia*, *Terminalia catappa*, and *Pandanus* sp. dominated and form a relatively higher canopy than the *S. taccada - H. foertherianum* community (Table 2).



Fig. 6 *Thespesia populnea - Pandanus* community (Romanum island).

5) *Hibiscus tiliaceus* - *Derris trifoliata* community (A22)

Hibiscus tiliaceus, *Barringtonia asiatica*, *Macaranga carolinensis*, and many tree species comprise this forest community. The richness of forest floor herbs (e.g. *Nephrolepis*, *Procris pedunculata*) and epiphytic plants (e.g. *Asplenium*) are relatively high. This type was observed on the rocky coast of Romanum and Weno island.

6) *Enhalus acoroides* (Sea grass) community (B)

This consists of one or some kinds of sea-grass such as *Enhalus acoroides*. This grass community was established in the shallow sea bottom (Fig. 7).



Fig. 7 *Enhalus acoroides* community: seagrass vegetation (Piis island).

2. Distribution pattern of coastal plant community

Although some endemic species of Chuuk, such as *Maniltoa yokotai* (Kaneh.) Hosok., *Garcinia ponapensis* var. *trukensis* (Kaneh.) Fosberg, *Mischocarpus guillauminii* Kaneh., and *Semecarpus kraemerii* Lauterb., have been known (Kanehira 1933), especially species in phytogeography, species like these did not occur in coastal vegetation. Many coastal species observed in the study sites have a broad distribution area around the Pacific. For example, *Sonneratia alba* and *Rhizophora mucronata* in Mangrove, and *Scaevola taccada*, *Hernandia sonora*, *Cassytha filiformis*, *Thespesia populnea*, *Hibiscus tiliaceus* in terrestrial coast vegetation reach to the Ryukyu Islands, Japan.

Vegetation pattern on the islands differs among these three islands. The mangrove and *Hibiscus tiliaceus* - *Derris trifoliata* community is established on Weno and Romanum islands, but not in Piis (Table 2). This pattern seems to be affected by the geology of the island, i.e., the base-rock type may relate to soil the condition or habitat formation in coastal areas. On the other hand, the *Vigna marina* - *Bidens pilosa* var. *radiata* community was established only on Weno island. The floristic character of this community is high dominant and rich with invader plants (except for crop plants). The establishment of this community may depend on human activity, because invader plants invade the open site that has been created artificially. However, this community

is absent in the coastal habitat on the village side of Piis and Romanum even though land-use seems strong and frequent. Therefore, the establishment of this community may be affected by the activity style of the people (traditionally or industrially?). To recognize the mechanisms of the formation of vegetation on an island, we need to clarify several environment factors related to geology, sociology, and economy.

References

- BRAUN-BLANQUET, J. 1964. *Pflanzensoziologie*, 3 Aufl. Springer, Wien.
- COLE T.G., EWELA K.C., DEVOEA N.N. (1999) Structure of mangrove trees and forests in Micronesia. *Forest Ecology and Management* 117: 95-109.
- GALBRAITH K., BENDURE G., FRIARY N. (2000) *Micronesia* 4th ed. Lonely planet publications, Australia.
- KANEHIRA R. (1933) *Flora Micronesica*. Inoue-shoten, Tokyo.
- MULLER-DOMBOIS D., FOSBERG F.R. (1998) *Vegetation of the tropical pacific islands*. Springer-Verlag, New York.
- SPACE J.C., WATERHOUSE B., DENSLAW J.S., NELSON D., MAZAWA T.R. (2000) Invasive plant species in Chuuk, Federated States of Micronesia. USDA Forest Service, Honolulu, Hawaii, USA, 41 pp.

<要約>

ミクロネシア、チューク諸島において、島の植生の分布パターンと多様性を明らかにすることを目的とし、ウエノ（Weno）島、ロマヌム島（Romanum）、ピース島（Piis）において海岸植生の調査を行った。海岸植生は、1) マングローブ、2) ハマアズキ (*Vigna marina*) - オオバナノセンダングサ (*Bidens pilosa* var. *radiata*) 群落、3) クサトベラ (*Scaevola taccada*) - モンパノキ (*Heliotropium foertherianum*) 群落、4) サキシマハマボウ (*Thespesia populnea*) - パンダヌス (*Pandanus*) 群落、5) オオハマボウ (*Hibiscus tiliaceus*) - シイノキカズラ (*Derris trifoliata*) 群落、6) ウミショウブ (*Enhalus acoroides*) 群落の6群落に区分された。マングローブは主に小河川の河口や海岸の塩生湿地に成立していた。一方、ハマアズキ-オオバナノセンダングサ群落、クサトベラ-モンパノキ群落、サキシマハマボウ-パンダヌス群落は砂浜に、オオハマボウ-シイノキカズラ群落は主に岩石海岸に成立していた。ウミショウブ群落は浅い海底に成立していた。このような分布パターンは各島の地質、地形的要因と関連していると考えられた。また、砂浜に成立している群落のうち、外来種を多く含むハマアズキ-オオバナノセンダングサ群落は、都市の発達したウエノ島のみで確認されたことから、人間活動も海岸植生の種組成に大きく影響を及ぼしていることが予想された。島の植生の形成メカニズムを理解するためには、地質・地形的要因および人間活動に関する要因が植生に及ぼす影響を明らかにする必要がある。



Chuukの海岸植生。ココヤシとともに様々な樹木、草本が海岸植生を形成している。
写真是Romanum島のサキシマハマボウ-パンダヌス群落

Shell-color polymorphism of intertidal gastropods in Chuuk State, Federated States of Micronesia

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Abstract

I investigated the relationship between shell color of *Nerita plicata* gastropods and habitat background color in Piis and Romanum Islands, Chuuk State, Federated States of Micronesia. The brightness of habitat background color ranged from 10 to 80, whereas the brightness of shell color varied from 40 to 98. The shell color was usually brighter than the habitat background color, suggesting that *N. plicata* inhabits backgrounds that are darker than its shell color. Only snails with brighter shell colors inhabited brighter backgrounds. By contrast, darker backgrounds were inhabited by snails with several types of shell color. My findings indicate that *N. plicata* may adapt to different environments by means of shell-color polymorphism.

Keyword: background, polymorphism, shell color

Introduction

Color and color-pattern polymorphism within animal species may be attributed to different modes of selection, such as selection for crypsis (e.g., BYERS 1990), sexual selection (e.g., ENDLER 1983), climatic selection (e.g., MIURA *et al.* 2007), or frequency-dependent selection (e.g., OLENDORF *et al.* 2006). Intertidal gastropods live under variable temperature and salinity regimes, and face changing wave action, habitat type, prey type, desiccation and predation risks, and other environmental factors (HUGHES 1986; LITTLE and KITCHING 1996). *Nerita plicata* is a gastropod distributed within the reef region of the upper intertidal zone of the Indo-Pacific Ocean, and it is known to exhibit shell-color polymorphism (ABBOTT and DANCE 1985; NEVILLE 2003). High intertidal neritid species, including *N. plicata*, are known to be better temperature regulators than low intertidal species (VERMEIJ 1971a). In addition, *N. plicata* changes the direction of its shell to face the sun at the time of emersion (WARBURTON 1973). These behaviors may help *N. plicata* adapt to changing temperatures in the upper intertidal zone. On the other hand, visual selection by predators may underlie shell-color polymorphism in *N. plicata* (BYERS 1990; McKILLUP and McKILLUP 2002). The species inhabits substrates of varying background color, including basalt rocks, limestone, and beach rocks, in the upper intertidal regions of the tropical Pacific Ocean (VERMEIJ 1971b).

In the present study, I investigated the relationship between shell color of *N. plicata* and habitat background color in Piis and Romanum Islands, Chuuk State, Federated States of Micronesia.

Materials and Methods

This study was conducted in August 2011, in Piis and Romanum Islands, Chuuk State, Federated States of Micronesia.

The shell color and habitat background color of each snail were recorded using a digital camera. The shell color and habitat background color varied according to time and weather conditions. Therefore, to adjust the quality of the photographs, standard colors (black and white substratum) were also photographed on each occasion. The colored photographs were adjusted to monochrome color using Photo Shop. For each shell area and habitat background area, the brightness of 3 points was calculated by Photoshop, and each value was adjusted using following formula:

Adjusted value = (sample brightness - standard black brightness) / (standard white brightness - standard black brightness) × 100

A value of 0 indicated that the color was fully black; a value of 100 indicated that the color was fully white.

Results

The brightness of habitat background color ranged from 10 to 80, whereas the brightness of shell color varied from 40 to 98 (Fig. 1). The shell color was usually brighter than the habitat background color. Only snails with brighter shells inhabited brighter backgrounds. By contrast, darker backgrounds were inhabited by snails with several types of shell color.

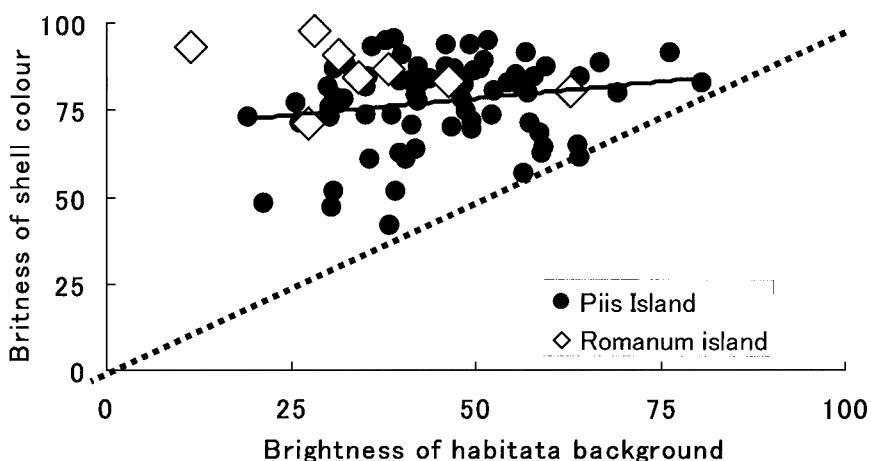


Fig. 1 Relationship between brightness of shell color and brightness of habitat background. A value of 0 indicates that the color is fully black; a value of 100 indicates that the color is fully white.

Discussion

In the present study, only snails with brighter shells inhabited brighter backgrounds. By contrast, darker backgrounds were inhabited by snails with several types of shell color. This finding indicates that *N. plicata* exhibits shell-color polymorphism, and that this polymorphism is strongly related to habitat background color.

Temperature can greatly affect the metabolism of gastropods (e.g., HUGHES 1986). Metabolic activities may be accelerated if the body temperature increases within a range that does not impede normal physiology. The difference in body temperature between *N. plicata* individuals living in beach rock (white-colored background) and basalt rock (dark-colored background) environments was 1-2 °C (Kawai, personal communication). Similar differences in body temperature have been recorded between banded and unbanded morphs in *Cepaea* and other snail species (JONES 1973; RICHARDSON 1974; HEATH 1975). When the body temperature of the land snail *C. hortensis* was increased from 25 °C to 26 °C, oxygen consumption increased from 2.6% to 4.5% (STEIGEN 1979). This finding indicates that a small temperature increase may have a relatively small effect on physiology in the short term. However, a long-term temperature differential may significantly influence rates of growth, reproduction, mortality, and other physiological conditions.

Many other environmental factors affect the frequencies of shell-color morphs in gastropods. Juveniles of a muricid snail, *Concholepas concholepas*, exhibit shell-color plasticity depending on the coloration of prey species (MANRÍQUEZ *et al.* 2009). Frequencies of shell-color morph may depend on parasites and predation (BYERS 1990; MCKILLUP and MCKILLUP 2002), with environmental gradients in temperature, salinity, and wave action frequently affecting the evolution of color polymorphisms (ETTER 1988; SOKOLOVA and BERGER 2000; MIURA *et al.* 2007). Shell-color polymorphism in some gastropods results from complex interactions between selective forces (JONES *et al.* 1977); the observed shell-color polymorphism of *N. plicata* may be derived from complex interactions between several such selective forces.

N. plicata is thought to have a comparatively long, free-swimming larval stage (KANO 2006), suggesting that the genetic differentiation underlying the observed shell variation in proximate populations is not large. In the present study, I observed similar trends in the frequency distribution of shell-color morphs between Piis and Romanum islands (Figure 2). However, the frequency of shell color variation differed according to habitat background brightness. This finding implies that genetic differentiation may contribute to shell-color polymorphism in *N. plicata* populations. To elucidate such genetic influences, I intend to conduct further detailed analyses using microsatellite DNA markers.

Acknowledgements

I would like to thank Mike and the staff of the Chuuk State Government for their kind support.

References

- ABBOTT R.T. and DANCE S.P. (1985) Compendium of seashells (Japanese Edition).

- Heibonsha Limited, Tokyo.
- BYERS B. (1990) Shell colour polymorphism associated with substrate colour in the intertidal snail *Littorina saxatilis* Olivi (Prosobranchia: Littorinidae). *Biological Journal of the Linnean Society* 40, 3-10.
- ENDLER J.A. (1983) Natural selection on color patterns in poeciliid fishes. *Environmental Biology of Fishes* 9, 1573-5133.
- HEATH D.J. (1975) Colour, sunlight and internal temperatures in the land-snail *Cepaea nemoralis* (L.). *Oecologia* 19, 29-38.
- HUGHES R.N. (1986) A Functional Biology of Marine Gastropods. Croom Helm, London & Sydney.
- JONES J.S. (1973) Ecological genetics and natural selection in molluscs. *Science* 182, 546-552.
- JONES J.S., LEITH B.H. & RAWLINGS P. (1977) Polymorphism in *Cepaea*: a problem with too many solutions? *Annual Review of Ecology and Systematic* 8: 109-143.
- KANO Y. (2006) Usefulness of the opercular nucleus for inferring early development in Neritimorph gastropods. *Journal of Morphology* 267, 1120-1136.
- LITTLE C. and KITCHING J.A. (1996) The biology of rocky shores. Oxford University Press. Oxford New York Tokyo.
- MANRÍQUEZ P.H., LAGOS N.A., JARA M.E. and CASTILLA J.C. (2009) Adaptive shell colour plasticity during the early ontogeny of an intertidal keystone snail. *Proceedings of the National Academy of Sciences* 106, 16298-16303.
- MIURA O., NISHI S. and CHIBA S. (2007) Temperature-related diversity of shell colour in the intertidal gastropod *Batillaria*. *Journal of Molluscan Studies* 73, 235-240.
- MCKILLUP S.C. and MCKILLUP R.V. (2002) Flies that attack polymorphic snails on coloured backgrounds: selection for crypsis by a sarcophagid parasitoid of *Littoraria filosa*. *Biological Journal of the Linnean Society* 77, 367-377.
- NEVILLE C. (2003) 2002 Sea Shells: Catalogue of Indo-Pacific Mollusca. Neville Coleman's Underwater Geographic Pty Ltd, Australia.
- OLENDORF R., RODD F., PUNZALAN D., HOUDE A., HURT C., REZNICK D. and HUGHES K. (2006) Frequency-dependent survival in natural guppy populations. *Nature* 441, 633-636.
- RICHARDSON A.M.M. (1974) Differential climatic selection in natural population of land snail *Cepaea nemoralis*. *Nature* 247, 572-573.
- STEIGEN A.L. (1979) Temperature effects on energy metabolism in banded and unbanded morphs of the snail *Cepaea hortensis* Müll. *Oecologia* 141, 163-173.
- VERMEIJ G.J. (1971a) Temperature relationships of some tropical Pacific intertidal gastropods. *Marine Biology* 10, 308-314.
- VERMEIJ G.J. (1971b) Substratum relationships of some tropical Pacific intertidal gastropods. *Marine Biology* 10, 315-320.
- WARBURTON K. (1973) Solar orientation in the snail *Nerita plicata* (prosobranchia: neritacea) on a beach near Watamu, Kenya. *Marine Biology* 23, 93-100.

Improving the foundation of the environment, resources, and life in Chuuk: Pursuing the progress in public sanitation betterment and the current state of social capital

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Introduction

Chuuk has been combating serious environmental problems since 1980s to improve their immediate surroundings, especially those pertaining to work in the sea and on land, and beginning with the waste problem. The beginning of 1980s saw the successful deployment of public-private initiatives, especially WHO and the traditional chief system working together to fight cholera. Improvement efforts have been successively put into practice thereafter, and case studies have been carried out to follow-up interviews with the state government and small island Piis on their success stories and in the later years the reasons behind the declining performance. We also investigated the current situation on the matters relating to boosting the life and economic foundation, and their supporting infrastructure and social capital. As a result, we found that the changes in the structure of social roles could not be bound only to the changes in tradition to modernism, and each role required functional cooperation. The public sector, especially the state government, should actively ask for collective engineer support, and reaching overseas should strive to raise the base technical skills fit for the next generation. At local government level, it will be more effective to employ quasi-public servants MIRAB (Migration, Remittance, Aid and Bureaucracy), whose main duties will be to improve/maintain environmental sanitation (cleaning local areas, proper waste disposal, etc.). Although the NPO and NGO organizational standard has not reached the level of its neighbouring country Palau, there is evidence that the germinating organizations are sprouting and strengthening. We have confirmed the base for human resources, so along with overseas cooperative funds and actively recruiting trainees, we can look forward to a significant result. The development and the expansion of Chuuk Women's Association is a leading effort and even outshines to those of neighbouring countries, and it can be a precedent to the whole of Micronesia. We expect its advance. In addition, tackling them will undoubtedly bring remarkable improvements to the MPA (Marine Protected Area) management approach and waste management. The pending problems of road conditions are rapidly progressing for its preparation. These remarkable changes would no doubt bring initiatives based on successful experience to the Chuukeese society. The next challenge will be to use these as new social capital and organically bring it together. By overlaying the pressing concern of dengue fever with improving public sanitation (let us not forget the majority of disastrous cholera victims were the women who did the fishery activities within the lagoon), we hope to help in its

deployment.

Research outline

1) Research aim and overall structure

This is a case study of securing, maintaining, and improving the favourable living environment, especially the quality of public sanitation, by boosting the entire societal infrastructure and raising living standards within the small islands and the island regions. Living standards can be raised through wide-ranging building blocks that affect the living environment; these elements are:

1. materialistic and economical (hard-ware)
2. imperceptible and institutional (soft-ware)
3. emotional and spiritual (spiritual-ware)
4. human interaction and relationships (human-ware), and finally
5. ecological and natural environmental (ecological-ware).

Each of these components mutually interact together to form fundamental foundations, and the malfunction of any one of these risk deterioration of quality improvement. Acknowledgment of this, therefore, becomes a necessary prerequisite in creating and executing strategies to improve the quality of life.

The solutions proposed by co-governance (whereby the residents within an area are subjects themselves) are in need of a new development phase. It is important to supplement them with a voice from an influential third party. These together will be the social capital. The current state will be assessed and investigated underpinning social capital as such and as a means of raising the societal infrastructure and human relationships. The principal relationships between the elements pertaining to quality of life as well as their mutual relationships need organizing as part of a crucial step towards the development.

Drawing from our previous research, several issues emerge pertaining to public sanitation. The first is poor waste management, which also affects the management of the marine environment. Another problem relates to nutrition, health, and infectious diseases. Lastly, there are stresses upon household finances as the base for subsistence economy em-brittles and the rapid penetration of a weakening commodity economy. They are all connected and have been a persistent setback since globalization became problematic in the 1980s. This is especially true in Chuuk, where it remains to be one of the most serious problems. Naturally, Chuuk also faces problems unique to huge reef areas, but it is a shared common burden with the other island regions. Their underpinning problems lie parallel to global warming. The concrete truth behind the picture was gathered covering these ranges.

2) Research Result Outline

- 1 In order to ascertain information on the current improvements made on people's lives in Chuukese small islands and island regions, past accounts of cholera can be used as an important verification source. We aimed to understand how the society as a whole tackled the condition. Fortunately we were able to interview the person in command during the very first outbreak.
- 2 Further research was carried out in Piis to delve into how a specific region

managed the situation. Luckily, a healthcare assistant who knew detailed accounts of the then circumstances was back in Piis from the hospital under treatment. We were also able to corroborate the functions and the achievements of the traditional societal leader as well as the post-operational life improvements.

- 3 We were able to find examples of their successful efforts in dietary and nutritional improvements via vegetable growing, etc. However, there have also been cases where it was discontinued. There were similar circumstances within the governmental level as well. The political leaders have acknowledged that the failure was partially due to social structure.
- 4 Marine environment management is a crucial prerequisite for island life. Its quality, degradation and long-term resource management are manifesting in serious forms within the recent years: we have previously indicated the increased water level especially tidal surge, coral reef bleaching due to local high atmospheric pressure and elevated water temperature, increased frequencies and strengths of disastrous devastations such as large typhoons. Here, we bring our attention to the tradition and direction of marine protected area (MPA) management and its new outlook, with Palau as leading example of furthering development. Chuuk has a world-wide rare tradition whereby the women work as fisherwomen within the lagoon. They have been harmed and injured due to sanitation problems in the past. We can expect for women to take the role of the leadership.
- 5 Compatibility of resource preservation and development of a cash economy is also an important prerequisite for sustainability. Investigation of fisheries has been already conducted; the results need to be recorded. As the foundation of population maintenance lies with fisheries, especially in small island Piis, it is necessary to provide suggestions for their future industrial development.
- 6 The severity of the waste problem is not only getting bigger, but it is also showing signs that it is steadily improving. But there is world class problem within the atoll relating to drifting oceanic waste. The solution to this problem also relates to management problems inland, providing education for residents, and creating resources to clean the beaches. Investigation was carried out to glean the current situation of treatment and management of inside the bay/gulf, inhabited islands, uninhabited islands, and beach in the capital. We will set down the issues drawing comparisons against Palau which leads cooperative improvement to elucidate the truth behind the current situation.
- 7 Interpersonal and organizational networks may create a new breakthrough to the limiting solution to the aforementioned problem. Despite the leaders being highly educated and have high intellectual standards, there have been issues with securing their own engineering groups, and there are empowerment tasks related to them. However, there are positive prospects from NPO/NGO, especially from the Women's Council. We expect their involvement in improving sanitation will bring positive changes.

Full detailed account of cholera in Chuuk

1) Problem solving through chief reciprocity

Head Chief Susumu Aizawa, a Japanese descendent, left an impression during a talk back in 1984 - he stated that the proposition by the Head Chief for each chief to monitor the complete abolition of ocean toilets on other islands and for the chiefs to take in turn to provide as a thorough measure against the outbreak of cholera. He mentioned that since chiefs are approachable and are relied upon like a parent, they may unintentionally be inclined to approve exceptions. He further shared the difficulties in completely collecting the debt of small businesses (small goods, Yamaha repair shop, etc), and says that chiefs are not suited to act as intermediaries in businesses. On the other hand, they excel at using reciprocity as a method for problem solving, which is an extension of the traditional process.

The current picture portrays that of a system rapidly weakening and becoming hollow, but under that a chief is required to undertake responsibility as a mayor and as a political leader. But the original principle is different. The modern principles are based on: ① not for personal profits or gains but ② securing equality, justice, and transparency. Furthermore, it is important to ③ coordinate and cooperates with external organizations (including state governments, countries, and foreign aid), ④ meeting the needs of cooperation and collaboration, and ⑤ ensuring the effectiveness of business outcome.

However, the rapid change especially ① has not been easy and after much time it is in current state. It is one in which the chiefs who are close to the mayor or island chief agonize over. The 'responsibility like a parent' is, even in its distinctive meaning, a social relation capital.

2) Disaster ranking - Disease

We had an interview with Mr. Wilfred S. Robert, the Chief of Disaster Communication who was also a victim of cholera. He was responsible for a wide range of disasters, including disasters caused by human neglect. There are 11 different types and are ranked according to the weighting and are listed in descending order: ① typhoon ② mead/grassland slide ③ disease outbreak ④ flood ⑤ drought ⑥ tide surge ⑦ fire ⑧ oil spill ⑨ plane crash ⑩ sea craft crash ⑪ drear due boats (small sea craft lost at sea). The outbreak of infectious disease comes third and it lies heavily on society. There have been cases of landslide which is a characteristic devastation for flat islands with heavy rain. Its destruction is comparatively large, and the staff member in charge was even surprised by the scale on his first assignment. Considering the disease outbreak occurs infrequently, we can understand it to have the second biggest social effect after typhoons.

The subject of sea surge on Mortlock atoll we saw at the Japanese Embassy became an adopted projected by the FEMA (Federal Emergency Management Agency), was granted a recovery relief fund, and the evaluative report submitted. This case has been discussed on a number of occasions with DCO and related departments, but as it continuously remains specific to Ta Island, the conclusion is that the disaster is not related to 'global warming.'

3) The reality behind the spread of cholera

Despite requesting resources such as statistical data from the Head of Department of Health and their staff pertaining to cholera in 1980s, they withheld the information. However, Mr Wilfred S. Robert was a victim himself and he had vivid memories of it. According to him, in year 1982, 60 people died, a few died in 1986, and none since. Even if there was an outbreak, there won't be any deaths. It says "Repeated outbreaks in past" on various written inquiries (Izumi Kobayashi etc.), the 1982 incident was not only a sudden occurrence but also consequently had many deaths.

Many people endured the illness and had not reported it. The cause of the illness puzzled people initially and only when it became unbearable that they reported it. The first victim was from outer island northern atoll Fallap and was carrying another victim. Mr. Robert contracted the disease in a similar manner. It is the first case even for this country. Time was also lost when sending samples to Manila, Guam, and Hawaii and waiting for the results. During this time, the disease spread to the whole area. Unaware of the cause, people endured using only adjusted salt water. Some victims could not stomach that and refused to drink it - only when it was mixed with coconut that the sweetness masked the salt and they drank it. Coming in direct contact and carrying patients with exposed contaminated discharge also spread the infection. Mr Robert had himself been given a few dozen intravenous shots, and the pierce marks still remain. 3-5 people died on Fallap. There are memories of young children, men, and women. Since he left the island because of the illness, he did not know any detailed accounts of the aftermaths on the island.

4) Nursing staff awareness and preventability via social capital

There were also many victims on Piis Island. According to the healthcare assistant Mr.Fabiano Kosmes, 28 people aged 11-50s, mainly women, contracted the disease in 1982. There was only one death - a male in his 50s. He could not be reached and the treatment came too late. This was due to the conventional way of life whereby one doesn't go to a dispensary even if one is very ill. That resulted unfortunately too late. This case has been used to teach others.

Not so long afterwards, specialists from Manila etc. were introduced and became an international undertaking. There was emergency dispatch from WHO with the staff of federal government lasting one year and there were study groups at hospitals. "Benjo" (a local term used from Japanese reign) education was deployed under US support. The complete abolition of ocean toilets was thoroughly implemented. It was organized as a community activity and they burned the toilets and buried them underground. New toilets were created and they accepted donations from foreign aid. Hospital staffs and chiefs went to supervise and inspect. Since then there haven't been any ocean toilets. There were zero incidents in 1986. Even work in the whole of Chuuk only lasted a few days.

This complete transformation brought changes to the traditional housing structure, and the abolition of ocean toilets was a success. Was the resolution in 1980s in truth led by chiefs? As a part of the whole activities that took place, they complementarily exhibited the old compelling power. One can even say that without borrowing that power, the project may not have had the thoroughness that it did then. They did

not allow any exceptions afterwards, which helped creating preventive measures. Therefore, this case can be summarized as an example of “preventive force of social capital.”

Public hygiene and sanitation

1) Establishment of public hygiene principles: post-cholera social development

Ms Cathy Mori Asor, the Head of Division of Sanitation, Department of Health, stated that the tribulation of cholera had initiated social development in public sanitation and its principles have not been shaken since. However she admits the shortcomings. The basic strategy for rural society sanitation is: good toilet, good water, and education. It pillars on 5 programs: ① food supply program, ② school sanitation program, ③ country hygiene program, ④ vector control port, and ⑤ health education. The preventative measures against epidemics such as dengue or filarial is not flawless, and they are continuing to request aid and accept training.

It is important to incorporate the community to spread effective preventative and improvement measures, and it has been expanding with introduced US funds. However, the funds stopped flowing when the funds did not reach to the level of the citizens. With that followed the cessation of campaigns to improve hygiene and sanitation. That means this became truncated due to circumstances within the social organization despite accomplishing grass-roots expansion. This can be seen as rebound back to the revival of conventional distribution of social capital principles. It also demonstrates a case of “an obstruction of grassroots support system by social capital.” However, there are not all examples of failure.

To note, the Head is a granddaughter of Koben Mori, one of the first immigrants who fathered 6 boys and 5 girls. She is a daughter of Sanro and is a member of Mori tribe consisting 2000 people. Her cousin is President Immanuel “Manny” Mori and her nephew is a lawyer. Therefore she is in a position to know and understand the deep truth of the political reality. She also possesses opinions about the running of social capital through modern principles.

2) Sanitation surveillance carried out by citizens

There is one lady of Japanese descendant, Nancy Aizawa, who is the youngest daughter of former Chief of Tol (Suiyo) Island Susumu Aizawa, he carried through with the business and was working in the metropolitan. However, with the death of her father, the agency of Yamaha moved to another store, and substantial management shrunk except shipping to outer islands. She specialized in computer science in a Hawaiian college and during this time she had written hygiene and sanitation reports for schools and restaurants. There were further demands of these reports, and she was employed by the Department of Health as a civil servant. We met during her first year there. She already possessed technical opinions. This is a case whereby monitoring of civilian activities was evaluated, but in MIRAB (Migration, Remittance, Aid and Bureaucracy) economic society, this is a conceivable form of employment. This case is related to proposition of Piis Island environment management which will be considered later. Her capability to be involved in societal matters is also related to Tol Island. The frequent occurrence of cholera amongst

women is associated with their active role in fisheries, which is a rare traditional gender role constituent. Women fish outside the mangrove within the lagoon in Tol, and men catch bonito and tuna using trolling. Nobody on the island possesses trailers or cars, and even now they only have wheelbarrows as transport on land. Living in a condition where opportunities to buy goods are limited, fisherwomen are still an important part of their lives. In addition to eliminating ocean toilets for sanitation, like the other islands, pigsties are located more than 15 feet away from the house as a measure to tackle leptospiros is. September is known as Sanitation Month, and there are a number of opportunities for campaigning for improved sanitation and hygiene.

3) Campaign against malnutrition: 1987-1988-1989

- Lessons from its success and its discontinuation -

The undertaking by a healthcare assistant (then) from Piis was an important archetypal grassroots sanitary and health movement. He organized and self-funded a campaign to combat malnutrition after noticing one undernourished child. Every two months, measurements such as weight and height and basic tests of the children were taken and were released- this brought a competitive edge to parents and guardians. This was an effective method as this small island society operated under a deep understanding of one another and their functions. Using tact, which makes use of communalism and constructive participation, as well as tapping into people's ambition to want the best for their families, are some of the elements of social capital.

This project extended to submitting monthly reports to hospitals and the state. It then advanced to gaining approval from the country and received inspections. Two years later, they received subsidies from overseas to support gardening projects. They grew vegetables such as egg plants, Chinese cabbage, cucumbers, cabbages, and watermelons. Almost all the households in Piis have started growing vegetables at home (side note: currently Pingelap and Kosrae are near deployment stage). Furthermore, nutrition education campaigns for women were developed. This was truly a striking case of a remarkable change brought forward from a small island, and it seemed to head to sustainability; however, due to the aforementioned circumstances, foreign aid was withdrawn even to a point where they could not buy seeds. The locals knew the health benefits of continuing to produce crops in the garden, but the project stopped due to problems securing funds.

A lesson can be learned from this that education and enlightenment are not enough to maintain the efforts to improve living. They need to secure MIRAB support or to create independent purchasing power. In other words, improvements must extend to the core base of private and social life. The indication of the latter is the vegetable patch, where a shop owner grows green leaves to cook. There are vestiges of a very few households who are continuing to grow vegetables on a small scale. There is a small amount of cash flow in Piis households, and its network of relatives (internal social capital) through income from fishery and associate public services. As the problem of malnutrition itself was recovered, it affected preparations for other progress. This also affects collaborating external driving forces and lacking outer social capital.

4) Compliance effects of prohibition act- its successful development and reality

As stated by David Hanlon (1988, Remaking Micronesia: discourses over development in a Pacific territory, University of Hawaii Press,pp.154-157), prohibition law of alcoholic drinking was established in Chuuk in 1977. This is an illustration representing the strong political power of the women. Since the beginning of the 1980s, there has been extensive coverage and many reports of its compliance and special exclusions from compliance in Weno, the state capital. It is still legally effective after 35 years. This problem parallels that of illegal drugs, especially ganja (marijuana), and social problems are both rooted in common grounds. This is also an important part of the public hygiene problem.

However, the reality is that of alcohol sales, which shows no signs of prohibition. Alcohol is sold generally, and public drinking is seldom reproached. The visits during the 1980s saw strictness, and private whisky-related gifts were much appreciated. As a way of saying thanks in early the 2000s, a Christian dignitary recommended against giving his counter parta gift as he knows his habits after drinking. On the roads, large quantities of empty beer cans are squashed by cars and found scattered. Some say it has been true since the 1970s, but there are heaps of empty cans and bottles on uninhabited islands, and even during this investigation there were many discarded in cardboard boxes. Due to certain circumstances drinks previously limited to restaurants and foreigners broke down in 1990s. However, this is a Christian society with constructive reciprocated participation, and within this complex social capital society they are creating prohibition compliance groups. Additionally, female splay a role in the society and its moral culture, and there are only a limited number of women who drink. It used to be absolute, but currently it is more relative. What might be highly praised of the present state is the effective control of excessive drinking, especially by families and associates, and it functions as a preventive social regulation as part of social capital control.

Furthermore, quickly brewed alcohol made from sugar using yeast (they call it flour) was seen in the shoreline forests located on the outer edge of the communities in Pingelap Island, Pohnpei. Also, recreational activities undertaken by youths during weekends and religious holidays are over looked as there is little alcoholic consumption and they do not cause problems apart from hygiene and sanitation. Similar observation was made within an outlying uninhabited island in Chuuk atoll with the presence of empty bags.

5) Illegal drugs, prohibition, and the reactions

Marijuana use has been indicated as a social problem since the 1990s. It is also related to high school dropouts. The latter is a by-product of declining social capital control as there are students from remote islands who live in relatives' homes to go to school, but it is accompanied by long-continued problems with social principles that cannot stop drug dependence. Last year, there was a murder on a dark public road near Weno airport in which drug use was implicated. Drug users, many of whom are in their 20s and 30s, can be occasionally seen on urban public roads day or night, unsteadily swaying with a hollow gaze or uttering strange sounds. Passers-by' s surround them at a distance and look worried, but they're only keeping distance.

The problem of drugs persists even under social capital monitoring, and it exists in remote islands as long as there is the difference in living standards. The regional police (who are not like civil servants, but lie close to volunteer firemen in Japan in social positioning), as well as island leaders' turn a blind eye to drugs. However, it is not socially acknowledged or recognized.

We have asked about the drug problems at various social levels. Levying is thought to be the most effective for alcohol and tobacco, but everywhere there is a cultivating environment for home-grown drugs, and it is not the public transactions (Goto, Shinpei officially imposed heavy taxes in Taiwan), and there are no specific scenes identified. There is no alternative but to enforce regulations such as compulsory punishment and custodial compliance. There have been a number of opinions supporting the need to pass laws to arrest, punish, and fine the offenders, but many add that it depends on the dispositions of leaders especially politicians. Within the social structure where there is reciprocal containment, some say there is no other way of breakthrough other than publicly elected leaders. As one of the solutions, there are many who support the possibility of women legislating as they did with the prohibition act. President Mori's sister is an avid anti-drug specialist and is expected to exhibit leadership and initiatives of the Women's Council. However, we are still anticipating.

Amongst those involved, it was considered as a decisive step. Radical improvement measures that target problems such as murder cases linked to drugs need a collaborative structure by the judicature, legislation, and administration, and we hope the complex matter to be handled properly. This again is connected to the public hygiene problem.

6) Dispensaries

Let's look at the current condition of Piis dispensary and then the case of small remote island with hygiene, sanitation, and health problems. The original system for the dispensary constituted two healthcare staff. The male staff underwent a treatment for an illness, but he returned to the island straight after his recovery. He is a younger brother of the Head of the Elementary and Middle School. The female staff only managed drugs, and the dispensary (of which the building is closed) has been semi-closed for the past two years.

We have summarized the interview results. The other remote island regions are in a similar position.

- a. The facilities of the initial dispensaries were funded by FEMA.
- b. Medications were covered by state budget and the order of priority was 1 antibiotics, 2 pain killers, 3 uacire, and 4 anti-worm medications.
- c. The emergency unit is not equipped with resuscitation or oxygen inhalation devices.
- d. External injury (severed abdomen) inflicted by engine trouble was treated reading first aid papers. He lost his private parts but survived. He was not sent to a hospital.
- e. The underlying demand is the restoration of the pharmacy building whatever the size.
- f. Solar-powered low-temperature medicine storage is needed.

- g. Expectant mothers, especially for the first birth, are strongly encouraged to go to the hospital in the capital Weno as there is nobody who can administer intravenous medication. There was a time when 3-5 mothers gave birth on the island. 10% of all births are on islands. From 5 years ago, 100% all first births are given outside of the island, which resulted in lower infant and maternal mortality rate. Surveys conducted on pregnant women are conducted annually and they are reported to health authorities.
- h. Three children on the island suffer from blindness, hard of hearing, and strabismus. There are no other illnesses.
- i. There were active family planning campaigns.
- j. At present no fisherwomen suffer from disabilities with their health.

Waste problem

1) Four waste problems and technocrats

Waste problems in Chuuk can be largely divided into four: ① serious refuse problem that continues to persist since 1980s, ② sewage problem, ③ oil spillage, and ④ garbage drifting into Chuuk atoll.

According to a veteran tour guide of diving originally from Tsushima, who has been diving in and around a sunken ship since taking up permanent residence from June 1978, he has noticed a clear change in the quality and transparency of the water. In recent years there has been ①a decrease in water transparency and increased incidences of muddiness/impurities found, ②lasting for a longer period, and ③is notably characterized by irregularities that are not due to the tidal currents. He adds that ④opaqueness and muddiness of the coast is very poor.

Chuuk aimed to have its atoll registered as a UNESCO site of world natural heritage, but it was rejected with one of the reasons being the oil pollution from sunken ships. Even before this assessment, oil contaminated water brought a sense of threat, and there have been social campaigns against the unstoppable oil spill from specific pre-war sunken ships, even starting to spread to foreign lands. We have directly received digital resources and materials from the said diver. From the point of view of “polluter pays principle,” both Japan and USA are implicated in the responsibility.

The construction of the sewage pipes under the road of the capital island of Weno is still incomplete. The pavement has many potholes and the roads are becoming bumpier year after year. Drainage seems impossible as the road is like a river. This has been the case for a few years, and islanders are disgruntled saying it may take another 10 years before it is restored. However, according to the person in charge of the project, sewage repair and complete tap water supply have been a long-running challenge, but the repair work is nearing its end. A New Zealand manager from Chuuk Public Utility Corporation had explicitly outlined the dates and processes of future plans. There was a contract in the background. A public tender and competitive bidding happened, and a USA businessman living in Majuro, Marshall Islands, came as an independent public utility contractor. Many labourers came from the Philippines and genuine work commenced. It is almost possible to see the finish line including the

road paving. ① Sewage network planning is not just at the stage in progress but it is due to be completed next year. ② As for serviceable water, there is a need to increase the size of storage tank. There needs to be surplus room to counteract the instability as it is heavily reliant on rainwater as well as the supply water for the sewage. ③ There are plans to build more power generators. This is thought to help during power cuts or time constraints. As for the plans for solar power, it has reached at a stage of implementation planning for installation of a large one on Getsuyo (Udot) Island, and others will be installed on Tatsu (Tonous) Island and the outer island of Ylul. The presence of foreign technocrats is encouraging especially since the FSM government suffered from technocrat shortages.

2) Refuse disposal

There have been some new developments with refuse disposal from Japanese JICA specialists and volunteers. As the JICA group is managed closely, we can predict that in the near future they will apply strategies learned from experiences and successes in the advanced and neighbouring Palau technical systems. The refuse has been a continuing problem in Weno (Haru) Island for more than 3 decades. This problem has been printed in English overseas technical travel books.

Garbage has been collected using two 20 year old machines received as a grassroots gift from Japan (recorded as Osaka City: South 144). Only the one has been used publically as the other one is exclusive to hospital use. It deals with an island population of 10,000 people, which is one third of the state, and it has been scrupulously and repeatedly repaired using readily available materials such as wood. It also has an added workload of a large number of commuters from remote islands, and its already suffering effectiveness in collecting refuse and is hampered by bad road conditions. Before long, one from Hachiooji'm Tokyo and another from another part of the country are expected to arrive. Landfill has reached its capacity. They are expecting to install new facilities with technologies that also target the rancid smell by ventilating air (JICA specialist is in charge of Palau, Yap, and Chuuk, and another person is in charge of Pohnpei, Kosrae, and Marshall Islands). Palau/Koror Model is a new ODA and JICA technical system uniting disposal site, collection, ventilation (combating foul smell), and systematic recycling processes are charged on a deposit basis. There is already a supporting unit for this in Palau and in addition has MPA established and put into practice; indeed it is an integral and combined environmental education.

The reality is for nearly 10 years it has been very difficult to use access roads as they were buried under heaps of rubbish, and a bulldozer was introduced to clear the road but suffered from frequent failures. Bolts needed for repair were on order. For a long time, it has been close to residential areas and has had children, dogs, and birds come and go. There are implications in some health problems. There were cases where garbage collection workers were paid in low level salary or in arrears. It is necessary to raise social awareness level.

3) Recycling

It was only in April that the proprietor of an iron (and iron-related) factory, a Chinese businessman, withdrew his business. The challenge was in the separate collection and establishing a compact disposal system. There are remains from Chinese businesses left, but additional measures are needed such as isolating aluminium, cleaning treatment, and shredders. After the investigation we visited Palau, and there was evidence of support from JICA etc and was fulfilling its potential especially on Koror Island.

There is also a task of securing foreign transactions. There is a plan for a joint business with Guangzhou, China, in October. They are also requesting for cooperative measures regarding unloaded cargo returned as a way of reducing transportation costs. Having a separation system will be especially important.

The deposit system whereby each empty can is awarded 5 cents has started, but there have been questions raised in meetings about its usage; exploring transparency should be welcomed in public debates. Currently, systematic checks run by local contacts are being organized.

The scrap body of motor vehicle switch out the useful scrap parts have been accumulating on empty land between the shore and the mountain. This has created a public difficulty with dust management. The problem with recycling faces the limit with civilian responses, and it is a problem that is spread to the whole of the Pacific island region. There is a strong need for international collaborative measures including from Guam. There is a limit to subsidies given for transportation costs for remote islands within the country, as political strategy; there needs to be an additional concentrated disposal unit within the region.

4) Composting

There is a regional characteristic whereby there is little kitchen waste that could be composted due to having dogs and raising domestic animals such as pigs. It is not as if they are stock breeding livestock. The Community Resource and Environment Project, headed by a Pilipino college teaching staff (College of Micronesia, Chuuk campus), was awarded \$20,000 from WHO. They are currently developing a plan for composting in line with the project, but they struggle to overcome the lack of raw greens. Moreover, vegetable or ornamental gardening is not an established component of their lives. Therefore, the state Environmental Protection Agency (EPA) has been reviewing the proposal of promoting “Go Local” which aims to cultivate local produce by encouraging agricultural farms and dietary improvement, establishing a discretionary system, and linking that with environmental education.

Understanding the refuse problem is an indispensable part of environmental education. Associating garbage with the environment will lead to their self-awareness of contributing to environmental pollution. It is part of lesson 101 and is a basic principle of environmental practice. This will lead to their understanding of social responsibility and environmental responsibility as consumers. It is the practical cognition of Global + Local = Glocal Citizenship. The new compost proposal is a practical example of conservation of mass; its principle lies on reducing, reusing, and therefore taking part in ecological recycling. In other words, it supports their

understanding of the ecological cycle, which comprises of organic decomposition, organic production, and organic consumption. Their understanding of natural regeneration may radically shift their perception of mother earth and mother sea and thereby improving the quality of their surrounding environment. This can be linked with produce growing, and thus widening the possibility of a sustainable subsistence economy. The education for their own local regeneration and its implementations are the most fundamental element of all basics in improving the foundation for living.

5) Cleaning the rubbish off road

Civilians are becoming actively involved with the problem of road and roadside rubbish. It is spreading to local women's councils, youth groups, and environmental groups. They are taking part in cleaning the roads of the capital one weekend a month (mostly polymers), and grass is maintained and compostable garden waste is collected on Mondays by the Department of Agriculture. However, the state unkemptness unfortunately returns even after a week. Nevertheless, improvements are starting to take effect in improving the situation. One of pressing tasks has been targeting trashing aluminium cans on roads; improvements made to collect littered aluminium cans on roads may be accelerated with the backing of a system (on Himejima Island in Oita, Japan, littering ceased with the introduction of deposit system with the effect of a deposit system and have advanced to become beautiful, still effective and active now).

There is large yellow metal shelving for garbage, which is donated by private individuals of whose names are inscribed on the gifts, and it is placed all around Weno Island and will have complete coverage including hill sides. This is not a problem unique to the capital, but its various maintenance and spread will need drastic measures. To name a few, the state of shore waste yard, increased amount of garbage drifting into the lagoon (of which is one of the largest in the world and is a paradise for divers wanting to explore the WWII shipwrecks), worsening water transparency of the bay, and reduced water quality in the coastal area. Because of the vast varieties of work on water, this should be worked on together with terrestrial improvement projects. By having people as part of the solution, it will help enhance their awareness and at the same time educating them about the environment. This hands-on approach will help to bestow civilian responsibility, and observing and experiencing the successful changes will hopefully encourage them further to look after the environment.

6) Rubbish in ocean and drifting garbage-the current situation and measures

(1) Measures against garbage on shoreline and promoting MPA opportunities

The shoreline of the capital island Weno seems to be in a constant state as a dumping ground for garbage and this is clearly polluting the ocean of a world class atoll. It has been a clear challenge even before registering for World Natural Heritage (similar to Fuji Mountain).The rubbish is not only a problem within the city. Moving away from the city, one can see more sights as if the sea is dumping ground. Pollution stands out on the whole of the ocean surface. There were also accumulated garbage sites deep in the mangrove on the coast. This is an unsightly comparison to the

Palau mangrove, which is environmentally similar, but no matter how deep one goes, rubbish is rare.

The manifestation of the environmental management (quality management as well as problems caused by global warming) and waste management to be the faces of the same coin is an indication that it has reached a critical state. New developments must take place which can help residents learn from previous achievements. For example, positive measures like an educational campaign taking an active part in coastal rubbish elimination (not of the drifted garbage but of the dumping ground) of Palau-type specified MPA is effective in that the results are seen right in front of their eyes. However, for a broader change it will take time. Children having positive hands-on experience with cleaning will help to continue that. It is advisable to involve Japanese specialist teams to contribute with procedural scientific management of beach cleaning, targeting the root cause and the branches. The waste management problems concerned are to be especially targeted for improvements so it is the best time to promote this.

(2) Coastal garbage within small island Piis

In principle, garbage is the responsibility of the individuals, including the roads and coastal areas reaching to shoreline which are in close proximity to one's house. Those neglecting their duties will be given warnings or orders from the mayor. However, beach cleaning has never been done collectively as a village (as a side note, Japanese remote islands do this on average at least twice a year), and the mayor himself, has not directly issued orders. We have spent three days consecutively to inspect the whole island.

1. The worst area was area facing Weno to area near the mayoral house, especially near ice making facilities
2. large quantities of foreign drink bottles, drink cans, and lunch packaging that have drifted ashore
3. a lot of plastics that have been there a long time that seaweed and algae have stuck themselves
4. a number of clothes, nappies, gas cylinders, empty ramen packets, rice bags, and even empty beer cans which is prohibited (they clearly originated from the islands)
5. Considering all of these, 70% -80% of the disposed items came from the houses near shoreline, and if including drifted garbage from within the island, more than 90% was the result of their own doing.

The measures needing in place are clear from this.

(3) Garbage problems on uninhabited islands

One can glean the seriousness of ocean pollution just by looking at the debris drifting on the water. They are easily visible everywhere even from moving vessels, especially the plastic bottles, shopping bags, flip flops, empty cans and bottles, and drink packs. This is a familiar sight, but it is getting worse and worse.

The six islands on eastern side of Piisareterrible:

- Pisemweu Island (Kojima in Japanese, hidden watch station of Navy): possibly due to fast currents but there are less than habited area. Some scattered near fishermen's camp

- Onaf Island (Ushijima, also known as the name of Military ship Island by grape): semi-residential island used for fishing. 1-2 houses occupied. Scatters of household goods present, however they keep comparatively clean around. Digging hole for dumping and water.
- Tewenik Island: scatters of drifted materials
- Eparit Island: little clusters of garbage from fishing camping grounds and drifted materials
- Fonochu Island: small clusters of drifted materials and used yeast packets
- Sopwerii Island: mixed rubbish from fishing camps and drifted waste. There are big items that have drifted- even polystyrene packaging that was used for the ice making facilities which was given by JICA as a gift to Piss. The damage to the facilities caused by typhoons was a few years ago. We of course brought it back but it is a sign that there is a considerable amount of drifting rubbish gets circulated within Chuuk atoll.
- It is bad every where is but 3 islands lying to the east are especially appalling. It may be affected by ocean tides.

Two islands west of Piis:

- Pisninin Island: very little but there is a barbecue site
- Pissamwe Island (aka Paradise Island): very little but some small floats

The reason behind the uneven distribution of drifts is due to a large flow of the northern waterway that passes the centre of the two regions, and it goes out to the open sea. On top of this, the direct cause is the interaction between the current within the lagoon and sandbank that catches it. On the east side, the debris that drifts onto the shore are both relatively recent household goods and those that have been drifting in the bay, but it is rare to see either of these on the western side. There is also a man-made origin that contributes to the difference between the two. Whereas the east is an active fishing area, the west is chief clan own the control and has a feel of sanctuary. It is a stunning place to the point that they named it 'Paradise' and they remain true to the psychological testament to preserve something that is beautiful.

Fenangat Island is an island located near centre point between Piis and Weno which lies south. It is not possible to see from the sea. But there is a lot of drifted debris. There are loads in the forest. There is quite a bit of trash from picnics that has accumulated throughout the island.

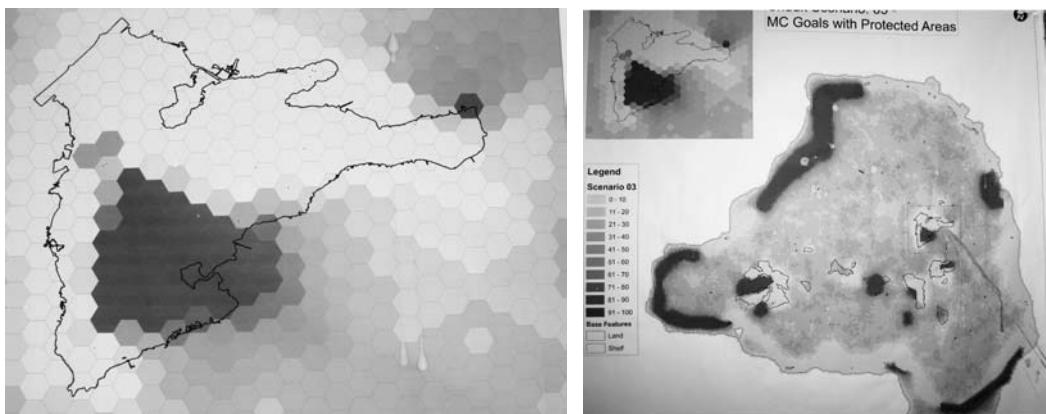
Pisiras Island was the worst of all. It is a relatively popular place for picnicking, and it has been used during weekends for drinking since 1970s (there were no visible old beer bottles, but they may possibly be present if dug out from the ground). There were concentrated cans and bottles trashed in and around new cardboard boxes in great quantities. Plastic bags contained remnants of food consumed during picnic. It is as if uninhabited island is a garbage dump. There was considerable amount of drifted materials also.

Ordering the level of severity, from worst to least, it is Weno's unofficial dump, Pisiras Island, Pis (Fanangat) Island, eastern islands to Pis, and the western islands especially Paradise Island.

MPA

1) Chuuk State MPA and personal rights adjustments

We were unable to find a map of Chuuk with clear and explicit lines drawing the boundaries in August 2011. A MPA schematic diagram of Weno/Moen Island was hung on a wall surface, but a detailed figure could only make out a blurred central part and its periphery. Environmental Protection Agency officer said there is no intention to release it to the public- a problem that could arise from making it public is that if the MPA adapted area and non-adapted area become clear, then fishermen will unashamedly come in to the privately owned part of the adapted area. He showed us the detailed diagram on the basis that it will not be made public as it is in process of making it formal. This problem is also associated with the daily lives of the fisherwomen working within the lagoon. Fishing activities carried out by women can be only seen in Japan and Korea, but women working in shallow sea is a unique traditional custom particular to Chuuk which has at times brought health problems including contracting cholera. The efforts and the chief/social response of the Japanese descendant head chief Susumu Aizawa has been introduced previously in (Nagashima 1986). The development, its details, and the surrounding circumstances are mentioned above. Chuukese society is considerably complex as matriarchal social principles penetrate through the transfer and the use of land ownership even today and it overlaps with fishing activities.



Figs. 1 The officially displayed Chuuk MPA map on the wall in EPA (with the logo of World Wildlife Fund).

Traditionally, MPA has originally been existing and has been controlled through use restrictions of areas owned by clans and taboos, but with growing awareness of personal rights and for business interests, even maintaining an order for fishing methods (mainly spear fishing), it is all at once giving birth to situations that could result in social changes. On the cost of the small island, women dive and fish and they process sea cucumbers on uninhabited islands while the men fish every day outside of small islands and on uninhabited islands. They pack them in ice purchased from state capital (ice maker given by JICA has been left untouched since it broke down), ship them every day, and are replaced next morning.

Comparing Chuuk and Palau MPA research, we conversely felt the lowness of commercial pacevitality in Palau. It may seem paradoxical that there are more commercially competitive Chuukese fishermen than Palau, but there is a high possibility of actualizing resource preservation and environment quality management through their systematic ‘wise use.’ ‘Wise use’ is inherently sustainable resource use, and per ISISA motto in Mauritius, one needs to learn from the intelligence of ethno-biodiversity order.

2) MPA as traditional societal custom

The funeral of an important clansman/woman is accompanied by sanctuary management on the remote island Piis located on outer periphery of Chuuk lagoon. This is known as *mochen*, which is a conceptual taboo termoriginating within the Pacific Islands. This area, which stretches 2 miles from the reef including islands and the terrestrial areas, is owned by the clan, and because they prohibit not only fishing and harvesting but also limit its usage, entry and becomes ‘closed’ during this period. The oldest clan member has the final say, but in his death his oldest biological nephew makes the decision and publicly declares it. When the mourning is over, they dine and the area becomes ‘open’ . Funeral aside, the period during its closure enables resources to restore and can pass on a recovered and better state for the next generation. The period varies from 30 days to 3 months, and it has been getting shorter recently. The harvest restriction on territorial resources has declined and is rare. The area on sea is also a limited area for clan relatives. However, the practice still exists as a regulation.

The custom is still practiced on Ramanung Island (Nichiyotou) where after the death of an important person the funeral the sacred area is declared (in recent years lasting for about one month) and is circulated to other places. There was a funeral of an influential person within the chief class near Weno Island (HaruShima) Salamen just before the research period, and the region between there and Dublon Island (NatsuShima) was specified as no fishing and no swimming area.

The ownership and exercising personal rights is by nature complex, and the above was an example of usage within Chuuk lagoon prominent island, but the fragmentation is advancing.

MPA related to the use of owned land depends on the aforementioned clan terrestrial management, but it is different from Yap’s ‘ridge to reef’ but it does not necessarily target watershed management. This is becoming more complex and fragmented because of recent cash economy transactions. Therefore, there is an acute need to establish MPA that combines appropriate territorial and marine management based on re-researched state of traditional plant uses. However MPA itself is specified as an individual’s owned area and the public has difficulty implementing specific actions. Overcoming this biggest challenge will need the present personal rights to be adjusted and with that are associated costs. It is essential to have procedures in place to cover complex and wide-ranging procedures even through facilitation of reasoning. In the current state of enforcement under traditional system (which is already fading) and with limited legislative measures or expenditure allowances, one could say that they are at a stage doing their best.

3) Fishing ban concerns and measures

One aspect of work JICA senior volunteers do is to introduce and spread the use of fishing nets to discourage fishermen from dynamite fishing. Some say that they are made in the black markets from construction sites and others make explosives by removing the fuse from sunken ships. It is a crime to take what is on a ship, but they seem to have a different conscience when it comes to bullets. Newly demolished areas are easily identifiable by a professional, so they are immediately inspected by a specialist from Palau International Coral Reef Centre (PICRC) and were reported. There are others who acquire dynamite through quarry black markets or stolen container fuses. Piis is the only island that does not use dynamite for fishing. Finely-meshed fishnets are also another problem along with resource management, and therefore Chuuk needs effective MPA.

However, there have been reports by overseas research groups, especially in the US, who claim the corals to be of good quality in MPA. It is necessary for them to see the picture outside of the area. The coral themselves are getting weaker. The mass breakout of crown-of-thorns starfish, they had to be killed by injections. It is a method different to Okinawa where mass of people is required to bring ashore, but there are associated costs involved.

As dynamite fishing itself is prohibited, there must be compliance, surveillance and appropriate punishments in place, but according to JICA senior staff, fishing using fishing nets along with its benefits of as uperior haul and understanding resource preservation are encouraged as a preventative measure. He has worked in the fishnet division of Y Company for a long time and has been instructing to create handmade nets. He is actively engaged in the abolition of destructive fishing through instructing people to dodemersal deep fishing around atoll which uses unused resources (OFCF has been spreading throughout Micronesia since 1980s after researching the resources) and reserving funds for the purchase of the nets. Deep water fishing is not only encouraged as it uses unused resources but also because fishing methods are becoming more proficient with technological support and are easier to fish. Even the successors are requesting for the dispatch of an expert in the same field with the knowledge (there already is an informal consent made with an applicant).

4) NGO for Marine resources and environmental conservation

Chuuk Conservation Society is a new NGO (established 2010) specializing in marine resources and environmental conservation. It was founded by Mr Wisney Nakayama, a son (age 36, born in Tochigi Prefecture) of the first President of FSM Mr Tosiwo Nakayama (born on Piharar Island, an outlaying island off Lucunor in Chuuk State; graduated from college at age 23 and was employed by East West Centre; since then he has been climbing up the success ladder; former Research Centre for the Pacific Islands visiting professor, Professor Hunlon, from Hawaii University Research Centre for the South Pacific Islands has been planning to do biographical research since his term at Kagoshima University. The Society was funded by the Micronesian Conservation Trust, Micronesian Challenge, and various other world conservation groups. It currently employs two permanent staff and one intern. He is maternally related to the Piis village chief. There have been three occasions conducting research

on socioeconomic and fishery resources since 2008. He has profound experience in marine research and has expansive knowledge of the seas, island conditions, and terrestrial ecology. The Society has been prioritizing the preservation and protection of biodiversity. He has been involved in generating summaries of the diversity of corals, invertebrates, echinoderms, and the fishes. He was surprised by the fact that Kasiwajima Island has approximately 1000 species of fishes. Watersheds are used for large islands enclosed in lagoons. He is aware of the difficulties in the open seas which are fundamentally of different nature. However, this is a specialized subject different to his own thus expressing his desires for training opportunities in Japan.

They have assigned Ruklechic Islands (uninhabited island belonging to north-western island groups) as MPA last year because it acts as a sanctuary for turtles, tortoises and birds; we were appointed to investigate on its marine source. They were excited at starting the new community-based project next week on Peren Island. This is a collaborative project between various government agencies and the local council as part of Locally Managed Marine Environment; this is a typical Chuukese style.

The state government involvement varies accordingly. In Kosrae and Pohnpei, the government is responsible for areas outside of the mangrove, but this is not the case in Yap and Chuuk. Watersheds are structurally identical as Yap, but the boundaries of the areas managed are different. The locally managed marine area in Yap not only covers the sea but also extends 300m beyond the reef; fishing is strictly prohibited within this region and despite its relative decline the chief is involved. On the other hand, Chuuk's boundary is in principle limited to the area within the reef. Piis is an exception and it covers 1-2 miles outside the reef. There is an area designated for aquaculture but is not as large as those on Marshall Islands. There are big and small giant clam farms in Pohnpei; as it had been 15 years ago as the author found, there are still cases of theft. This may be due to difference in the fundamental awareness relating to the commons where in effect introduce and share resource uses opportunities.

The difference with Palau is that there are no incentives financially or with its national policy.

Yap authorities undergo deliberation during budgeting processes, and to the testament they are rarely in the red. The budget system has just changed from project-based budgeting to performance-based budgeting, making successful performance vital. The jobs with heavy responsibilities have increased and their duties heavier. Once can hope this organizational enrichment to also plant international and collaborator significance.

5) Development and protection of marine resources and research institutions

The Korea South Pacific Ocean Research Centre of Korea Ocean Research Development Institute is located on eastern edge of Weno. They bought what was a resort hotel and refurbished into a facility. Such a department does not exist at College of Micronesia and its state branches. There is only one other research institution with this department, and it is University of Micronesia which does not host students with U.S. Land Grant Program in Pohnpei. This aquaculture development division has been having remarkable results with pearl oyster farming project and has advanced to

product development, commercial and marketing phase.

Their recent research has been to transport cultivatedlapu-lapu, a variety of grouper, and flatfish, in its dormancy. They were tested based on survival rate after 48 hours when placed in sponges between 17°C and 29°C , and they found that 4 out of 8 survived at 22°C and started swimming again.

These two institutions have high level of expertise, but they still have yet to appoint a marine environment conservation specialist.

6) Challenges facing Chuuk MPA

The challenges facing Chuuk MPA can be summarized into 10 points:

1. MPA setup linked to personal rights and any small gap in the area becomes target for illegal fishing
2. Continuation of dynamite fishing
3. Oil leakage from sunken ship specified but not budgeted
4. Decreased water transparency
5. Corals weakening. Killed through injections during mass breakout of crown-of-thorns starfish, a method different to Okinawa where mass of people is required to bring ashore
6. Shoreline garbage and drifting pollutants worsening
7. Limited research institution collaborations
8. Need for organizational and functional expansion and staff enrichment for NGOs/NPOs that have recently been established
9. No presence of Palau-like incentives
10. Not enough activities to promote understanding and education for all residents.

Socioeconomics and Improving Coastal Environment on Piis Island

1) Civil servants on small island Piis

The whole area of Micronesia has a MIRAB structured society. It is important to understand the structure on which the society is based on and of its current state, but there isn't much understanding of the individual condition. We interviewed its state on small island Piis. It has been misconceived as being a heaven for civil servants but the reality is far different, and we have learned the hardships of island management.

There are supposed to be 700-800 residents but there are 648 people registered. The actual number of people living inside the island is 500 of whom 200 are children, and 300 live outside.

It receives around \$2000 per year from the state to cover the community municipal maintenance fee, but its expense reaches \$2245 per year. Those who receive payment are the Mayor, deputy mayor, traditional chief, and 12 councilmen, 8 police of whom 6 are from each clan and 2 are appointed by the Mayor. Even 100 \$/year per each member will be \$2300; it's like glorified volunteer work.

Training costs for policemen are covered, and they receive training on the job through undertaking various duties within the state. In 2000, the training period lasted only 2 months. Any administrative communications to each policemen or new information go through the village mayor.

The Mayor himself has been at the post since the independence in 1992. He reached his retirement age in 2003 and had been in the office for 21 years. He spent three years studying sciences at the College of Micronesia and graduated in 1983. He gained teaching qualification for primary school. From 1980s he worked in Weno and moved to a new appointment in Piis where he became the Principle of the school. It is from there that he came to the position of trust.

Civil servants paid by the state are 3 primary school teachers (grades 1-6), a dispenser assistant at pharmacy (there are 2 regular staffs but one is taking temporary leave of absence), 2 kindergarten teachers (one in charge of school lunch became redundant after they stopped lunch service). Their salary covers 52-week period. There are other state civil servants who work at tourist boards in Weno.

The teachers receive unexpectedly low wages. Principle aged 57 receives \$240/2 weeks. A teacher (49) who became a teacher after graduating from high school and has an additional qualification receives \$200/2 weeks. There is another teacher who is 38 years old. When asked in person, transportation costs \$25 each leg of the journey to and from Weno, and they say that \$100/week is not enough to cover the educational costs for their children. In the city washing dishes pays \$500- \$600/2 weeks. The answer to the question was that life on the island is not easy.

We also enquired about the school life. It is separated into morning session (8:30, 9:30, 10:30, 11:30) for grades 1-2 and 3-4, followed by afternoon session (13:00-15:30) for grades 5-6 and 7-8. The Principal is directly responsible for only grades 7-8. There are no classes for children with special needs. Academic year starts in August/September. Currently there are 90 children in total (Grade 1=18, Grade 2=13, Grade 3=9, Grade 4=11, Grade 5=14, Grade 6=20, Grade 7=8, Grade 8=8-9). Those progressing onto high school and therefore need to make preparations tend to spend more time out of the island. 20% tend to drop out mostly due to marijuana and alcohol use; this remains a social problem.

2) Overseas funds and state financial support to Piis

[FEMA]The Federal Emergency Management Agency (FEMA) has been to investigate Chuuk State on four different occasions- typhoon, ElNiño, heavy rainfall, and big waves. They communicate directly via phone once they arrive on scene. They may be stabilizing system from disaster social damages, as if social capital by overseas.

2002 July 12- 50 died due to heavy rain. Biggest damage seen on Tonous=Dublon Island (Natsushima), Fefen, Udot, Weno, Uman, and Toll. The Mayor was in Weno when this happened and recalls the severe damage. Luckily, Piis was not directly affected.

2003 December: attacked by big waves. Similar to when violent typhoon hit in 1970s, although not to same extent. There were some houses that were swept away and flood reached above floor. As it is a low-lying island taro-patches etc. received damage. They received compensation of \$200- \$2000 depending on valuation of each house. This is when the dispensary in Piis was built (the building itself which is currently inactive need to be repaired or rebuilt).

2004 summer- local ElNiño

2006 April: sea surge at Ta Island, etc.

[Plans for support and aid] Recent aid (\$200,000) was donated by Turkey for drinking water network service construction. It uses solar power to pump up the water, enabling supplying using stored energy during night time. This was a petition made by the Mayor himself. In primary school wireless network will be equipped, funded majority by state but also through donations from overseas support compact funds; this will improve electronic communications and correspondences. Two computers are due to arrive. Primary school toilets will be revamped. Kindergarten will re-open in September. The dispensary will return to its 2-people operation.

[Funding requests] Talking with the Mayor regarding the garbage found on the road within Piis island as well as on the shoreline, we have shared a collective understanding of the situation. As a persuasive reference, we introduced him to the case on outlaying island Pingelap in Pohnpei State whereby two people were placed as cleaners who have revamped the cleanliness of the island and maintained it. As current administrative budget for Piis is limited, he has requested for support in employing 2 permanent beach and street cleaners, the proposal of which will go to drafting state government budget.

3) Piis income structure

The most stable income for the island is social security. The largest source of income is the fishing industry.

[Driedsea-cucumber] Recent sea-cucumbers have been good- there are two regular Korean merchants who transferred their business from Republic of Kiribati 3 years ago. These merchants tend to buy in bulk and move from place to place. In previous years it even attracted Japanese merchants. It nearly became prohibited as there was a fear of the resources drying out, but they have made successive appearances. Palau was hit badly and not only did Korol State prohibit harvesting the sea cucumbers for business but even private consumption nor was possession prohibited. However, there have been some Taiwanese descendants have privately harvested and dried them in an inconspicuous place; its demand is very strong and is becoming a boom. As a record, we will write the current selling value but the price itself varies according to its quality: penimwrang, pineapple = \$25/kg (can even drop to \$14 or \$20 depending on quality), potato asia, penifu, women leg, penikapach = \$15/kg, sea-cucumber = \$4/kg. On an island belonging to Piis, they were being boiled and dried using a camp. Lots were packed in many bags. The recovery of resources needs long durations.

[Fresh fish] 3-4 ice boxes are shipped between 3 families. They fish every morning between 8-9am apart from Sundays, and for late-night fishing they go out when the moon is not bright. The catch is shipped next morning 7-8am to Weno. The families split the profit after subtracting that with the cost of a box full of ice chunks that are priced at \$20 and fuel prices each way \$5. They don't take the extra charge of the carrier, and in all their taking is roughly \$25 per person. They usually come back with some shopping and relatives. Generally the fishes are sold to market vendors at \$1/pound, and in Weno they are sold in markets for \$1.5. Because bonitos are large they are cheaper per pound (75¢), and as troc as shellfish is heavy it is priced relatively cheaply at \$1/1kg (25¢/pound). Lobsters are \$2. Oysters (Pachang) which are locally harvested solely by women are packed in pet bottles and priced at \$2.25 and sold in

markets as \$2.5. They are usually boiled in brine, garlic, or coconut milk and are amongst the popular items at the market. Currently, this is the only processed marine product produced within the island.

4) Fisheries in Piis

Fisheries in Piis have been undergoing the most active developments within Chuuk atoll. JICA has even gifted them with fishing boat and equipped them with ice maker. The ice maker was installed around 1997-1998 and was in operation for roughly 6 years. Since it broke the mechanism could not be maintained and fuel charges soared. It became irreversibly damaged after the typhoon. The fishing boat was even named 'Saraw' meaning barracuda, but it went down after the big waves hit. It is still left abandoned near bya broken embankment.

The main fishing method used is rubber spear gun. They use fins and snorkel to fish. They tend to use nets only for driving them into the net. These rules may be included as a kind of local MPA.

The foreshore within Piis lagoon is the fishing ground for women and they catch octopus, oyster, and fishes. Octopus catching is a family secret passed down from mothers to daughters for generations, instructing them the know how of a good catch. They usually work 7-8 hours 6 days a week. On the day of investigation, two women wearing one lens goggle (aged 49 and 37-38) were catching oysters near Pachang rock. An older woman aged 65 used to work as they have until recently but she has reduced her workload to 5-6 hours each day, 3-4 days per week. This is for household consumption, but it is also a precious opportunity for cash income.

There were also a few islanders constructing new stone tidal weir which already had caught a fairly large fish. It looked like a family unit working. They can draw the image without any map.

[Fishing ground] Islands lying to the eastern side of Piis are superb fishing ground. Especially between Pisemweu and Onafit is perfect for hurling fish. They were fishing



Fig. 2 Fish trap by stone fence.

as a family unit as well as catching sea-cucumber.

Social Contributions by Regional Groups

1) Chuuk Women's Council (CWC)

CWC truly has been developing and expanding numerous ways of contributing back to the society. They have handicraft studios in Dublon and Fefen and have a shop selling traditional goods in Weno. Men also work as well but they do more heavy-duty work and sculpting. At the shop there were stacks of books and printed materials (there are many in Chuukese as well) relating to activities they are involved in. They bring cooperative force to blood donation campaigns. They actively take the initiative to bring other organization to help cleaning roads. Their presence is vital for health, nutrition, and public hygiene developments.

They have long had the idea to create a museum for cultural preservation, but after tribulations it finally was completed on November 25th: it was assisted by a hotel owner (a former US Peace Corps member) and his wife who is the present CWC chairperson (her mother involved in launching CWC and a is direct descendent of Koben Mori) who supported financing and land, and they started building it with Japanese ODA. Amongst many there were high ranking governmental officials such as Vice President of FSM and Japanese Ambassador and had reached a total of 400 attended in the biggest ever large scale opening ceremony in Chuuk. In the following year, their first campaign took action to support "Multipurpose Facility to Promote Women's Independence and Local Populations' Health," funded by Japan's Grassroots Human Security Grant Aid scheme, calling attention to health. Locally this centre is referred to as "SMPoll Memorial Centre" after the mother of CWC chairperson.

The basis of its social structure is matriarchal, and Chuukese women are at the core of all activities; in Yap patriarchal structure has been more predominant and the women fought, but things are changing with the help with overseas NGO involvement including Japan. As their involvement stretches beyond Weno to islands in atoll or outer islands, they are in need of machine that can create and print out their own materials in Chuukese language. Ordering them from overseas or receiving ones using English can delay the processes, may incur more cost and is too reliant on others; these factors create too many opportunities for things to go wrong. Having their own devices will help them be autonomous and affordable in the long run. This concern was acknowledged by executive leaders.

2) Youth NGO

The youth program has been more critical in comparison. There may be organizations like NGO that exist, but its activities are limited. Leaders to an extent have participated in leadership workshop program which was supported externally and has been passive. Its main plan is at most organizing and running small scale entertainment and sports.

Considering the seriousness of the youth problems, there is very little targeting of the issues. For example, of the adolescents and young adults who came from remote islands or outer islands to attend middle school, high school, or collage, roughly 20%

drop out. In majority of the cases, they have no one to turn to and even the foster parents or home staying hosts themselves become helpless and not be involved in the programmes that help youths to reintegrate back into the society and rebuild their lives. Such social care is imperative for bringing quality personnel in future. It is important to have national policy to encourage youths to climb up the social ladder and be empowered, but the roles played by fellow civilians and NGO will reach out far and thin to provide beneficial treatment on individual basis, together with cooperative and collaborative efforts with the country, state, and the educational institutions. There is no evidence of meetings discussing development and revitalization of the local community. However, they showed interest in success stories of children on Marshall Island who faced similar problems; the programme was aimed at youths, including school dropouts, to be 'rehabilitated' and proactively engaging in social activities through music and making friends. They were also interested in Japanese Neyako system, an established and longstanding tradition found on Toushi Island. It is a youth camp system for boys above 15 with the aim to gain qualifications, be disciplined, partake in youth activities, and creates long-lasting relationships with their foster family and other enrolled boys (usually 5-7 people); this is an empowering system.

The level of developments required to bring changes cannot be only local a trial-and-error approach, but is in need of a well-experienced professional who can act as a supporter to build up achievements over the years. To bring forth cooperative developments for a social structure where the society raises its regional children, it is necessary to join forces with international NGOs and dispatch senior volunteers especially as it is the most fundamental task facing Chuuk, which is in the midst of a traditional social structure reformation.

3) Japanese Involvement and Overseas Groups

1. Overseas support and cooperation (Japan)

Japanese support groups are not lavishly but are contributing significant achievements. Japanese involvement is drastically changing in the midst of generational change and declining ex-servicemen's club meetings. Here are some cases.

Tokyo Rotary Club has been joining forces with its Chuukese counterpart and has been reaching its support to outer islands as well. Recently, 5 solar-powered salt extractors, which allow sea water to convert to both drinking water and salt, were donated and were received in the community with high praise and success. The remote islands off Chuuk lagoon each received about five machines. These outer islands are: Halls region, Nommn Ruo, One, Ululu Onan, Onoun, Pathw region, Tamamatam, Polowat, Houk, and Pollap. They have also donated towards Terakoya-style (i.e. those organized by the local residents) educational facilities, enriching them with both hard-ware and soft-ware. The Rotary Club gifted them with machineries such as computers and a New Zealander is involved providing tutorial support. We were able to visit the facility at the opening ceremony during the research period. The facility was named "Akoikoi" which is name of a bird. Opening Ceremony was held by Japan (rice cake or candy throwing as if ridgepole-raising ceremony) and Christian mix style.

There were many local residents and children present. It is located in a region where it received attention because of a problematic public order and shoreline garbage, but amidst problematic inclination introducing this new advanced system targeting the future generation will enrich and deepen the living foundation.

On a separate note regarding local rotary club activities, when we introduced donations made by Pohnpei Rotary Club, they donated handcars and welfare equipment. significance is deeper than foreign aid in that they know the ins and outs of the island and its former member is involved in creating a large-scale settled community since immigrating 100 years ago to Sohkes, and 55 years ago to Mand, Pohnpei. A local providing support for their fellow locals in itself is an aid from the social capital network.

A group from Hiroshima has been actively donating educational materials, sports goods, stationeries, etc.

The Kanagawa Prefecture Medical Association has been involved in a deep and meaningful exchange. Currently, the relative of the former traditional chief Susumu Aizawa is the chairman of the group. The benefactors have been actively supporting medical consultations and donating simple but useful medical equipment. During the research period, there were two doctors present.

Other people such as the tea ceremony group are also contributing to and supporting the development of FSM. It was started by a Kansai person who likes islands and has further aims to investigate difference between tea and kava (yangona) cultures, breeding piperaceae (pepper family) crops and providing plantation support (a plantation operated by a Japanese in Pohnpei is facing difficulties in continuing business due to aging) and be involved in its fair trade import. The supporter has started to visit Chuuk more frequently.

2. Quasi-Japanese society space and the significance of the interchange

It has been estimated that at most 40% Chuukese have Japanese ancestry on some level. This is not a strict number but even its important leaders show a strong trace. This strong ancestral link is one of the reasons for an active civilian support. It was relatively easy to find Japanese descendants in Piis, for example a farmer named Romeo Harfmann. His grandfather on the maternal side was Japanese (who passed away in Piis on 2002 October 21; born and raised on Suiyo Tol Island with Japanese mother and German father) and the paternal grandmother was Toshiko (Japanese father, Sakayama).

For a few years there have been emerging pictures of buildinga Japan-Chuuk Exchange Centre on the land owned by former village chief Susumu Aizawa. The FSM Ambassador to Japan and Chief of State Tourist Board are amongst those involved. This is the land where pioneers starting with Koben Mori had a family with a local and started becoming involved even before Japanese reign started. It soon approaches 100th anniversary of Japanese reign. It has been an important place for dried bonito production, and it was a combined fleet anchorage and received concentrated damage.

The recent economic link has dwindled to receiving periodical shipments of imported goods. On Dublon Island (Natsushima), FSM government built an ice making facility with ¥2 billion loan from Japanese government, but the facility started deteriorating

to a point when it needed a replacement, but due to lack of funds it had to make do by carrying out patches of repair work where possible, and the facility was scaled down. Its biggest user is the Chinese fishing group (120 vessels including 12 long-liners), but it has no employees locally. This merely reaches 4% of Japanese fishing. Overseas Fishery Cooperation Fund (OFCF) FSM operation manager is Kagoshima University Fishery Department alumnus, but when asked 15 years ago about its business evaluation project, it had developed its use of fishing baits, and an Okinawan fisherman was instructing stick-held dip net fishing. The most important points of the former Japanese reign was working hard together, learning together, and experiencing achievements together. These exchanges including technical instructions are as face-to-face undertakings connecting to nurturing future generation, and also in having this succeeded, promote desirable friendship.

There is a requirement to further the solidification of base for academic exchange and having research partnerships with KORDI branch, college, and enriching museum contents. There is a suitable environmental condition in place for Japanese researchers for the academic endeavour.

References

- NAGASHIMA S, (1986) Hygiene, Health Management, and Lifestyle Improvements- Lessons from Truk Island etc, *Kateika Kyoiku*, 60:13, pp.79-83.

Adoption in the changes of family, kinship, and marriage: A comparative view based on studies from Micronesia and India

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Abstract

Adoption was widespread in Oceania and has been a subject of many anthropological studies. Reviewing previous studies, first I point out that adoption customs in Micronesia can be broadly differentiated into two; one is a transfer of right over a child among the same kin and the other is that between kin and affine. The former functions as a mechanism for acquiring heirs to continue a vertical line, while the latter for compensating labour lost in marriage exchange.

Second, I consider the recent decline of adoption on Romonum. I suggest that the adoption between kin and affine might have decreased, while the marriage transaction which exchanges siblings between two families has increased. It is assumed that a long term exchange of labour between lineages (marriage followed by adoption) is replaced by an immediate exchange between families (sibling-exchange in marriage). Describing a peasant society in India, it is shown that both adoption and marriage are systems which are structured by the ways how land, labour and fertility are controlled in the society.

As for concluding remarks, I argue to see a link between adoption and marriage and to understand a change of the ways in controlling resources (land, labour, and fertility) as household politics over them. This perspective enables us not only to understand a recent change of adoption in Micronesia but to discuss it cross-culturally.

Key Words: Adoption, Sibling-exchange, Politics over household resources, Micronesia.

Introduction

This is a comparative study on adoption in the changes of family, kinship and marriage. I had a chance to visit Romonum, an island of Chuuk in Micronesia for the first time in 2011. During the interviews, I was impressed by attitudes of the people to step-relations, adoption and fosterage. After returning to my country, I came to know that adoption was widespread in Oceania and had been a subject of many anthropological studies (cf. CARROLL 1970, BRADY 1976).

In the following I will review those previous articles on adoption in Micronesia. A series of discussions have been made, but I think there are confusions about different types of adoptions motivated by different factors. Adoption customs in Micronesia can be broadly differentiated into two; one is a transfer of right over a child among the same kin and the other is that between kin and affine. The former functions as a mechanism for acquiring heirs to continue a vertical line, while the later for

compensating labour lost in marriage exchange.

Then, I will consider recent changes of adoption in Romonum island, with reference to those in a peasant society of India where I had studied for a long time (cf. NAKATANI: 2008). Giving an example from a peasant society in India, I suggest that transformation of marriage and adoption, institutions which transfer productive resources such as land and labour among different groups, will be caused by the changes of the way how productive resources are controlled in the society.

This paper, in which I try to explain adoption in terms of resource control system (land inheritance, labour organization, and marriage exchange etc.), is inspired by a GOODY's paper titled "Adoption in cross-cultural perspective" (GOODY 1969). His paper has not been discussed so much by students of Oceanic adoption, partly because his definition of adoption seems not to fit into cases in Oceania and partly because most of the studies in Oceania have engaged the solidarity or sterility debate over a factor of adoption. However, I believe that control and access over productive resources are important factors, based on which a system of family and kinship is structured.

Before examining adoption studies in Micronesia, I will give a summary of GOODY's paper. In the paper he enquired into the reasons why adoption was quite common in major Eurasia such as China and India, while it was less found in Africa. Liking the uneven distribution of adoption with other broad differences of those societies, he specified the functions of adoption. His conclusion is very suggestive in the point that the institution of adoption, he says, is related to the system of inheritance.

In a society where property is transmitted from one generation to the next by vertical inheritance, adoption is often used to provide an heir for a man's property in the shape of a direct descendant, who can continue a man's name and often his worship. In Africa where the productive system makes less intensive use of land and there is less to leave in terms of restricted resources, property is less problematic and may pass through brothers or nephews; meanwhile personal continuity is often maintained through begetting sons rather than adopting. When one's wife is barren, he may get wives by polygamy, levirate, or widow inheritance. Under these conditions, the institution of adoption has not developed, while fostering (which involves no permanent change of identity) is common to take care of orphans. He differentiated adoption from fosterage and argued that the need for heirs (and for adoption) is diminished in Africa.

Previous studies on adoption in Micronesia

Studies of adoption have ramifications that lead scholars to explore aspects of kinship, land tenure, social stratification, legal systems, and genetics. The main discussions in Micronesia, however, evolved around the relative importance of kinship and demography as variables influencing rates of adoptions. WECKLER published the first article on adoption in 1953 and pointed out that adoption practices are particularly common in the Pacific. Based on the data in Mokil island, he suggested the foremost motive for adoption is childlessness (WECKLER 1953). Following this observation, literature over reasons for adoption developed a quarter of a century later. In order to understand the context in which adoption was discussed, I will review some of those studies in different islands of Micronesia (Fig.1).

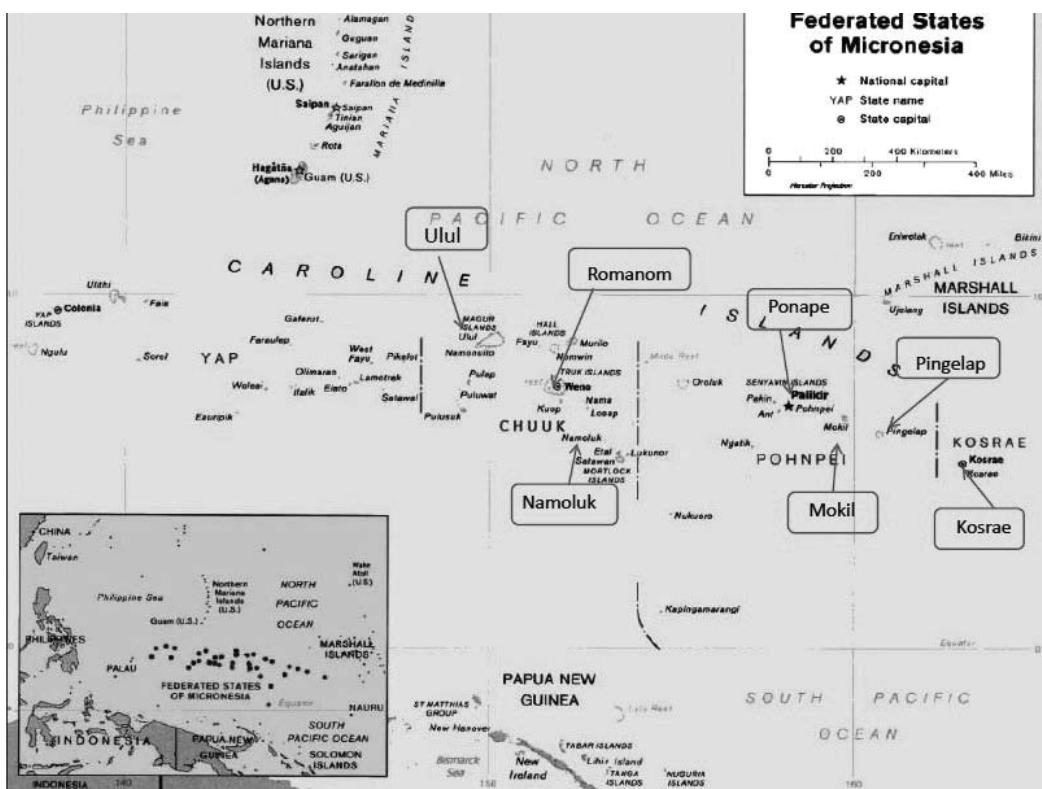


Fig. 1. Location of islands discussed in the paper.

Ruth GOODENOUGH attributed a high adoption rate on Romonum to “unevenly reduced fertility in women, most notably as a result of venereal infection, and she predicted that the rate of adoption declines in the face of more balanced fertility (GOODENOUGH 1970:337). By contrast, Marshall reported an even higher adoption rate for the Namoluk atoll, despite a more favourable fertility picture. He argued that the high rate of adoption and fosterage represent part of a larger pattern of sharing among relatives (MARSHALL 1976:47).

Looking for a single reason of adoption, some studies emphasized the sterility, while others the solidarity of kin. Little attention has been paid to the family, kinship, and marriage which are structured by the system of control and access over productive resources. Exceptionally SUDO's paper (1977), which is written in Japanese and has not been referred so much, discusses the validity of a GOODY's cross-cultural perspective for understanding adoptions in Oceania (Table 1).

Comparing seven islands mainly of Micronesia, SUDO concludes that adoption for the purpose of acquiring an heir (or heiress) is more important in the society where the size of a corporate group is smaller and lands are also privately owned by individuals. There are some societies (Ponape, Mokil, Kapigamarangi) in which adoption works as a mechanism for acquiring heirs, while in the other society (Romonum), where a corporate group is consisted of two to four generations of a matrilineage members and productive resources are collectively controlled, acquiring

Table 1. Comparisons of seven islands in Micronesia based on SUUDO (1977).

Island	Researchers	Line of Inheritance	Residence	Cooperative Group (Land ownership)	Adoption
Romonum	R.G.Goodenough(1970)	Matrilineage	Matrilocal	Matrilineage of two or three generations	There found no adoption for the purpose of acquiring a heir. Adoption never changes clan membership.
Ponape	Fisher(1970)	Matrilineage	Virilocal	Nuclear family	Adoption is related to land inheritance. A first born boy is preferred. There is a special type of adoption which plans a cohesion of different matrilineages.
Mokil	Weckler(1953)	Patrilineage	Patrilocal	Extended family	A boy is preferred for adoption. Adoption is closely related with land inheritance and practiced (within a patrilineal cohsangnine.) within a patrilineal consanguine.
Yap	Lingenfelter(1975). Sehneider(1962)	Patrilineage	Patrilocal	Extended family	Adoption involve a change of clan membership and land inheritance.
Kapingamarangi	Emory(1965)	Siblings	Uxorilocal	Sibling set of two or three generation	Adoption is based on a need to have a cross sex sibling.
Marshall	Spoehr(1949). Mason(1954)	Matrilineage	Matrilocal	Matrilineage	Adoption does not involve land inheritance and change of lineage membership.
Palau	Force and Force (1972)	Matrilineage	Virilocal	Extended family of matrilineal brothers	Adoption is a mean of contiuion of a lineage. Adoption unites distant kins.

< Table1 > Drawn by the Author based on Sudo (1977)

heirs is not problematic. In the latter society the adoption has a different purpose which cannot be explained by the descent theory (SUDO 1977: 264).

SUDO further describes the adoption custom observed in Ulul island as an example of the latter society. A first child of a couple is customarily adopted by a lineage corporate group out of which the husband married. The child is adopted in compensation for his father. He argues that this type of adoption intensifies the role of a father's lineage in a matrilineal society and that it is closely related with the system of ritual exchange between kin and affine (SUDO 1977: 278).

Recently RITTER also mentioned the two categories of adoption which need to be differentiated. He addresses himself to the diachronic aspects of adoption and argues that adoption agreements are distinguished from adoption outcomes. In Kosrae there are many cases of unrealized adoption agreements. Some adopted babies do not adjust well to new environment and return to the parents. When growing old, some make a decision to return to their natural parents for several reasons. Kosraens often says "up to them" in regard to the child's role in the termination or continuation of adoption relationship (RITTER 1981: 53).

When an adoption agreement is initiated, no one knows that the adoption relation will be successful in fulfilling the expected ideas such as using the male adopter's name, inheriting his land and acting as son or daughter in his family. Thus, adoption in Kosrae does not function as a mechanism for acquiring heirs. He points out that the analytical term adoption is used in different ways. It might refer to either adoption agreements, adoption outcomes, or current adoption relationships (many of which will eventually terminate as unsuccessful adoption). The problem of carefully defining what is meant by the term adoption is extremely important if comparisons between societies are to be meaningful. One theory might deal with the occurrence and frequency of adoption agreements, as found in the Pacific society. Another theory would be necessary to explain the frequency of adoption involving land inheritance, more complete incorporation of adoptees into the new kin identity, and permanent residence change (RITTER 1981: 59).

The distinction of adoptions suggested by Ritter resembles the different types of adoptions discussed by SUDO. According to him, the former is adoption explained by exchange theory and the latter by descent theory. These distinctions are, however, analytical categories and do not fit into a local idea. I propose to differentiate an adoption among the same kin from that between kin and affine. The former is mainly for acquiring heirs and the latter for exchanging labours. Both are concerned with how to share, exchange, and distribute productive resource (land, labour, and fertility).

The previous studies have debated the factor of adoption, but most of them have assumed that the state of childlessness is a primary condition for recipients and the donors have economic difficulties with many children. This proposition also needs to be reconsidered in the case of adoption between kin and affine. DAMES analysed the motive for giving children in adoption and argues against the notion that adoption acts as a balancing mechanism to level differences in family size in response to economic needs (DAMES 1983).

His Pingelap data show that one-third of the donor families gave up their firstborns, and that over two-thirds of the children adopted came from families with

no other child or only one child. In a patrilineal society of Pingelap, the dominant form of adoption is one by maternal grandparent. Asked about the preference for giving children in adoption to maternal rather than paternal grandparents, a chief informant of Dames tells that the daughter's husband may be asked to pay for the work of his wife by donating a child to the maternal grandparent¹. Also, in many cases unwed mothers live with their parents and divorced women return with their children to their parents. Upon marriage or remarriage, these women tend to leave their children behind to be formally adopted by the grandparents. In reviewing the role of kinship in Pingelapse adoption, Dames argues that the importance of bilaterality is evident (DAMES 1983: 338).

This type of adoption found in Pingelap is an oppositely directed transfer of a child which is observed by SUDO in matrilineal Ulul society. In both cases the purpose of adopting a child is to compensate for lost labour. The adopted child moves in another direction that his/her father in matrilocal residence or mother in patrilocal residence moved. The same type of adoption between kin and affine was observed in Romonum, too. GOODENOUGH (1970) counted 18 cases out of 57, while 28 cases are adoptions among a kin. She did not recognize a functional difference of the two because she considered a high rate of sterility among women at that time as a main cause of adoption in Romonum. However, the people of Romonum most probably knew the different function played by two types of adoption.

Recently overall rates of adoption have declined in Oceania. According to DAMES, the rate of adoption among a kin seriously declined on Pingelap to the extent that such a sample is meaningless in its small size. What does happen with the other type of adoption to compensate for labour of a person who married out? In the next section, I will make an assumption about the change of adoption in Romonum, based on a comparison with a peasant society in India.

Changes of adoption caused by the change in controlling productive resources

I interviewed to some families in Romonum about their kinship and affinal relations. Though it was a sample survey to just a dozen of families, I was surprised to find out four cases of marriage transaction which exchange siblings directly (Fig. 2).

The direct exchange of siblings is found in recent marriages after the 1990s not

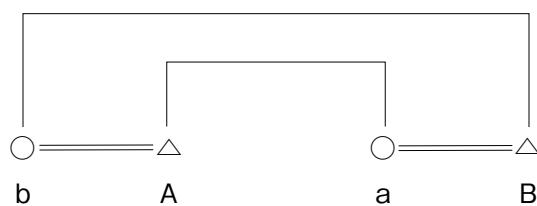


Fig. 2. Direct exchange of siblings in marriage.

¹ The same type of adoption is reported by Ritter, too from Kosrae where maternal grandparents are more likely to adopt than paternal grandparents, a phenomenon WILSON (1976: 84) found in Lelu village in 1964.

According to Ritter some people feel that the maternal grandparents should be given a child to compensate for losing their daughter(RITTER 1981: 52).

in old marriages. The increase of the sibling exchange in marriage seems to be related with the change of ways in controlling productive and reproductive resources (labour, land, and fertility of woman), because marriage transactions are a means in which households attempt to adjust labour needs, transfer property and reproduce themselves.² The adoption between kin and affine might have decreased in Romonum, while the marriage transaction which exchanges siblings between two families has increased. It is assumed that a long term exchange between lineages is replaced by an immediate exchange between families.

These changes, I guess, happened in a recent situation where a lineage solidarity and interdependence of different lineages are getting weak under the influence of modernisation. Compensating a lost labour of a man by adopting a child takes a long time until the child grows up. It is not sure that the adopted child will stay with the adoptees in the future and work for them. On the other hand, the direct sibling exchange results in a total equivalence at a shorter period between what is given and what is received. People must have preferred a short term exchange which seems to be more assured.

The discussion I proposed here cannot be attested with a lack of the empirical data which tell a present situation of adoption in Romonum. Instead, I will describe a case from a peasant society in India to show that adoption and marriage will change in accordance with changes of social systems which control productive and reproductive resources (labour, land, and fertility of woman). It helps to explain the causal link of those changes.

In a peasant society in Rajasthan, north-western part of India, the marriage of bride-service which is followed by matrilocal residence was common before the land reform in the 1950s³. Bride-service refers to the transfer of labour from the groom to the bride's family. At that time, most of land in Rajasthan was controlled by the state directly or by the feudal lords (holders of the estate given by the state). The peasant family held tenancy rights over a certain piece of land and inherited it from generation to generation. Since land was plentiful, if infertile, the most important productive resource was labour.

In getting married, a boy used to work for the girl's family for a certain period. During the pre-marital service to his in-laws, he was sometimes given a tenancy right by the girl's family or by the landlord in her village if he worked hard and was favoured by them. Then, he continued to stay in his wife's natal village after completing his service. In those days, peasants easily shifted to any village where they could get a tenancy right and daughters used to play a key role to deliver it to her husband. Thus, I found several cases of bride-service marriage with matrilocal residence among men beyond age 70 when I interviewed in 2003. However, I did not

² SCHLEGEL and ELOUL discuss that the determining factors in marriage transactions lie within household organization since it is households that give and receive partners in marriage. The marriage transactions are ways in which households attempt to adjust labour needs, transfer property, and reproduce their social status (SCHLEGEL and ELOUL 1988).

³ The data of marriage alliance among a peasant society was mainly collected in 2003 in a Rajasthan village (NAKATANI 2008).

find even a case of it among men under age 50 who got married after the land reform.

When a peasant family got a private ownership of land, the land was registered by a name of a household head and inherited by sons not by daughters. Living in the village of his wife became considered to be dishonourable, because he does not have any right over land in her village. Patrilocal residence was enforced in the peasant society. The marriage of bride-service became also unfavourable, since it does not involve a transfer of right over land.

Today, a boy marries either paying money to a girl's family (bride-price) or giving his sister instead of cash to his brother in-law (sister-exchange). The new system of adopting a son in-law as an heir has appeared for those who have no son. In this way the systems of marriage and adoption have changed. This change was mainly caused by land reform which gave private ownership of the land to its male cultivators, but at the same time, it deprived peasant women (daughters) of rights to inherit tenancy and of the chance to live in their natal places. The system of marriage and adoption had changed in a close relation with change in the way of controlling land and labour.

Concluding Remarks

In this paper, I discussed a link between a recent change of adoption and that of marriage. Describing a peasant society in India, I argued that adoption and marriage are systems which are structured by the ways how land, labour and fertility have been controlled in the society, and in which a household as a cooperative unit deals with issues of labour needs, of property inheritance, and of social and biological reproduction.

In the traditional societies in Micronesia, main productive resources of land and people were collectively controlled by each lineage cooperate. Marriage was a system to transfer human resource between lineages for reproduction and an adopted child who moves to affine was a compensation for the resource lost in marriage. The transfer of resources in adoption was not only conducted between lineages, but within a lineage. The former consolidated a tie between different lineages, while the latter consolidated solidarity of a lineage.

Recently in Micronesia, private property is getting more and more important. Even in the matrilineal society of Romonum, for example, the amount of property which is inherited from a father and owned by an individual or siblings has been increasing, while some of compounds and houses are still collectively owned by a matrilineage group. There has been a tendency in which a unit of controlling resources is getting smaller. It resulted in an increase of sibling exchange in marriage and a decreasing of adoption in Romonum. Adoption, a long term exchange of labour between lineages is replaced by sibling exchange in marriage, a short term direct exchange of labour between families.

A reviewing of previous studies made clear firstly that there are two types of adoptions in Micronesia; one is adoption among a kin for acquiring heirs and the other is adoption between kin and affine for exchanging labour. Secondly it was discussed that the former type of adoption is explained by a descent theory and the latter by a system of exchange and distribution. However, both types of adoptions and their changes, I argue, can be understood by a perspective which sees them as politics of

household over resources. Adoption among a kin is a mean for controlling recourse vertically while adoption between kin and affine and marriage of sibling exchange are both means for controlling resources horizontally. Empirical analysis on changes of adoption custom and on household politics over resources in Romonum will be a research subject in the future.

Bibliography

- BRADY I. 1976 (ed.) *Transactions in Kinship: Adoption and Fosterage in Oceania*. ASAO Monograph No.4. Honolulu: University Press of Hawaii.
- CARROLL V. 1970 (ed.) *Adoption in Eastern Oceania*. ASAO Monograph No.1. Honolulu: University Press of Hawaii.
- DAMAS D. 1983 "Demography and Kinship as Variables of Adoption in the Carolines," *American Ethnologist*, 10(2): 328-344.
- GOODENOUGH R. G. 1970 "Adoption on Romonum, Truk" In Carroll (ed.) *Adoption in Eastern Oceania*. ASAO Monograph No.1. pp.314-40. Honolulu: University Press of Hawaii.
- GOODENOUGH W. H. 1974 "Changing Social Organization on Romonum, Truk, 1947-1965." In ROBERT J. S. (eds), *Social Organization and the Applications of Anthropology*. Cornell University Press.
- GOODY J. 1969 "Adoption in Cross-Cultural Perspective" *Comparative Studies in Society and History*, 11(1): 55-78.
- MARSHALL M. 1976 "Solidarity or Sterility? Adoption and Fosterage on Namoluk Atoll." In Ivan Brady (ed.) *Transactions in Kinship: Adoption and Fosterage in Oceania*. ASAO Monograph No.4. pp.28-50. Honolulu: University Press of Hawaii.
- NAKATANI S. 2008 "Politics of women's labour and reproductive power" In *Negotiating Social Changes: Ethnography of a Rajasthan Village* (in Japanese), Ph.D dissertation submitted to Kanazawa University,
- RITTER P. L. 1981 "Adoption on Kosrae Island: Solidarity and Sterility," *Ethnology*, 20: 45-62.
- SCHLEGEL A. and ROHNE. 1988 "Marriage Transactions; Labor, Property, and Status," *American Anthropologist*, 90(2): 291-309.
- SUDO K. 1977 "Adoption Customs in Micronesia" (in Japanese), *Bulletin of the National Museum of Ethnology*, 2(2): 245-81. Osaka: National Museum of Ethnology.
- WECKLER J. E. 1953 "Adoption on Mokil," *American Anthropologist*, 55(4): 558-568.

Socio-economic influence of overseas Filipino workers in the Federal States of Micronesia

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Abstract

The economy of the Philippines heavily depends on overseas workers. The major destinations and dominance of simple labor has not changed in the last 30 years. However, the destinations have been more diversified. And the professional jobs are more dominant in some countries. The paper discusses a case by illustrating the situation in the Federal States of Micronesia. The economy of this country is called MIRAB, which means the economy depending on migration, remittance and bureaucracy. The paper shows that the result of this economy has not brought around the development of the private sector but, rather, frustration. The paper concludes that the increasing number of Filipino workers will heighten the stressful nature of the society.

Keywords: FSM, Philippines, overseas workers

Introduction

Globalization of goods, capital and labor is taking place among developing countries as well as among advanced countries. This paper focuses the growing presence of the Philippines in the Federal States of Micronesia (FSM). It shows the trend with statistical data of the government, and it also tries to figure out the socio-economic influence of this relatively new phenomena.

Growing presence of the Philippines in the FSM economy Overseas workers as a national policy

The Philippine government has been promoting the increase of overseas workers as a policy in order to get more foreign currency since 1982 when it launched the Philippine Overseas Employment Authority (POEA). POEA is aimed to protect the human rights of the Filipino overseas workers as well as accelerate the numbers of the workers abroad. According to the government statistics, the number of Filipino overseas workers in 2008 was 8, 19 million, which was nearly 10 % of the total population. The POEA statistics in 2010 shows the characteristics of the Filipino overseas workers. The main destinations are Saudi Arabia, UAE, Hong Kong and Qatar. The popular kinds of jobs are different between men and women. While maids, caretakers and cleaners are dominant for women, cleaners and construction workers are leading for men. This trend of main destinations and popular kinds of jobs has not basically changed since the 1980's up to now. However, there are also several new

phenomena taking place. Firstly, the destinations are becoming more diversified to all over the world, such as Oceania and Africa. Secondly, some of the destinations are developing countries where the average wage level is as low as the Philippines. The paper discusses the case of FSM as this new trend of overseas Filipino workers. It tries to analyze the impact of it on the FSM as well as on the Philippines.

Overseas workers and trade of the Philippines in FSM

According to POEA, the number of Pilipino workers has increased recently since 2006 to 2010 (Fig. 1). The same trend can be read off from the FSM government data (Fig 2). It shows the total estimated number of Filipino workers, which are non-tourists visitors to the FSM. Filipinos are the second largest number of workers to Americans. Table 1 shows the kind of jobs of the 135 Pilipino workers based on POEA statistics. It is noteworthy that there are no maids and cleaners which are more common in other countries. On the other hand there are many professional workers such as foremen in construction sites (6), technicians (4), and accountants (4).

Imports from the Philippines to the FSM are also increasing. Figure 3 shows the growth rate of imports from the main countries between 2000 and 2006. It shows that imports from the USA, Japan and Guam stayed at almost the same level, but that from the Philippines is growing rapidly, as well as Singapore. More detailed statistical analysis is necessary in order to understand this trade structure, but the author found that the importance of products in the FSM markets were of great importance by simple field research. Table 2 shows the origin of the 89 items sold in a FSM supermarket. It indicates that the USA (45) and Japan (11) were more dominant, but the Philippines (7) was ranked close to them. One of the accountants of the supermarket was a Filipino. We can infer that the increasing number of Filipino workers will promote the importation of Filipino products.

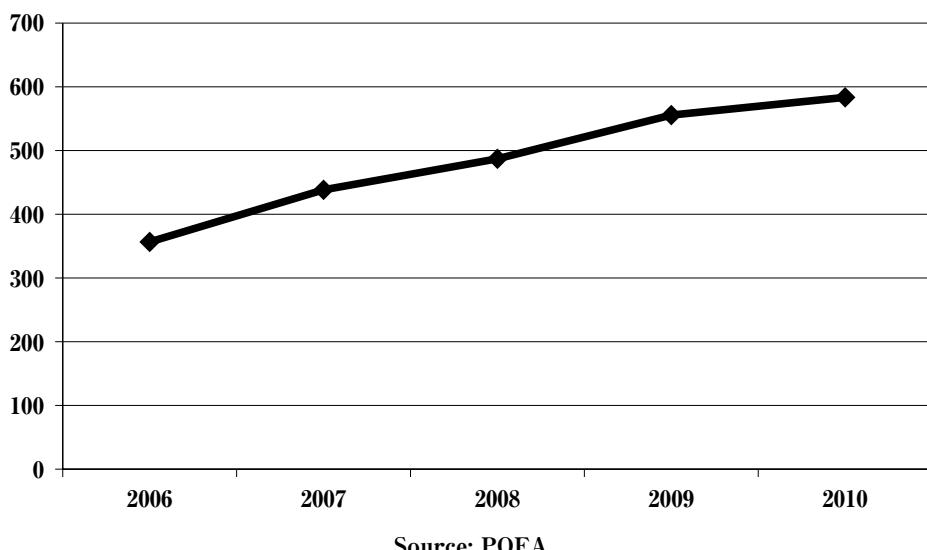
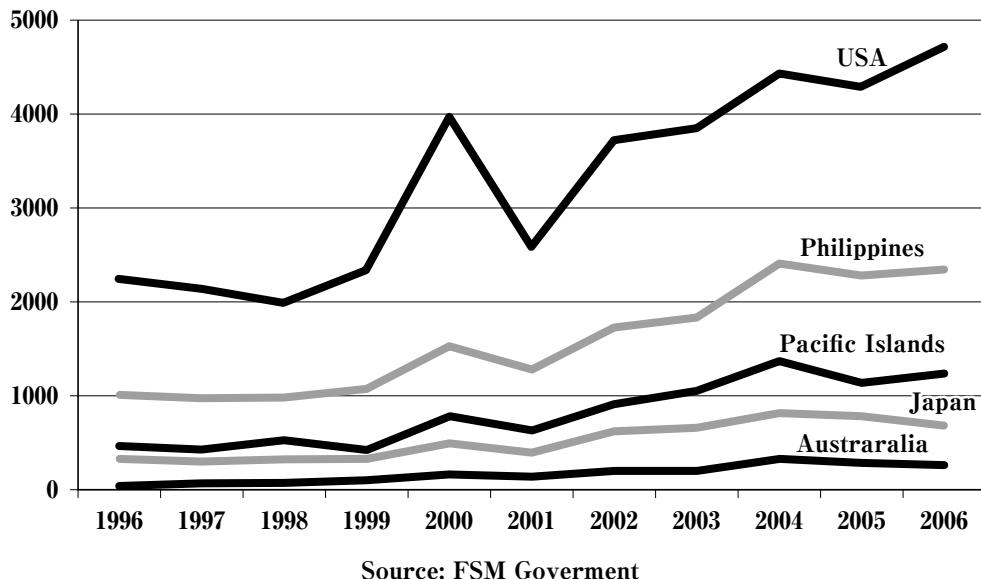


Fig. 1 Philipino overseas workers in FSM.



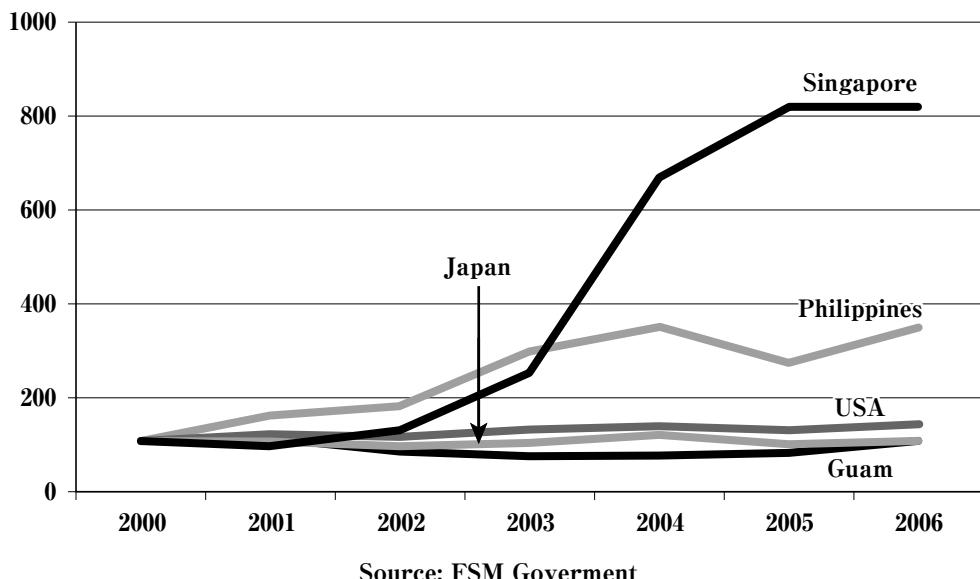
Source: FSM Government

Fig. 2. Non-tourists visitors to FSM.

Table 1 Philipino overseas workers in FSM by skills.

skill	number
Production and related workers transport equipment operations and laborers	99
Carpenters, joiners and parquetry workers	20
Bricklayers, stonemasons and tile setters	14
Supervisor production and general foremen	5
Others	60
Professional technical and related workers	19
Engineers civil	4
Accountants	4
Architects and town planners	2
Pharmacists	2
Others	7
Clerical and related workers	7
Maschine operators automatic/ electronic data	2
Clerks stock	2
Others	3
Sales workers	5
Managers (whole sale and retail trade)	2
Supervisors sales	2
Salesmen technical and service advisors	1
Administrative and managerial workers	2
Manager general	2
Service workers	3
Cooks and related workers	3
Total	135

Source: POEA



Source: FSM Goverment

Fig. 3 Growth rate of export to FSM by main countries (year 2000 = 100).

Table 2 Origin of items sold in a supermarket (weno city, Chuuk state, FSM, 2011 August 3).

items (89)								items(89)			
rank	canned foods	59	rank	seasonings	9	rank	sweats	21	rank	total	89
1	USA	39	1	Japan	4	1	China	6	1	USA	45
2	Australia	6	2	Philippines	2	2	USA	4	2	Japan	11
3	Philippines	4	3	USA	2	3	Japan	3	3	Philippines	7
3	Japan	4	4	China	1	4	Taiwan	2	3	China	7
5	Thailand	2				5	Canada	2	5	Australia	6
6	Korea	1				6	Indonesia	2	6	Taiwan	3
6	Taiwan	1				7	Philippines	1	7	Canada	2
6	Poland	1				8	Hong Kong	1	7	Indonesia	2
6	Malaysia	1							7	Thailand	2
									10	Korea	1
									10	Hong Kong	1
									10	Poland	1
									10	Malaysia	1

FSM economy: MIRAB economy and stress of men

FSM consists of four states, or Yap, Chuuk, Pohnpei, and Kosrae. The population is around 110 thousand. It used to be a UN Trust Territory and it became independent in 1979. It has a strong relationship with the USA through the Compact of Free Association. While it allows the USA free access to its territory, it is receiving a huge amount of the compact grant. The present compact grant is scheduled to continue to 2023. Figure 4 shows that 43% of the government revenue depended on compact grant in 2006. This bloated public sector is contributing a lot to infrastructure, education, community development in the islands and so on. However, the provision of basic education does not necessarily lead to the development of the public sector. It has just enlarged the inefficient public sector. Figure 4 illustrates the unemployment rate and percentage of labor force in subsistence economy in 1994 and 2000. The unemployment rate has increased from 16.3% to 22%, and the subsistence economy has augmented from 22.6% to 28.4%. It can be said that more than 50% percent of the working population were not employed in 2000, which means the country is going back to the non-market economy from the viewpoints of its labor market.

This crooked economic system is sometimes called the MIRAB economy. It means that the economy heavily depends on Migrants' Remittance and Aids from the USA and other countries, and consequently the public sector or Bureaucracy is extremely enlarged while the private sector stays undeveloped. Regarding the MIRAB economy, there are both positive and negative views among researchers. Brazys (2010) insists that influx of the compact grant increased the relative price in FSM and it entails the potential of export competitiveness. He resembles the situation as 'Dutch disease,' which was brought around by export of newly discovered oil in the country in the 1980's. Holland had a difficult time to export its industrial products because of its own strong currency caused by oil money. Cassels (2006) claims that the rapid growth of foreign currencies led to the import of processed food, and eventually the local

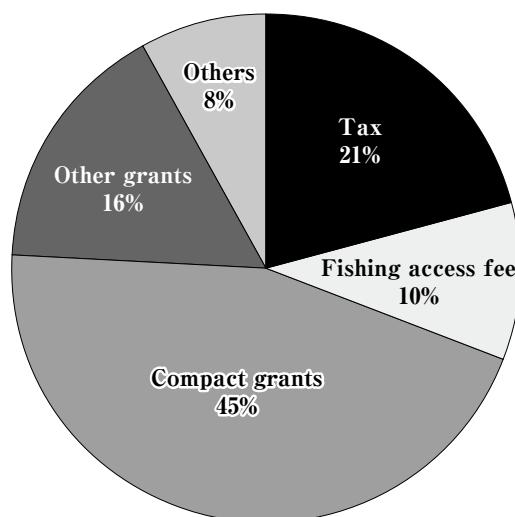


Fig. 4 Composition of revenue (2006). Source: FSM government.

Table 3 Unemployment rate and subsistence economy rate in FSM (1994 and 2000) (%).

	1994	2000
Unemployment rate	16.3	22.0
Percent of labor force in subsistence	22.3	28.4

Source: FSM government

diet was changed to unhealthy market food, which was one of the reasons for the increasing number of people with obesity and other adult diseases. On the other hand, Ware (2005) maintains that the freer access to the US labor market contributed a lot to lessen the dispute over the land and thus minimized the social tension. Naylor (2002) sees the role of imported processed food. He appreciates its role as a buffer to the vulnerable eco-system based on the mangrove forests. The view of Cook (1998) contrasts to that of Brazys. He claimed that there was no statistical evidence that the public sector had crowded out the private sector. He inferred that the reasons for the undeveloped public sector should be explored in other contexts.

Influence of growing Filipino presence on the FSM socio-economy

If the whole structure of the present situation continues, a more negative scenario will be put into place. The decline of the MIRAB economy caused by the compact grant cut will force to scale down the bloated bureaucracy. The people in the FSM will have a more difficult time to find jobs in the public sector. Moreover, the influx of Filipino workers will reduce the chances of the local people to the job market in private sector. Especially, males in the FSM will have more frustration mixed with the traditional female dominant family structure. Figure 5 illustrates the unemployment rate of men and female in 1994 and 2000. While the rate of men increased rapidly from 10.7% to 20.7%, that of women slightly dropped from 26.9% to 23.6%. It is likely that the spread of public education has contributed a lot to lessen the gap between males and females in job hunting. However, it also means that the stress of men has been amplified. The stress has led to a different kind of social problem of men, such as high suicide rate (Hazel 1991), violence and crimes (Oneisom 1991a), mental disease (Hezel and Lightfoot 2005) and abuse of illegal drugs such as marijuana (Oneisom 1991b).

When we conducted research on a small island in Chuuk, we observed a lot of social problems to prove the negative scenario. Many houses and public buildings were broken partially or totally. Some houses were covered with graffiti painted with spray cans. Figures 6 and 7 show how much the islanders are frustrated. The ice cube plant was built by JICA (Japan International Cooperation) planning to provide ice for the fishermen who carry the fish to sell by boat in the market. We are not sure for the reason, but for some reason the building was targeted by the frustrated islanders. The walls were broken and the inside was painted with graffiti with a spray can. It is safe to say that some islanders are stressed and small or big social problems easily lead to violence. We have also observed that some young men who smoke marijuana in the middle of the day. We felt like we were in a global city full of crime. Essentially,

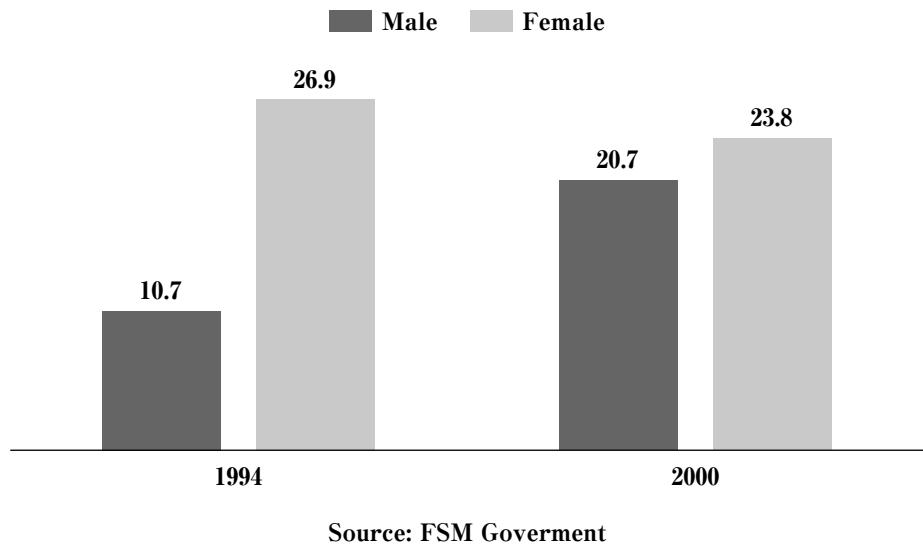


Fig. 5 Unemployment of male and female (1994, 2000).



Fig. 6 A broken JICA ice plant.



Fig. 7 A broken JICA ice plant (inside the plant).

it is a small pacific island with only a few hundred people.

If the FSM is not capable of increasing the number of overseas workers or the people are not willing to work abroad, it needs to launch a kind of inward economy strengthening policies which accompanies the tighter migrant regulation. It is easy to say but difficult to carry out.

Acknowledgement

I would like to express my deep gratitude to the people in Chuuk state who are truly supportive to our field research. I would also thank Research Center for the Pacific Islands, Kagoshima University which has funded my research and provided me the basic information and viewpoints. Without the help of them, it would be more difficult to carry out this study.

References

- BRAZYS S. (2010) Dutch Disease in the Western Pacific: an overview of the FSM economy under the Amended Compact of Free Association, PACIFIC ECONOMIC BULLETIN, Vol. 25, No. 3, pp. 24-39.
- CASSELS S. (2006) Overweight in the Pacific: links between foreign dependence, global food trade, and obesity in the Federated States of Micronesia, GLOBALIZATION AND HEALTH, 2:10.
- COOK P. and KIRKPATRICK C. (1998) Labor market adjustment in small open economies: The case of Micronesia, WORLD DEVELOPMENT, vol. 26, no. 5, pp. 845-855.

- HEZEL F. X. S.J. (1991) What Can We Do to Prevent Suicide? *Micronesian Counselor*.
- HEZEL F. X. S.J. and LIGHTFOOT C. (2005) The Myths of Economic Development in the FSM, *Micronesian Counselor*.
- ONEISOM I. I. (1991a) Chuuk's Violence: Then and Now, *Micronesian Counselor*.
- ONEISOM I. I. (1991b) Marijuana in Chuuk *Micronesian Counselor*.
- NAYLOR R. L., BONINE K.M., EWEL K.C. and WAGUK E. (2002) Migration, markets, and mangrove resource use on Kosrae, Federated States of Micronesia, AMBIO, vol. 31, no. 4, pp. 340-350.
- WARE H. (2005) Demography, migration and conflict in the Pacific, JOURNAL OF PEACE RESEARCH, vol. 42, no. 4, pp. 435-454.

Statistics

- 2005 FSM Statistical Yearbook, FSM National Government.
- Household Income and Expenditure Survey Analysis Report FSM 2005, FSM.
- International Trade Publication FSM 2004, FSM National Government.

Web pages

- CIA (USA) <http://www.doi.gov/oa/Islandpages/fsmpage.htm>
- Division of Statistics, FSM <http://www.spc.int/prism/country/fm/stats/>
- POEA (2010) *Overseas Employment Statistics 2010* http://www.poea.gov.ph/stats/2010_Stats.pdf

Mosquitoes collected on Weno Island, Romonum Island and Piis Island, Chuuk State, Federated States of Micronesia (Diptera: Culicidae)

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Abstract

Mosquito larval surveys were carried out on Weno Island, Romonum Island and Piis Island in August 2011. Larvae were collected from 133 natural and artificial habitats. A total of 1,761 larvae belonging to nine species including one unidentified species were collected. On Weno Island, eight species, *Aedes hensilli*, *Ae. albopictus*, *Ae. lamelliferus*, *Aedes* sp., *Culex quinquefasciatus*, *Cx. carolinensis*, *Cx. annulirostris* and *Lutzia vorax*, were collected. On Romonum Island, four species, *Ae. scutoscriptus*, *Ae. hensilli*, *Cx. quinquefasciatus* and *Cx. carolinensis* were collected. On Piis Island, six species, *Ae. scutoscriptus*, *Ae. hensilli*, *Aedes* sp., *Cx. quinquefasciatus*, *Cx. carolinensis* and *Cx. annulirostris*, were collected. Distributions of *Ae. hensilli* and *Ae. albopictus* were confirmed in this survey. To prevent the outbreak of dengue fever, environmental management should focus on the destruction, alternation, disposal or recycling of containers that produce the greater number of adult *Aedes* mosquitoes.

Key words: *Aedes hensilli*, *Aedes albopictus*, mosquito fauna, Chuuk State, Federated States of Micronesia

Introduction

It is a well-known fact that major vectors for dengue fever and dengue hemorrhagic fever are *Aedes aegypti* and *Ae. albopictus* in urban areas of Southeast Asia and in the Western Pacific Region (WHO, 1995). SAVAGE *et al.* (1998) reported a dengue fever outbreak in Yap State between June and July 1995 caused by dengue-type-4 virus. After this outbreak of dengue fever, it was also reported in 2004, 2007 and 2011 in Yap State. Entomological investigations implicated the native mosquito species, *Ae. hensilli*, as vector of dengue virus (SAVAGE *et al.*, 1998; NODA *et al.*, 2005). There is a possibility of outbreak of dengue fever in other states of Federated States of Micronesia. However, there is a little information for vector mosquito species. To know the geographical distribution of vector mosquitoes, entomological surveillance was carried out on Weno Island, Romonum Island and Piis Island, Chuuk State, Federated States of Micronesia. This report describes a survey of mosquito fauna and breeding sites of mosquitoes.

Materials and Methods

Mosquito larval surveys were carried out on Weno Island, Romonum Island and Piis Island in August 2011, Chuuk State, Federated States of Micronesia (Fig. 1). Weno

Island is the capital and commercial center of Chuuk. At just over 18km², it is the second largest island in the lagoon. Tropical forests make up much of the interior, with the highest point, the 370m Mt. Tonoken, nearly in the center. Romonum Island is also located in the lagoon, and it is less than 1 km². Piis island is located on the atoll ring reef, and it is also less than 1 km².

Larval collections were made at 133 habitats in Weno Island (86 habitats), Romonum Island (21 habitats) and Piis Island (26 habitats). The habitats are composed of coconut shells, rock pits, tree hole, banana stumps, wells, puddles, taro fields and artificial containers such as concrete puddles, plastic water barrels as well as discarded drink cans, glass containers, plastic containers, rubber containers, metal containers, buckets, plastic bags, pans, tires, freezer, washing machine and track loading platform, and the collections were made with a pipet and dipper. Collected larvae were preserved in 70% ethanol, and some larvae were reared to the adult stage.

Identification of the larvae and adults was made by using the keys and descriptions of BOHART (1957) and BOHART and INGRAM (1946). And, the classification of the species belonging to the genera *Lutzia* follows that of TANAKA (2003).

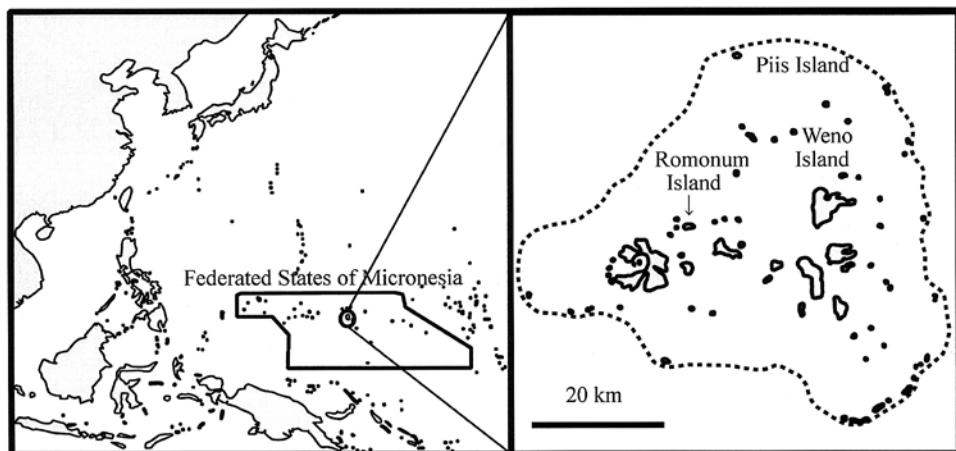


Fig. 1 Map of Chuuk Atoll. Mosquito larval surveys were carried out on Weno Island, Romonum Island and Piis Island.

Results

On Weno Island, a total of 1,180 larvae belonging to eight species including one unidentified species were collected at 86 natural and artificial habitats. They were identified as *Aedes hensilli*, *Ae. albopictus*, *Ae. lamelliferus*, *Aedes* sp., *Culex quinquefasciatus*, *Cx. carolinensis*, *Cx. annulirostris* and *Lutzia vorax* (Table 1). Among them, *Cx. carolinensis* was the most predominant species collected (656 larvae, 41 habitats) followed by *Ae. hensilli* (318 larvae, 44 habitats). *Ae. albopictus* was collected from discarded containers along the main road.

On Romonum Island, a total of 204 larvae belonging to four species were collected at 21 natural and artificial habitats. They were identified as *Ae. scutoscriptus*, *Ae. hensilli*, *Cx. quinquefasciatus* and *Cx. carolinensis* (Table 2). Among them, *Ae. scutoscriptus* was the most predominant species collected (99 larvae, 11 habitats).

Mosquitoes collected on Weno Island, Romonum Island and Piis Island, Chuuk State, Federated States of Micronesia (Diptera: Culicidae)

Table 1. Numbers of mosquitoes and their habitat types collected in Weno Island, Chuuk State, Federated States of Micronesia.

	Number collected	Number of habitat *	Habitato types (No. of habitat)
<i>Aedes hensilli</i>	318	44	Coconut shells (14), Drink cans (9), Glass containers (4) Plastic bag (1), Plastic containers (9), Metal container (1) Bucket (1), Tires (3), Freezer (1), Plastic water barrel (1)
<i>Aedes albopictus</i>	41	10	Coconut shells (2), Drink cans (5), Plastic container (1) Rubber container (1), Tire (1)
<i>Aedes lamelliferus</i>	11	1	Coconut shell (1)
<i>Aedes</i> sp.	1	1	Coconut shell (1)
<i>Culex quinquefasciatus</i>	72	6	Coconut shells (3), Pan (1), Tire (1), Washing machine (1)
<i>Culex carolinensis</i>	656	41	Coconut shells (18), Drink cans (7), Plastic containers (6) Rubber container (1), Bucket (1), Tires (8)
<i>Culex annulirostris</i>	80	6	Drink can (1), Glass container (1), Bucket (1) Concrete puddle (1), Track loading platform (1), Taro field (1)
<i>Lutzia vorax</i>	1	1	Drink can (1)

* Total number of habitat is 86.

Table 2. Numbers of mosquitoes and their habitat types collected in Romonum Island, Chuuk State, Federated States of Micronesia.

	Number collected	Number of habitat *	Habitato types (No. of habitat)
<i>Aedes hensilli</i>	23	4	Coconut shell (1), Drink can (1), Rock pits (2)
<i>Aedes scutoscriptus</i>	99	11	Coconut shells (2), Banana stumps (2), Drink can (1) Glass container (1), Rock pits (2), Plastic containers (3)
<i>Culex quinquefasciatus</i>	16	3	Coconut shell (1), Glass container (1), Well (1)
<i>Culex carolinensis</i>	66	4	Coconut shell (1), Glass container (1) Pan (1) Plastic water barrel (1)

* Total number of habitat is 21.

Table 3. Numbers of mosquitoes and their habitat types collected in Piis Island, Chuuk State, Federated States of Micronesia.

	Number collected	Number of habitat *	Habitato types (No. of habitat)
<i>Aedes hensilli</i>	82	8	Coconut shells (4), Drink cans (3), Pan (1)
<i>Aedes scutoscriptus</i>	65	10	Coconut shells (5), Drink can (1), Banana stump (1) Tree hole (1), Plastic containers (2)
<i>Aedes</i> sp.	17	2	Well (1), Taro field (1)
<i>Culex quinquefasciatus</i>	59	3	Tree hole (1), Concrete puddle (1), Puddle (1)
<i>Culex carolinensis</i>	105	7	Coconut shells (4), Drink can (1), Taro fields (2)
<i>Culex annulirostris</i>	49	3	Puddle (1), Taro fields (2)

* Total number of habitat is 26.

On Piis Island, a total of 377 larvae belonging to six species including one unidentified species were collected at 26 natural and artificial habitats. They were identified as *Ae. scutoscriptus*, *Ae. hensilli*, *Aedes* sp., *Cx. quinquefasciatus*, *Cx. carolinensis* and *Cx. annulirostris* (Table 3). Among them, *Cx. carolinensis* was the most predominant species collected (105 larvae, 7 habitats) followed by *Ae. hensilli* (82 larvae, 8 habitats).

Discussion

In this survey, a total of 1,761 larvae belonging to nine species including one unidentified species were collected at 133 natural and artificial habitats. Five *Aedes* species were collected and *Ae. hensilli* was most abundant *Aedes* species in Weno Island and Piis Island, and also distributed in Romanom Island. *Ae. hensilli* is a main vector of dengue fever in Yap State (SAVAGE *et al.*, 1998; NODA *et al.*, 2005). In Weno Island, *Ae. albopictus*, which is a one of the major vectors of dengue fever, was also collected. Therefore, these islands seem to be highly dengue-sensitive areas. The exact house index (No. of houses positive for vector species / No. of houses inspected x 100%) was not examined in this survey. The house index may be more than 50. Mosquito surveys were carried out only on three islands of Chuuk lagoon. The mosquito distribution and density seem to be the same situation in other islands of Chuuk lagoon.

Aedes species lay eggs in practically all types of man-made containers, and also in some natural containers. Fig. 2 shows typical habitats for *Ae. hensilli*. Generally, the *Aedes* adults will be found around 50 meters from the breeding sources with a maximum flight distance of around 200 meters. To prevent the outbreak of dengue fever, environmental management should focus on the destruction, alternation, disposal or recycling of containers that produce the greater number of adult *Aedes* mosquitoes.

Weno Island is the main island, and the district center, government offices and

Mosquitoes collected on Weno Island, Romonum Island and Piis Island, Chuuk State, Federated States of Micronesia (Diptera: Culicidae)



Fig. 2 Typical habitats for *Aedes hensilli* and *Aedes albopictus* (A: Coconut shell, B: Drink can, C: Glass container, D: Plastic container, E: Metal container, F: Tire).

airport are on the northwest side. Many people visit Weno Island from other islands for work, trade, shopping and other purposes. The northwest side of Weno Island is a very busy place. Fig. 3 shows the lump of the throw-away dust along the main street of Weno Island. *Aedes* larvae were often collected from artificial containers of throw-away dust. Unfortunately, the northwest area is highly dengue-sensitive. A patient infected with the dengue virus will arrive at this site from other states or countries, and may become the source of outbreak of dengue fever. As there was an outbreak of dengue fever in Palau, Yap and Majuro in 2011, an approach should be employed to reduce the potential for *Aedes* mosquitoes to breed in this area.



Fig. 3 The lump of the thrown-away dust along main street of Weno Island.

Acknowledgments

This work was supported by the Japan Society for the Promotion of Science (Project No. 22510271)

References

- ASHFORD D. A., SAVAGE H. M., HAJJEH R. A., McREADY J., BSRTHOLOMEW D. M., SPIEGEL R. A., VORNDAM V., CLARK G. G. and GUBLER D. G. 2003. Outbreak of dengue fever in Palau, Western Pacific: risk factors of infection. Am. J. Trop. Med. Hyg., 69: 135-140.
- BOHART R. M. 1957. Insect of Micronesia Diptera: Culicidae. Bernice P. Bishop Musium, Insect of Micronesia, 1956 (12): 1-85.
- BOHART R. M. and INGRAM R. L. 1946. Mosquitoes of Okinawa and Islands in the Central Pacific. U. S. Navmed., 1055: 1-110.
- NODA S., GILMATAM J., OGINO K., TOMA T. and MIYAGI I. 2005. Mosquitoes collected on Yap Islands and Ulithi Atoll, Yap State, Federated States of Micronesia (Diptera: Culicidae). Med. Entomol. Zool., 56: 349-353.
- SAVEGE H. M., FRITS C. L., RUTSTEIN D., YOLWA A., VORNDAM V. and GUBLER D. J. 1998. Epidemic of Dengue-4 virus in Yap State, Federated States of Micronesia, and implication of *Aedes hensilli* as an epidemic vector. Am.J. Trop. Med. Hyg., 59: 519-524.
- TANAKA K., 2003. Studies of the pupal mosquitoes of Japan (9). Genus *Lutzia*, with establishment of two new subgenera, Metalutzia and Insulalutzia (Diptera, Culicidae). Jpn. J. Syst. Entomol., 9: 159-169.
- WHO 1995. Guidelines for Dengue Surveillance and Mosquito Control. 104 pp., World Health Organization, Geneva.
- WHO 1997. Dengue Haemorrhagic Fever; Diagnosis, Treatment, Prevention and Control, 84 pp., World Health Organization, Geneva.

Use of *Capsicum frutescens* in Weno, Romanum, and Piis islands, Chuuk Atoll, Federated States of Micronesia

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Abstract

The local nomenclature and usage of *Capsicum* in Weno, Romanum, and Piis islands, Chuuk Atoll, Federated States of Micronesia (FSM), were surveyed to investigate the relationship between people and *Capsicum* with a focus on dispersal routes, ethnobotany, and food security. Two species of *Capsicum*, *C. annuum* and *C. frutescens*, are cultivated in Chuuk Atoll, but *C. frutescens*, especially the green type, is a common seasoning in the daily diet of locals and has become an important and indispensable condiment. *Capsicum* peppers are called “*mwik (mwiik)*” in Chuuk Atoll, which is of unknown origin. People used *C. frutescens* in various ways: as a condiment (fresh fruits and fruits soaked in the water of mature coconuts), vegetable (leaves), and medicine (fruits and/or seed for treating toothaches, fruits for eliminating the stomach parasite known as “*nikanipwun*”, roots for an ointment to treat skin wounds, fruits for treating sick domestic fowl, and fruits for boosting energy of gamecocks after fighting). However, with modernization, residents of Chuuk Atoll have been eating fewer *C. frutescens* leaves in recent years. The FSM has faced serious public health problems due to a new diet and other lifestyle changes especially from the 1980s, and the government, non-governmental organizations, and many researchers have attempted to promote a return to local foods because of their higher carotenoid and vitamin contents compared to modern foods. On small islands and atolls, imported foods and medicines may not arrive for more than a month if a typhoon or an oil crisis occurs. Therefore, for food security, it is imperative to re-discover plants already naturalized on each island. From this perspective, an important candidate plant is *C. frutescens*, which can serve not only as a spice but also as a vegetable rich in carotenoids and vitamins. *Capsicum frutescens* has long been naturalized in these regions; therefore, it does not need to be cultivated and its fruits and leaves can be harvested throughout the year. To improve public health on Pacific islands, there should be renewed focus on plants that are already naturalized on each island.

Keywords: dispersal routes, ethnobotany, leaves as vegetable, local food, medicinal use, naturalized plants

Introduction

Capsicum peppers, consisting of approximately 25 species belonging to the Solanaceae family, are native to both tropical and temperate regions of the Americas (ESHBAUGH 1993). *Capsicum frutescens* is a semi-domesticated species characterized by

seed dormancy, small fruit size, deciduous fruit, and the inhibition of flowering under prolonged illumination (YAMAMOTO and NAWATA 2006, 2009b, YAMAMOTO *et al.* 2007, 2008). It is widely distributed throughout the tropical and subtropical regions of the world.

Capsicum was introduced to Europe from the New World in 1493 by Columbus (BOSWELL 1949). After spreading through European countries in the early sixteenth century, *Capsicum* was introduced to Asia in the late sixteenth century (ANDREWS 1995, KUMAZAWA *et al.* 1954, STURTEVANT 1885) and into Oceania during the early European era (WHISTLER 1992a). However, its detailed dispersal routes remain unknown. Many varieties of *Capsicum annuum* have been produced and distributed around the world, making it difficult to reconstruct its dispersal routes, whereas numerous local varieties of *C. frutescens* still exist in Asia and Oceania. YAMAMOTO and NAWATA (2004, 2005, 2009a) and YAMAMOTO *et al.* (2011) studied the distribution and dispersal routes of *C. frutescens* in Southeast and East Asia and found that accessions from the Ryukyu Islands in Japan have a rare isozyme pattern, known as shikimate dehydrogenase phenotype B (ShDH-B), and that this phenotype is distributed throughout Taiwan, the Batanes Islands in the Philippines, Indonesia, Vanuatu, and Ecuador, but not in continental Southeast Asia. The authors postulated that this phenotype was introduced to the Philippines from the Americas via Oceania by the Manila galleons (Spanish trading ships) in the mid-sixteenth century through to the early nineteenth century, and thereafter dispersed into insular regions of Southeast and East Asia. To further elucidate the dispersal and distribution of *C. frutescens*, it is necessary to survey the distribution of the ShDH-B phenotype in Oceania. However, very few accessions of *Capsicum* have been collected from Oceania partly due to its geography, which makes it difficult to access.

The Federated States of Micronesia (FSM) consists of four states (Yap, Chuuk, Pohnpei, and Kosrae, from west to east) composed of approximately 600 small islands, which amounts to only approximately 700 km². However, the FSM is spread over more than 2,600,000 km² of the Pacific Ocean and spans approximately 2,500 km from east to west. The FSM is considered to be one of the best regions for studying the hypothetical dispersal routes of *C. frutescens*, from the Americas via Oceania to Asia, because it lies along one of the routes used by the Manila galleons and spans many degrees of longitude between Southeast Asia and the Americas. However, there is very little information on *Capsicum* in the FSM, except for that published in a recent study conducted in Pohnpei State (YAMAMOTO 2011).

In the 1950s, people in the FSM still ate a “traditional” diet (MURAI 1954), but this began to be replaced by a modern diet rich in rice, flour, sugar, fatty foods, and other imported, processed foods after the United States Department of Agriculture started its supplementary feeding program in the 1960s (ENGLBERGER *et al.* 2003). This phenomenon accelerated after a Compact of Free Association was signed between FSM and the United States in 1986 (HEZEL 2004). Since then, FSM has faced serious public health problems due to this new diet and other lifestyle changes, and the government, non-governmental organizations (NGOs), and many researchers have attempted to promote a return to local foods because of their higher carotenoid and vitamin contents compared to modern foods (*e.g.*, ENGLBERGER *et al.* 2008, 2009). Even

though *Capsicum* did not originate in the FSM, it has been cultivated and consumed there for about 400 years and thus it is reasonable to consider it a traditional local food. Although the fruits and especially leaves of *Capsicum* are rich in carotenoids and vitamins (RESOURCES COUNCIL OF THE SCIENCE and TECHNOLOGY AGENCY 2001), the importance of this plant as a nutritious local food in this region has been largely overlooked.

In the present study, the local nomenclature, usage, and distribution of *Capsicum* in Chuuk Atoll were surveyed to investigate the relationship between people and *Capsicum* with a focus on dispersal routes, ethnobotany, and food security.

Study Site and Data Collection

Fieldwork was conducted over a month-long period in July and August 2011 on the islands of Weno, Romanum, and Piis in Chuuk Atoll, Chuuk State, FSM. The work consisted of interviewing locals and documenting local knowledge, use, and dispersal of *Capsicum* species. Figure 1 shows the study sites. A total of 76 people (34 males and 42 females, including 38 from Weno, 19 from Romanum, and 19 from Piis) were interviewed regarding the local nomenclature and use of the genus *Capsicum*. These interviews sought to capture taste perception of pungent *Capsicum*; knowledge of weed forms of *C. frutescens* and bird behavior toward fruits of *Capsicum*; usage as a condiment, vegetable, and/or medicine; and popular beliefs, agricultural rituals, and taboos related to this genus. The interviewees were aged 20 to 75 years old, with a median age of 46. Chuukese words are given following GOODENOUGH and SUGITA (1990).

Results and Discussion

Local nomenclature for *Capsicum* and perception of pungent *Capsicum* in Chuuk Atoll

Two species of *Capsicum* are cultivated in Chuuk Atoll: *C. annuum* (two pungent types, one with a long fruit and another with a round fruit; Fig. 1A) and *C. frutescens* (several pungent types of various sizes with a green or greenish-yellow color when immature; Fig. 1B). People on Weno Island who cultivate the *C. annuum* cultivars reported that they bought seeds or seedlings at an agricultural institute. Sweet peppers (paprika) and dried fruits of *C. annuum*, some of which were confirmed to be imported from the United States, are also sold in small stores, but this species seems to be rarely cultivated on the three islands studied. In contrast, *C. frutescens*, especially the green type, is a common seasoning in the daily diet of locals and has become an important and indispensable condiment in Chuuk Atoll.

Capsicum peppers are called “*mwik (mwiik)*” in Chuuk Atoll. Other regional names include “*t’eebil*” in Yap State (JENSEN 1977) and “*meringel*” in Palau (JOSEPHS 1990), both located to the west of Chuuk State, and all of these names are of unknown origin. YAMAMOTO (2011) reported that local names for *Capsicum* in Pohnpei State, located to the east of Chuuk State, include “*sele*” and “*jeli*”, possibly derived from “*chile*” in Spanish or English. Local names such as “*pwepuh*” in Kosrae State (LEE 1976) and “*peybah*” or “*pepah*” in Marshall (ABO *et al.* 1976), both to the east of Pohnpei State, seem to be related to “*pepper*” in English or other languages. Further linguistic studies in Micronesia may serve to elucidate the dispersal routes of *Capsicum*.

Among the 76 interviewees, 30 recognized only one kind of pungent *Capsicum* (Table

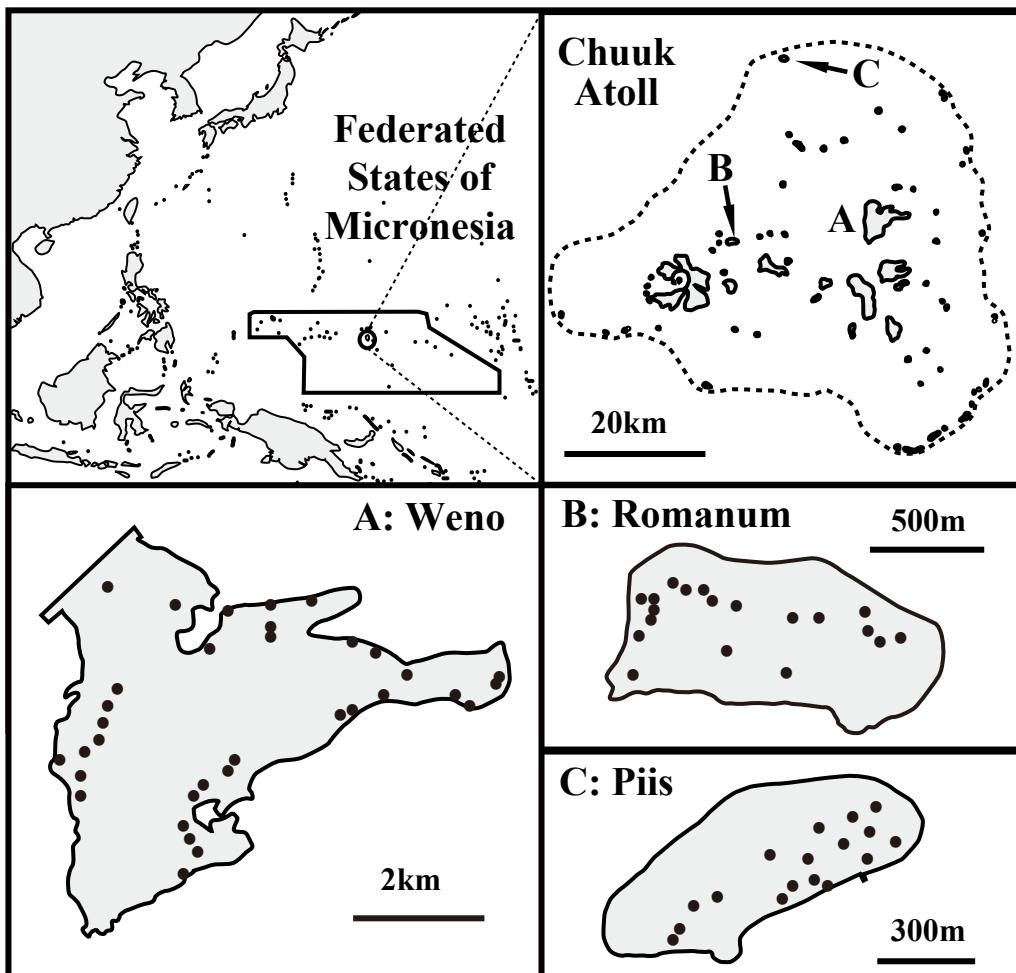


Fig. 1 Study sites (●) on Weno (A), Romanum (B), and Piis (C) islands, Chuuk Atoll, Chuuk State, Federated States of Micronesia.

1), which was a cultivar of *C. frutescens* with small green fruits (Fig. 2B-1). The other 46 interviewees recognized more than two types of pungent *Capsicum* with the highest number being five types, although they did not have any specific names for each type. Many people thought that the *C. frutescens* cultivar with small green fruits was native to their region and that the other *Capsicum* peppers were introduced from the outside after World War II, although YAMAMOTO (2011) revealed that at least two kinds of *C. frutescens*, including that with greenish-yellow fruits, were found in Oceania before 1945 during a specimen survey at the Bishop Museum, Hawai'i. These results may imply that people in Chuuk Atoll are more attached to the small fruits of *C. frutescens* in their local culture.

The 46 people who recognized more than two types of pungent *Capsicum* were asked to comment on each pepper's spiciness and smell, and which pepper they preferred. Table 1 presents the results. Forty-three people considered *C. frutescens* to



Fig. 2 Use of *Capsicum* peppers on Weno, Romanum, and Piis islands, Chuuk Atoll.

A long fruit (A-1) and a round fruit (A-2) cultivar of *C. annuum*. A green immature fruit color type (B-1) and a greenish-yellow type (B-2) of *C. frutescens*. A weed plant of *C. frutescens* found growing in an abandoned car (C-1) and seedlings of *C. frutescens* in a small cup (C-2). "Setifat" on Weno and "unuken" on Romanum (water, salt, and fruits of *C. frutescens*) (D-1), raw fish mixed with a sauce made of *C. frutescens*, soy sauce, and lime juice (D-2), and using the peppers as a stimulant (D-3: *C. frutescens* and salt; D-4: *C. frutescens*, salt, and lime juice). Water of mature coconuts placed in the sun for fermentation (E-1) and *C. frutescens* fruits soaked in such water, occasionally with garlic, also placed in the sun (E-2 and E-3).

Table 1 Perception of pungent *Capsicum* on Weno, Romanum, and Piis islands, Chuuk Atoll.

	How many kinds of pungent <i>Capsicum</i> do you know?			Questions for 46 interviewees who knew several kinds of pungent <i>Capsicum</i>									
	1 * ¹	2	more	Total	C. f. * ²	C. a. * ²	S * ³	C. f.	C. a.	S	C. f.	C. a.	S
Weno	12	11	15	38	23 [GR:23, GY:0] * ³	2	1	18 [GR:17, GY:1]	5	3	18 [GR:18, GY:0]	2	6
Romanum	13	5	1	19	6 [GR: 6, GY:0]	0	0	2 [GR: 2, GY:0]	2	2	4 [GR: 4, GY:0]	0	2
Piis	5	5	9	19	14 [GR:14, GY:0]	0	0	11 [GR:11, GY:0]	2	1	6 [GR: 6, GY:0]	5	3
Total	30	21	25	76	43 [GR:43, GY:0]	2	1	31 [GR:30, GY:1]	9	6	28 [GR:28, GY:0]	7	11

*¹: people know only *C. frutescens* (small fruits of which immature fruit color was green).*²: C.f.: *C. frutescens*, C.a.: *C. annuum*, and S: Same.[] *³: GR: small fruits of which immature fruit color was green, GY: fruits of which immature fruit color was greenish yellow.Table 2 Perception of weedy forms of *C. frutescens* and bird behavior toward fruits on Weno, Romanum, and Piis islands, Chuuk Atoll.

	Do you know weedy forms of <i>C. frutescens</i> ?			Do you know birds eat its fruits?			Do you have its plants in your home garden?			How did you get the plants? * ¹			
	Yes	No	Yes	No	Yes	No	Yes	No	Seeds or plants from villagers			Weedy forms * ²	
Weno	35	3	31	7	24	14	14	9				15	
Romanum	19	0	18	1	15	4			1			14	
Piis	15	4	17	2	7	12			4			3	
Total	69	7	66	10	46	30			14			32	

*¹: questions for 46 people who had *C. frutescens* plants in their home garden.*²: including transplantation from weedy forms in home garden or village.

be hotter, and all of these people reported that the small, green fruit type (GR) was hotter than the greenish-yellow type (GY). Of the remaining three respondents, two said that *C. annuum* was hotter, and one reported that *C. frutescens* and *C. annuum* were equally hot. Many people remarked that smaller fruits were much hotter. Regarding smell, 31 people thought *C. frutescens* smelled better (GR: 30, GY: 1), nine thought that *C. annuum* smelled better, and six thought there was no difference between the two species. As for preference, 28 people preferred to eat *C. frutescens* (GR: 28, GY: 0), seven preferred *C. annuum*, and 11 had no preference. Those who preferred spicy flavors tended to prefer *C. frutescens*, whereas others tended to prefer *C. annuum* or GY type *C. frutescens*.

Weed forms of *C. frutescens* and bird behavior toward fruits

Weed forms of *C. frutescens* were found along forest edges and the roadside in Chuuk Atoll (Fig. 2C-1). More than 85 % of interviewees had seen weed forms of *C. frutescens* (Table 2) and knew of or had seen birds eating fruits of *C. frutescens*. These birds included a species known as “*anga*” on Weno and Romanum or “*mwii*” on Piis (*Aplonis opaca* subspp.), as well as the “*chuko*” (common domestic fowl) on three islands and “*nikeitopar*” (*Myzomela cardinalis* subspp.) on Weno (the scientific names of these birds are taken from ENGBRING *et al.* (1990); Table 3). A common domestic fowl and birds belonging to the genus *Zosterops* are known to disseminate seeds of *C. frutescens* in Pohnpei State (YAMAMOTO 2011), Japan (YAMAMOTO 2010a), Taiwan (YAMAMOTO 2009), the Batanes Islands, the Philippines (YAMAMOTO 2010b), and Cambodia (YAMAMOTO and MATSUMOTO 2008).

Table 3 Local names for birds that eat fruits of *C. frutescens* on Weno, Romanum, and Piis islands, Chuuk Atoll

	Local name	People answered
Weno	<i>anga</i> (: <i>Aplonis opaca</i> subspp.) *	23
	<i>chuko</i> (: common domestic fowl)	17
	<i>nikeitopar</i> (: <i>Myzomela cardinalis</i> subspp.) *	4
Romanum	<i>anga</i> (: <i>Aplonis opaca</i> subspp.) *	18
	<i>chuko</i> (: common domestic fowl)	8
Piis	<i>mwii</i> (: <i>Aplonis opaca</i> subspp.) *	17
	<i>chuko</i> (: common domestic fowl)	5

* referred to Engbring *et al.* (1990).

Use of *C. frutescens* on Weno, Romanum, and Piis islands, Chuuk Atoll

Fresh or dried fruits

Locals who preferred spicy flavors reported eating fresh *C. frutescens* fruits raw, adding them to soups and canned meats or fish, and using them to make a dipping sauce (a mix of fruits, salt, soy sauce, and lime juice, occasionally with garlic, onion, and/or black pepper) for fish (Fig. 2D). Some people put only the fruits of *Capsicum* into un-boiled water with salt (a dish called “*setifat*” on Weno or “*unukan*” on Romanum) and used it as a soup and/or dipping sauce (Fig. 2D-1). Several females noted eating the peppers raw with salt and/or lime juice as a stimulant (Fig. 2D-3,4). People throughout Chuuk Atoll appeared to use dried fruits only rarely, similar to people in Pohnpei State (YAMAMOTO 2011) and the Batanes Islands (YAMAMOTO 2010b). This is likely because the relatively warm temperatures and generally plentiful rainfall throughout the year in Chuuk Atoll enable people to collect fresh *C. frutescens* fruits year-round.

Processed or preserved fruits

People in Chuuk Atoll soak *Capsicum* fruits, especially those of *C. frutescens*, in the water of mature coconuts (*Cocos nucifera*). These are placed in the sun for several days, and allowed to ferment and then sour (Fig. 2E), creating a spicy-sour condiment called “*manakini*”, which is then added to fresh fish, soup, and other dishes. People in Pohnpei State (YAMAMOTO 2011) and Fiji (unpublished data) do this, suggesting that this technique may be common throughout Oceania. People also soak fruits into lime juice, but they thought it would be a recent technique in Chuuk Atoll, as same as in Pohnpei State (YAMAMOTO 2011). On the Batanes Islands, “*bagun*” is made by soaking *C. frutescens* peppers in “*silam*” (a sour vinegar made from sugarcane; YAMAMOTO and NAWATA 2009a), while in Cambodia one of the most important elements of soaking fruits in liquid seems to be the sour taste (YAMAMOTO *et al.* 2011). As noted by YAMAMOTO (2010b), it is unknown whether people in Southeast and East Asia developed this spicy-sour flavor themselves or had widely adopted it after its introduction from Europe. The same phenomenon was observed in Chuuk Atoll.

Use of leaves of *C. frutescens*

The leaves of *Capsicum*, especially *C. frutescens*, are used in soups and in mixes of vegetables in Chuuk Atoll; in contrast, no one interviewed reported eating the roots as a spice or vegetable. On Romanum and Piis islands, 15 of 19 people indicated that they still use *Capsicum* leaves for food (although this was not observed during the study period). On Weno, 19 of 38 people reported that they had not recently eaten the leaves (Table 4). The frequency of using leaves did not differ among the three islands (Table 4). YAMAMOTO (2011) reported that, in Pohnpei State, the frequency of using the leaves is much higher in remote atolls, such as Mokil and Pingelap, than on the main island, Pohnpei Island. It is known that the lifestyle on Pohnpei Island was more modernized than that on Mokil and Pingelap atolls (KAWAI *et al.* 2010), which seems to have affected the use of *C. frutescens* leaves. In Chuuk Atoll, Weno is the main island and is also more modernized, which may explain the decreased usage of leaves on that island. YAMAMOTO (2009) reported that indigenous peoples of Taiwan used to add

Table 4 Use of leaves of *C. frutescens* on Weno, Romanum, and Piis islands, Chuuk Atoll.

	Use of leaves of <i>C. frutescens</i> as vegetable			Frequency of use of leaves of <i>C. frutescens</i> per * ²					
				Week		Month		Year	
	Yes	No	Total	Several times	One time	Several times	One time	Several times	
Weno	19 [SO:18, FR:4]	19	38	0	7	5	4	3	
Romanum	15 [SO:15, FR:0]	4	19	0	1	2	4	8	
Piis	15 [SO:13, FR:2]	4	19	0	4	1	7	4	
Total	49 [SO:46, FR:6]	27	76	0	12	8	15	15	

[] *¹: they used leaves for SO: soup and FR: fried vegetables. Results from multiple answer.

*²: questions for 49 people who eat leaves of *C. frutescens*.

C. frutescens leaves to gruel made of foxtail millet (*Setaria italica*) or maize (*Zea mays*), or to soup as a vegetable, but that today they seem to rarely use the leaves because they can buy other vegetables at markets. These results suggest that the leaves of *C. frutescens* may be used less in modern society.

Medicinal uses of *Capsicum*

When asked about medicinal uses of *Capsicum*, three people answered that the peppers are used to treat toothaches. In other regions of Oceania, the fruits, seeds, and leaves are used to treat various ailments: fruits for painful joints in Pohnpei State (YAMAMOTO 2011); fruits for back pain (UHE 1974) and leaves and/or fruits for other pains (WHISTLER 1996) in Samoa; seeds for aching muscles and body pains in Hawai'i (WHISTLER 1992a); fruits for sore throats in the Cook Islands (HOLDSWORTH 1990); fresh leaves for aching muscles and rheumatism in Vanuatu (BRADACS 2008); red pepper juice as an analgesic for body pains and aches on the Admiralty Islands (HOLDSWORTH and WAMOI 1982); and fruits for aches and pains, especially chest pains, on New Britain Island (HOLDSWORTH 1992). Modern medical researchers have found that capsaicin, the pungent ingredient in hot peppers, has a long-lasting suppressive effect on sensory neuron activity, and this compound is used to relieve pain caused by arthritis and pruritus in modern medicines (CRAFT and PORRECA 1992).

Some have claimed that eating *Capsicum* fruits eliminates the stomach parasite known as "nikanipwun", as previously reported for Pohnpei (YAMAMOTO 2011). *Capsicum* fruits are also used to treat stomach problems in Samoa (UHE 1974), Taiwan, the Batanes Islands (YAMAMOTO and NAWATA 2009a), and Cambodia (YAMAMOTO *et al.* 2011).

Four people said that eating fruits or leaves is good for eyesight, as in Pohnpei State (YAMAMOTO 2011). One person reported learning this information at a local workshop. People in seventeenth-century Spain reportedly ate two roasted *Capsicum* peppers after every meal to improve poor eyesight (NAJ 1992). However, indigenous peoples in Taiwan and the Batanes Islands claim that consumption of too many

Capsicum fruits, apart from *C. frutescens*, could cause poor eyesight, which may be related to a concept in Han Chinese traditional medicine (YAMAMOTO and NAWATA 2009a).

The leaves of *Capsicum* are often applied to boils or wounds in Tonga (WHISTER 1992b), Samoa (UHE 1974, COX 1993), the Cook Islands, Tahiti (WHISTER 1992a), and Fiji (unpublished data). Although this remedy was not observed in Chuuk Atoll in the present study, the locals did report drying the roots of *Capsicum* and mixing them with coconut oil to prepare an ointment for treating skin wounds. There is little information on the medicinal use of *Capsicum* roots, but people in Cambodia and Taiwan use them as medicine (YAMAMOTO and MATSUMOTO 2008, YAMAMOTO 2009).

Other uses of Capsicum

People in Chuuk Atoll also give *Capsicum* fruits to gamecocks after fighting to boost their energy. A man in Weno also mentioned that a gamecock will perform well if juice from the *Capsicum* pepper is placed on its spur. The use of *Capsicum* on gamecocks has also been confirmed in Pohnpei State (YAMAMOTO 2011), the Batanes Islands (YAMAMOTO 2010b), and Cambodia (YAMAMOTO and MATSUMOTO 2008). Some interviewees reported that the fruits are also used to treat sick domestic fowl. Similar practices have been reported in Pohnpei State, Taiwan, the Batanes Islands, and Japan (YAMAMOTO and NAWATA 2009a, YAMAMOTO 2010b, YAMAMOTO 2011).

Capsicum peppers have been found to play a role in popular beliefs, agricultural rituals, and taboos in many areas of Southeast and East Asia (YAMAMOTO 2009, 2010a, YAMAMOTO and MATSUMOTO 2008), and they are also used to produce rice malt and in rituals related to rice malt production (YAMAMOTO and MATSUMOTO 2008, YOSHIDA 1993). However, in the present survey, there was no evidence of any of these uses in Chuuk Atoll.

Conclusion

Capsicum frutescens remains a very important spice, vegetable, medicine, and cultural resource in Chuuk Atoll. However, the present study suggests that its use as a medicine is more limited in Chuuk Atoll than on other small and remote Pacific islands, such as Pohnpei (YAMAMOTO 2011) and the Batanes Islands (YAMAMOTO 2010). Moreover, people in Chuuk Atoll have been eating less *C. frutescens* leaves in recent years. In the FSM, the government and NGOs have encouraged people to cultivate vegetables such as squash, cucumber, lettuce, tomato, and eggplant to improve public health, but the outlook for this project is bleak, partly due to local inexperience in cultivating such crops. On small islands and atolls, imported foods and medicines may not arrive for more than a month if a typhoon or an oil crisis occurs. Therefore, for food security, it is imperative to re-discover plants already naturalized on each island. From this perspective, an important candidate plant is *C. frutescens*, which can serve not only as a spice but also as a vegetable rich in carotenoids and vitamins. *Capsicum frutescens* has long been naturalized in these regions; therefore, it does not need to be cultivated and its fruits and leaves can be harvested throughout the year. To improve public health on Pacific islands, there should be renewed focus on plants that are already naturalized on each island.

Acknowledgements

I am very grateful to all of the interviewees from Weno, Romanum, and Piis islands for their great hospitality, kindness, and openness. I am also grateful to Mason Fritz, Director of Chuuk Visitors Bureau, who helped me conduct research in Chuuk Atoll. I wish to thank the following people for arranging my surveys in Chuuk Atoll: Neterik (Sally Poll) on Weno Island, Tomisian Tan on Romanum Island, and Benito Nero and Julian Kinoch on Piis Island. I could not have made efficient surveys without their warmhearted and persevering help. This work was partly supported by the International Program of Collaborative Research, Center for Southeast Asian Studies, Kyoto University.

References

- ABO T., BENDER, B. W., CAPELLE A. and DEBRUM T. 1976. Marshallese-English Dictionary, pp. 236, 240, University of Hawai'i Press, Honolulu, Hawai'i, USA.
- ANDREWS J. 1995. Peppers - the Domesticated Capsicums. New edition, 274pp., University of Texas Press, Austin, Texas, USA.
- BOSWELL V. R. 1949. Garden Pepper, both a Vegetable and a Condiment. In Our Vegetable Travelers. The National Geographer, 96: 145-217.
- BRADACS G. 2008. Ethnobotanical Survey and Biological Screening of Medicinal Plants from Vanuatu. Ph D dissertationder Universitat, pp. 74, 96, Regensburg, Frankfurt, Germany.
- COX P. A. 1993. Saving the Ethnopharmacological Heritage of Samoa. Journal of Ethnopharmacolog, 38: 181-188.
- CRAFT R. M. and PORRECA F. 1992. Treatment Parameters of Desensitization to Capsaicin. Life Sciences, 51: 1767-1775.
- ENGBRING J., RAMSEY F. L. and WILDMAN V. J. 1990. Micronesian Forest Bird Surveys, the Federated States: Pohnpei, Kosrae, Chuuk, and Yap, pp. 168, 175, 181, 186, 201, 209, 217, Department of Interior, Washington, D. C., USA.
- ENGLBERGER L., MARKS G. C. and FITZGERALD M. H. 2003. Insights on Food and Nutrition in the Federated States of Micronesia: A review of the literature. Public Health Nutrition, 61: 5-17.
- ENGLBERGER L., SCHIERLE J., KRAEMER K., AALBERSBERG W., DOLODOLOTAWAKE U., HUMPHRIES J., GRAHAM R., REID A. P., LORENS A., ALBERTA K., LEVENDUSKY A., JOHNSON E., PAUL Y. and SENGEBAU F. 2008. Carotenoid and Mineral Content of Micronesian Giant Swamp Taro (*Cyrtosperma*) Cultivars. Journal of Food Composition and Analysis, 21: 93-106.
- ENGLBERGER L., SCHIERLE J., HOFMANN P., LORENS A., ALBERT K., LEVENDUSKY A., PAUL Y., LICKANETH E., ELYMORE A., MADDISON A., DEBRUM I., NEMRA J., ALFRED J., VANDER VELDE, N. and KRAEMER K. 2009. Carotenoid and Vitamin Content of Micronesian Atoll Foods: Pandanus (*Pandanus tectorius*) and Garlic Pear (*Crataeva speciosa*) Fruit. Journal of Food Composition and Analysis, 22: 1-8.
- ESHBAUGH W. H. 1993. Peppers: History and exploitation of a serendipitous new crop discovery. In: New Crops (Eds. JANICK, J. and SIMON, J. E.), 132-139, Wiley, New York, USA.
- GOODENOUGH W. H. and SUGITA H. 1990. Trukese-English Dictionary. Supp vol: English

- Trukese and Index of Trukese Word Roots, 560 pp., American Philosophical Society, Philadelphia, USA.
- HEZEL F. X. 2004. Health in Micronesia: Over the Years. *Micronesian Counselor* Issue 53, 15 pp., Micronesian Seminar, Pohnpei, FSM.
- HOLDSWORTH D. K. 1990. Traditional Medicinal Plants of Rarotonga, Cook Islands Part I. *International Journal of Crude Drug Research*, 28: 209-218.
- HOLDSWORTH D. 1992. Medicinal Plants of the Gazelle Peninsula, New Britain Island, Papua New Guinea. Part I. *International Journal of Pharmacognosy*, 30: 185-190.
- HOLDSWORTH D. and WAMOI B. 1982. Medicinal Plants of the Admiralty Islands, Papua New Guinea Part I. *International Journal of Crude Drug Research*, 20: 169-181.
- JENSEN R. D. 1977. Yapese-English Dictionary, p. 71, University of Hawai'i Press, Honolulu, Hawai'i, USA.
- JOSEPHS L. S. 1990. New Palauan-English Dictionary, p. 192, University of Hawai'i Press, Honolulu, Hawai'i, USA.
- KAWAI K., KUWAHARA S., ONJO M., NODA S., NISHIMURA A., TOMINAGA S. and NAGASHIMA S. 2010. The Influence of Environmental Changes on the Micronesian Area: A Case Study of Islands in Pohnpei State, Federated States of Micronesia. *South Pacific Studies*, 30(2): 23-43.
- KUMAZAWA S., OHARA T. and NIIUCHI K. 1954. The differentiation of Varieties of Peppers in Japan. *Journal of the Japanese Society for Horticultural Science*, 23: 152-158 (in Japanese).
- LEE K. D. 1976. Kusaiean-English Dictionary, p. 107, University of Hawai'i Press, Honolulu, Hawai'i, USA.
- MURAI M. 1954. Nutrition Study in Micronesia. *Atoll Research Bulletin*, 27: 1-239.
- NAJ A. 1992. Peppers: A Story of Hot Pursuits, 245 pp., Vintage Books, New York, USA.
- RESOURCES COUNCIL OF THE SCIENCE AND TECHNOLOGY AGENCY (eds.) 2001. Standard Tables of Food Composition in Japan. Kagawa Nutrition University Press, Tokyo, Japan.
- STURTEVANT E. L. 1885. Kitchen Garden Esculents of American Origin. II. Peppers. *The American Naturalist*, 19: 542-553.
- UHE G. 1974. Medicinal Plants of Samoa: A Preliminary Survey of the Use of Plants for Medicinal Purposes in the Samoan Islands. *Economic Botany*, 28: 1-30.
- WHISTLER W. A. 1992a. Polynesian Herbal Medicine, pp. 82, 98, 112, 131, 132, National Tropical Botanical Garden, Kauai, Hawai'i, USA.
- WHISTLER W. A. 1992b. Tongan Herbal Medicine, pp. 91-92, University of Hawai'i Press, Honolulu, Hawai'i, USA.
- WHISTLER W. A. 1996. Samoan Herbal Medicine. p. 87, Isle Botanica, Honolulu, Hawai'i, USA.
- YAMAMOTO S. 2009. Use of *Capsicum Frutescens* by the Indigenous Peoples of Taiwan. *Studies on Indigenous Peoples of Taiwan*, 13: 39-75 (in Japanese).
- YAMAMOTO S. 2010a. *Nihon no togarashi hinshu* [Japanese cultivars of *Capsicum* peppers]. In: *Togarashi sanka* [Chili Hymn]. (Ed. YAMAMOTO, N.), 247-255, Yasakashobo, Tokyo, Japan (in Japanese).
- YAMAMOTO S. 2010b. Use of *Capsicum* Peppers in the Batanes Islands, the Philippines.

Use of *Capsicum frutescens* in Weno, Romanum, and Piis islands, Chuuk Atoll, Federated States of Micronesia

- South Pacific Studies, 31: 43-56.
- YAMAMOTO S. 2011. Use of *Capsicum Frutescens* on Pohnpei Island, Mokil Atoll, and Pingelap Atoll, Federated States of Micronesia. People and Culture in Oceania, 27: 87-104.
- YAMAMOTO S. and NAWATA E. 2004. Morphological Characters and Numerical Taxonomic Study of *Capsicum Frutescens* in Southeast and East Asia. Tropics, 14: 111-121.
- YAMAMOTO S. and NAWATA E. 2005. *Capsicum Frutescens* L. in Southeast and East Asia, and Its Dispersal Routes into Japan. Economic Botany, 59: 18-28.
- YAMAMOTO S. and NAWATA E. 2006. The Germination Characteristics of *Capsicum Frutescens* L. on the Ryukyu Islands and the Domestication Stages of *C. Frutescens* L. in Southeast Asia. Japanese Journal of Tropical Agriculture, 50: 142-153.
- YAMAMOTO S. and NAWATA E. 2009a. Use of *Capsicum Frutescens* L. by the Indigenous Peoples of Taiwan and the Batanes Islands. Economic Botany, 63: 43-59.
- YAMAMOTO S. and NAWATA E. 2009b. Effect of Root Zone on Flower Bud Formation and Flowering of Genus *Capsicum*. Tropical Agriculture and Development, 53: 55-58.
- YAMAMOTO S., MISUMI M. and NAWATA E. 2007. Effects of Various Photoperiods on Flowering in *Capsicum Frutescens* and *C. Annum*. Environment Control in Biology, 45: 133-142.
- YAMAMOTO S., MISUMI M. and NAWATA E. 2008. Effects of Photoperiod on Vegetative Growth, Flowering and Fruiting of *Capsicum Frutescens* L. and *C. Annum* L. in Japan. Environment Control in Biology, 46: 39-47.
- YAMAMOTO S. and MATSUMOTO T. 2008. Use of *Capsicum* by Khmer and Other Ethnic Groups in Cambodia. Udaya, Journal of Khmer Studies, 9: 29-61.
- YAMAMOTO S., MATSUMOTO T. and NAWATA E. 2011. *Capsicum* Use in Cambodia: The Continental Region of Southeast Asia Is Not Related to the Dispersal Route of *C. Frutescens* in the Ryukyu Islands. Economic Botany, 65: 27-43.
- YOSHIDA S. 1993. *Toho Asia no sake no kigen* [Origin of rice wine in East Asia], 349 pp., Domesu, Tokyo, Japan (in Japanese).

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FOR THE PACIFIC ISLANDS
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PUBLISHED BY
KAGOSHIMA UNIVERSITY RESEARCH CENTER
FOR THE PACIFIC ISLANDS
Korimoto 1-21-24, Kagoshima 890-8580, Japan

Tel. : +81-99-285-7394

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February 25, 2013

[www <http://cpi.kagoshima-u.ac.jp/index-j.html>](http://cpi.kagoshima-u.ac.jp/index-j.html)

鹿児島大学国際島嶼教育研究センター
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鹿児島市郡元一丁目21番24号

電 話 099(285)7394

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平成25年2月25日発行