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Future Collaboration on Island Studies between Pattimura University and Kagoshima University

Edited by YAMAMOTO Sota and LEATEMIA J. Audrey

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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Preface

This volume is the outcome of an international workshop “Future Collaboration on Island Studies between Pattimura University and Kagoshima University” held from 17 to 19 October, 2016 in Kagoshima, Japan. The Memorandum of Understanding for Academic Cooperation between Pattimura University and Kagoshima University was concluded in March, 2014, and a workshop “Research and Education Linkage between Pattimura University and Kagoshima University” was held on 23 June, 2014 in Ambon, Maluku, Indonesia as an initial step of long-term cooperative research among scientists of two universities. After the workshop, several collaborative research projects were launched, such as ethnobotanical research on crops (e.g., citrus, chili pepper etc.) and entomological research on mosquitoes and black flies in Maluku. The objectives of this workshop were to share and discuss issues in small islands especially in Maluku Province and Kagoshima Prefecture by scientists from different disciplines and to promote more research collaborations between two universities. Eight researchers from Pattimura University visited Kagoshima with the financial support of Pattimura University (DIPA-2016) funding, and they discussed challenges and prospects on “general issues”, “conservation of natural resources”, “fishery”, “agriculture” and “agricultural and fishery engineering” in the islands of Maluku and Kagoshima with many researchers from Kagoshima University. We hope two universities will establish a closer relationship and initiate new collaborative research in the near future.

YAMAMOTO Sota
Research Center for the Pacific Islands,
Kagoshima University

LEATEMIA J. Audrey
Faculty of Agriculture, Pattimura University

March 2017

Welcome Address

I am honored to have distinguished guests from Pattimura University for this very important partnership university with Kagoshima University. I hope you will have enjoyable stay in Kagoshima. The Memorandum of Understanding was concluded in 2014, and six scholars from our university participated in a workshop “Research and Education Linkage between Pattimura University and Kagoshima University” held in your university. Last year, we invited one scholar from Pattimura University as a visiting associate professor. We would like to promote our exchange programs more actively.

First of all, I would like to give you a brief overview of our university. Kagoshima University has a long history and rich tradition in education. The university’s origins can be traced back to the Hangaku Zoshikan School, which was established in 1773 and was run under the feudal domain of the Shimazu family.

After the merger of several higher education institutions including the Seventh Higher School established during the Meiji period (1868-1912), Kagoshima University inherited this educational tradition and was newly established in 1949 as a national university. The university has developed into one of the leading comprehensive universities of Japan.

It is comprised of nine faculties, ten graduate schools and fourteen education and research institutes with approximately 9,000 undergraduates and 2,000 post-graduate students including 300 international students. In 2014, Dr. Akasaki, who graduated from our Seventh Higher School currently Kagoshima University, was given a Nobel Prize. Recently, we have to address the population decline in Japan and to promote local creation in Japan. Based on the characteristics and development potential of Kagoshima, our university, as a key local engine we are expending effort in the area creation and turning out strong students with the “spirit of enterprise.”

There are many historical spots in this city. I hope you will enjoy not only this campus, but also our historical spots, along with the delicious local food, *shouchuu* (liquor made from sweet potato) and hot springs available in Kagoshima.

Thank you very much for visiting at Kagoshima University.

MAEDA Yoshizane
President of Kagoshima University

Opening Speech for the Workshop

On behave of the staff of Kagoshima University I would like to express to all the distinguished guests from Pattimura University: Welcome to our university and thanks for attending this international workshop “Future Collaboration on Island Studies between Pattimura University and Kagoshima University.”

Kagoshima University consists of 9 faculties and 10 postgraduate schools with about 11,000 students and 2,500 staff. We have also 24 education and research institutes such as Research Center for the Pacific Islands. Kagoshima Prefecture has several active volcanoes (e.g., Mt. Sakurajima, Kirishima etc.), and also a lot of small islands, such as Amami-Oshima and Yakushima islands.

We are now promoting two kinds of strategic studies. One is five regional studies contributing to community development: Islands, Environments, Food and Health, Renewable Energies and Water. The other is several studies with excellent results at a top international level, such as Infection Control, Biological Diversity, Experimental Animal Models, the Milky Way Galaxy and Intractable Cancer.

The subject of this workshop is related mainly to the former region studies, and I hope that discussion about future collaborations on Island Studies between the two universities will contribute much to the community development in both countries.

I wish a great success of this workshop and an enjoyable stay of all the distinguished guests in Kagoshima.

SUMIYOSHI Fumio
Executive Vice President (Research),
Kagoshima University

Photo Album

Group Photo

Welcome and Opening Speech:
SUMIYOSHI Fumio
(Executive Vice President (Research), Kagoshima University)

Speech from Pattimura University:
OSOK Rafael M.
(Head of Research Institute, Pattimura University)

Presenter 1: TAKAMIYA Hiroto
(Research Center for the Pacific Islands, Kagoshima University)

Presenter 2: OSOK Rafael M.
(Study Center for Disaster Research and Climate Change Adaptation (PSPB-API), Pattimura University)

Presenter 3: APITULEY Yolanda M. T. N.
(Faculty of Fisheries and Marine Science, Pattimura University)

Presenter 4: TORII Takashi
(Faculty of Fisheries, Kagoshima University)

Presenter 5: LIMMON Gino V.
(Maritime and Marine Science Center of Excellence, Pattimura University)

Presenter 6: FUJII Takuma
(Research Center for the Pacific Islands, Kagoshima University)

Presenter 7: ABRAHAMSZ James (Research Center for Small Islands, Coastal Area and Outer Islands, Pattimura University)

Presenter 8: SUZUKI Mariko (Research Center for the Pacific Islands, Kagoshima University)

Presenter 9: RAHARJO Simon H. T. (Faculty of Agriculture, Pattimura University)

Presenter 10: SAKAI Norio (Faculty of Agriculture, Kagoshima University)

Presenter 11: LEATEMIA J. Audrey (Faculty of Agriculture, Pattimura University)

Presenter 12: SAKAMAKI Yoshitaka (Faculty of Agriculture, Kagoshima University)

Presenter 13: MALLE Dominggus (Faculty of Agriculture, Pattimura University)

Presenter 14: HETHARIA Wolter R. (Faculty of Engineering, Pattimura University)

Presenter 15: ICHIKAWA Hidetaka (Faculty of Law, Economics and Humanities, Kagoshima University)

Discussion on Future Collaboration: KAWAI Kei (Director of Research Center for the Pacific Islands, Kagoshima University)

A gift from Pattimura University to Research Center for the Pacific Islands, Kagoshima University

Courtesy call on President MAEDA Yoshizane (Kagoshima University)

Courtesy call on IWAI Hisashi (Dean of Faculty of Agriculture, Kagoshima University)

Courtesy call on MOMII Kazuro (Dean of the United Graduate School of Agricultural Sciences, Kagoshima University)

Welcome Reception

Visit to Education and Research Center for Fermentation Studies

Studying Amami culture at the Village of Amami Island in Kagoshima City

Enjoy Amami cuisine

Excursion to the Experimental Farm, Faculty of Agriculture, Kagoshima University (blueberry, mandarin, Japanese persimmon etc.)

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The Islands of Amami and Okinawa Where Hunter-Gatherers Once Throve

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Abstract

Many islands in the world were colonized by *Homo sapiens* (modern human) after 10,000 years ago. Considering the high degree of adaptability of *H. sapiens*, who were all hunter-gatherers prior to 10,000 years ago, to various environments, one might wonder why the colonization of islands was recent phenomenon in human history. Archaeologists and anthropologists have examined human colonization processes to island environments and come up with several reasons: the low level of water crossing technology, difficulties in finding adequate amount of food in newly arrived islands, also difficulties of small human population group avoiding natural disasters and diseases and so on.

Among these the most challenging thing for hunter-gatherers was how to obtain enough food resources in resource poor island environments. Hunter-gatherers move quite often, changing their camps from one place to another. Most archaeologists and anthropologists argue that many islands in the world are/were not large enough for mobile hunter-gatherers successfully colonize them. Therefore, most of them were colonized after agriculture was invented at around 10,000 years ago.

Rarely, exceptions exist. That is small number of islands were colonized by hunter-gatherers. These islands are characterized by as follows: 1) large islands, 2) islands closely located from a continent or large island, 3) large sea mammals more or less constantly available, 4) hunter-gatherers translocated edible plants and animals from their mother lands to islands and 5) if combination of 1) to 4) is possible.

None of these are/were applicable to the islands in the Amami and Okinawa archipelagos. Therefore, some archaeologists and anthropologists proposed the Shellmidden period (ca. 6,500 BP to 1,000 BP) agriculture hypotheses. Archaeologists and anthropologists have worked intensively for the last twenty years or so especially focusing on faunal and plant remains. The former contained only wild animals except the dog. The latter too mainly consisted of wild species except the bottle gourd. The results of the analyses strongly indicate that the hunter-gatherers successfully adapted the islands. The data is an extremely unique and important case in human history.

Keywords: archaeobotanical analysis, faunal analysis, *Homo sapiens*, island colonization, the Shellmidden period

Introduction

Homo sapiens (or modern human) emerged in Africa sometime between 200,000 and 100,000 years ago and soon after that they spread from there to all continents, except Antarctica. They reached Australia by about 50,000 years ago, to Europe and East Asia ca. 40,000 years ago. From Siberia, they entered into North America (Alaska) at about 15,000 years ago. Astonishingly, they expanded from the northern North America to the southern tip of South America within less than 5,000 years. This spread from the northern tip to the southern tip by 10,000 years ago demonstrates high degree of adaptability of *H. sapiens* into various environments. Since every human being living at that time was hunter-gatherers, the fact simultaneously indicates high degree of adaptability of hunter-gatherers into different kinds of environments.

While hunter-gatherers adapted into various environments, they had extremely difficult time conquering island environments. Indeed most islands were colonized after 10,000 years ago. The main reason is that hunter-gatherer populations could not or do not colonize small depauperated islands. Thus, it has been hypothesized that in order for modern humans to successfully colonize islands, food production is necessary (CHERRY 1981). Were they hunter-gatherers or farmers who colonized the islands of the Amami and Okinawa archipelagos?

Background

Prehistory of this region begins with the Paleolithic period (ca. 32,000 to 10,000 BP; see Table 1 for chronology). The earliest known site is the Yamashita cho No.1 cave site, dating to ca. 32,000 years ago, on Okinawa Island. In the Okinawa Archipelago, eight Paleolithic sites are reported. In the Amami Archipelago, the number of known Paleolithic sites is five. The Paleolithic period is followed by the Shellmidden period (ca. 7,000 to 1,000 BP). This period is characterized by the emergence of pottery culture. The earliest pottery in this region until recently is known as the finger-nailed pottery and the plain pottery, dating about 6,500 to 7,000 years ago. Pottery culture might go back to 7,000 to 9,000 years ago by the recent findings from the Kikai sogo ground site, the Minatogawa fissure site, and the Tiiragama site (TAKAMIYA *et al*. unpublished data). At about 1,000 years ago, the Gusuku culture began. This period is characterized by the beginning of food production, the use of iron tools, the long distant exchange and the emergence of the stratified societies.

This brief review of the prehistory of the region shows that agriculture was established by the Gusuku period. Also, since the Paleolithic people were hunter-gatherers worldwide, it implies probably hunter-gatherers lived on the islands during the Paleolithic period too. The

Table 1. Chronology of the Amami and Okinawa archipelagos.

	Amami and Okinawa	Mainland Japan (except Hokkaido)
ca. 1,100/1,200 ～ 1,500 AD	Gusuku	Muromachi-Kamakura
1,400 BP	Shellmidden Late 2	Heian-Asuka
2,600 BP	Shellmidden Late 1	Kofun Yayoi
3,000 BP	Shellmidden Early 5	Final Jomon
4,000 BP	Shellmidden Early4	Late Jomon
5,000 BP	Shellmidden Early 3	Middle Jomon
6,000 BP	Shellmidden Early 2	Early Jomon
7,000 BP	Shellmidden Early 1	
	Beginning of Pottery culture?	Initial Jomon
10,000 BP ≀ 32,000 BP	Paleolithic	Incipient Jomon / Paleolithic

*Table shows approximate comparison with the mainland Japan. They do no perfectly correspond between these two regions.

biggest question is whether the people of the Amami and Okinawa archipelagos during the Shellmidden period depended on wild resources or agricultural products.

The Shellmidden Islanders: Were They Hunter-Gatherers or Agriculturists?

As mentioned above, most islands in the world were colonized by hunter-gatherers. Exceptionally, several islands were colonized by hunter-gatherers. These islands are characterized by as follows: 1) large islands, such as Tasmania, 2) islands located closely from a continent or a large island such as the California Channel Islands, 3) islands where sea mammals are reliable as food source such as Kodiak Island, 4) hunter-gatherers translocated edible plants and/or animals from their mother land, such as Manus Island and 5) if

combination of 1) to 4) is possible, such as the California Channel Islands. None of these applies to the islands of Amami and Okinawa prehistorically including the Shellmidden period (TAKAMIYA *et al*. 2016). Therefore, it is extremely important to address the question entitled for this session. In order to answer the question, let me examine faunal remains first, and then review plants consumed by the Shellmidden people.

Faunal remains

Archaeologists constantly collected faunal remains since almost the same time when archaeological work was first introduced into the region, some one hundred years ago. It is important to note that since 1990s, faunal remains have been sampled and analyzed by specialists. TOIZUMI (2014) has been working on vertebrate remain analysis, and KUROZUMI (2014) has been analyzing shell remains from archaeological sites since 1990s. They have applied meticulous methods in order to collect small sized animal remains, such as using 1 mm sized mesh screening. Consequently, they are able to analyze faunal remains larger than 1 mm. TOIZUMI's analysis (2014) has revealed all vertebrate remains recovered from the sites were wild species, except the dog. According to him, important vertebrate animal foods were wild boar and fishes available from the coral reef environment. No site is known where sea mammals preoccupy vertebrate remains. Indeed the carbon and nitrogen isotope analysis demonstrates sea mammals were not important food (TAKAMIYA and CHISHOLM 2004, YONEDA 2010). Also, the vertebrate remains contain no tranlocated animal foods from the outside, except the dog. KUROZUMI (2014) sees no signs of shellfish farming from the shellfish remains from the archaeological sites. Thus, in terms of faunal remains, people lived there during the Shellmidden period relied on wild animal species.

Plant remains

What about plant foods? Compared with faunal remains, since plant remains were small and very fragile, it had been difficult to unearth plant remains. As a result, only two sites in the Amami Archipelago (NAKAYAMA 2009) and eight sites in the Okinawa Archipelago yielded plant remains prior to 1991 (WATANABE 1991). The plant remains recovered and identified from these sites were all wild plants such as nuts. These pieces of information imply that the Shellmidden people were gatherers of the wild plants. However, since the amount of plant remains recovered from these sites are fragmentally, and at the same time since the number of sites which yielded plant remains was only ten, some scholars proposed the Shellmidden agriculture hypotheses (e.g., YANAGITA Kunio, NITTA Jusei, TAKAMIYA Hiroe, SATO Yoichiro, ITO Shinji and TAKAMIYA Hiroto, see TAKAMIYA 2005).

In order to understand subsistence economy of the Shellmidden period, flotation was first introduced into the region in 1992. Flotation was developed by archaeologists in order to collect carbonized plant remains, such as carbonized seeds, efficiently from archaeological

sites. From several archaeological sites dating from the Early 2 to the Late 2 periods, soil samples were collected. Also around 2000, wetland sites were excavated for the first time in this region. From these wetland sites numerous amounts of plant remains were recovered and identified by OMATSU and TSUJI (1999), TAKAMIYA (1999), TAKAMIYA (2006) and TSUJI *et al*. (2007). Below, plant remains recovered from the Shellmidden sites will be briefly introduced.

The Early 1: the Shinjoshichabaru No.2 site

The site is a wetland site and yielded one of the earliest pottery, finger-nailed pottery. The ^{14}C date of wild boar was cal. BC 5050–4910. The site unearthed more than 20 taxa of plant remains. All belonged to wild species, such as red bayberry and silvervine (TAKAMIYA 2006).

The Early 2: the Ireibaru site

This site is also a wetland site and yielded the Sobata pottery. The ^{14}C dates ranged between cal. BC 4250–3770. TSUJI *et al*. (2007) analyzed plant remains from the site and report numerous amounts of nuts species. In addition to nuts species, they have reported more than 60 taxa, all of which belonged to wild species, except bottle gourds. While plant remains recovered from the Hango site is still in the process of analysis, all plant remains identified so far are nuts (TSUJI *et al.* 2007).

The Early 3 to the Early 4: the Omonawa No. 4 site

A small amount of soil samples was collected and processed by flotation. Consequently, only few plant remains were collected and identified. They were nuts and silvervine (TAKAMIYA unpublished data).

The Early 4: the Mebaru site

This site was a wetland site and the ^{14}C dates range between cal. BC 2300–1940. OMATSU and TSUJI (1999) report 50 taxa and TAKAMIYA (1999) identified at least 30 taxa. They all belonged to wild species. OMATSU and TSUJI (1999) mention a large amount of nuts was recovered. The Kuzuri site, which dates to this period and whose plant remains have been in the process of analysis, has so far yielded only wild species (TAKAMIYA unpublished data).

The Early 5: the Sumiyoshi Shellmidden

This site unearthed several house pits, and soil samples were mainly collected from these features. The ^{14}C dates ranged between cal. BC 1540–1210. The result of plant remain analysis showed all plant remains were wild species such as nuts. The Tobaru site, the Nakazato site and the Nishinagahamabaru site, which belong to the Early 5 also yielded only wild species (TAKAMIYA *et al.* 2016).

The Late 1: the Takachikuchibaru Shellmidden

The Takachikuchibaru Shellmidden was the first site where flotation was applied in the archipelagos. Therefore, a large amount of soil samples was collected for flotation. While a large amount of soils was processed by flotation, the plant remains from the site did not contain any cultigens. Again, all of them were wild species such as nuts (TAKAMIYA *et al.* 2016).

The late Late 1 to the Late 2: the Yomisaki, Arago, Matsumoto and Nagarabaru Higashi sites

The first three are located on Amami-Oshima Island, and the last one on Ie Island in the Okinawa Archipelago. All sites yielded only wild plant remains (TAKAMIYA *et al.* 2016).

The late Late 2 to the Initial Gusuku period

Cultigens appear for the first time in flotation samples dating to this period. The Nazakibaru site, Kumuibaru site, Uganhira-hoppo site and Yabumedabaru site on the mainland of Okinawa yielded barley, wheat, foxtail millet and broomcorn millet. The Gusuku site group (among them, plant remains were analyzed from the Yamada-nakanishi, Yamada-handa, Maehata, Kohane and Oufu sites) on Kikaijima Island and Akakina gusuku site on Amami-Oshima Island unearthed barley, wheat, foxtail millet and broomcorn millet. The ^{14}C dates of these cultigens are between the ninth to twelfth centuries AD, indicating the transition from hunting and gathering to food production took place at about this time. At the same time, it has become evident that people lived on the islands prior to this time (the Shellmidden period) were hunter-gatherers (TAKAMIYA *et al.* 2016).

Discussion and Conclusion

Were people of the Shellmidden period hunter-gatherers or farmers? Faunal remain analyses have demonstrated that they relied on wild animals for foods. Recent intensive archaeological work focusing on recovering plant remains using flotation successfully collected plant remains from sites dating to the Early 2 to the Late 2. In addition, fortunately enough the wetland archaeological sites were excavated for the first time, and numerous amounts of plant remains were recovered from these sites. The results of plant remains analyses unearthed from most of the Shellmidden sites contained no cultigens but all wild plants. The results strongly indicate that the Shellmidden people were gatherers of the wild plants. Thus the answer to the above question is, they were hunter-gatherers.

In the background section, I have mentioned very rare cases where hunter-gatherers adapted island environments. The Amami and Okinawa archipelagos case do not belong to these five cases. Thus, the Amami and Okinawa case provide a new perspective of

hunter-gatherer adaptation to the islands. While we still need more data, the Early 1 people relied on nuts and wild boar, the Early 2 on nuts and inner bay fishes and from the Early 3 to the Late 2 on nuts and coral reef fishes. Also the shellfish species inhabits in the coral reef environment played important role during the entire Shellmidden period. These are new strategies which enabled hunter-gatherers successfully colonize island environments. The case from Amami and Okinawa archipelagos provides an extremely rare case in human history.

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Development of Fresh Fish Marketing in Maluku

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Abstract

In modern marketing concepts, markets are no longer positioned at the end of the process, but in the beginning of production. By that means, the ultimate goal of a production is markets or consumers. Geographical condition of Maluku which has thousands of small islands leads for its abundant fresh fish. However, characteristics of fresh fish such as seasonal and perishable, added by the distance of production and consumption center as well as inadequate facilities, resulted in the need of development of island-based marketing. The purpose of this study is to develop marketing of fresh fish in Maluku which is known as one of the archipelago provinces in Indonesia. Based on the results of Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis, the position of fresh fish marketing system in Maluku is in Growth Oriented Strategy. It means that the strategy adopted in this condition should support the aggressive growth policy. These strategies are: 1) improving the infrastructures of production and marketing of fresh fish, 2) integrating facilities and infrastructures of production, marketing and processing, 3) improving skills of fisher folks in fish handling and processing, 4) increasing cooperation with financial institutions in the provision of venture capital, 5) improving function of marketing institutions and 6) establishing an agency that has a mandate to stabilize prices of fisheries products.

Keywords: archipelago, fisheries products, Growth Oriented Strategy, policy, SWOT analysis

Introduction

Fresh fish are highly perishable and damaged; the production centrals are scattered and far from consumption centers. As they are seasonal, while the consumption of them is stable throughout year, a special treatment is required to maintain their quality and durability (GALLEGATI *et al*. 2011, HANAFIAH and SAEFUDDIN 2006). The price of fresh fish is fluctuated, leads to complicated of business prediction, both in the calculation of profit and loss, as well as risk management (BRINSON *et al*. 2011).

Unimplemented properly cold chain in post-harvest handling lower the fishermen bargaining position (HANAFIAH and SAEFUDDIN 2006), so they tend to get results that are not in accordance with the risk level of their jobs. To make these activities well developed, some requirements are needed, such as high quality of products and able to take advantage of market opportunities.

Maluku has 1,340 small islands, divided in one city and ten regencies. Those islands spread with inadequate infrastructures which make transportation to and from those islands

are very dangerous. This condition is also influenced the marketing process of fisheries products in Maluku that could lead to the lower fishermen revenue. Therefore, this paper is aimed to analyze the strategy of fresh fish (fisheries products) marketing in Maluku.

Research Method

Fresh fish marketing system survey was conducted to all stakeholders (fishermen, collectors, retailers and bureaucrats) who involved in that system by using questionnaire and observation. Strategy of fresh fish marketing was developed through Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis. Each SWOT factor was scored from 1 (most important) to 0 (unimportant) and rating was scaled 4 to 1. For internal factors (strength and weakness): strength rating will be 4 when the factor is very strong, and vice versa. Weakness rating will be -1 when the factor is very weak, and on the contrary it will be -4 when it is weak. For external factors (opportunity and threat): the bigger the opportunity, the higher (4) the rating, and vice versa. The rating threat will be -1, when it is high, and will be -4 when it is low (RANGKUTI 2002).

Results and Discussion

Internal and external factors of fresh fish marketing

Based on the SWOT analysis, the condition of fresh fish marketing system in Maluku is in Quadrant I (0.8; 2.2) (Fig. 1, Table 1), which means support aggressive strategy or Growth Oriented Strategy (RANGKUTI 2002). By that, the strategy produced should support aggressive development policy.

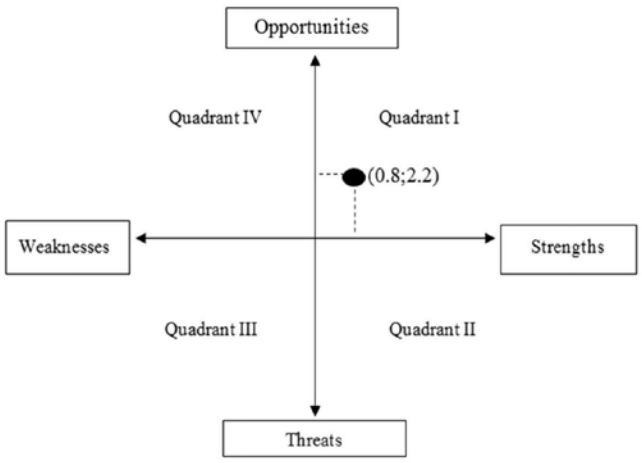

Fig. 1. Grand Strategy Diagram of fresh fish marketing in Maluku.

Table 1. Analysis of internal and external factors.

	Internal and External Factors	Weight	Rating	Score
Strengths				
1	High potency of fish resources	0.10	3	0.30
2	Many islands make fish available anytime	0.07	2	0.14
3	Transportation available	0.05	2	0.10
4	Maluku was declared as National Fish Granary	0.10	3	0.30
5	Ambon was determined as minneapolitan area	0.10	3	0.30
6	Maluku was determined as one of economic development accelerating corridor in East Indonesia	0.10	3	0.30
7	Availability of cold storage	0.05	2	0.10
Weaknesses				
1	Low of fishermen awareness in maintaining fish quality	0.05	-1	-0.05
2	Limited capital	0.04	-1	-0.04
3	Low of fishermen bargaining position	0.04	-1	-0.04
4	Production areas spread and far from consumption areas	0.03	-2	-0.06
5	Fish Auction Place is only in Ambon and not functioned	0.03	-3	-0.09
6	Limited marketing infrastructures	0.04	-2	-0.08
7	High marketing cost	0.02	-3	-0.06
8	Fluctuation of fish price	0.04	-2	-0.08
9	Market structure tend to oligopoly	0.05	-1	-0.05
10	Low of market integration	0.05	-1	-0.05
11	Low market information	0.02	-4	-0.08
12	Limited alternative of processed product diversification	0.02	-3	-0.06
Total score strengths-weaknesses		1.00		0.80
Opportunities				
1	Increasing of population in Maluku	0.10	3	0.30
2	Increasing of community's awareness in eating fish	0.10	3	0.30
3	Potential market outside Maluku	0.20	4	0.80
4	Increasing of income per capita and purchasing power	0.10	3	0.30
5	Government attention to fishermen	0.20	4	0.80
Threats				
1	Illegal, Unreported and Unregulated fishing in Maluku	0.10	-1	-0.10
2	Unregularly sea patrols	0.10	-2	-0.20
Total score opportunities-threats		1.00		2.20

Development strategy of fresh fish marketing system in Maluku

Aggressive marketing development policy means a policy of marketing system from upstream to downstream. That policy covers product availability, production infrastructure provision, product handling and processing, fishermen capacity building and marketing infrastructure support development. Table 2 shows strategies produced based on external and internal factors identification.

Table 2. Qualitative SWOT analysis of fresh fish marketing in Maluku.

Internal Environment / **External Environment**	**Strengths (S)**	**Weaknesses (W)**
	1 High potency of fish resources 2 Many islands make fish available anytime 3 Smooth transportation 4 Maluku was declared as National Fish Granary 5 Ambon was determined as minneapolitan area 6 Maluku was determined as one of economic development accelerating corridor in East Indonesia 7 Availability of cold storage	1 Low of fishermen awareness in maintaining fish quality 2 Limited capital 3 Low of fishermen bargaining position 4 Production areas spread and far from consumption areas 5 Fish Auction Place is only in Ambon and not functioned 6 Limited marketing infrastructures 7 High marketing cost 8 Fluctuation of fish price 9 Market structure tend to oligopoly 10 Low of market integration 11 Low market information 12 Limited alternative of processed product diversification
Opportunities (O)	**SO strategies**	**WO strategies**
1 Increasing of population in Maluku 2 Increasing of community's awareness in eating fish 3 Potential market outside Maluku 4 Increasing of income per capita and purchasing power 5 Government attention to fishermen	1 Develop environment insight of capture fishery (S1,2,4,5,6; O1,2,3,4) 2 Integration development of processing and marketing infrastructures (S1,2,3,4,5,6,7; O1,2,3,4,5) 3 Increasing skills of fish handling and processing (S1,2, 3,4,5,6; O1,2,3,4,5)	1 Improving cooperation with finance institutions in providing capital for fishery business (W2,8;O1,2,3,4,5) 2 Increasing skills of fish handling and processing (W1,3,11,12; O1,2,3,4,5) 3 Improving marketing institutions function (W4,5,6,7,9,10; O1,2,3,4,5) 4 Forming institution that has mandate to stabilize fresh fish price (W7; O1,2,3,4,5)
Threats (T)	**ST strategies**	**WT strategies**
1 Illegal, Unrepported and Unregulated fishing in Maluku 2 Unregularly sea patrols	1 Integrated control by involving local community (S1,2,3,4; T1,2) 2 Tighten mechanism and controlling function (S1,2,3,4,5,6; T1,2) 3 Improving raw material distribution (S1,2,3,4,5,6,7; T2)	1 Improving sea security capacity (W3;T1) 2 Improving infrastructure of fish production and marketing (W1,2,3,4,5,6,7,8,9,10,11,12; T1,2) 3 Tighten mechanism and controlling function (W1,2,3,5,6,7,8,9,10,11; O1,2)

SO strategies

When strengths (S) are combined with opportunities (O) that happened due to current global economic improvement, it will result some SO strategies as below.

1) Improvement the environment insight of capture fishermen
2) Integration of processing and marketing infrastructures
3) Increasing skills of fish handling and processing

Increasing of population and awareness of fish consumption as well as community's income and purchasing power are challenges for fishermen to catch fish at most. Imbalance of fish resources exploitation and reproduction capacity resulted in catching pressure in some places in Maluku. Fishery resources condition in Fishery Management Area (FMA) Maluku in 2010 showed that almost all kinds of fish were in maximum exploitation/fully exploited and over fishing (PURBAYANTO 2011). The essence of environmental fisheries development is to manage fisheries resources in sustain. Limitation input control on catching efforts is one of management strategies, in addition to regulation of catching gears selectivity and catching time limitation (PURBAYANTO 2011). Furthermore, WIDODO and SUADI (2006) stated that, the principle of fisheries regulation can be approached by two methods: 1) input arrangements such as catching restrictions through licensing, size of vessels and fishing gears, as well as catching time and 2) output arrangement such as determination of catching allowed and dividing quota according to fleets, companies and fishermen.

Abundantly of fish resources in Maluku is not followed by the ability of fishermen as producers and fish traders to maintain the quality. Therefore, the price of it can be much fluctuated, even in a day sales. Improving of handling and processing skills in harvest and post-harvest time as well as integrating the facilities of processing and marketing is a must, so the system gives balanced share to effort. Fishermen processing skills should also be enhanced for the alternative diversity processed fish in Maluku. By that, the value of fish increase and there will be no more wasted fish into the sea.

WO strategies

WO strategies obtained by minimize the weaknesses in fresh fish marketing in Maluku to utilize currently opportunities. The strategies are as below.

1) Increasing collaboration with financial institutions in providing business capital
2) Increasing programs of fish handling and processing skills
3) Increasing function of marketing institutions
4) Establish institution that has mandate to stabilize fish price

Capital limitation is faced by most fishermen from time to time and will continue to happen if there will be no assistance from the Government. Therefore, strategy emerge from

this condition is to increase cooperation with financial institutions in assisting fishermen access credits to broaden their business. In connection to fish price fluctuation, an institution which has mandate to stabilize fish price should be formalized by the Government. This institution will have similar role and function with National Logistic Agency, to market and to secure national food as well as to manage the state-owned food commodities.

Fishermen's skills of fish handling and fish processing should be increased, for the quality of fish can be maintained and able to distribute to consumers who live far from the producers' area.

ST strategies

This strategy obtained by maximized strengths in anticipating threats in marketing of fresh fish in Maluku. Strategies resulted based on analysis as below.

1) Integrated control by involving local community
2) Restriction of imported fish that contained chemical agents
3) Tightening mechanism and function of controlling
4) Improving raw material distribution

Illegal, Unreported and Unregulated (IUU) fishing in Maluku causes limited fish resources for the local fishermen. According to NIKIJULUW (2008), practice of IUU fishing near the coastal area can disturb local fishery management system. An organized IUU fishing with modern technology urges fishermen run out from the resources and makes them obtain small income.

The rampant practice of IUU fishing is one of the causes which makes Indonesia was formerly known as the fish export country is now becoming one of the fish import country, including China, India and Pakistan. Fish are basically imported due to the scarcity of them in the processing industry. But, the abuse of import permits and lack of coordination of Government surveillance resulted in uncontrolled circulation of imported fish, so they are easily to distribute in remote areas. Yet the flood of imported fish have been highly detrimental to fishermen and hit the competitiveness of the national fisheries.

Evaluation of import regulation, data of fish necessity for processing industry and the ability of national production to fulfill the need of fishery processing industry as well as open-close system are strategies performed by the Government to solve the problem (KOMPAS 2011). However, those strategies are still raises pros and cons. To some parties, fish import policy is just considered a shortcut way in solving the scarcity of raw material in fish processing industry. In fact, the main problem of fish scarcity in processing industry is chaotic distribution of fish from production centers to the processing places. Therefore, improving fish distribution by providing production and marketing infrastructures, improving marketing agencies function, tightening the mechanism and supervision functions should be conducted, so the life of fishermen will increase.

WT strategies

This strategy obtained by minimize own weaknesses and anticipate threats, or to face possible threats from external environment of fresh fish marketing in Maluku. Some strategies appeared from weaknesses and threats fusions are as below.

1) Improving sea security capacity
2) Prohibiting imported fish contained chemical agents
3) Increasing production and marketing infrastructure
4) Tightening sea supervision capacity

Those strategies are presented to overcome some weaknesses such as limited awareness of fishermen in maintaining fish quality and limited capital of fishermen that lower their bargaining position in marketing fresh fish. Scattered production area and far from consumers, malfunction of Fish Auction Place and limited marketing infrastructure can also lead to higher marketing cost and higher of price fluctuation range in the market.

Another challenge in fresh fish marketing in Maluku is IUU fishing, and unsustainable sea patrol operation which causes irresponsible exploitation of fish resources. If this condition could not be overcome, the resources perhaps will be endangered and never be known by future generation.

Conclusion

Strategies to develop fresh fish marketing in Ambon Island are: 1) improving the infrastructures of production and marketing of fresh fish, 2) integrating the facilities of production, marketing and processing, 3) improving skills of fisher folks in fish handling and processing, 4) increasing cooperation with financial institutions in the provision of venture capital, 5) improving function of marketing institutions and 6) establishing an agency that has a mandate to stabilize prices of fisheries products.

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Efforts for Improving the Distribution of Fishery Products in Toshima, Kagoshima Prefecture

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Abstract

The fishing industry in remote islands often has disadvantages in terms of the distribution of products. Although remote islands enjoy abundant resources in surrounding fishing grounds, they are at a great disadvantage when it comes to deriving value from such resources. Therefore, fishing businesses in remote islands generally do not tend to be profitable. Fishery is a key industry for most remote islands. There is a possibility that a decline in fishing activity may weaken the local economy, local communities and the multifaceted functions of the remote island's fishing activity (e.g., maritime surveillance function and resource management function). Further, maintenance of the fishing industry on remote islands is a great challenge for the national economy. In this paper, I will discuss the case of Toshima, a village in Kagoshima Prefecture, where the distribution of fishery products has been improved through the introduction of freezing technology. Previously in Toshima, fishery products were shipped fresh using ferries. However, the ferries run only twice a week and are cancelled in bad weather. Further, ferry shipment requires a large amount of time and cost in transporting fishery products to the Kagoshima City Fish Market. In 2011, Toshima introduced state-of-the-art freezing facilities and established a system wherein a private company would undertake the freezing and selling of fishery products. This has resulted in reliable shipping and low transportation cost, among other benefits.

Keywords: disadvantages in terms of the distribution, freezing facilities, low transportation cost, reliable shipping

Purpose of the Study and Challenges

The fishing industry located in remote islands witnesses many disadvantages from production to sales. With respect to production, operating costs are high due to the high cost of fuel and fishing materials. Due to their small local markets, remote islands have to rely on the mainland market and shipping costs to reach such markets are high. Moreover, shipping is restricted by ferry schedules, and the time taken to reach the mainland market results in the reduction of freshness of products, thereby reducing their unit prices.

In this paper, using a case of Nakanoshima Island (one of the islands of Toshima) which has been making efforts to improve the distribution of fishery products through the introduction of freezing technology, I will discuss the history of such efforts, the results achieved so far, and future prospects.

Outline of the Fishing Industry in Toshima

Toshima is a village consisting of the Tokara Islands and has a population of 689 people. The Toshima Fisheries Cooperative has 33 full-time members of which five members are full-time fishing operators. Many of the other members are part-time fishing operators concurrently running accommodation, livestock, recreational fishing boat or other businesses.

The main fishing methods used in Toshima are rod fishing, gillnet fishing and free dive fishing. The village has been witnessing an increase in both the annual catch volume and value. Compared to the levels in early 2000s, the total catch value increased fourfold and the total catch amount increased threefold in 2014 (Fig. 1). These increases were due to the introduction of freezing facilities in 2011. Previously, shipping to the mainland market had to be cancelled when lots were not filled owing to the inability to cover shipping expenses. Now, as will hereafter be discussed, Yamaguchi Suisan, the company that manages the new freezing facilities, purchases even one fish, and because of this, local fishing operators have started shipping out fish and shellfish that would otherwise have to be consumed by the operators themselves. Seeing this as a new income generating opportunity, some elderly fishing operators have started operating more often.

Until 1998, all fishery products from the village were shipped to the Federation of Fisheries Cooperative Associations in Kagoshima Prefecture (hereinafter the Federation), a wholesaler for the prefectural market. However, shipping destinations have become

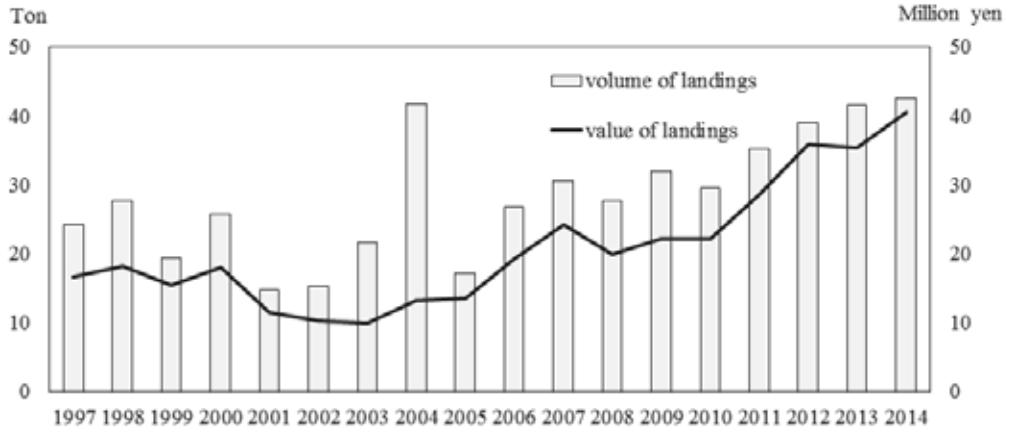

Fig. 1. Change of fishery in Toshima (Source: Toshima Fisheries Cooperative Association).

diversified since 1998 and the rate of selling fish through the Federation has dropped to 60–80% since 1999. The introduction of freezing facilities in Takarajima Island in 2011 and in Nakanoshima and Tairajima islands in 2013 (Yamaguchi Suisan was designated as a manager for these facilities) prompted many fishing operators to send their catches to Yamaguchi Suisan, reducing the rate of selling fish through the Federation to slightly over 10% since 2013.

Unit shipping prices have been rising since 2011 owing to a slight increase in the unit prices of fish and shellfish at the Kagoshima City Fish Market since 2011 and an increase in the available shipping options, among other reasons.

Background on the Efforts to Improve Distribution by Freeze-Shipping

Ferry Toshima, which is used to ship fishery products from Toshima, is operated twice a week, and the annual in-service rate is between 90% and 93%. Its operation is susceptible to natural conditions such as typhoons and seasonal winds; therefore, the shipping of fish and shellfish from the village is dependent on natural conditions.

Further, shipping to mainland Kagoshima by ferry is expensive. For example, transporting 100 kg of fish or shellfish from Toshima to the Kagoshima City Fish Market costs 89.5 yen per kg. In addition to this cost, shipping commissions of 5% and 5.5% are charged by the Toshima Fisheries Cooperative and the Kagoshima City Fish Market, respectively. Due to the high cost of and other restrictions on shipping fish and shellfish, the development of a distribution system has been a challenge for promoting the fishing industry in Toshima.

In the midst of this, in 2011, the president of the Toshima Fisheries Cooperative at the time and a member of the village assembly played a key role in examining the approach to improve the village's distribution system and deciding on the introduction of freeze-shipping. It was agreed that Toshima would pay the cost of approximately 30 million yen for the installation of freezing facilities and Yamaguchi Suisan, as a designated manager, would manage the freeze-processing business and the selling of processed products.

Freeze-Processing Business of Yamaguchi Suisan

History of Yamaguchi Suisan

Yamaguchi Suisan is a wholesaler of fishery products headquartered in Kagoshima City. It operates in Miyazaki, Kumamoto and Oita prefectures as well as Kagoshima Prefecture. In Kagoshima Prefecture, its customers are accommodation businesses and mass retailers. The company also sells fishery products to mass retailers and accommodation businesses in Miyazaki and Oita prefectures.

Business expansion to the Tokara Islands

Background on the launch of the business

In 2011, Yamaguchi Suisan commenced the freeze-processing business in the Tokara Islands. In response to the Toshima Village Office's desire to improve their distribution system for fish and shellfish harvested around the islands, in October 2011, the Toshima Village Office, the Toshima Fisheries Cooperative and Yamaguchi Suisan concluded an agreement on the purchase of local fish and shellfish.

First, in 2011, Toshima installed quick-freezing facilities on Takarajima Island. As a designated manager of the facilities, Yamaguchi Suisan started a business of filleting fish harvested near the island and quick-freezing them. However, the catch amount on the island was too small for the capacity of the facilities, which highlighted the need to use the facilities more effectively.

Then, in 2012, Toshima installed quick-freezing facilities on Nakanoshima Island. The original plan was that the residents of the island would run the facilities; however, the plan was cancelled due to the residents' inexperience in this business and since January 2013, Yamaguchi Suisan has been running the business as a designated manager. It is involved in the business of filleting fish harvested near the island, quick-freezing them and transporting them to Yamaguchi Suisan in Kagoshima City using Ferry Toshima. Mr. Yuhei Yamaguchi was in charge of the business and was essentially based on the island in 2013 and 2014.

When the business was launched, local fishing operators and local residents were keen to know the purchasing conditions, hourly wages at the fishery processing plant etc. It was decided that monthly purchase prices would be set based on the average prices at the Kagoshima City Fish Market. Further, it was decided that in principle, the total volumes of fish and shellfish would be purchased; however, only shallow water fish and shellfish up to two days after harvest and other fish and shellfish up to one day after harvest would be accepted. Other conditions required that the fish caught was properly killed in seawater ice, and blood was removed from yellowfin tuna, skipjack and barracouta. Fish and shellfish that were not sufficiently chilled would be purchased at half prices or returned.

It was decided that local women would carry out freeze-processing. Currently, over 10 women are registered for this role and when fish and shellfish come in, the information is circulated among the registrants and those available to perform the work. The hourly wage has been set at 700 yen.

Development of the freeze-processing business

Apparently, Yamaguchi Suisan experienced many troubles when they launched the business on Nakanoshima Island. Initially, only a small amount of fish and shellfish was brought in. The islanders portrayed a wait-and-see attitude, doubting the motive of the company for starting the business. Most local fishing operators continued to ship their catches to the Kagoshima City Fish Market, sending only a small amount of fish and shellfish (amount not large enough to fill up lots) to the island's processing plant. As a result, freeze-processing at the plant often took only one hour.

In addition, the company had difficulty in handling fish. Once, the company purchased a large amount of skipjacks but had to discard poor-quality fish stacked low in a ship's hold. The company lacked an understanding about the reality of the local fishing operations. They even had difficulty in filleting fish.

With regard to fish species sellable at retail levels, the company continued to accumulate knowledge through the operation of the processing plant and selling activities. Bycatches could only be sold for a limited time and quantity due to their small amounts, making it difficult to incorporate them into the business. On the other hand, species such as Japanese bluefish, splendid alfonsino and Japanese butterfish were selling well, prompting the company to consider increasing the transaction volumes of such fish.

Some local fishing operators misinterpreted "total volume purchase" for Yamaguchi Suisan purchasing fish and shellfish of any quality. Occasionally, fish and shellfish that were improperly treated or harvested several days ago were brought in. The company had to explain to such operators the intentions of the business and asked them to carry out thorough freshness control.

Through these efforts, Yamaguchi Suisan gradually won the trust of the islanders and local fishing operators. From the summer six months after the launch of the business, an increasing number of fish and shellfish started to be brought in. It appears that the benefits of using the processing plant in comparison to directly shipping to the market, e.g., saving of transportation and ice costs, time and effort, were finally understood by the operators.

As the business picked up, the company started receiving requests from clients. Local fishing operators wanted the processing plant to operate whenever they went fishing, including during the Bon period, indicating that the local operators regarded Yamaguchi Suisan as an important buyer. With regard to purchase prices, some operators requested that their products be purchased at higher than average market prices. When market prices remained high, some operators expressed dissatisfaction with the purchase prices set by the company. Yamaguchi Suisan has adhered to the policy of offering average market prices to clients and letting them decide whether they want to sell their catches to the company.

Results of the efforts for improving distribution, future prospect

It has been five years since Yamaguchi Suisan's business in Toshima gained momentum, and local fishing operators have expressed merits of engaging with the business, including the "avoidance of shipping expenses," "saving of time and effort," "ability to sell from small lots" and "stable purchase prices." The introduction of the freeze-processing plants has allowed local fishing operators to operate regardless of the ferry schedule. Another change observed is that the associate members of the local fisheries cooperative, many of whom harvest fish and shellfish for self-consumption, have started using the processing plants. In the past, when they had a good catch, they tended to give away excess fish and shellfish to people on the island because such excess fish and shellfish were not enough to fill lots for shipping. Yamaguchi Suisan, which purchases even one fish from operators provided it is fresh, now functions as a buyer for such fishing operators.

As a result, catches in the district managed by the Toshima Fisheries Cooperative have increased, and the business of Yamaguchi Suisan has grown and now handles a quarter to one-third of the total fish and shellfish yield in the area. On the other hand, the need to strengthen the sales force of Yamaguchi Suisan has emerged.

Conclusion

In this paper, I discussed the effects of the freeze-processing business run by Yamaguchi Suisan and its future prospects. The introduction of freeze-processing plants created a new distribution route not restricted by the ferry schedule, giving local fishing operators another shipping option. Local fishing operators can now determine the buyer of their fish and shellfish considering market prices, catches, transportation cost, time/effort required etc.

Because of the eased shipping-related restrictions, some fishing operators have started going fishing more frequently. In addition, fishing operators who would not send their catches to the market because they could not fill lots are now able to sell their products. As a result, since 2011, both the catch amounts and values handled by the Toshima Fisheries Cooperative have increased, indicating that the installation of the freezing facilities to promote the local fishing industry and the efforts made by designated manager Yamaguchi Suisan have produced a certain level of benefits.

The most significant reason that the development of a distribution system in Toshima has promoted the local fishery production is the involvement of a private company with a strong sales force. It may be true that fishing operators or the staff of a fishery cooperative would be able to produce frozen products if freezing facilities are available and the necessary skills are mastered by them. However, simply freezing fish and shellfish do not make them products of value. Only with the involvement of a company with the required experience and knowledge on product creation and selling does frozen fish become a product in the true sense. Through the collaboration of suppliers (local fishing operators), a private company handling production and selling (Yamaguchi Suisan) and a government that has been providing the necessary facilities (Toshima), the results reported in this paper have been achieved.

P.S.

I hope that this paper assists Indonesia’s Maluku Province, which faces similar problems, in developing policies for improving their distribution system.

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The Diversity of Grouper (Epinephelinae) in Ambon Island, Maluku, Indonesia

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Abstract

Located in the heart of world's coral triangle, Maluku seas were estimated to harbor around 1,500 species of fish, which make Maluku seas one of the highest in fish diversity. However, the data to support this claim is not yet available. In this report, we focused our research on the diversity of grouper (family Serranidae, subfamily Epinephelinae) that have the highest economic value and usually exported to various countries around the world. Our preliminary research on diversity of groupers landed at fish market around Ambon Island showed astonishing result. We identified 36 species of groupers that belong to 9 genera. Importantly, two of the species *Epinephelus ergastularius* Whitley 1930 and *Saloptia powelli* Smith 1964 were never reported to be found in Indonesia and can be potentially be declared as a new record. Furthermore, there is one species *Cephalopholis igarashiensis* Katayama 1957 that has been found in North Sulawesi but never reported to be found in Maluku waters. The mitochondrial DNA of the above mentioned species are being sequenced and will be reported in a separated report. Our results will have a great contribution in building a new database on the diversity of fish in Maluku and will provide new information to revise the geographical distribution of groupers.

Keywords: coral fish, fisheries, geographical distribution, management, Serranidae

Introduction

Epinephelinae is Subfamily of Serranidae, a large family of fishes from Order Perciformes that comprises about 450 species in 65 genera. They are recognized as groupers. Fishes belong to this group have considerable high economic value. Groupers are among the most marketable group of tropical marine fish. They have high prices at markets and consequently become the main target in fisheries industry (BEETS and HIXON 1994, MORRIS *et al*. 2000, RANDALL 1987, SLUKA and REICHENBACH 1996). The taste and high market value are some of the reasons that cause this group becoming the most important mariculture commodity in Asia and around the world (CHIU *et al.* 2008, JEFRI *et al*. 2015).

The subfamily Epinephelinae has approximately 159 species in 15 genera (HEEMSTRA and RANDALL 1993, MORRIS *et al*. 2000). The group populates a wide range of habitats and exhibits a wide variety of reproductive and growth strategies (JOHANNES 1978, MORRIS *et al*. 2000, SHAPIRO 1987). Some species have a home range larger than 1.8 ha and can migrate in a distance up to 2 km (SAMOILYS 1987, SAMOILYS *et al.* 1997, UNSWORTH *et al*. 2007). Groupers play key function in structuring coral reef communities due to its role as top predatory fish feeding on fish. A thriving and productive reef community is indicated by a large grouper population. However, the population is intensely exploited (BOHNSACK 1994, CHIAPPONE *et al*. 2000, COSTA *et al*. 2003, UNSWORTH *et al*. 2007). Currently, some species of groupers such as Giant Grouper (*Epinephelus lanceolatus*), Mouse Grouper (*Cromileptes altivelis*) and Brown Marbled Grouper (*Epinephelus fuscoguttatus*) are listed as vulnerable, threatened and near-threatened, respectively, based on the Red Data listed by IUCN (RODRIGUES *et al*. 2010). Some researches have been conducted to explore the biodiversity of groupers around the world. HEEMSTRA *et al*. (2002), for example, describes groupers in Atlantic Sea. The result is quite comprehensive, comprises diagnostic character, size, habitat, biology, fisheries, distribution, remarks and key identification to species level. On the other hand, other researches concerning phylogenetic relationship that are still poorly understood due to the high variety of taxa that must be considered. Information about the relationships among the Serranidae has been equally limited (CRAIG and HASTINGS 2007, JEFRI *et al*. 2015).

Evaluation of genetic diversity and phylogeny using modern molecular biology techniques has enabled comparisons between nucleotide and amino acid sequences of different populations. Studies in fish taxonomy using DNA markers have been developed by for example RODRIGUES *et al.* (2010) that utilized microsatellite markers for the identification of some groupers including *E. lanceolatus*, *C. altivelis* and *E. fuscoguttatus*. Recently, the use of molecular phylogenetic approach has been widely accomplished by the newly developed DNA barcoding method. However, identification of fish species based on morphological trait still play important role and irreplaceable especially when the access to sophisticated molecular biology equipment is limited.

Materials and Methods

This research was conducted from April to November 2016 in Ambon Island, Maluku, Indonesia. Coral reef fish were collected at fish markets around Ambon Island (Fig. 1). Three to five specimens from each species were bought and kept in the cool box filled with ice to maintain the integrity of DNA. To avoid redundancy in sampling, list of species collected were developed following each sampling activity. The sellers were interviewed to collect data

for biogeography distribution. Samples from other islands were separated. Samples were then brought to marine ecology laboratory, at Maritime and Marine Science Center of Excellence, Pattimura University. Each specimen was measured, tagged, then laid on styrofoam. The fins were spread with nail and arranged for photograph. The tissue samples were then collected and stored in 95% ethanol for DNA extraction. The reef fish found were identified to the species level based on ALLEN (2000), KUITER and TONOZUKA (2001), ALLEN *et al.* (2003), KUITER and DEBELIUS (2006) and ALLEN and ERDMANN (2012). Samples were then stored in 4% formalin for long term storage.

Results and Discussion

It is widely known that landings of marine fishes in the markets are not similar but depended on natural abundance, consumer preference, geography, history and ease of catch. Consequently, in areas surrounded by coral reef ecosystems, high diversity of species is harvested with various fishing techniques. Usually fish landed in the fish markets of these areas including snappers (Lutjanidae), surgeonfishes and unicornfishes (Acanthuridae), parrotfishes (Labridae), emperor breams (Lethrinidae) and groupers (Epinephelinae) (GARCIA and ROSENBERG 2010, SALAS *et al*. 2007). Among them, groupers are known to be heavily exploited, because they have the highest market price (CHIAPPONE *et al.* 2000, SADOVY 1994). The consequence of dropping grouper fisheries sometimes devastated for many coastal communities and ecosystems especially for those that depend solely on fisheries.

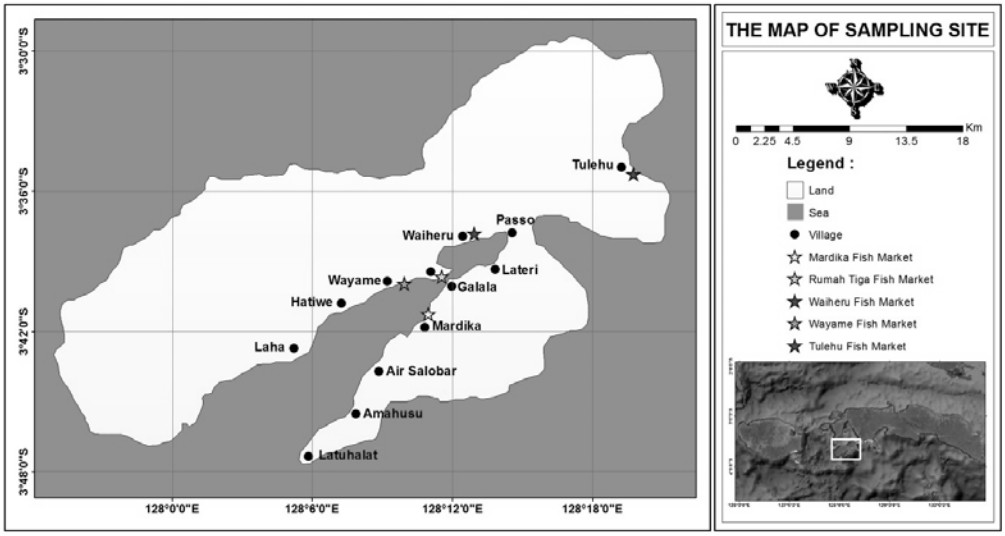

Fig. 1. Map of fish markets in Ambon Island.

Strikingly, despite the reports of decreasing groupers population in Indonesia, we found 36 species of groupers (Epinephelinae) that belong to 9 genera during the study in fish markets of Ambon Island (Table 1). The diversity of groupers found in our study is higher that found in similar studies conducted by RHODES and TUPPER (2007) that found 24 species of groupers in fish markets of Pohnpei, Micronesia and ALCANTARA and YAMBOT (2016) that identified 27 species of groupers from major fish landing sites and markets in the Philippines. Interestingly, two of the species found in Ambon fish markets *Epinephelus ergastularius* Whitley 1930 and *Saloptia powelli* Smith 1964 were never reported to be found in Indonesia and can be potentially declared as a new record. *Epinephelus ergastularius* Whitley 1930 is also known as sevenbar grouper that usually inhabits deep rocky reefs. The original name of this species was recently changed to *Hyporthodus ergastularius* (CRAIG and HASTINGS 2007, SMITH and CRAIG 2007). This species was previously reported to be found only in Southwest Pacific and the Eastern coast of Australia. *Saloptia powelli* Smith 1964 with common name golden grouper was reported to be found in Pacific Ocean, Western Pacific and French Polynesia. This species has been found in Taiwan, Okinawa (Japan), the Mariana Islands, the Society Islands, American Samoa, Samoa, the Cook Islands, Federated States of Micronesia, French Polynesia, Fiji, Kiribati, New Caledonia, Niue, Palau, Papua New Guinea, the Solomon Islands, South China Sea, Tokelau, Tonga, Tuvalu, the Tuamotu Islands and Vanuatu (HEEMSTRA and RANDALL 1993). This species is widely known to inhabit deep rocky reefs.

Table 1. Groupers found at fish markets in Ambon Island.

No.	Family	Species	No.	Family	Species
1	Serranidae	*Aethaloperca rogaa*	19	Serranidae	*Epinephelus coralicola*
2	Serranidae	*Anyperodon leucogrammicus*	20	Serranidae	*Epinephelus cyanopodus*
3	Serranidae	*Cephalopholis argus*	21	Serranidae	*Epinephelus epistictus*
4	Serranidae	*Cephalopholis aurantia*	22	Serranidae	*Epinephelus ergastularius*
5	Serranidae	*Cephalopholis boenak*	23	Serranidae	*Epinephelus fasciatus*
6	Serranidae	*Cephalopholis cyanostigma*	24	Serranidae	*Epinephelus faveatus*
7	Serranidae	*Cephalopholis igarashiensis*	25	Serranidae	*Epinephelus maculatus*
8	Serranidae	*Cephalopholis miniata*	26	Serranidae	*Epinephelus melanostigma*
9	Serranidae	*Cephalopholis nigripinis*	27	Serranidae	*Epinephelus merra*
10	Serranidae	*Cephalopholis polleni*	28	Serranidae	*Epinephelus ongus*
11	Serranidae	*Cephalopholis sexmaculata*	29	Serranidae	*Epinephelus quoyanus*
12	Serranidae	*Cephalopholis spiloparaea*	30	Serranidae	*Epinephelus spilotoceps*
13	Serranidae	*Cephalopholis urodeta*	31	Serranidae	*Gracila albomarginata*
14	Serranidae	*Epinephelus amblycephalus*	32	Serranidae	*Liopropoma lemniscatum*
15	Serranidae	*Epinephelus areolatus*	33	Serranidae	*Pogonoperca punctata*
16	Serranidae	*Epinephelus bilobatus*	34	Serranidae	*Saloptia powelli*
17	Serranidae	*Epinephelus caeruleopunctatus*	35	Serranidae	*Variola albimarginata*
18	Serranidae	*Epinephelus coioides*	36	Serranidae	*Variola louti*

Furthermore, there is one species *Cephalopholis igarashiensis* Katayama 1957 that has been found in North Sulawesi waters but never reported to be found in Maluku waters. Previously, this species has been reported to be found in Tropical Western Pacific, Southern Japan, Taiwan, Guam, Philippines, South China Sea, Samoa and Tahiti (PERISTIWADY *et. al*. 2009). Our results will have a great contribution in building a new database on the diversity of fish in Maluku and will provide new information to revise the geographical distribution of groupers.

Given that fishing pressure is the major driver of population declines in most threatened grouper species, it must be addressed to move towards their recovery. Grouper management has been attempted in various ways, ranging from minimum size limits to protect juvenile fish, recreational bag limits and commercial fishing quotas, gear and seasonal controls, marine protected areas, to limited entry fisheries and slot sizes. Moreover, the establishment of no-take-area (NTA) has been shown to be effective management strategy to increase the population and help maintain and increase the grouper stocks.

Acknowledgement

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Species Diversity of Hexacorallia around the Satsunan Islands, Japan

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Abstract

The Satsunan Islands, in the middle to the north of the Ryukyu Islands, Japan, are located in an important location for biogeography, as there is a shift of marine fauna in this region from subtropical to temperate. However, few have studied about marine biodiversity of this region for many taxa, with exceptions such as fishes. In this report, the biogeographic relations between the Coral Triangle region of highest marine diversity, and the Satsunan Islands, using previous reports related to species diversity of subclass Hexacorallia are reviewed. In the near future, it is strongly needed to more clearly reveal the species diversity of order Hexacorallia within the Satsunan Islands, a region of ecological variety, based on thorough and taxonomical surveys.

Keywords: biogeography, ecological variety, ecozone, Scleractinia, Zoantharia

Suborder Hexacorallia

Class Anthozoa, currently consisting of 3 subclasses; Hexacorallia, Octocorallia and Ceriantharia, is characterized by a lack of the medusa stage in their life cycles. Anthozoans are common organisms that are widely distributed in various marine environments from shallow to deep, from the equator to the polar region. The phylogenetic relationships within Anthozoa are not yet resolved. Compared to the other two suborders, inter-order level phylogeny within the subclass Hexacorallia is still under revision (DALY *et al*. 2007, STAMPAR *et al*. 2014). Octocorallia is characterized by eight plumate tentacles and eight complete mesenteries inside the body cavity. Ceriantharia, recently promoted to subclass from an order within subclass Hexacorallia, is characterized by a nest tube formed utilizing a specialized nematocyst, and unpaired, coupled mesenteries in the body cavity. In contrast to the two easily definable subclasses, Hexacorallia is a less coherent taxon. The morphological and ecological features within the subclass are very varied compared to the other subclasses. The synapomorphys of hexacorallians are considered to be the appearance of spirocysts, a type of nematocyst, and the first six mesenteries in the development of polyps.

Currently, subclass Hexacorallia consists of five orders; Scleractinia, Corallimorpharia, Actiniaria, Zoantharia and Antipatharia. It has been estimated that there are around 4,000 species contained within this subclass in a previous study (DOUMENC and VAN PRAET 1987). However, as well as the other marine invertebrates, the development of the analytical techniques have provided more and more discoveries of new taxa (e.g., studies for order Zoantharia: REIMER and FUJII 2017), and reconstructions of taxonomy have been performed (e.g., studies for order Scleractinia: FUKAMI *et al*. 2008, KITAHARA *et al*. 2010). In the orders Corallimorpharia, Actiniaria and Antipatharia, the accumulation of basal knowledge of species diversity is still required.

The Coral Triangle and the Satsunan Islands

The "Coral Triangle", an area of Southeast Asia between Malaysia, the Philippines, Indonesia and Papua New Guinea, is considered to be the center of the coral reef region, and the center of maximum marine biodiversity. Recently, the global patterns of biodiversity with various parameters such as species richness, uniqueness, or threats for major marine organisms have been discussed and analyzed for this region. However, further basal studies are required to properly estimate detailed biogeographical patterns. Most previous studies were focused on only major taxa, such as fish, snails, zooxanthellate corals, or lobsters, and the information on the border areas of the Coral Triangle is seriously deficient (e.g., HOEKSEMA 2007, ROBERTS *et al*. 2002).

The Ryukyu Islands are at the northern edge of the Coral Triangle, and are considered as one of the highest centers of marine bio-endemism (ROBERTS *et al*. 2002). Moreover, the Satsunan Islands are an important area to study the gradient of marine biodiversity from subtropical to temperate zones following the Kuroshio Current. The Ryukyu Islands are the southern chain of islands in Japan, from the east side of Taiwan to the Osumi Islands, and spans from the subtropical to temperate zone. The Ryukyu Islands, or even the Nansei Islands, span over two prefectures, Okinawa and Kagoshima. The northern part is called the Satsunan Islands of Kagoshima Prefecture (TOYAMA 2009). From a biogeographical point of view, the Satsunan Islands extend into two regions as well; the Palearctic and Indomalaya ecozones. The border between these two ecozones, designated as Watase line, is crossed on Tokara Strait where is between Kodakarajima Island and Akusekijima Island. The border of the biogeographical ecozones was decided based on the terrestrial organisms, and it's still doubtfully if it can be applied to the marine benthic fauna. For example, the northernmost coral reef region is considered to be around Tanegashima Island (approx. N30° 21' to N 30° 51'), where in the areas where the average sea surface temperature of the coldest month is greater than 18°C (YAMANO 2009). Either way, the Satsunan Islands possibly having high

marine biodiversity from ecological, species to genetic levels. Previously some faunal reports on the major taxa of marine organisms were published only on some part of the islands (e.g., fish: MOTOMURA 2016).

Faunal Reports on Subclass Hexacorallia from the Satsunan Islands

The order Scleractinia, generally called stony corals, is one of the key taxa in the coral reef region. More than half of the approximately 1,400 species of this order are symbiotic with photosynthetic brown algae and known as reef-building corals or zooxanthellate corals (CAIRNS 1999). Zooxanthellate corals have important ecological roles in shallow warm waters as the primary producers and constructing complex physiological structures on the sea floor that providing various spaces to live for other organisms. Because not only of their ecological but also of the economic importance, recently the scleractinian species have become to be much studied regarding their species diversity for ecological monitoring, particularly by local administrative agencies and civilian organizations (see THE JAPANESE CORAL REEF SOCIETY and MINISTRY OF THE ENVIRONMENT 2004). Unfortunately, it is often difficult to access to details of such reports and to recognize if the surveys were carried out scientifically or not.

A field guidebook edited by VERON (2000) may be the most widely used material to identify zooxanthellate corals in recent years, and currently a beta version of the associated web database has been updated (VERON *et al*. 2016). Based on this database (2016), 369 species of zooxanthellate scleractinian corals have been listed in "Ryukyu Islands North" region (=from Okinawajima Island and the Kerama Islands to the Tokara Islands), and 218 species in the "Kyushu South-east" region (=from the Osumi Islands to the Koshiki Islands, southern Kyushu Island and east coast of Kyushu Island). However, these list contain some uncertain information as the distribution was reported based either or both on specimens or *in situ* photographs clearly identified combined with possibly distributed species in which the distribution was estimated but currently no records exist. Thus, although there are no doubts that this field guide and database are valuable in the preliminary identification and estimation of biogeographical patterns, these data should treat carefully and with caveats for scientific studies.

Within the Satsunan Islands, SUGIHARA *et al*. (2015) reported 161 species of zooxanthellate scleractinian corals from Tanegashima Island in the Osumi Islands. Although this work is an open access electronic field guide book and there is an absence of descriptions of voucher specimens, it can be considered to be a valuable distributional report as the methodology of identification and the traceability of the taxonomy were clarified. YABE and SUGIYAMA (1935) and SUGIYAMA (1937) reported 63 zooxanthellate scleractinian corals species from the Amami Islands and UTINOMI (1956) reported 15 species from the Tokara

Islands based on vouchered specimens in public museums. However, these older reports were simply the results of elementary surveys in each reports, and asides from the Tanegashima Island data, these reports are too old to be treated as information on the current species diversity around the Satsunan Islands region. Thus, there is an overall lack of basal information on coral species diversity in the Satsunan Islands.

The Zoantharia is the other hexacorallian order in which recently the studies on species diversity have been advanced as much as the order Scleractinia. This order, often called colonial sea anemones or sand-encrusting sea anemones, is characterized by a specialized bilateral mesenterial arrangement. This order is as large as Scleractinia, consisting of around 300 species, and the fact that almost all the species have no hard tissues such as a skeleton or sclerites had limited the progress of taxonomy in the past. However, molecular techniques have helped to sort out the taxonomy and advanced biogeographical research. Previously, 13 zoantharian species were recorded from the Satsunan Islands region based on voucher specimens or the descriptions of *in situ* observation, with 9 zooxanthellate species and 4 azooxanthellate species (see REIMER and FUJII 2017). Zooxanthellate zoantharians are considered to occupy a similar niche with zooxanthellate corals and assuming the ecological role as the primarily producer in the coral reef ecosystems, although they have no skeletal tissues to construct the new structures on the sea floor. ONO *et al*. (2008) revealed the distribution patterns of 9 zooxanthellate zoantharian species in the Satsunan Islands, showing decreasing species richness from south to north.

The other hexacorallian orders; Corallimorpharia, Actiniaria and Antipatharia, have been studied little regarding the species diversity around the Ryukyu Islands region. There is no doubt that these orders also have high species diversity around not only the Satsunan Islands but also in the whole Ryukyu Islands, as there are many photographs on field guides (e.g., SHIRAI 1977, UCHIDA and SOYAMA 2001). The preliminary results of this author's informal survey suggest the distribution of 7 species including 2 previously unrecorded species of zoantharias around Takarajima Island, the Tokara Islands (FUJII 2016). Thus, it is easy to estimate that the species diversity of Hexacorallia is higher than has been previously reported within this region, particularly given that Takarajima Island is a comparatively small island and the eco-habitats for hexacorallian species are less varied within the Satsunan Islands.

In the near future, it will be strongly required to more clearly reveal the species diversity of order Hexacorallia not only within the Coral Triangle, the region of highest marine biodiversity, but also within the Satsunan Islands, a region of ecological variety, to report representatively based on the thorough field and taxonomic surveys utilizing identification with voucher specimens.

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Identification and Inventory of Coastal and Small Islands Conservation Area in the Lease Islands, Maluku Province

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Abstract

Maluku Province is targeting 1,000,000 ha of coastal and small island conservation areas until 2019. For that reason, this study was conducted to identify and to inventory the conservation area in the Lease Islands region as part of the Cluster VII island of Maluku. The conservation areas in this region were categorized into three namely conservation of coastal and small islands, maritime conservation area and marine waters conservation area. The most suitable conservation area among those three classifications was determined based on score system and value-weighted score for three main criteria, i.e., ecological, social and economic which consist of 20 parameters. The results indicated a potential conservation area on the Island Cluster VII, i.e., on the Lease Islands region with an area of 81,573.48 ha. Conservation of coastal and small islands have the highest score and become the selected category with a score-weighting of 1.15, higher than the other two categories. The type of conservation area is set to become Small Island Park and designated by the name of Small Island Park of the Lease Islands.
Keywords: category, conservation policies, islands cluster, score-weight

Introduction

Until 2020, there is targeted Marine, Coastal and Small Islands Conservation Area of 20,000,000 ha in Indonesia. This target is to answer the mandate of Indonesia Republic Law No. 27 of 2007 as amended by Law No. 1 of 2014. This law defines conservation as the protection, preservation and utilization of Coastal Areas and Small Islands and the ecosystem to ensure the existence, availability and continuity of resources while maintaining and improving the quality of the value and diversity.

Conservation Areas according to the Regulation of the Indonesia Minister of Marine and Fisheries No. 17 of 2008 is part of coastal areas and small islands that have certain characteristics as a whole ecosystems are protected, preserved and/or utilized in a sustainable manner to realize the management of coastal areas and small islands sustainably.

Conservation of coastal areas and small islands is held: 1) to preserve coastal and small island ecosystems, 2) to protect migration of fish and other marine life, 3) to protect the habitat for marine life and 4) to protect the traditional culture.

To support the policy of the Indonesian Government, the Government of Maluku Province took the initiative to develop a Conservation Area of Marine, Coastal and Small Islands on the entire island cluster as the unit of planning area. Maluku Government expects up to 2019 there were 1,000,000 ha of conservation area. In the province there are 12 island clusters, and 8 island clusters already have a conservation area.

In 2015, the Department of Marine and Fisheries Maluku Province collaborated with the Research Center for Small Islands, Coastal and Outermost Islands of Pattimura University, to determine the potential of protected areas at the Islands Cluster VII (including Ambon Island and the Lease Islands) which has not had conservation area. This study aims to identify and inventory the conservation areas of marine, coastal and small islands waters.

Method

This study was conducted on the Lease Islands as a part of the Islands Cluster VII of Maluku. The study was conducted from September to December in 2015.

The method includes 20 parameters according to Supplement 1, Guide to Identification, Inventory and Reservation of Marine, Coastal and Small Islands Conservation Area (LUBIS *et al*. 2014). Twenty of these parameters are clustered in three criteria. First, an ecological criterion includes 10 parameters: 1) biodiversity of mangrove, seagrass and coral reefs, 2) originality, 3) the ecological connectivity, 4) representation, 5) uniqueness (distribution of flora, fauna and ecosystems), 6) productivity (biomass, kg/ha), 7) migration area, 8) habitat of endangered, endemic and protected fishes, 9) spawning ground and 10) nursery ground.

Second, a social criterion includes 6 parameters: 11) community support, 12) conflicts of interest potential, 13) threats potential, 14) the potential of maritime history, 15) local wisdom and 16) customs.

Third, an economic criterion includes 4 parameters: 17) the importance value of fisheries, 18) the potential for recreation and tourism, 19) aesthetics and 20) access to location.

The category of conservation area, such as conservation of coastal and small islands, maritime conservation and marine conservation, was determined by using the scoring system and the value of score-weighted. The type of conservation areas was chosen by using comprehensive study approach.

Results and Discussion

General condition

The identification results show that a conservation area candidate has an area of 81,573.48 ha, of which 70.11% is marine water and 29.89% are land. The area has six border points: 1) 128°29'59,08" E and 3°29'56,24" S, 2) 128°35'18,80" E and 3°28'19,61" S, 3) 128°45'3,97" E and 3°28'48,76" S, 4) 128°52'2,91" E and 3°29'52,48" S, 5) 128°48'2,59" E and 3°44'2,90" S and 6) 128°30'59,10" E and 3°39'11,88" S, covering most of Haruku, Saparua, Molana, Nusalaut islands and adjacent waters (Fig. 1).

Bathymetric mapping results showed that waters depth average near the islands ranging from 50 to 150 m. Deep water in general is in the southern part of the conservation area, directly opposite the Banda Sea, as well as the eastern part of Saparua and Nusalaut islands.

Chlorophyll-a concentration ranged from 0.4 to 1.0 mg/m^3. The concentration of chlorophyll-a was high (1.0 mg/m^3) in the bay waters and around the estuary. The high concentration of chlorophyll-a on the waters of Saparua and Nusalaut islands indicates that these waters contribute to high productivities.

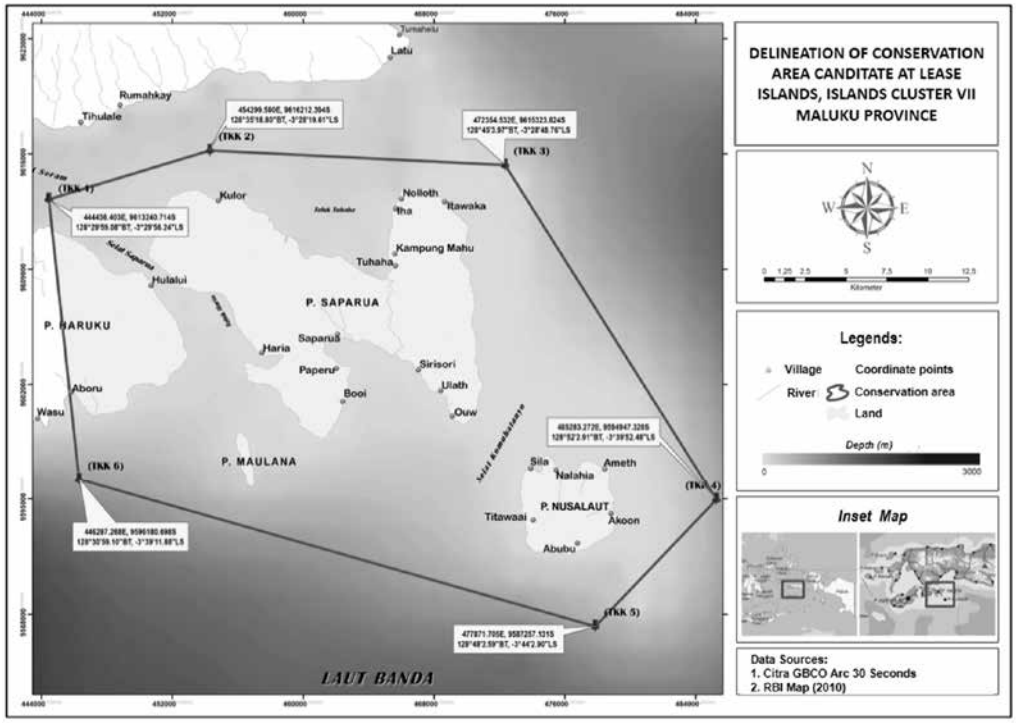

Fig. 1. Delineation of the Lease Islands (the Islands Cluster VII) conservation area.

Criteria and parameters to determine conservation area category

Ecological

Biodiversity: a biodiversity parameter rate was based on the existence of three keystone ecosystem at the coastal area, mangroves, seagrass and coral reef. Among three ecosystems, a biodiversity value was in accordance with the species distribution. Distribution of mangrove species ranged from 4 to 12 species and that of seegrass ranged from 5 to 8 species. Moreover, many species of coral reefs were found in this area. The average value of the entire ecosystem diversity is 3.01. Biodiversity is given a score of 3.

Originality: 75.96% of mangrove, 76.51% of seagrass and 75.74% of coral reefs were original ecosystems. Originality is given a score of 3.

Ecological Connectivity: the status of ecosystem components connected to 73.15%. Ecological Connectivity is given a score of 2.

Represent: assessment of these parameters is based on the number of ecosystem types and the main habitats in an area. At a regional level, there are 11 types include: mangroves, seagrass beds, coral reefs, lagoons, muddy, sandy beaches, rocky beaches, steep coast, *pasi*, shallow waters and deep sea. There are 9 types (81.82%) at Haruku, 10 types (90.91%) at Saparua and 10 types (90.91%) at Nusalaut. The average value of the representation is 87.88%. Represent is given a score of 3.

Uniqueness: some uniqueness were found in this area, such as local wisdom (*sasi*) and community knowledge about the location of fishing ground of red snapper group (this knowledge is called *pasi*). These wisdom and knowledge are found only in the Moluccas, particularly in the Lease Islands, thus Uniqueness is given a score of 2.

Productivity: productivity was assessed by abundance of reef fish. It is found that the productivity was 949 kg/ha at Haruku, 2,151.5 kg/ha at Saparua and 2,411.5 kg/ha at Nusalaut, which indicates very high productivity in this region. Productivity is given a score of 3.

Migration Area: the waters around the candidate of conservation area is a migration area of 7 species of whale, 5 species of dolphins and 4 species of sea turtles. The presence of three groups of mega fauna illustrates the highly migratory species richness around the area. Migration Area is given a score of 3.

Habitat of Endangered and Protected Species: an endangered species is found in Dugong dugon and protected species are found in whales, dugongs, turtles, top shell and green turban. Habitat of Endangered and Protected Species is given a score of 3.

Spawning Ground: a location of spawning ground was found only at the Leinitu waters, Nusalaut Island by using participatory mapping. Spawning Ground is given a score of 1.

Nursery Ground: 491.67 ha of mangrove area and 91.98 ha of seagrass beds were an area of nursery ground of marine fauna in the surrounding area. Nursery Ground is given a score of 3.

Social

Community Support: among 80 respondents in three islands, 88.75% agreed to support conservation area development. The result shows the status of more than 75% of people support the development of a conservation area, so Community Support is given a score of 3.

Conflicts of Interest Potential: conflict of space utilization, fishing gear conflicts and political conflicts were assessed. All the components are generally considered low, an average of 92.50% of respondents said that the potential for conflict is low. Conflicts of Interest Potential is given a score of 3.

Potential of Threats: results of field assessment show only one of the six factors identified as potential of threats (the use of fishing gear and techniques damages the environment). The status of the potential of threat is low, thus Potential of Threats is given a score of 3.

Potential of Maritime History: three potential of maritime history, such as a route colonial cruise, a historical tourism and an international live aboard since 1949, were identified. Potential of Maritime History is given a score of 3.

Local Wisdom: three types of local wisdom, such as *sasi laut*, *amula laut* and local knowledge of *pasi* as a potential fishing ground, were identified in this area, which can support conservation. Local Wisdom is given a score of 3.

Customs: assessment is done to find the existence of institutions and customs as well as the effectiveness of potentially support on conservation area development. About 14 local agencies are considered effective. Local institutional governance systems still work effectively, thus Customs is given a score of 3.

Economic

Importance Value of Fisheries: the assessment was based on the value of Location Quotient (LQ) of the value of fishery production. The calculation of the value of LQ was 1.07 which shows fisheries potentially are very important economically. Importance Value of Fisheries is given a score of 3.

Recreation and Tourism Potential: recreation and tourism potential of the conservation areas candidate includes beaches, mangrove ecotourism, seagrass ecotourism, coral reef ecotourism and maritime history. Recreation and Tourism Potential is given a score of 3.

Aesthetics: coral reefs in the waters, white sand of beaches and cleanliness of the marine environment in this region have a high aesthetic value, thus Aesthetics is given a score of 3.

Access to Location: assessment of the access was done by calculating the average value of access to three main islands, Haruku, Saparua and Nusalaut through sea transportation. The value of access was 89.58%, 92.19% and 67.86% in Haruku, Saparua and Nusalaut, respectively. These results indicate that the status of access is very easy, thus Access to Location is given a score of 3.

Determination of category and type of conservation area

Categories of the conservation areas are determined through an assessment of scores and weights in three general categories, conservation of coastal and small islands (CCSI), maritime conservation area (MCA) and marine waters conservation area (MWCA). The results show the highest value is the value of CCSI, 1.15 (Table 1). These results illustrate that the conservation area candidate of the Lease Islands should be developed with CCSI category.

Table 1. The results of the determination of Conservation Areas Criteria.

No	Criteria and Parameters	Score (S)	CCSI*		MCA*		MWCA*	
			Weight (W)	WxS	Weight (W)	WxS	Weight (W)	WxS
Ecological								
1	Biodiversity	3	4	12	2	6	4	12
2	Originality	3	4	12	1	3	4	12
3	Ecological connectivity	2	4	8	1	2	4	8
4	Represent	3	4	12	1	3	3	9
5	Uniqueness	2	4	8	1	2	4	8
6	Productivity	3	3	9	1	3	3	9
7	Migration area	3	3	9	2	6	3	9
8	Habitat (endangered and protected species)	3	3	9	1	3	4	12
9	Spawning ground	1	4	4	1	1	3	3
10	Nursery ground	3	3	9	1	3	3	9
Social								
1	Community support	3	2	6	4	12	2	6
2	Conflict interest potential	3	2	6	4	12	2	6
3	Threats potential	3	2	6	3	9	4	12
4	Maritime history potential	3	2	6	4	12	1	3
5	Local wisdom	3	2	6	2	6	1	3
6	Custom	3	2	6	4	12	1	3
Economic								
1	Importance value of fisheries	3	2	6	3	9	2	6
2	Recreation and tourism potential	3	2	6	4	12	2	6
3	Aesthetics	3	2	6	4	12	2	6
4	Access to location	3	2	6	4	12	2	6
Total		56	56	152	48	140	54	148
Total score			1.15		1.13		1.14	
Status of the area			Selected		Not selected		Not selected	

*CCSI: conservation of coastal and small islands, MCA: maritime conservation area and MWCA: marine waters conservation area.

CCSI consists of four types, Coastal Asylum, Small Island Asylum, Coastal Park and Small Island Park. In accordance with three criteria, Coastal Asylum has a value of 22, Small Island Asylum with a value of 27, the Coastal Park with a value of 30 and Small Island Park with a value of 35. These results suggest that Small Island Park is suitable for the conservation area candidate. High value on the type of Small Island Park is also based on the importance of conservation in the region that has been utilized by the community, with the support of the potential of small islands and the surrounding waters.

In general, the effectiveness of a protected area depends on a complex set of interactions between biological, economic and institutional factors. While MPAs might provide protection for critical habitats and cultural heritage sites, their impact is less certain as a tool to enhance fishery management (SANCHIRICO *et al*. 2002).

Protected areas are essential for the conservation of biodiversity and are one of the pillars of virtually all conservation strategies (AGOSTINI *et al*. 2015). In this context, the management of coastal/marine protected areas represents one of the main mechanisms for the protection of areas with significant ecological importance, functioning as an essential tool for ensuring the conservation of nature and the promotion of sustainable development (ESTIMA *et al*. 2014).

Conclusion

Conservation area candidate of coastal and small islands at the Lease Islands has the highest score and becomes the selected category with a score-weighting of 1.15, higher than the other two categories. The type of conservation area is set to a Small Island Park, and designated by the name of Small Island Park of the Lease Islands.

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Assessment of the Impact of Wildlife Tourism on Animals: A Case Study of Amami-Oshima Island

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Abstract

Wildlife tourism is a large and global industry. It contributes to wildlife conservation, while sometimes negatively impacting on animals. Numerous studies have reported the impact of wildlife tourism on animals. They have used several parameters, such as physiological response, behavioral modification and population dynamics, to evaluate the effects of such tourism on animals. In Amami-Oshima Island of Kagoshima Prefecture, Japan, the number of tourists has been increasing recently. One of the main wildlife tourism activities is a night tour for watching a nocturnal animal including Amami rabbit (*Pentalagus furnessi*), which is an endemic species inhabiting only Amami-Oshima and Tokunoshima islands. In order to evaluate the effects of wildlife tourism on Amami rabbits, we investigate their physiological and behavioral responses to the fluctuation of traffic volume on the road used for night tours. Such research will lead to the realization of stress-free tours on wildlife.
Keywords: Amami rabbit, human disturbance, stress, traffic, wildlife tourism

Wildlife Tourism for Animals

Wildlife tourism has recently become a large and global industry. In order to watch wild animals, people visit natural areas, such as rain forests and savannas, even if they are in distant countries. Because a tourist spends money not only on tour, but also on transport, accommodation, food and souvenirs, it is considered that wildlife tourism brings an economic profit to the habitat countries and/or regions. Moreover, the experience in nature gives an opportunity of environmental education to tourists. The economic and social value of wildlife tourism let people stop a destructive development and choose the sustainable use of a nature, which leads to the conservation of the target animals and their living environment (e.g.,

WEAVER 1999). However, several studies have reported negative impacts of tourism on animals (for example a review about birds: STEVEN *et al*. 2011).

How to Assess the Impact of Wildlife Tourism

Several ways are used to assess the impact of wildlife tourism on animals. Measuring physiological response has been a major technique for evaluating the impact on animals in the last decade. The plasma and/or feces glucocorticoid (GC) concentration (BUSCH and HAYWARD 2009, MILLSPAUGH and WASHBURN 2004), the heart rate (king penguins [*Aptenodytes patagonicus*]: VIBLANC *et al*. 2012) and hematological changes (southern stingrays [*Dasyatis americana*]: SEMENIUK *et al*. 2009) are used for measuring the phisiological response to the tourism. GCs have been used as an index of stress level though the primary role of GCs is to regulate the basic energy metabolism of the cells. When individuals encounter unexpected challenges, their GC concentrations rise beyond the threshold, sometimes posing a threat to their survival (in details: BUSCH and HAYWARD 2009). However, the interpretation of results can be complicated because many factors such as season, sex and age can affect GC levels (BUSCH and HAYWARD 2009). The modifications of animals' behavior after an encounter with tourists have also been surveyed as the effects of wildlife tourism. The self-scratching, aggressive behaviors, and change of habitat area were observed as the behavioral responses of animals to wildlife tourism (LUSSEAU 2005, MARÉCHAL *et al*. 2011, STAFFORD-BELL *et al*. 2012). Although mortality and reproductive success are the most important parameters of population dynamics and useful for evaluating the impact of tourism, it is difficult to investigate these parameters of animals with long life spans. While measuring the physiological responses provide us the quantitative data, animals can cope with human disturbances by changing their behavior and/or being habituated without physiological disorder. Therefore, it is considered better to perform a comprehensive evaluation by combining several parameters.

What of Tourism Affects Animals Negatively?

Several factors of tourism have been reported to negatively affect wildlife. Firstly, the heavy traffic can affect the behavior and physiology of animals. For example, bottlenose dolphins (*Tursiops* spp.) in New Zealand seem to avoid the fjord, which is a tourist spot, during the seasons of increasing boat traffic (LUSSEAU 2005). The hoatzin (*Opisthocomus hoazin*) chicks living in the tourist-exposed sites in Amazonian rainforest lakes also showed higher mortality and plasma GC levels, than those living in the undisturbed sites (MÜLLNER *et*

al. 2004). These indicate that the heavy traffic might cause noise disturbance and increase the risk of traffic accidents for the animals living there.

Even while observing the animals on foot, the tourists give some stress to the animals. In the Red Ape Encounters in the Malaysian state of Sabah, an ecotourism program which facilitates trekking for wild orangutans (*Pongo pygmaeus morio*), although the visitors are provided guidelines when observing animals, the stress hormone levels of the two habituated orangutans significantly elevated on the day after tourist visitation (MUEHLENBEIN *et al*. 2012). At Sandfly Bay in New Zealand, as the number of tourists increased dramatically, the yellow-eyed penguins (*Megadyptes antipodes*) showed higher stress hormone levels and reduced breeding success compared to those at the undisturbed breeding sites (ELLENBERG *et al*. 2007). In addition, close observation by tourists also might cause the disease transmission from humans to animals (WOODFORD *et al*. 2002).

Wildlife Tourism in Amami-Oshima Island

Amami-Oshima Island belongs to the Nansei Islands in the south of Japan, and is located at the northern limit of the subtropical climate zone. Approximately 80% of its land is covered by evergreen forests, most of which are secondary forests. The island is surrounded by the coral reefs, and is famous as a diving and fishing spot. The Nansei Islands, including Amami-Oshima Island, are one of the biodiversity hotspot areas in the world because they are inhabited by many endemic species such as Amami rabbit (*Pentalagus furnessi*), Habu (*Protobothrops flavoviridis*) and Otton frog (*Babina subaspera*).

Wildlife tourism in Amami-Oshima mainly involves a night-tour for watching Amami rabbits by automobile, and a whale-watching tour by boat. During whale watching, the tourists can see the humpback whales (*Megaptera novaeangliae*) and bottlenose dolphins (*Tursiops aduncus*). In the night tour, one can see not only the Amami rabbits but also other nocturnal animals including rats, frogs and snakes. The number of tourists in these wildlife tourism areas has been increasing recently. One of the reasons for this is the registration of the Amami and Ryukyu islands as the World Natural Heritage Sites by the UNESCO, and the annual total number of tourists has been increasing constantly in Amami-Oshima Island (KAGOSHIMA PREFECTURE 2016).

An increase in the number of tourists has led to an increase in the concern about the impact of tourism on animals. The Amami-Oshima Eco Tour Guide Association implements rules and conducts the training of guides for all tourism sites. The night-tours are carried out by using the forestry roads spread through the forests and old roads which were no longer used. These roads make it easy for the tourists to access the Amami rabbits' habitats and they sometime visit there without guides. This makes difficult to regulate all tours.

Monitoring Physiological and Behavioral Responses of Amami Rabbits in Amami-Oshima

In order to assess the impacts of such activities on the Amami rabbits, we have investigated their physiological and behavioral responses to the fluctuation of the traffic volume on the road used for a night-tour. The Amami rabbit is a nocturnal and burrowing animal, and is endemic to Amami-Oshima and Tokunoshima islands (YAMADA *et al*. 2000). It often uses open areas, including roads, for feeding on grasses and excreting during the night. We investigate the road use by Amami rabbit on the forestry road used for a night tour in Amami-Oshima Island. The fecal piles and the videos by camera trapping during a night were counted on 1.7 km of the road from July to December 2015. In addition, in order to measure the cortisol levels, fecal samples were collected. Each fecal sample has been individually identified by analyzing the DNA extracted from it and then the stress level of each individual has been investigated. Hormonal and DNA analyses are ongoing. We also obtained the data on the traffic volume of the target road using a counter machine which was installed by the Kagoshima Prefecture.

The traffic volumes during nights in August (mean: 3.5 cars per night, max: 9 cars) and September (mean: 3.4 cars, max: 11 cars) were greater than those during the other months (e.g., mean: 0.8 cars, max: 3 cars on December). The number of fecal piles and videos in August were lower than those in the other months (SUZUKI *et al*. 2016). These results suggest the negative impact of tourism on the behavior of Amami rabbits. We are going to analyze the relationship between the fluctuation of traffic and their stress levels.

We use the traffic volume as a parameter of the tourism pressure to animals because it has been often used and is the measureable even at night. However, it is difficult to observe the situation of each tour in detail. Other parameters, such as distance between animals and tourists, speed of a vehicle and tourist behaviors may be necessary to be analyzed. Furthermore, in order to assess the impact on the population of the Amami rabbit, we would like to focus on the effect of tourism in long-term. Such research will lead to the realization of stress-free tours on wildlife.

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Cassava and Sweet Potato in Western Seram, Maluku Province: Diversity, Cultivation and Utilization

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Abstract

Small islands in Maluku have a high diversity of root crops, with cassava and sweet potato being among the most common. The objectives of this research were to study the diversity of cassava and sweet potato in Western Seram, their cultivation systems, their role as staple food crops and to collect the accessions *ex situ*. This study used a survey method in 15 sample villages/*negri* scattered throughout Western Seram. Morphological characterizations used cassava and sweet potato descriptors (adapted from HUAMÁN [1991] and Fukuda *et al*. [2010]). Information on the local varieties, their cultivation and utilization was obtained by Focus Group Discussion (FGD) plus interviews with farmer respondents from the sample village/*negri*. Secondary data were gathered from a desk study. From the surveys, 105 cassava accessions and 71 sweet potato accessions were found and collected. They were grown under mixed culture/agroforestry system called *kabong* or *dusun*, consisting of forestry plants, spices, perennial and annual crops. Inamosol Subdistrict which is in an inland (non-coastal) region has the greatest diversities of both crops. Both crops were found to be among the most important staple food sources, in addition to sago and cereals. Their ease of cultivation and adaptation to a wide range of geographic conditions made them have an important role as security food crops in Western Seram.
Keywords: agroforestry, food security, genetic diversity, germplasm, staple food

Introduction

Cassava (*Manihot esculenta* Crantz, Euphorbiaceae) and sweet potato (*Ipomoea batatas* (L.) Lam., Convolvulaceae) are annual root crops which are classified as *palawija* (non-rice annual food crops) in Indonesian agriculture. They are important food crops in eastern Indonesia. In the archipelagic Maluku Province (the southern half of the Moluccas), cultivation of these crops is spread widely in medium and small islands, primarily as subsistence crops and food reserves. Thus, these root crops also have an important role in food security and resilience. Both of these root crops are grown in most of the islands of Maluku as a component of plant cultivation systems of *kabong* or *dusun* (polyculture,

agroforestry), and especially has a role as a source of staple food for the families. They are an important source of carbohydrate, besides rice and sago. Rice has increasingly displaced the position of sago and root/tuber crops as the major staple food sources. However, there is a determination of the local government and the community recently to revive the role of root crops and sago, which will strengthen food security in the region.

Traditional farmers in Maluku who grow cassava and sweet potato usually use several cultivars or landraces on their lands. Tens or even hundreds of landraces can be found in a region. For example, studies conducted previously showed that in one village in Maluku more than 10 different sweet potato accessions were found (HUKUNALA 2010, MAITIMU 2008). Studies in the field have also shown that the same is true of cassava.

Scientific studies which include germplasm characterization, genetic and agronomic evaluation and estimation of crop potentials of both root crops have been conducted in Western Seram District in order to strengthen its role in supporting food security and enhance their economic value. So far the two root crops still have limited roles as subsistence crops. Currently there is 13,000 ha of potential land for food crops in Western Seram District, which can be planted with cassava and sweet potato. Thus, space for development of both crops is still wide open toward their utilization for home industries and for supply of raw materials for the food and beverage industry, animal feed, chemical and pharmaceutical industries in the future.

As subsistence crops, cassava and sweet potato are considered to have low economic and social values. Their roots are generally consumed immediately after being boiled or fried. Processed products from these crops are still very limited in Maluku, for example in the form of *enbal* dry bread (in Southeast Maluku), *suami* and *keripik* cracker from cassava, whereas sweet potato is only prepared by boiling/steaming and frying. Thus, possibility for their processing development is still very widely open, to improve the roles of both crops in addition to that of subsistence one.

To strengthen the role of cassava and sweet potato, both as a subsistence or food security and as cash crops in Western Seram District, various information need to be collected about the genetic resource potentials of both crops in Western Seram, cultivation land sizes at the farmer level, farming technology level applied by farmers and utilization of the crops.

Objectives

The objectives of the research described in this paper are to: 1) explore, collect and describe the genetic diversity of cassava and sweet potato in Western Seram, 2) study cultivation and utilization of cassava and sweet potato by farmers in Western Seram and 3) study the role of both crops in the supply and diversification of staple food.

Methodology

This research was conducted with an exploratory survey, involving exploration, morphological characterization of cassava and sweet potato germplasms, as well as collection of data about their cultivation and utilization at farmers' level. In this research, a desk study was also undertaken, which began with collection of secondary data and literatures relevant to the achievement of the research objectives, information about geographical conditions of the fields.

The location of the exploratory survey that was conducted from July to October 2012 was Western Seram District, with 15 village samples within 8 subdistricts that were geographically spread throughout the district, on north, west and south coastal areas and inland areas. It covered the subdistricts: Inamosol, Kairatu, Kairatu Barat, Seram Barat, Hunamual Muka, Waesala, Taniwel and Taniwel Timur.

Assignment of the sample villages and farmers were conducted with purposive sampling. One to two sample villages were taken from each of the 8 subdistricts. The number of respondent farmers was 4–8 per village. Information from the farmers was gathered through guided interviews and Focus Group Discussion (FGD), which were guided by questionnaires. Heads of villages (*raja*) and Agricultural Extension Workers (*Petugas Pertanian Lapangan*, *PPL*) were also included as key informants in separate interviews. Observations of crops were conducted directly in the sample farmers' fields, to collect data on the cultivars/landraces of cassava and sweet potato that were grown and their cultivation techniques. Observations to obtain description and characterization data were performed with morphological description forms which were previously prepared based on descriptors of cassava and sweet potato (FUKUDA *et al*. 2010, HUAMÁN 1991).

Results and Discussion

Cultivation of cassava and sweet potatoes in Western Seram

The climate in Western Seram District belongs to a tropical marine climate. It is strongly influenced by the surrounding wide seas and by the monsoon climate, i.e., the North West or East or Southeast seasons. A change of seasons is always punctuated by a transitional season (*pancaroba*). Based on the records of rainfall and number of rainy days for the 2011 (Kairatu Climatology Station), the peak of rainy season occurs between June and August.

Cropping patterns of cassava and sweet potato by farmers are based less on consideration of season. They are based more on the habits of the local farmers. After land clearing or previous harvest they immediately plant the crops. Replanting was done immediately after harvesting previous crops with no or minimal land preparation. Cassava with different harvesting ages is harvested as needed for daily family consumption. Sweet potato is usually planted at the end of the rainy season, and its harvest time is more based on the harvest ages.

Western Seram District is a second-largest cassava producer district in Maluku after Central Maluku District. Harvested areas of cassava and sweet potato in Western Seram in 2013 were 9,810,000 ha and 458 ha, with a production of 176,900,000 t and 5,137 t fresh roots, respectively. This means that the productivity of both commodities was relatively low, amounting to about 18.0 t/ha for cassava and 11.2 t/ha for sweet potato (BPS 2014).

To support the economy and food security of Western Seram District, the expansion of planting area of cassava and sweet potato are still very possible, considering the district still has a large enough suitable potential land for food crops, amounting to 13,000 ha (BPS 2012). For Maluku Province, development of the root crop cultivation can be directed to dry land suitable for food crops, namely IV and IV ay ax zones, amounting to 718,000 ha in Maluku (SUSANTO and BUSTAMAN 2006).

In Western Seram, cassava and sweet potato are generally grown in mixed cultivation systems called *kabong* or *dusun*. These systems are practised by indigenous inhabitants of Western Seram, i.e., the Alune and Wemale ethnics, from the coast up to the upland. In such a cultivation system, both crops have an important role as a source of subsistent staple food which also means to contribute to food security of the people. Therefore, efforts to increase their production will strengthen their food security.

Although in the urban areas the position of root crops has been increasingly displaced by rice, in the rural areas traditional communities still maintain a diet with mixed staple food sources, consisting of tubers (especially cassava, sweet potato, yams/*Dioscorea* spp., taro and cocoyam), sago, plantain, corn and some legumes. Cassava and sweet potato are the staple food sources that are very important for and generally prefered by Western Seram people. They also 'must be present' in the foods provided in traditional events.

Many subsistent, traditional and relatively underdeveloped farmers can still be found in Western Seram District, whereas more advanced farmers are concentrated in transmigration areas, such as in Kairatu and Kairatu Barat, which were not included as sample areas. In general, ownership of cultivated lands ranged between 0.25 and 2 ha per farmer family. The practised agriculture systems are mixture of annual crops (maize, beans, root crops and vegetables) and the more dominant perennial plants (bananas, clove, nutmeg, coconut, cacao and others).

Cassava and sweet potato are grown as subsistence crops and as sources of carbohydrates, generally with small acreages ranging from 100 m^2 to 0.5 ha of the total farmers' cultivated lands (0.25 to 2 ha). They are among the dominant food crops; nevertheless, their cultivation areas are small. Most of the farmers' lands are planted with perennial crops cash crops. This pattern of cultivation is actually the result of cultivation system that is directed towards the establishing perennial crop plantation, which is practiced by most farmers in Western Seram. The system starts from forest clearance by slashing (*pameri*) and burning (*pembakaran*), minimal land preparation/tilage and planting of initial annual crops. In the first year, the land was planted with cereals, legumes and vegetables, which will gradually be shifted to root crops, including cassava and sweet potato, as well as

bananas. At the same time in the early years of the land opening, the newly cleared land is planted with seedlings of or young perennial crops. Establishing a perennial cash crop plantation generally becomes the main long-term goals. The main perennial crops include coconut, cloves, cacao, nutmeg, varieties of fruit, multipurpose and timber trees. Sago trees are rarely planted intentionally. During the time that the perennial plants is growing into production ages, subsistence food crops are grown in the spaces between the growing perennials. In such a system, cassava, sweet potato and other root crops are the dominant crops grown, when the soil fertility has begun to decline and less suitable for cerreals, legumes and vegetables, and when the annual cash crops are growing into production ages.

All respondent farmers grew cassava and sweet potato among various crops and plants in a mixed cropping system, either with or without regular arrangements. In Seram, this type of mixed cropping system is called *kabong*. Other root crops that are grown in the such a land include cocoyam (*Xanthosoma sagittifolium*), yam (*Dioscorea alata*) and *gembili* (*D. esculenta*), in addition to other important sources of carbohydrates, namely banana, sago, upland rice and corn. In agriculture system adopted by farmers in Western Seram, land preparation techniques is done by slashing bushes and felling some trees (*pameri*), followed by burning them when dry. For cultivation of food crops, including cassava and sweet potato, most farmers apply no- or minimal tillage. A simple soil preparation is done to form *kuming* (mounds to plant cassava or sweet potato cuttings) using tools that include hoes, wooden drills and other tools with a low efficiency. The cost for production facilities is usually low because it is only needed to buy hoes, machete or other simple tools that can be used for many years. Sometime manure is used, but synthetic fertilizers and pesticides are rary applied. Intensive crop maintenance are rarely practiced. Family labor is usually not considered as a component of cost. Thus, in the *kabong* cropping system, input cost for the root crop production is low. This farming system is basically a traditional agricultural system that has been employed for generation by the various communities living in the villages and near the forests. The low input system is initially applied in cassava and sweet potato cultivation because of a lack of capital other than the land, as well as a lack of education and training on agriculture technology.

The respondent farmers rarely grew cassava and sweet potato with orderly plant spacing. During field observations, irregular plant spacing ranging from 0.6 m x 0.6 m to 1 m x 1 m for cassava and 0.25 m x 0.5 m to 0.5 m x 0.5 m with 1–3 cuttings per mound for sweet potato were found. Some farmers take into account planting season for cassava and sweet potato, i.e., the end or after the rainy season (August to December). Nevertheless, most farmers do not take into account certain months as cassava planting season. Cassava are planted throughout the year, that is right after harvesting the previous crop. On the other hand, farmers tend to plant sweet potato at the end of the rainy season.

Because cassava is generally harvested in accordance to the need for family consumption, there is practically no harvest season for cassava. Either cassava or sweet potato is not harvested at once, but as needed for family consumption or for sale at a small scale. Root

sales are usually done locally and in a small scale (Fig. 1). Transporting further to other regions is rare. This is related to the fact that farmers in Western Seram seldom store cassava and sweet potato storage roots for more than several days, except "storing" with the plants alive or by delaying harvesting. Live storing is seldom practised for sweet potato roots, because farmers know if they are harvested late (after the harvesting age) then a high percentage of the storage roots will get damaged. Farmers generally do not dry the roots, make *gaplek* or cassava flour, as practiced in Java. They harvest the roots as needed, so that excess of production is not common. Sweet potato roots are also utilized only in fresh condition. According to the farmers, harvesting age for cassava ranges from 3 to 12 months (mostly harvested at 6 months of age), and for sweet potato 3 to 4 months.

As a result that the farmers do not harvest cassava and sweet potato simultaneously in one cropping season, it is difficult to predict their yields per unit area. It is also complicated by the fact that farmers do not weigh the harvested storage roots. However, a raw estimate of yield for cassava is between 2–5 kg per plant (≈20–50 t/ha). This is higher than that stated by ALFONS and WAMAER (2015) on the estimated productivity of cassava in Maluku of 12 t/ha or the Maluku statistical data (BPS 2012) of 17.87 t/ha. Estimated productivity of sweet potato is 1–1.5 kg per plant, or approximately 20–30 t/ha.

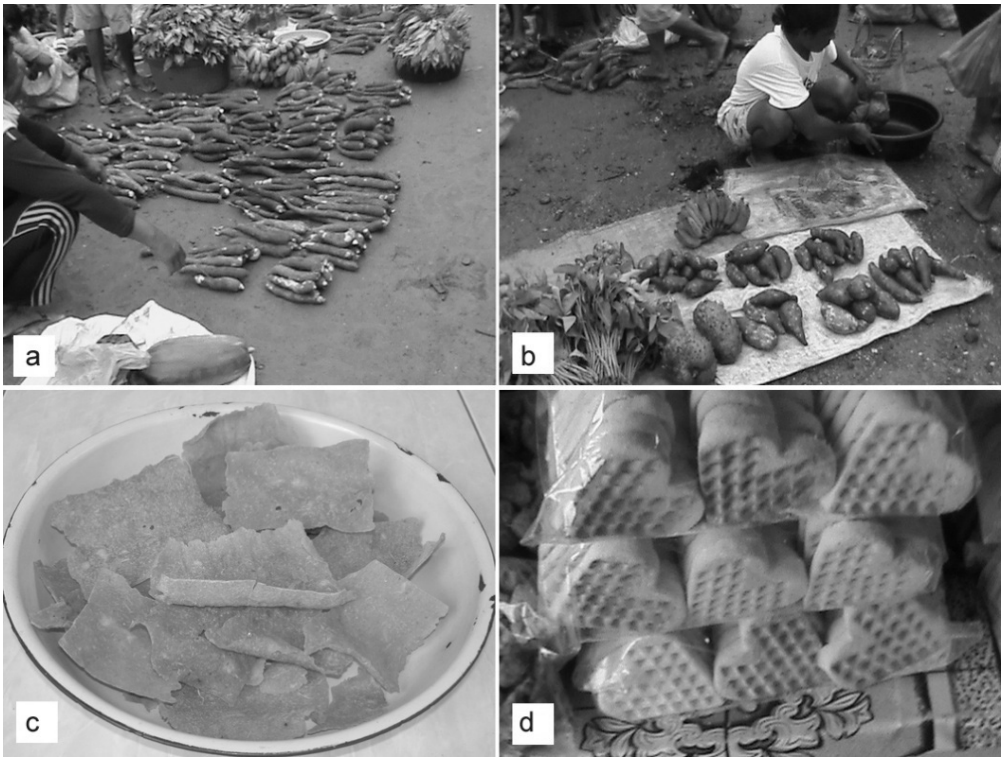

Fig. 1. Marketing and processing of cassava and sweet potato in Western Seram; (a) and (b) small-scale sale of fresh roots in a local market in Piru, (c) and (d) processed cassava in the forms of dry products, such as crackers and *embal* (a dry poisonous cassava bread).

Cuttings as planting materials used by farmers are generally obtained from the plants grown previously and only rarely do farmers obtain them from other farmers or from neighboring villages. From the observations in the respondent farmers' fields it was found that the farmers grew in average one to three varieties of cassava or sweet potato on their field. However, it was also found that some farmers grew more than five varieties of cassava on their field, such as those found in Morekao (West Seram Subdistrict), Seaputih (Hunamual Muka Subdistrict) and Musihuwey (Taniwel Timur Subdistrict). In Ursana (Inamosol Subdistrict), in a field of a farmer group 6 sweet potato varieties were found. Such farmers can be seen to become "collectors" of local varieties (landraces) and may play a role in the *in situ* conservation of the genetic diversity of cassava and sweet potato.

The main reasons that respondent farmers grew a particular variety of cassava or sweet potato were the good taste (taste preference) and the earliness of harvesting age. But there were also an indication that farmers grew a particular variety because it was common (known for generations), the planting materials were available or because the farmers did not see other options. This was supported by the fact that the farmers did not grow new high yielding varieties because they were never available or accessible. Thus, the establishment of planting material supply system for cassava and sweet potato, which are reproduced vegetatively, is needed in Western Seram District. The farmers need to be assisted to grow cassava and sweet potato varietes that are productive and with clear identities, in order to guarantee a high productivity and in turn a better income.

Most farmers grew cassava and sweet potato just for their own consumption and only a small portion was for sale. In spite of such farming conditions, according PESIRERON *et al*. (2011) the average food crops in the Western Seram District were economically feasible because they had Revenue/Cost (R/C) values > 1. Based on the results of the financial analyses of R/C for cassava and sweet potato farming in the Western Seram District, the values of 1.93 and 1.30, were obtained respectively, which means they were feasible to be cultivated by farmers in the region (PESIRERON *et al*. 2011).

Results of interviews with the farmers indicated that there were still many obstacles in the cultivation of cassava and sweet potato, including the climatic factors, pests, especially wild pigs (*Sus scrofa*), labor and marketing. The application of technological innovation on the traditional farmers has been generally hindered by biophysical, sociological, technological and economic factors. The application of technology for cassava and sweet potato production was still very limited in the study area. Therefore, it is very possible that increased productivity can still be achieved through an effort of providing planting materials of superior varieties and various other agricultural inputs.

Diversity of cassava and sweet potato in the Western Seram

In situ characterization of cassava and sweet potato accessions in the farmers' fields have been conducted using descriptors adapted from those of HUAMÁN (1991) and FUKUDA *et al*. (2010). In this research, 105 accessions of cassava were obtained and collected from 8

subdistricts, namely Inamosol, Kairatu, Kairatu Barat, West Seram, Hunamual Muka, Taniwel, Taniwel Timur and Waesala. The highest cassava diversity in Western Seram District (in hilly inland region) was found Inamosol subdistrict with 17 cassava accessions, followed by Taniwel Timur Subdistrict with 15 accessions. The number of accessions found per sample varied from 2 accessions (Kamarian and Kamal) to 12 accessions (Morekao).

Most of cassava accessions obtained (98 accessions or 93%) belong to the type that can be consumed directly (sweet cassava, with low hydrogen cyanide [HCN] content). Only seven accessions belong to the bitter type (with high HCN content) which can not be consumed directly without special processing, and one of them is considered to be very toxic cassava (Kasbi Galela). Based on the HCN content, cassava is classified into either sweet cassava, with a HCN content < 40 mg/kg of fresh roots, or bitter cassava with a HCN content ≥ 50 mg/kg of fresh roots. High HCN content can cause poisoning to human and animals, so cassava with a high HCN content is not recommended for fresh consumption (SUNDARI 2010). Most of the accessions obtained have white root flesh. Seventeen accessions (16.2%) have yellow root flesh and 3 accessions (2.85%) have cream root flesh.

From the exploratory survei, 71 sweet potato accessions have been obtained and collected from the 8 subdistricts. The highest sweet potato diversity was found also in Inamosol Subdistrict with 18 accessions, followed by West Seram and Taniwel subdistricts with 9 and 7 accessions, respectively.

The data described previously indicate that Western Seram District has high genetic diversities of cassava and sweet potato, which also means that the region is rich of genetic resources of both crops. The root crops have long been spread in the region, so that in the long term this has enabled formation of many new genotypes probable through natural cross breeding. The habits of farmers that do not use new superior varieties but rather use several local varieties (landraces) simultaneously has allowed the *in situ* conservation of the diversity of these two crops. The genetic diversity is a very valuable source of genes that are important for breeding programs of the crops in the future.

Processing, utilization and home industry of cassava and sweet potato in Western Seram

Each family of the respondent farmers had an area of land for subsistence annual crops and perennial trees that ranges from 0.25 to 2 ha. Cassava and sweet potato fresh products were generally consumed by the farmers' family or sold in a small scale. However, their processed products were found to be limited. Communities in the study area, especially those who have the main livelihood as farmers, consume cassava and sweet potato that have been grown by themselves as staple food sources. They do not buy them in the market. In addition to cassava and sweet potato, people also consume rice as a staple food eventhough they do not grow rice. They buy rice with the money they obtain from sales of other agricultural products or from other revenue.

Cassava and sweet potato can be consumed as a staple food because their storage roots contain a high carbohydrate, which is 34.7 and 25.6 g/100 g of material, respectively. Cooked

roots of cassava and sweet potato are eaten with side dishes such as fish, meat and vegetables, to improve nutritional values. In addition to the carbohydrate content, the storage roots also contain protein, but not as much as rice. Their fat, vitamin A and vitamin C contents, however, are higher than those of rice. The calcium contents in cassava and sweet potato are even higher than rice, i.e., 33 and 27.7 mg/100 g, respectively, compared to 6 mg/100 g in rice.

The common daily meal composition of the community in Western Seram is roots/tubers/sago/rice-vegetables-fish/meats. The food composition consists of carbohydrates as an energy source, proteins and fats from the fish/meats as well as vitamins and minerals from the vegetables. In general, cassava and sweet potato, as well as vegetables, are obtained from the farmers' own gardens. Whereas fish or meat as a protein source are purchased or are obtained from the sea or the forest. Cassava and sweet potato plays an important role as staple food sources, especially in rural farming communities. In many other regions, cassava is an important food for the farmers only in certain seasons when other foods are less available or more expensive (FALCON *et al*. 1986). However, in most of Western Seram cassava along with the other root and tuber crops are still the major and daily staple food sources, comparable to sago; and in some communities they are consumed greater and more often than rice. This suggests that in Western Seram, the community, especially the farmers, still maintain diverse staple food sources other than rice. The consumption patterns in the study area thus provide a significant contribution to better security of staple food supply and provision of balanced nutrition for the community.

In addition to being consumed as a staple food, cassava and sweet potato are also cooked into snack foods. A limited quantity of cassava is processed into processed products. Cassava leaves are cooked as a vegetable. In all the study villages, the only common daily cooking method of cassava and sweet potato for staple food is by boiling or steaming the fresh storage roots. For production of snacks, cassava roots may be processed into fried snack, *onde-onde* and *lemet*; whereas sweet potato roots are commonly prerpared by frying. Both may be cooked into *kolak*, a sweet soup made from a mixture of tuber and plantain cubes with brown sugar and coconut milk.

In the food consumption system, diversification is an important aspect. The diversification of processed cassava and sweet potato is one of the alternatives to support of the food diversification program promoted by the government. Food diversification is intended to gain nutrient diversity as well as to free the community from dependency on one particular type of staple food source, particularly rice. High dependency on a particular type of food sources, such as rice, can lead to instability if the supply is interrupted. Based on the findings, it can be stated that cassava and sweet potato play an important role for food security in Western Seram.

In Western Seram, cassava and sweet potato storage roots are generally consumed by the people as a staple food and only a small portion of them is processed into a variety of traditionally processed products, either to meet their own need and for sale. Therefore, the utilization of cassava and sweet potato should be encouraged and developed further by

developing new and more modern products with a better nutritional value and with an application of food technology. Given the fact that cassava and sweet potato fresh storage roots are perishable and their fresh conditions last only several days after harvesting, proper handling and processing techniques should be applied to extend their shelf life. Cassava and sweet potato can also be upgraded into higher value food products. However, this study found that product processing of both comodities is rarely performed by Western Seram farmers, because they lack capabiliy of agriculture product processing technology.

In the rural area, cassava and sweet potato can be processed directly into a variety of wet and dry foods, and the resulting products can have a variety of flavors. One attempt to preserve the two commodities can be achieved by processing them into flour and the flour can be processed further into a variety of interesting food products. Flour-making technology can become a choice to be recommended to the farmers to produce a semi-finished product. The flour is durable to store, easily blended, can be fortified, and can be cooked faster into various foods, which is more suitable to the practical modern life (e.g., ANTARLINA 1998, ONYENWOKE and SIMONYAN 2014).

Small business development goals in rural areas, among others, should be directed to increase employment opportunities, especially to absorb labor in the agricultural sector, to increase added values of agricultural products, and to increase incomes of the rural community. Therefore, agribusiness development program of production and utilization of local crop resources, such as cassava and sweet potato, by developing food home industry needs to be initiated by the government of Western Seram District.

Because cassava and sweet potato cultivation in Western Seram is generally a small-scale activity, its upstream and downstream development efforts should be devoted to developing small agribusinesses that is efficient and involves farmers' family labors. To lift the economic value of cassava and sweet potato, processing technology development as well as a good marketing strategy are needed, which in turn can improve the image of the root crops as inferior food into widely accepted one. This will expectedly increase consumers' acceptance of cassava and sweet potato products. Efforts to increase the added value of cassava and sweet potato through agro-industry can also play a role in supplying staple foods that are more diverse and with better qualities. Through the development of rural home agro-industry, the quantity of staple foods can be increased and the types of their products available in the market will be more diverse.

Constrains faced by the farmers to develop downstream agribusiness include lack of skills and mastery of post-harvest handling and product processing technology. Such constrains affect farmers' income which tends to be low. Another alternative to improve the income of farmers is by developing product diversification. The cassava and sweet potato fresh storage roots may be processed into refined products that can be stored longer, among other into flour, starch, dried roots, chips and pellets. By this, the market of the commodities is expected to be better guaranteed, their added values increased, and in turn well-being of the farmers improved.

Conclusion

Conclusions from this research are as follows: 1) cassava and sweet potato are rarely grown in a monoculture system in Western Seram, however, they are important crops in a mixed farming system called *kabong* and *dusun*, 2) both play an important role as subsistence crops and major sources of staple food, 3) farmers' planting areas of cassava and sweet potato are generally small (patches less than 0.25 ha) and only small portions of the whole lands owned by the farmers, 4) their cultivations are traditional, low-input and low-technology ones and long fallow cultivation is commonly practiced by the farmers to recover soil fertility, 5) the genetic diversity of cassava and sweet potato in Western Seram is large, however, conservation, assessment and utilization of their germplasms are still very limited and 6) only limited post-harvest processing of cassava and sweet potato products are applied.

Therefore, possibilities are still open: 1) to increase production in order to strengthen their position as staple and security food sources, 2) to diversify their intermediate processed products, such as dried cassava, chips, pellets and flour, to ease storing, transporting and marketing and 3) to diversify and improve quality of foods based on both crops.

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Production and Distribution of Potatoes in the Kagoshima Island Areas

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Abstract

Potato production is important in Japan, especially in island areas. Potato production and price have increased in the Kagoshima island area. The red soil on the islands allows the production of healthy looking potatoes. Potatoes grown in island areas are produced during the mainland non-growing season and are sold as fresh potatoes.

Broadly, there are two types of potato collectors in the islands, Japan Agricultural Cooperatives and purchase brokers, who compete with each other in terms of prices and services. Each collector plays a role in the potato market.

Keywords: distribution, JA, Nagashima Island, Okinoerabujima Island, potato, purchase broker, Tanegashima Island, Tokunoshima Island

Introduction

Potato varieties such as sweet potato, potato and taro are important crops in Japanese agriculture and are grown in remote areas and island areas. Potato farmers face many challenges in regards to potato cultivation and marketing. However, there are only a few previous studies on potato production and distribution in island areas (IMURA *et al*. 2015, SAKAI 2016, SAKAI and NAITOH 2016).

In the current paper, I describe the current state of potato production and distribution in the island area of Kagoshima Prefecture.

Potato Production and the Preferences of Consumers Pertaining to Potatoes in Japan

Main potato production areas in Japan

Potato production is the highest among vegetable crops in Japan and is important not

only for Japanese agriculture but also for Japanese consumers. The main prefectures that produce potatoes are Hokkaido, Nagasaki and Kagoshima (Fig. 1, 2). These prefectures are geographically distant from the main markets such as Tokyo and Osaka.

Hokkaido Prefecture

Hokkaido Prefecture accounted for 82.5% of potato production in Japan during 2014. In Hokkaido, 44%, 24%, 14% and 18% of potatoes are grown for starch, food processing, food applications and seeds and other uses, respectively. Potatoes for use in food products are harvested from summer to fall and are sold until April.

Nagasaki and Kagoshima prefectures

Nagasaki and Kagoshima prefectures produce potatoes for food applications and market an image of fresh produce. Nagasaki Prefecture accounts for 4.4% of potato production in Japan, with potatoes shipped from May to June. Kagoshima Prefecture yields 4.1% of total potato production, and potatoes are shipped from January to May. Both prefectures ship fresh potatoes during the period in which Hokkaido cannot ship fresh potatoes.

Preferences of consumers for potatoes in Japan

Japanese consumers value esthetically pleasing produce and show preference to potatoes grown in red soil. Consequently, potatoes grown in red soil are the most expensive of all the potato varieties.

In addition, different types of potatoes are used for different purposes. The round type of potato is used for potato salad and croquettes due to its soft texture. The ellipse type potatoes are used for boiled dishes and soup because this type does not disintegrate during cooking.

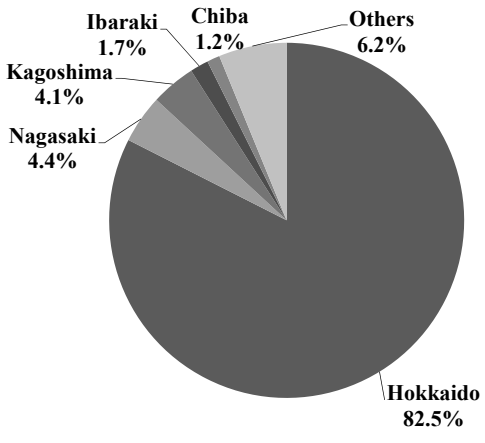

Fig. 1. Potato production in Japan.

Fig. 2. Map of Japan.

Potato Production in the Kagoshima Island Areas

Potato producing area in Kagoshima Prefecture has been increasing since the 1980s (Fig. 3). In Kagoshima Prefecture, potatoes are mainly grown in island areas (Fig. 4, Table 1). The potatoes produced on islands are generally shipped to the mainland.

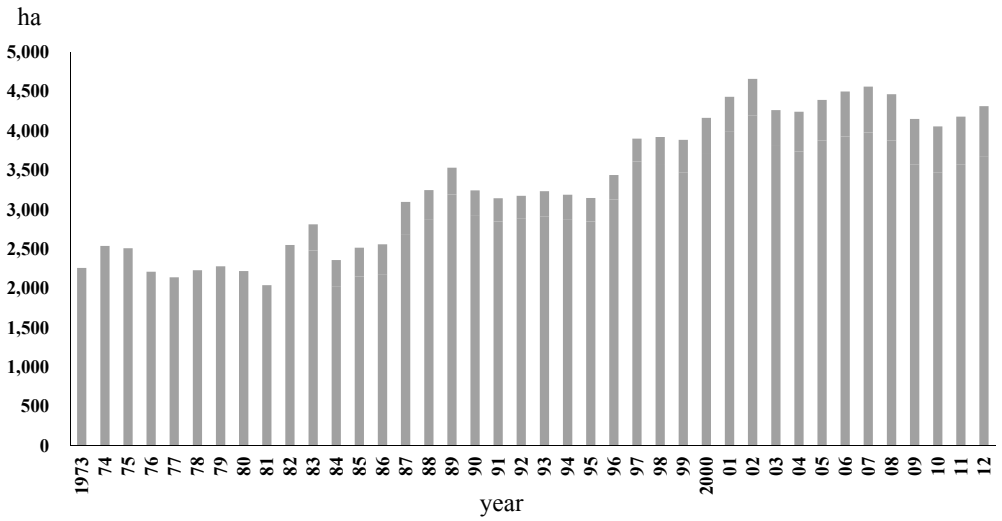

Fig. 3. Potato planted area in Kagoshima Prefecture.

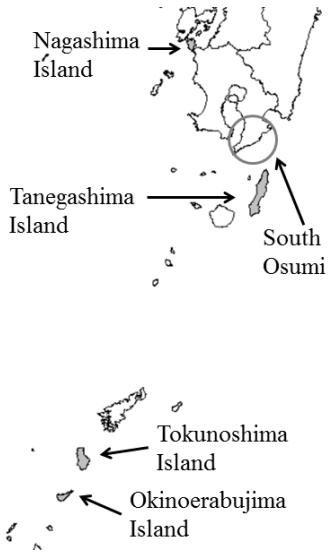

Fig. 4. Map of potato producing regions in Kagoshima Prefecture.

Table 1. Potato producing regions in Kagoshima Prefecture.

	Planted area (ha)	Yield (t)	Harvesting season
Tokunoshima Island	338	6,820	Feb.-Apr.
Okinoerabujima Island	1,052	14,780	Feb.-Apr.
Tanegashima Island	193	4,063	Feb.-Apr.
South Osumi	253	5,450	Mar.-Apr.
Nagashima Island	1,130	27,100	Apr.-May.
Others	1,444	33,487	—
Kagoshima Prefecture	4,410	91,700	—

During summer, it is difficult to grow vegetables in island areas because of strong typhoons and drought. In addition, the remoteness of island potato production areas poses an economic disadvantage because it is expensive and time-consuming to transport products off the islands. Therefore, farmers grow sugarcane and rear beef cattle in summer.

In winter and spring, it is too cold to grow vegetables and flowers on the mainland in Japan. However, because the island areas remain warm, farmers grow vegetables and flowers for the mainland. Because the soil type on islands is mainly red derived from coral limestone, farmers can produce fresh red soil potatoes during winter and spring. Therefore, the price of potatoes produced on the islands of Kagoshima Prefecture is more than the average price of potatoes in Japan (Table 2). Consequently, potato sales constitute approximately 70% of the vegetable crop sales in the Amami Islands.

Table 2. The price of potatoes in Tokyo Central Market.

	Japan		Produced in Kagoshima	
	Shipment quantity (t)	Price (JPY/kg)	Shipment quantity (t)	Price (JPY/kg)
2008	37,950	98	10,312	141
2009	41,662	119	8,629	160
2010	42,014	140	9,941	205
2011	44,276	168	12,589	233
2012	45,750	169	14,424	157
2013	48,889	112	14,281	110
2014	48,829	109	15,055	144
2015	49,797	124	11,339	211

Potato Distribution in the Kagoshima Island Areas

Potato distribution in the island areas is complex. Broadly, there are two types of potato collectors in the island areas: Japan Agricultural Cooperatives (JAs) and purchase brokers, who compete intensively with each other to collect potatoes.

JAs

JAs are large agricultural cooperatives, and almost every farmer in Japan is a member of a JA. JA branches are widely distributed throughout Japan. In the island areas, JAs collect almost half of the potatoes produced. Because every island contains a JA automatic potato sorting facility, the potatoes collected by JAs are shipped to the mainland after being sorted on

each island. JAs do not buy potatoes from farmers; they instead send the potatoes to market and receive sales commission from farmers.

So as to avoid competition among the islands, JAs coordinate the varieties of potatoes and shipping destinations. For example, on Tokunoshima Island, farmers mainly produce the round type of potatoes that are shipped to Nagoya, whereas Okinoerabujima Island produces the non-round type of potatoes, which are shipped to the south of Osaka.

Because JAs collectively constitute a large organization, they are responsible for a stable supply of potatoes to the wholesale markets. Therefore, JAs ships potatoes to markets as soon as they are received. However, continuous rain can delay the shipping of potatoes to the mainland. Because red soil is a hard clay type soil, farmers cannot harvest potatoes for a few days after a rainfall event. The option of JAs constructing a potato storage facility on the mainland is uneconomical because the facility would need to be huge and would only be used during monsoon.

Purchase brokers

There are approximately 5–20 brokers on each island. The brokers buy potatoes from farmers, which are then transported to the mainland. Brokers generally deal with relatively small numbers of potatoes. Because brokers have no sorting facilities on the islands, they sort the potatoes on the mainland. After sorting, brokers sell the potatoes to wholesalers or retailers.

Brokers engage in price competition while buying potatoes from farmers. If one broker buys at a high price, others have to raise their prices. However, there is no competition between JAs and brokers regarding price, whereas they do compete with each other to provide services to the farmers. Because JAs do not buy potatoes, competition with brokers relates to services such as potato collecting, supplying harvesting labor, speedy payment to farmers and technical advice.

As mentioned above, because the business scale of brokers is relatively small compared to JAs and that they are a private business, they can react rapidly to situations and behave opportunistically. If the market price is too low, some brokers refuse to buy potatoes from farmers, which consequently place farmers in a difficult situation. Other brokers adopt a strategy of buying potatoes at a low price and storing them in mainland facilities. Subsequently, during periods of continuous rain when JAs cannot supply potatoes, the brokers sell the stored potatoes to the markets at a high price. For wholesalers and retailers, brokers are useful when there is a shortage of potatoes. However, the behavior of brokers can sometimes lead to price volatility.

Future Problems

In the island areas of Kagoshima Prefecture, potato production and price have experienced continual increases. However, some problems that require solutions exist within potato production. First, there is a shortage of potato harvesting labor on the islands; therefore, securing laborers or the development of harvesting technology is an important issue for the continuation of potato production.

Second, potato consumption in Japan has been declining because of the decreasing and aging population and the greater participation of women in the workforce. The price of potatoes will decrease in future. To prevent price decline, efforts will be required to differentiate the products and increase their added value.

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Productivity of Nutmeg (*Myristica* spp.) in Agroforestry System (*Dusung*) in Ambon Island

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Abstract

Nutmeg is an icon of Maluku which has historic value in the world history of spice. However, the research on nutmeg in Maluku is still lacking. The objective of this study was to get the potency of nutmeg in farmers' plantation, cultivation and utilization of nutmeg by farmers, and kind of pests and diseases of nutmeg in Ambon Island. The research was conducted in three districts which are the center of nutmeg production in Ambon Island. Survey method with purposive sampling was used to determine village and farmer samples. Data was collected through direct observation in the field as well as by interviewing farmers. The result showed that nutmeg is cultivated in agroforestry system (*dusung*). The climate in research location is suitable for nutmeg growing and production. Productivity of nutmeg in Ambon Island is consider low which were 0.58, 0.77 and 0.39 t/ha in Leihitu, Leihitu Barat and Salahutu districts, respectively. Pests and diseases found in nutmeg plantation were stem borer, dry fruit rot, wet fruit rot, stem cancer, curly top, die top and thread blight.

Keywords: agroforestry, diseases, pests, potential, spice

Introduction

Agriculture sector has an important role in Indonesia, not only as labor market for 42% people but also as source of income especially for estate crop such as clove, nutmeg and cacao.

Nutmeg (*Myristica* spp.) is a spice that serves as source of farmer income, country foreign exchange and supporting industrial. Nutmeg plant that has economic value is its fruit which is consist of flesh (77.8%), mace (4%), kernel (5.1%) and seed (13.1%), and the most valuable parts are mace and seed that can be used to produce nutmeg oil.

Nutmeg is growing well in the tropical area of Asia, America and Africa. Nutmeg is classified into family of Myristicaceae that consist of 15 genera and 250 species in which 5 genera found in the tropical area of America, 6 genera in Africa and 4 genera in the tropical area of Asia (RISMUNANDAR 1990). There are six species of nutmeg in Maluku, i.e., *Myristica fragrans*, *M. argentea*, *M. fatua*, *M. specioga*, *M. sucedona* and *M. malabarica*, with the most economic value is *M. fragrans* (HADAD *et al*. 2006).

Based on historical review and fact in the field, *M. fragrans* is originally from the Maluku Archipelago (the Banda Islands). Therefore, Maluku has an important role in the world economy as a producer of high quality of nutmeg. However, the production of nutmeg in this area is not optimal yet, because there are many problems faced by the farmer ranging from cultivation technology to post-harvest processing problems.

Nutmeg is planted by almost all communities in Maluku. According to BPS (2013), the majority of population that most heavily cultivated nutmeg crop is resident of Central Maluku as many as 9,580 households, followed by 6,542 of East Seram, 4,800 of West Seram, 1,557 of South Buru, while the other districts of less than 1,000 households.

Nutmeg farm in Maluku Province is mostly smallholder plantations and it tends to increase from time to time (BPS 2013). The production and productivity (production/area of productive tree) of nutmeg is also increasing over the past three years (0.34–0.54 t/ha; Table 1) but they are considered to be still low. Low production and productivity of nutmeg are caused by unsuitable seed used for cultivation, unused of fertilizer and uncontrolled pest and disease (HADAD *et al*. 2006).

Ambon Island is one of the areas that produce nutmeg in Maluku Province. In this area, nutmeg is cultivated traditionally by using a system called *dusung*. *Dusung* is traditional knowledge practiced in Central Maluku including Ambon Island in which nutmeg is planted together with other crops (agroforestry) (MATINAHORU 2014).

Pests and diseases in nutmeg plants highly influence the production; decline in production due to pests and diseases can reach 10–25% (SEMANGUN 2008).

As mention above, productivity of nutmeg is still low because the problems faced by farmer range from cultivation system to post-harvest processing. Therefore, solution is needed to improve the system in order to improve income of the nutmeg farmers.

The objective of this research was to get data on potential of nutmeg, to study the cultivation system and utilization pattern of nutmeg by farmer as well as to get data of pest and disease of nutmeg plant in Ambon Island.

Methods

This research was conducted on July to November 2014 in three districts namely Leihitu, West Leihitu and Salahutu of Central Maluku Regency in Ambon Island. Three villages of each district were purposively chosen as sampling areas because they are main producer of nutmeg in Ambon Island.

Direct observations were done in the field as well as interviewing key respondents. The number of key respondents for each village is 10% of the nutmeg farmers. Data collected were field resources, variety of plant, cultivation techniques, indigenous knowledge, climate conditions, plant pests and diseases, production and post-harvest handling. Secondary data

Table 1. Area and production of nutmeg in Maluku during 2010 to 2012.

Year	Area (ha)			Production (t)	Productivity* (t/ha)
	Young tree	Productive tree	Old tree		
2010	11,949	6,635	3,741	2,391	0.36
2011	13,232	7,943	3,886	2,700	0.34
2012	16,688	8,568	3,608	4,622	0.54

*productivity = production (t)/area of productive tree (ha)

collected from related institution were statistics and agroclimate data as well as other information relevant to the study.

Agroclimate data was analysed using formulas proposed by OLDEMAN (1977) for raining probability, SCHMIDT and FERGUSON (1951) for climate clasification and OLDEMAN (1975) for type of climate. Pest and disease were indentified in Plant Pest Laboratory and Plant Disease Laboratory, Faculty of Agriculture, Pattimura University.

Results and Discussion

Climate aspect in nutmeg cultivation

Water is necessary by plants for photosynthesis, transpiration of mineral and product of photosynthesis, growth and transpiration. For estate crops, major water resource is rainy water.

In nutmeg cultivation area in Maluku (the Banda Islands), average of rainfall is 3,116 mm/year with 215 rainy days. According to RIDLEY (1912), rainfall needed by nutmeg crop is 2,175 to 3,550 mm/year without any period of real drought. The more rainfall the higher production per plant per month. In contrary, dry season causes decrease in production as well as the quality of the seed. According to HADAD *et al*. (2006), nutmeg seed harvest in dry season has lower germination rate compare to that in rainy season. Based on climate suitability, RUHNAYAT and MARTINI (2015) stated that nutmeg crop is suitable to cultivate in area with average rainfall of 2,000–4,500 mm/year. According to FLACH (1966), nutmeg crop cultivated in flat land with low water holding capacity has potential in puddle which will inhibit the growth of plants and susceptible to root rot disease if there is too much rainfall. Rainfall in the research area is 1,692–4,231 mm/year with 153 to more than 223 rainy days, and type of climate B (SCHMIDT and FERGUSON 1951) therefore the research area meets the criteria of climatic suitability for the development of nutmeg.

Varieties of vegetation have been naturally selected to grow in different latitude and altitude. At various latitudes and altitudes above sea level, there are different temperature and rainfall that would affect the lives of the various types of plants.

Relative humidity is related to the amount of water vapor in the air and it depends on air

temperature as well as air pressure. Therefore, temperature is linearly correlated to relative humidity. In general, air temperature and relative humidity is directly related to plant growth, as well as to development of plant pests and diseases. In the research area (Ambon Island) average temperature annually is 26.5°C, according to HADAD *et al*. (2006), optimal temperature for nutmeg growth is 25–30°C.

In Moluccas, nutmeg and clove crops distribution are found on 0–700 m above sea level. Nutmeg cultivated in more than 700 m above sea level will have low production due to high relative humidity that good for plant pathogen (fungus) to grow. Therefore, nutmeg is suitable to be cultivated on area less than 700 m above sea level (LEE 1957). In Banda Island, nutmeg is grown from the coastal to area of 458 m above sea level.

Wind has a role in moving heat, water vapor and CO_2 between the surrounding air and the plant, especially the leaves. In relation to nutmeg cultivation, wind speed and direction should be taking into account since strong wind can cause damage to crops, flowers and/or fruit fall. In area with strong wind, the speed could be reduced using compact wind barrier or other plant. For example, in most of nutmeg plantation in Banda Island, walnut (canary) tree are being used as wind breaker that protects nutmeg tree from the sea wind. Wind direction is also important in spreading of fungus spore and migration of certain plant pests.

Cultivation system of nutmeg in Ambon Island

Farmers in the districts of Leihitu, West Leihitu and Salahutu cultivate nutmeg on their own land by using the system called *dusung* mixed with other crops. Nutmegs were planted from flatland up to the hill with the gradient > 45% and canopy of 80% in the area of 0.5 to 4.0 ha. Nutmegs are harvested 3 times a year in March–April, July–August and November–December with the peak on March to April. Description on the number of plant, production and productivity of nutmeg in three districts are presented in Table 2.

It can be seen in Table 2 that productivity (production [t]/area of productive tree [ha]) of nutmeg is low due to limited cultivation system. Land used for nutmeg cultivation is also planted with other vegetation in order to protect nutmeg plants. Those plants are durian, albizia, walnuts (canary), *gayam*, mangosteen, mango, *lenggua*, teak and resin (upper stratum), clove, langsat, jackfruit, guava, coconut, betel nut, palm, cocoa, avocado (mid stratum) and banana, papaya, cassava, yam, pineapple, soursop (lower stratum).

In nutmeg cultivation, farmers has not used fertilizer and pesticide and the tools that been used only hoe, knife and crowbar. Sanitation of the plantation has not been done properly, and only been done once every 6 months, therefore there were some plant pests and diseases. Very limited and simple cultivation techniques caused low productivity of plant.

In addition, low productivity was also caused by lack of knowledge of the farmers to differentiate between female and male plants. The best ratio for male and female is 1:8, but fact in the field shows that farmer cultivated more male than female plants.

Based on field observation, it is found that there are three species in the study area in

which two are cultivated, i.e., *Myristica fragrans and M. argentea* and the other is wild nutmeg, *M. fatua* (Fig. 2).

Mature nutmeg fruits (6–7 months old) are harvested by using long stick. The most valuable parts of the fruit are seed and mace while most of the fruit flesh are discarded and just a little are kept to produce nutmeg syrup such as observed in Morela Village. Sun-drying of seeds usually takes 3–5 days while for mace just one day (Fig. 3). In the rainy season, seed and mace are smoked.

Table 2. Number of tree, production and productivity of nutmeg in Leihitu, West Leihitu and Salahutu districts in Central Maluku Regency.

District	Village	Number of tree*			Total	Production (t)	Productivity**
		YT	PT	OT/DOT			
Leihitu	Morella	8,869	7,127	2,340	18,336	28	0.61
	Mamala	5,627	5,760	1,960	13,347	23	0.62
	Hila	5,151	4,827	1,763	11,741	14	0.45
	Mean	6,549	5,905	2,021	14,475	22	0.58
West Leihitu	Alang	21,800	29,291	3,409	54,500	167	0.89
	Lilibooy	4,545	9,810	789	14,144	43	0.68
	Hatu	5,654	20,390	2,500	28,544	97	0.74
	Mean	10,666	19,830	2,233	32,396	102	0.77
Salahutu	Liang	2,620	20,149	1,989	24,758	49	0.38
	Tengah Tengah	5,669	26,235	3,457	35.361	70	0.42
	Tial	4,060	17,110	1,740	22,910	41	0.37
	Mean	4,116	21,165	2,395	15,901	53	0.39

*: YT=young tree, PT= productive tree, OT=old tree and DOT=damaged old tree.
**: It is assumed that there are 156 trees in 1 ha based on tree spacing.

Fig. 2. *Myristica fragrans* (A), *M. argantea* (B) and *M. fatua* (C).


Fig. 3. Harvesting and post-harvesting handling of nutmeg.

In relation to harvesting, there is a traditional community based management in Ambon Island called *sasi*. *Sasi* system refers to temporal prohibition on particular resources, e.g., nutmeg and when it is applied (*tutup sasi* closed season), no usage whatsoever is permitted until the *sasi* is lifted (*buka sasi* opened season). Violation of the *sasi* system will cause punishment or fine for the violators. *Sasi* system for nutmeg is still practiced in the villages of Mamala, Morela (Leihitu District) and Allang (West Lihitu District). Through *sasi*, we can get the best quality of nutmeg fruit because it is harvested in condition of physiologically mature.

Pests and diseases

Many pests and diseases were found during the study in all study areas (Table 3). As mentioned earlier, very limited cultivation techniques were used by farmers. Pest and disease control was not done intensively due to lack of knowledge of the farmers. Sanitation was not been done properly, it was only done twice a year usually before harvesting. The trees that had been damaged by pests and diseases were left in the field so they become the source of

Table 3. Diseases and pests found in the study area.

District	Disease	Pest
Leihitu	Stem cancer (*Phytophthora palmivora*)	Stem borer (*Batocera* sp.)
	Curly top	Termites
	Dry fuit rot (*Stigmina myristicae*)	
	Thread blight (*Marasmius* sp.)	
	Wet fruit rot (*Colletotrichum gloeosporioides*)	
	Plant parasite	
	Upasia salmonico	
West Leihitu	Curly top	Stem borer (*Batocera* sp.)
	Stem cancer (*Phytophthora palmivora*)	Termites
	Thread blight (*Marasmius* sp.)	
	Die top	
	Red Algae	
	Dry fuit rot (*Stigmina myristicae*)	
	Wet fruit rot (*Colletotrichum gloeosporioides*)	
	Leave Spot	
	Cracking of young fruit	
Salahutu	Thread Blight (*Marasmius* sp.)	Stem borer (*Batocera* sp.)
	Stem cancer (*Phytophthora palmivora*)	Termites
	Curly top	
	Dry fuit rot (*Stigmina myristicae*)	
	Wet fruit rot (*Colletotrichum gloeosporioides*)	
	Plant parasite	
	Die top	

inoculum to healthy trees. In most of plantations, the upper stratum trees (durian, albizia, canary, mangosteen etc.) occupied the upper canopy and covered the nutmeg and other mid stratum trees. Therefore, they can hinder the sunlight to go through and can cause high humidity in the field which in turn can support the development of the diseases.

Conclusion

Based on the study, it can be concluded that: 1) nutmeg in Ambon Island has a great potential to be developed because climate and physical condition support its growing and production, 2) productivity of nutmeg is low (0.37–0.89 t/ha) due to the non-optimal cultivation system, 3) the unsuitable ratio of male and female trees in the field can cause low productivity and 4) pests and diseases that found are similar among the study areas.

Therefore, improvement of cultivation system including sanitation of plantation, pest and disease control as well as the settings of male and female trees ratio by providing female trees need to be done in order to improve productivity of nutmeg in the area.

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A Newly Invasive Long-Horned Beetle from Mainland Kyushu Attacks Citrus Trees in the Amami Islands

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Abstract

In the Amami Islands many kinds of citrus have been introduced from continental China and Taiwan. As there are few indigenous insect pests, introduced citrus species have been well-kept and have diversified in Kikaijima, Tokunoshima and Okinoerabujima islands. As a result, we can now find a plentiful variety of citruses in home yards in these areas. About 2008, however, many of the trees appeared to weaken and then died over the course of one or two years. The problem spread rapidly. For example, in one village in Kikai Island the total number of citrus trees drastically decreased from 2,800 to 2,000 over a period of four years. These dead trees had many distinct 2cm-circular exit holes of long-horned beetle at ground level. The islands have long been home to a type of long-horned beetle, *Anoplophora oshimana*, that had never attacked citrus trees. From 2011, we started to simultaneously examine the species of long-horned beetles in the citrus orchards and to conduct new control strategy against the beetles. The new strategy involves a wide-area application of biopesticide band, *Beauveria bassiana*, Bio-Lisa®, conducted in the abovementioned village. It took three years to decrease long-horned beetle numbers by 90%. DNA analysis revealed that the long-horned beetle in the orchards was hybrid population between *A. oshimana* and *A. malasiaca*. *Anoplophora malasiaca* is a notorious pest of citrus trees in main island Japan. We estimate that the latter long-horned beetle established itself in the islands before 2008 and hybridized with the endemic long-horned beetle.

Keywords: *Anoplophora malasiaca*, *A. oshimana*, biopesticide band, DNA analysis, hybrid population

Introduction

The history of citrus cultivation on the Amami Islands, which include Amami-Oshima I., Kikaijima I., Okinoerabujima I., Tokunoshima I. and Yoron I., is ancient. The people living on these islands have cultivated many types of citrus trees from China and mainland Japan, but sports and natural hybrids of these citrus trees have been cultivated and handed down within individual homes for centuries. Consequently, each farmer has unique cultivars of citrus in his orchard or residential yard, which can be considered valuable genetic resources (YAMAMOTO *et al*. 2006). For example, in two local citrus cultivars on Kikaijima I. (*Citrus keraji* and *C. keraji* var. *kabuchii*), the polymethoxy flavone content of the juice is four-fold higher than

that of satsuma mandarin (*Citrus unshu*), and these local citruses are considered to be a good source of phytonutrients (YAMATOMO *et al*. 2008). Few studies have examined the phytonutrients in local citruses from the Amami Islands or examined the cultivars from the islands in detail. YAMAMOTO *et al*. (2006) reported that severe citrus damage caused by the citrus long-horned beetle on Kikaijima and Tokunoshima islands is worsening and becoming a serious threat to local citrus cultivation. In this report, we interviewed people living on the islands who have experienced citrus damage caused by the long-horned beetle to confirm YAMAMOTO's report. Second, we assessed the damage status in 2011 and began to control the long-horned beetle in an experimental model village in Kikaijima in 2012. Here, we provide an interim report of these actions to protect local citruses against long-horned beetle damage and discuss the future of these control methods to conserve local citrus populations.

The citrus long-horned beetle, *Anoplophora malasiaca*, is one of the well-known wood-boring species of the family Cerambycidae that is distributed across mainland Japan. This species usually attack many types of hardwood trees, as well as citrus trees, willow, poplar, walnut, ficus, sycamore, rose, pear, peach and winter hazel (HAYASHI 1984, MAKIHARA 2007). The closely related species *Anoplophora oshimana*, which is distributed across Amami-Oshima, Okinoerabujima, Tokunoshima, Okinawajima, Ishigakijima and Iriomotejima islands, is also known to have a broad spectrum of host plants (HAYASHI 1984, MAKIHARA 2007), but it is thought to prefer winter hazel over citrus; thus, *A. oshimana* is not commonly regarded as an insect pest for citrus cultivation on these islands.

We tried to interview a number of citrus farmers and local government officials from Kikaijima I. regarding citrus damage caused by the long-horned beetle in 2011–2012. They stated that a severe outbreak of the beetle started about 10 years ago and that the damage was obvious from 2006–2008. Another farmer that observed damage more than 10 years ago answered that the beetle rarely attacked citrus trees, but did observe damage to winter hazel trees used as a windbreak in orchards. In the area one official had been aware a phenomenon where white spots pattern on back of the long-horned beetle changed from yellowish to bluish-white was reported on Amami-Oshima I. (MAKIHARA 2007), which suggests that the native *A. oshimana,* which has yellowish white spots, was replaced by *A. malasiaca*, which has bluish white spots, originating from mainland Japan, Kyushu, Shikoku and Honshu islands.

Example of Decreased Citrus Trees in a Village on Kikaijima I.

Oasato-Nishime is a small village (approximately 25 ha) in the center of Kikaijima I. There are fewer than 100 houses in the village, and half of the houses are empty. In the village, a tree suffering from citrus greening disease (Citrus Huang-Long-Bin) was first observed in December 2003. Since this was the first record of the disease on the island and some additional trees suffering from the disease were found in the village, all citrus trees cultivated and present (about 2,800 trees in total) were counted, identified, numbered and mapped using

a GIS system by the local government of Kikai Town in 2005 as part of a citrus greening disease eradication program. Using this map, a mortality survey of all citrus trees in the village was traceable. Thus, we traced the change in number of citrus trees in the village using the map and numbering system. Additionally, fewer than ten trees were felled by citrus greening disease after 2005.

The change in number of citrus trees in the village during 2006–2008, which decreased slightly but was generally stable, was about 2,800. The number of trees then decreased to 2,600 by the end of 2006 and to 2,500 by 2010. Only 1,600 trees were thicker than about 2 cm in diameter, meaning we could use a microbial insecticide containing *Beauveria brongniartii* (Biolisa Kamikiri Slim®; Idemitsu Kosan Co. Ltd., Tokyo, Japan). When we established control of the long-horned beetle using this microbial insecticide, we excluded trees narrower than 2 cm in diameter to reduce the use of the expensive insecticide and the labor required to set the control measures. In addition, we did not count the number of narrow trees. If we assume that the trees we excluded accounted for approximately 20% of the citrus trees in the village, the total number of citrus trees would be decreased to about 2,000 (Fig. 1). In this case, the village lost 1/3rd of the trees over four years.

Choice of a Suitable Control Method

We avoided using chemical insecticides to control the long-horned beetle because the village has a water well that many people living in adjacent villages use, and we had to conserve the village's insect fauna, which was damaged by a chemical insecticide used to control an insect vector of citrus greening disease during 2004–2008.

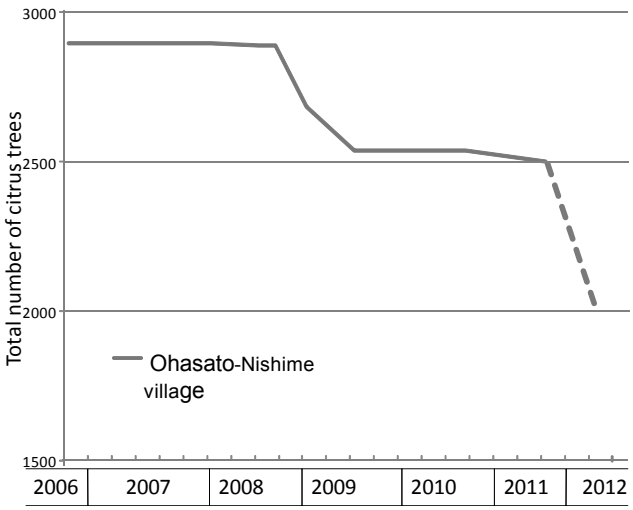

Fig. 1. Change of the number of citrus trees in Oasato-Nishime Village of Kikai Town, 2006–2008. The Oasato-Nishime Village lost 1/3rd of citrus trees from 2008 to 2011.

Alternatively, we chose a microbial insecticide (Biolisa Kamikiri Slim®), which consists of a non-woven fiber band impregnated with a fungus (*B. brongniartii*) to control the beetle on citrus trees. The reason we chose this particular microbial insecticide is that the fungal strain originated from Japan, ensuring that the fungus would die in the local environment. Thus, the use of microbial agents to control the long-horned beetle is one form of environmental load-reducing control.

However, the microbial band takes 10 days to kill an adult beetle, so the female beetle can still lay a portion of her eggs. Since the longevity of an adult female is typically 2–3 months, the fungus can reduce the beetle longevity time to 1/9th to 1/6th if the fungus infects just after emergence.

Since the female beetle typically has 200–300 eggs in her ovary and the preoviposition period of the beetle is 7–15 days, a female exposed to the insecticide just after emergence will lay few eggs. The fungal infection rate using the microbial band is approximately 1 month. Therefore, an effective technique for setting the microbial band is to fasten it to an infected tree at about 40 cm above the ground during the onset of the adult emergence season.

An efficacy report on the microbial band from Okinawajima I. (KYUSHU AGRICULTURE PROMOTION COUNCIL 1994) stated that 50–100% of adult beetles captured in experimental orchards (about 11–15 ha) containing the microbial band were infected by *B. brongniartii*, but the larvae boring into the citrus tree did not decrease during the later season. Consequently, the report concluded that control by the band was limited on Okinawajima I. because the subtropical island has more essential host tree species adjacent to the forest than mainland Japan. The report estimated that many non-infected females invaded from surrounding forests and deposited eggs within the experimental orchard (Fig. 2). The report did not perform a trial of the band on the other islands in the Okinawa Islands and their adjacent Amami Islands, and people living in the isolated island area have abandoned use of the band. Since Kikaijima I. belongs to the Amami Islands, whose climate is subtropical and similar to that on Okinawajima I., a similar phenomenon may occur if we set the band in some citrus orchards. To avoid similar failures, we set a microbial band on all citrus trees in the village (about 25 ha). Using this widespread approach, we hoped to determine the actual efficacy of the microbial band (at least in the central area of the village). It may be possible to identify invader females at the edge of the setting village to decrease the likelihood of invader females reaching the central area of the village.

An Effect of Wide-Area Control by an Entomopathogenic Fungal Pesticide

During our first visit, we observed that many residents were unaware of the correlation between citrus tree damage and the citrus long-horned beetle. We first distributed a leaflet to all residents of Kikaijima I. to discuss the correlation between citrus damage and the long-horned beetle, the life cycle of the long-horned beetle, the morphology of the beetle at all developmental stages (egg, larva, pupa and adult) and control methods. Simultaneously, we

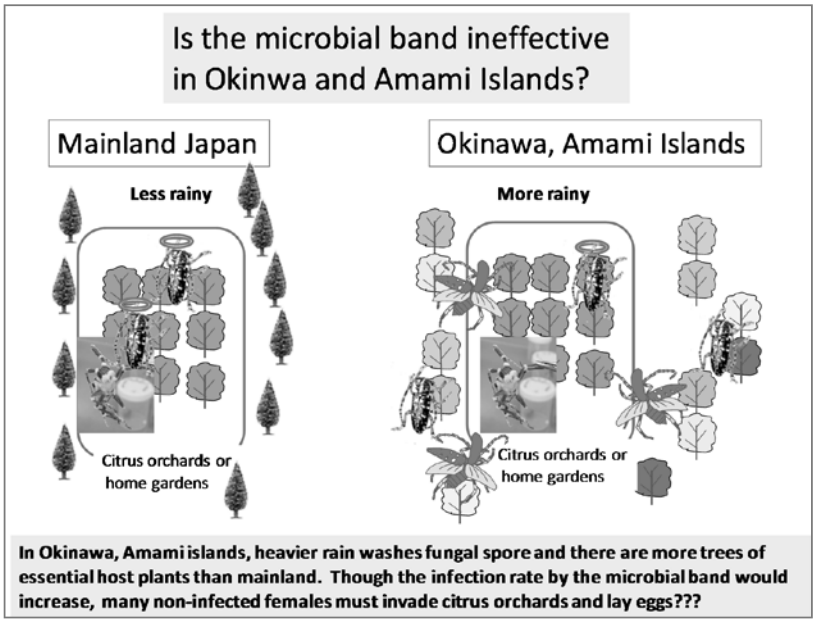

Fig. 2. Schematic comparison of environmental conditions for setting the microbial band between mainland Japan and subtropical isolated islands (Okinawa, Amami).

held a meeting to explain the long-horned beetle control method using the microbial band and we identified participants to set bands the next day in the Oasato-Nishime. These actions increased the residents' awareness of control of the citrus long-horned beetle.

When we set the microbial bands in May 2012 and in May and June 2013, more than ten residents participated. Since they knew the position of every citrus tree, setting the bands on more than 1,500 trees only took half a day. The infection rate of *B. brongniartii* in the wild beetle at 2 weeks after setting the bands was more than 70% in May and June 2013 (MIYAKE *et al*. unpublished data). This indicated that most of the female beetles that emerged in the village could lay few or no eggs and died. In autumn, when the damage caused by larvae became visible, we searched for freshly damaged trees and counted the number of damage signs by larvae, which exhausted frass like sawdust. The larval density, which was calculated based on the number of damage signs, was 1.3 larvae/citrus tree before setting the bands in 2011, but was 0.11 larvae/tree at 2 years after setting the bands (in 2013; MIYAKE *et al*. unpublished data). Thus, we were able to achieve high efficacy for the control of long-horned beetle larvae. This control efficacy was completely different from that on Okinawajima I. (KYUSHU AGRICULTURE PROMOTION COUNCIL 1994). This may be because we set the microbial bands in a larger area than on Okinawajima I. (i.e., broader effect).

These results suggest that microbial band control can be extremely useful in isolated island areas if people use this approach with considering a broader effect. Unfortunately, during our 2-year survey 30% of the fixed observation trees (n=108) died. To protect the citrus trees throughout Kikaijima I., we need to rapidly expand the treatment area.

DNA Analyses of the Citrus Long-Horned Beetle in Kikaijima I.

We conducted DNA analyses of Mitochondrial COI region (about 800 bp) and nuclear ITS2 region (about 500 bp) of the long-horned beetle from Kikaijima I. The COI sequences of those samples were similar to the sequence of *Anoprophora oshimana*, but the ITS2 sequence were intermediate status between *A. malasiaca* and *A. oshimana.* These results must explain as introgressive hybridization of the citrus long-horned beetle inhabit in Kikaijima I. by *A. malasiaca*'s gene.

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Design and Application of Unsinkable Tuna Longboat for Local Fishermen

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Abstract

The activities of fishermen in archipelago regions (Eastern Indonesia and Pacific) mostly relate to the efforts in catching fishes and other marine resources. One of the most valuable fish is Tuna which is caught by simple up to modern big vessels and fishing gears. Most Moluccas fishermen are using small “tuna longboats” for this purpose. Those small boats operate in open seas where most of the time the sea conditions are rough. In many cases, those small boats could not resist in such conditions which will end-up with flooding, capsizing or sinking. Some records showed the fishermen and boats are lost at sea. A study was executed to solve this problem. Three new tuna long boats, with the size of 1.5 GT each, were designed. Those boats were provided with solid boxes inside to provide reserve buoyancy. The boats were constructed with the material of composite (Fibre Glass Reinforced Plastic). Then, the boats were tested at sea. The results of test showed that for a maximum flooding of boats, they still float (unsinkable) with a minimum trim level. In addition, for a capsize condition, they were still afloat and easily were returned to upright position. The results of boat design and evaluating were recommended to be applied to the users. A training program was conducted for the local boat builders during the study. Nowadays, the local boat builders have developed this unsinkable concept to their new boats into the market.

Keywords: Fibre Glass Reinforced Plastic (FRP), reserve buoyancy, solid boxes, training program

Introduction

Eastern Indonesian waters as well as some Pacific regions have great potential of marine products, particularly tuna fish. This kind of fish has a valuable selling price in the international markets. Tuna fishes are caugth in some fishing grounds in Eastern Indonesian and Pacific waters. They are caugth by using some simple up to modern vessels with fishing gears. Local fishermen, especially in Moluccas, are using small boat, called “tuna longboat” with the capacity of 1.5 GT. The boat is operated by two fishermen where they use the fishing gears of hand or trolling lines. The fishing grounds are in open waters with some rough sea conditions. At certain periods, there are strong winds with big waves. The operation of those small boats in such rough waters is not possible. Some accidents occurred where the boats were flooded, capsized and sinked. The fishermen lost their life at sea. The boats were

designed and constructed by local boat builders without paying any attentions of boat design concept. The design process were only based on traditional experiences where this issue lasts for long time. Such small boats were constructed with the material of wood or Fibre Glass Reinforced Plastic (FRP).

A study was conducted to find the solutions. New boat configuration was introduced in this study. A team of design and construction of small fishing boat, Faculty of Engineering, Pattimura University was responsible for this work. Three boats (hull material of FRP), with the size of 1.5 GT each, were designed and constructed based on proper ship design concept. Those boats were provided with some solid boxes inside. The configuration and dimensions of solid boxes were calculated and distributed properly along the boats. Furthermore, the boats were tested at sea for floating purpose. At the test, the boats were filled with sea water into all compartments inside. It was found that the boats were still afloat at certain draft. In addition, the boats were capsized at an upside-down position. It was found also that the boats were still afloat at certain condition and easily to be turned into their initial upright position.

Boat Design and Construction

Design of a boat should be based on some requirements, design considerations and following the whole design process (TAGGART 1983). In this case, design consideration is the boat ability to afloat on upright or even in capcized positions. In addition, a consideration of boat operation and environmental conditions would end up with a boat configuration. Other considerations are based on the requirements of small fishing boat with a certain cathing target. The boat was also designed to fulfill the requirements as a fishing boat (FYSON 1985). Some input design parameters should be determined to be included in the design process. Fishing gears were choosen properly to be fixed in this small fishing boat (HETHARIA *et al*. 2001, HETHARIA *et al*. 2003). The design process ended up with boat dimensions, geometrical hull forms, structures, general arrangements and other design parameters. In addition, blue prints are included for construction phase.

To keep a boat afloats on its upright position at designed waterline, a certain reserve buoyancy is required. A relationship of total boat weight should be the same as boat weight displacement and is presented as (LEWIS 1988, RAWSON and TUPPER 1984):

Total weight = Δ, (t) and $\Delta = V \times \gamma$ (1)

Total weight = lightweight (LWT) + deadweight (DWT) (2)

where: Δ = weight displacement (t)

V = volume displacement (m^3)

γ = specific weight of sea water (t/m^3)

LWT = lightweight = boat hull+engine+ equipments.

DWT = deadweight = cargo (fish and ice) + crews + fuel + lugages + fishing gears + live bait fishes.

For a critical condition, cargo is considered as water that fills all compartments in boat.

$$\text{Cargo} = W_{\text{total water}} \quad (3)$$

In this study, some solid-closed boxes (with foam inside) were provided inside the boat in order to reduce total water weight or to keep the boat still afloat. On the other hand, the inside solid boxes provide the buoyancy forces when the boat is in the capsized condition. This will make the boat afloat at capsized condition.

In addition, a distribution of closed boxes along the boat were arranged in order to obtain a proper longintudinal centre of gravity (LCG) which aproaches the position of longintudinal centre of buoyancy (LCB).

$$\text{LCG} = \text{LCB} \quad (4)$$

When the boat is in capsized condition, the relationship of volume below should be met:

$$V_{\text{boat}} = V_{\text{hull sheel + structures}} + V_{\text{solid boxes}} \quad (5)$$

In the case where the boat still afloat at the upright or capziced positions then the quantity of inside solid boxes should be provided to meet Archimedes' principle of floating subject. Besides, the location of LCG should be as close as LCB to ensure the boat would not be in excessive trim condition.

The hull material of FRP was applied for the boats. The construction of boats were based on the procedure of using FRP (reffered to "Marine Design Manual for Fiberglass Reinforced Plastic"). The boats were constructed at the Faculty of Engineering, Pattimura University, Ambon, Moluccas. The boats were constructed as prototype for evaluating their performance at sea (HETHARIA 2008). Three boats (similar configurations) were constructed based on the parameters of output design. All boats have the same size which was 1.5 GT. They were Fatek 08, Barracuda and Yellow Fin, as seen in Fig. 1. The boat dimensions and output design parameters are presented in Table 1.

Fig. 1. Tuna longboats 1.5 GT.

Table 1. Dimensions of tuna longboat.

No	Items	Symbol	Dim	Unit	No	Items	Dim	Unit
1	Length Overall	L_{OA}	8.050	M	**Condition: Full Load at Designed Waterline**			
2	Length of Waterline	L_{WL}	7.600	M	**Flooding to Upper Line, Upright Position**			
3	Length Bet. Perpend.	L_{BP}	7.600	M	19	Reserve weight	0.509	Ton
4	Beam	B	1.076	M	20	Reserve volume	0.497	M^3
5	Maximum Beam	B_{max}	1.165	M	21	Reserve freeboard	0.067	M
6	Draft	D	0.390	M	22	After draft	0.518	M
7	Height	H	0.640	M	23	Fore draft	0.713	M
8	Block Coef.	C_B	0.641		24	Reserve freeboard aft to U.L	0.224	M
9	Midship Coef.	C_M	0.795		25	Reserve freeboard fore toU.L	0.037	M
10	Prismatic Coef.	CP	0.807		**Condition: Capsized, Upside Down**			
11	Waterplane Coef.	CW	0.773		26	Volume displacement	0.807	M^3
12	Gross Tonnage	GT	1.500	Tons	27	Weight displacement	0.827	Ton
13	Vol. displacement	V	2.045	M^3	28	Long. Centre of Buoyancy	-1.360	M
14	Wt. displacement,	Δ	2.096	Ton	29	Total boat weight	0.548	Ton
15	Length C. Buoyancy	LCB	-0.200	M	30	Long. Centre of Gravity	-4.540	M
16	Total boat weight	W	2.088	Ton	31	Trim: by stern		
17	Length C. Gravity	LCG	-0.202	M	32	Reserve weight	0.279	Ton
18	Trim : even keel				33	Reserve volume	0.272	M^3

Other output design parameters are:

- Payload: 0.7 t fish and 0.35 t ice — Ratio ice/fish: 0.5
- Volume of solid boxes: 0.623 m^3 (14.3 %) — Total volume: 4.37 m^3
- Prime mover: outboard engine 25 or 40 HP — Crew: 2 persons
- Fishing gears: hand line and trolling line — Autonomy: 50 nautical milles
- Fishing grounds: Banda Sea, Seram Sea and other Moluccas waters

Sea Trial

The boats sea trial tests were excecuted in order to confirm the output design. The tests included speed and floating conditions. The test of speed was executed based on a procedure of speed testing. The tests were executed in Ambon bay for three boats (Fig. 2). The results of the tests met the design requirements. At the floating test, all components such as engine and equipments were still attached on boats (Fig. 3, 4). The boats reached the speed of 12 or 15 knots for the engine power of 25 HP or 40 HP, respectively.

The tests for floating purpose were executed in three conditions, which are:

1. Loading condition up to designed waterline to check full capacity of cargo loads.
2. Loading condition up to upper line to check the ability to afloat in flooding condition.
3. Capsized condition to check the ability of boat to afloat in such condition.

The test of full cargo load was set-up for boat draft up to the designed waterline. This was adjusted for a payload of 0.70 t and bulk ice of 0.35 t. It was found that the boats were in even keel position. The test of flooding condition was executed by filling sea water to all compartments inside the boat. All compartments were filled with water meanwhile some boat equipments were fixed. From theoretical computation, the total weight of displacement was 4.08 t and total boat weight was 3.576 t.

Fig. 2. A sea trial test for the speed.

Fig. 3. A floating test for upright position.

Fig. 4. A foating test for capsized condition.

This means that there was still a reserve weight of 0.50 t or reserve volume of 0.50 m^3 was provided. It was found also from the test measurement that the boats were trim by bow. A reserve freeboard was measured for three boats as follows:

After freeboard to upper line:
Fatek 08: 0.20 m Barracuda: 0.22 m Yellow Fin: 0.215 m

Fore freeboard to upper line:
Fatek 08: 0.041 m Barracuda: 0.045 m Yellow Fin: 0.042 m

The tests of capcized were executed by turning the boats to upside-down position. From theoretical computation, total weight displacement was 0.827 t and total boat weight was 0.548 t. This means that reserve weight of 0.279 t or reserve volume of 0.272 m^3 were provided for the boats. It was found also from the test that the boats were trim by stern. Vertical dimensions of freeboard height were found from measuring floating conditions. They are:

After freeboard measured from DWL (immersed):
Fatek 08: -0.010 m Barracuda: -0.011 m Yellow Fin: -0.010 m

Fore freeboard measured from DWL (emerged):
Fatek 08: 0.018 m Barracuda: 0.019 m Yellow Fin: 0.017 m

It was seen from the results of sea trial tests that the designed boats were afloat to their upright as well as capziced positions. Those results were closed to the theoretical computations. For a loading condition to designed waterline, it was found that the boats were in even keel condition. A cargo capacity of fish 1.0 t and ice 0.50 t was designed in this work. A critical conditon where the boats were fully flooded was obtained by filling water into all boats' compartments. The results were all three boats still afloat with a little trim by bow. According to theoretical computations, a reserve of after and fore free board to upper line were 0.224 m and 0.037 m, respectively. Where from the results of sea trial tests, they were 0.21 m and 0.043 m. The differences were came from the difference of LCG position in this loading condition.

When the boats were capcized, they were still aflot as seen from the results of the tests. The boats were trimmed by stern. An indication of measurement for this condition was freeboard measured from designed waterline. On the average, after freeboard measured from DWL for the three boats are -0.11 m. The negative sign means that the boats were immersed at after perpendicular. Meanwhile, fore freeboard measured from DWL for the three boats are +0.018 m. The positive sign means that the boats were emmerged at fore perpendicular.

Training Program for Local Boat Builders

During the project of boats construction in 2008, the local boat builders were participated. The training project was organized by Department of Naval Architecture, Faculty of Engineering, Pattimura University, Ambon, Moluccas. The total of 55 participants from private and government sectors in Moluccas are involved. They were trained for theoretical and practical approaches of boat design and construction (Fig. 5). By the knowledge achieved during the training period, they continue to develop this concept to their new product of boats.

Conclusion and Future Work

From the results of theoretical computation and sea trial tests, it was concluded that when a boat is provided with some solid boxes inside it is still afloat even in full of water or capsized conditions. Those solid boxes reduce the quantity of water coming into the boat. Besides, the solid boxes create the buoyancy of the boat in the capziced position. A proper distribution of solid boxes give a condition where the boats were not trimmed excesivelly. This condition makes easy operation of turning back the boat from the capsized condition to its initial upright condition.

The boats were designed, constructed and tested for their capability to afloat. It was recommended to be applied to the users. The local boat builders have developed this concept for their new products and this help the local fishermen for preventing the sink of boat in the rough seas. This concept of boat design is recommended to be used for the fishermen in Eastern Indonesia as well as the users in the Pacific regions.

The application of this concept for the larger fishing boats is still in the question mark but it will be some solutions for the future. However, this concept will be applied soon for the small fast passenger boats operated in the archipelago regions.

Fig. 5. A training session for local boat builders.

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Renewable Energy Makes Life Style Change: An Example of Yakushima Island's Zero Emissions

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Abstract

Tohoku Earthquake, which occurred on March 11, 2011, was a cause of great shock, not only to Japan but to the rest of the world as well. The quake has led to a paradigm shift in terms of the use of electricity power. We must now review our nuclear power policy and change our lifestyles by imposing limitations on the use of electrical power. In the past, we have thought of nuclear power as being low cost, which is important in terms of business activities. Subsequently, we have found nuclear power to be high risk, as evident in this accident. We have to find alternatives. Nuclear power is the most effective way of generating large amounts of electricity, and it is difficult to achieve these large volumes except other energy sources.

Yakushima Island, a World Natural Heritage Site located in Kagoshima Prefecture, Japan, is almost completely powered by hydroelectricity. Focusing on this unique island, Kagoshima Prefecture is promoting the "Zero Carbon Emissions Island" initiative, which aims to create a developed area where carbon dioxide (CO_2) emissions are effectively reduced. I thus propose alternatives to nuclear power as well as a new lifestyle, using Yakushima Island as an example.

Keywords: electric vehicles, new lifestyle, World Natural Heritage Site, Zero Carbon Emissions Island

Use of Renewable Energy

Renewable energy has been used in the world. It depends on country terrain, wind power and solar power are developing in Spain and United States. In Japan, hydro water power is the most popular, but wind power is not widely open because of the terrain and operation. On the other hand, Japan is surrounded by the sea; it is supposed the use of offshore wind.

According to the investigation of the International Energy Agency (IEA), the amount of electricity generated by renewable energy in the world in 2008 account for only 18%. IIDA Tetsuya said that diffusion of renewable energy power generation in Japan is about 10% and it has not been changed for past 10 years (THE NIKKEI NEWSPAPER 2012). Compared with the same period in Germany and Spain, it increased by 18% and by 20% in Germany and in Spain, respectively. About the reason for the delay in promoting renewable energy in Japan, IIDA

says that there are four problems: (1) no support system, (2) monopoly of the transmission line by the power company, (3) excess of the amount due to local government regulations and the country and (4) absence of agreement with the local community (THE NIKKEI NEWSPAPER 2012). For (1), feed-in tariff of renewable energy was adopted late in Japan. In Spain and Germany, it is already adopted. Solar cell manufacturers, such as Q-Cells, have increased its share. In this early century, Japanese companies, such as Kyocera and Sharp, had the majority of the share of solar power, which were reversed in Western companies because these were effectively utilized the feed-in tariff. Now, here is momentum in Chinese companies such as Suntech Power and JA Solar with low cost that will dominate the market. For (2), power industry intends to try to promote nuclear power than renewable energy because each power company has a monopoly on the wall next to the power transmission network. For (3), this is the adverse effects of traditional Japanese legacy system. When you are trying to take advantage of renewable energy, its application is impeded by a number of regulations. For example, trying to take advantage of geothermal energy has been placed under the control of the National Park, you will not be able to use actively. If you want to use it, you have to submit many applications to more than one municipality, prefecture, city, Government and so on. For (4), this is the problem of water rights, which is a major concern in the region. When you are trying to set up the hydropower, you must get permission to the water rights of downstream to do it. This task is very difficult. To make this easier, it will be necessary to penetrate the recognition of renewable energy. The biggest advantage of renewable energy is the eco-friendly and cleanly. But, it is difficult to understand it. The biggest concern for a water right is that their rights are infringed.

There are many problems which renewable energy does not penetrate in Japan. The lack of understanding of renewable energy is also one of the biggest problems. The merit of using renewable energy is that energy is never dirty after use, and we are able to reuse many times. By recognizing the benefits, we have to use renewable energy as energy that can be used semi-permanently.

Lifestyle Change from Large-Scale Power Generation-Dependent

Each household made a self-generation to correspond to the power demand in the late 19th century (CARR 2008). Then, the customers have come to rely on large-scale power generation facilities. Because of the economies of scale, electricity price is reduced, many appliances are developed. Moreover, an electrical-dependent lifestyle has evolved in a way to maximize the benefits of low-cost power. It means that you can use the required amount of power, you don’t worry about the lack of power in order to enrich the lives of your own. As far as economic development continues, you were able to increase in ever-increasing amount

of power you need. Thus, further economies of scale in power will advance, which is promoting the construction of large power plants such as nuclear power that can generate electricity efficiently.

At this time, if this flow is reversed, you do not depend on the power company; each household produces the power required. It is renewable energy which makes it come true.

Hydro Power in Yakushima Island

Yakushima Island is the fifth largest island in Japan, 132 km perimeter, 503 m^2 area. In "Drifting Clouds" book, HAYASHI Fumiko wrote "in Yakushima it rains 35 days in one month" (HAYASHI 1953). It is an area very much rain which caused by mountain conditions. Yakushima Island is blessed with the natural environment. Hydroelectric power using the abundant water takes up a lot of power in Yakushima.

According to "The History of the Power in Kagoshima" (KYUSHU ELECTRIC POWER CO., INC. KAGOSHIMA BRANCH 1998), the hydropower has been planned early by geographical inconvenience of outlying and abundant rainfall. In 1916, Kagoshima Electricity got the water rights of Anbou River and tried to build a fertilizer plant but not achieved. In 1924, Yakushima Hydroelectricity Company was established. Takeno River Plant was completed two years later and general electric light was supplied to Isso, Yoshida and Nagata area. In 1949, hydroelectric power was 385 kW power generation in just four areas; there were 1,530 light lamp. Yakushima Denko Co., Ltd., in 1953 completed Senpiro Fall Plant, and in 1960 Anbou River Plant was completed. So there are four hydropower plant and one thermal plant in Yakushima. Miyanoura thermal power plant is not running basically. It operates just when the hydropower is insufficient. Instead of Kyushu Electric Power, Yakushima Denko has been responsible for it in Yakushima. The amount of hydroelectric power generation have more than enough, the power supply is not considered stagnation. Yakushima power has been met by hydroelectric power, which will serve as a model for Japan that is to increase the percentage of renewable energy. So we have to think of the effective use of available capacity hydroelectric and need to promote the benefits that will change as the disadvantages of the island.

The Use of Electric Vehicles

It is possible that hydropower generated from abundant water in Yakushima covers the most of the island's power. The geographical disadvantage of islands, for the supply of gasoline, is about 20% higher than the price of gasoline in mainland. If many use the electric

vehicles, we will save about 50%. If gasoline can be replaced by electric, economic burden of the people in Yakushima can be reduced and it is expected that the realization of zero emissions and CO_2-free will come true.

Many people in Yakushima can finish the requirements in less than 30 minutes. Range of activities is within 20 km. Disadvantages of electric vehicles are the time for a single charge. As described, this condition is sufficient. In other words, the electric vehicle is very economical and reasonable in Yakushima.

New Lifestyle

With the spread of electric vehicles, a new lifestyle is proposed in Yakushima. What electric car brings is not only zero-emissions, CO_2-free, but also low cost convenient life. But, the electric car is not yet sufficiently diffused in Yakushima. The environment which electric vehicles spread is not enough in Yakushima. So, we have discussed the environment surrounding the electric vehicles; “What elements are missing?”, “What should be improved?”, “If these problems are eliminated, are electric vehicles prevalent in Yakushima?”, “Will we achieve zero emissions and CO_2-free?” I mentioned about the problems to be solved and the potential for electric vehicles.

(1) High selling price compared to equivalent gasoline vehicles
(2) Infrastructure on the island, namely lack of charging facilities
(3) Lack of understanding to the electric car
(4) Impact on existing industries, the creation of new industries

For (1), not only national and local government subsidies, but the innovation to reduce the selling price by automobile company is necessary. It is important to be able to sell to consumers without burden.

For (2), not only subsidies for charging equipment, but the small and lightweight battery, such as a 100 V household power supply, which we can be replaced when needed is expected to be developed. And we would require an extension of the cruising range due to improved battery technology.

For (3), rate of more than 65 years of age accounted for 28.7% in Yakushima Island. Car is also the necessities of life, the driving is essential for their life. Many elderly drive often, a simple way of charging and anxiolytic to out of batteries in the middle of operation will be necessary. Only the benefits of electric vehicles would not be an appeal to purchase. We would need to make surely awareness for electric vehicles to islanders. As described in this paper, automotive operating environment at Yakushima is very limited, it is expected that the

possibilities of out of batteries is as same as the shortage of gasoline when you drive the internal combustion engine. As long as the battery is not in trouble, we make it sure that out of batteries never happen in the use of electric vehicles during the day if we have each night charge.

For (4), with the spread of electric vehicles may have a major impact on the conventional industry and business. For example, gas station would go no longer required due to the spread of electric vehicles. The conventional garages must be corresponding to the electric vehicles, mechanic technology is not intended for combustion; it may be required to that of electrical systems.

Resume operations of nuclear power plants is a difficult situation, it may be required to increase the power rates and rolling blackouts. So hydropower potential in Yakushima will become the coveted for many companies. Disadvantage of solitary island has come to hamper the development of new industries, young people has gone out to the city to get the job. Based on the abundant hydro and power crisis, you should actively attract new companies. Compared to the demerit to be away from the city and the merit to the stability of the power supply, there is a benefit to the company to advance to Yakushima. Hydroelectric power provided by abundant water in Yakushima, which is the renewable energy and does not give a load to the nature, will bring a new life style.

Conclusion

By using renewable energy, in this paper I have proposed the creation of a new lifestyle to take advantage of electric vehicles. In Japan, most of the nuclear power plant is shut down currently, alternative method that is the thermal power mostly. But, thermal power generation has environmental impact of carbon dioxide emissions, as became apparent this accident, nuclear power also has a large risk to the environment. The only way to remove the environment risk would be use of renewable energy. Power generation per one facility is very small. In Japan, mountainous areas account for approximately 65%, as hydropower have been utilized since ancient times, we have very big potential for renewable energy.

Benefits of hydroelectric power are not polluting the water after use. Although there are problems such as water rights, rediscovering the validity of hydropower, I wonder if it might become an opportunity to review the hydro power as an alternative to conventional power generation.

I have an example of Yakushima because of special situations, abundant annual rainfall and hydroelectric power. So it is possible to use the hydroelectric power effectively to drive electric vehicles. Also be registered on the World Natural Heritage Site, Yakushima appeals to nature conservation and the maintenance. Most of the island is occupied by forest and if we

can achieve CO_2-free, zero emissions, we can enhance the value of its presence more. If alternative to gasoline-powered vehicles are electric vehicles, they will not emit CO_2, it will be a big help to protect the natural environment. Gasoline prices in Yakushima are about 20% higher than those in mainland Japan, it would be a great benefit if you change from gasoline to electrical energy for vehicle. To use the renewable energy is a competitive advantage to another area. In Yakushima, small hydroelectric power has begun to be implemented, which is the amount of close to zero. There are many rivers, waterfalls everywhere, it is expected that there are so many places that we can take advantage of hydroelectric power. Taking advantage of them, you will be able to interchange the power unit residents. It will serve as a model of power generation and supply system of a recycling-oriented not only Japan but also world should aim to. We have been building a power plant in the form of destroying nature so far, but with an awareness of the use of more natural, we should think we will live together in the form of power generation facilities.

It is expected that renewable energy will be utilized in many places in the future and energy recycling system will be constructed more efficiently. Yakushima is a cutting-edge area of the model, we will be sure to create a form that does not leave a load on the future to generate the power.

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