



ISSN 1656-4707

The Palawan Scientist

Volume 2 Number 1

January 2005

001.433

P153

2005



**A Publication of the Western Philippines University
Aborlan, Palawan**

Flowering and Fruiting Phenology of Selected Mangrove Species in Tabon, Quezon, Palawan

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ABSTRACT

The flowering and fruiting phenology of *Rhizophora apiculata* Bl., *R. stylosa* Griff., *R. mucronata* Lam., and *Xylocarpus granatum* Konig at Brgy. Tabon, Quezon, Palawan under Philippine climate type I were monitored from November 1997 to October 1998. Ten individuals of these species were selected from three 100-m long and 6-m wide transects and visited every second Saturday of the month to score the flowers and fruits using crown density method.

R. apiculata flowered from November to February (peak in January) at 75% intensity and 100% prevalence and fruited from March to July (peak in May) at 62.5% intensity, 98% prevalence and 98% fruit set. Flowering of *R. stylosa* occurred from January to April (peak in May) at 85% intensity and 95% prevalence while fruiting occurred from May to September (peak in July) at 75% intensity with 92% prevalence and 96.8% fruit set. With 80% intensity and 100% prevalence, *R. mucronata* flowered from July to October (peak in September) and fruited from November to April (peak in January) at 77.5% intensity, 66.7% prevalence and 82% fruit set. *X. granatum* flowered from November to February (peak in January) at 60% intensity and 100% prevalence and fruited from March to June (peak in April) at 32.5% intensity, 92.5% prevalence and 90% fruit set.

Keywords: *flowering, fruiting, phenology, mangrove, Palawan*

INTRODUCTION

Palawan still has an estimated 44,500 ha of mangrove forest or roughly 40% of all that remains in the entire country (PCSD 1998). These mangrove forests are highly threatened by conversion into fish and prawn farms and resorts, and are heavily exploited for charcoal production and tan barking, leaving cleared mangrove areas which need rehabilitation.

Phenology pertains to the study of periodicity of growth or production of plant parts such as leaves, flowers and fruits. Its importance lies in relation to seed propagule production, nutrient enrichment, seed and seedling selection, and nursery operations. The main purpose of phenological studies has been to describe

the seasonal variability of food for mammals and birds and to try to determine which climatic factors might be responsible for triggering flower and fruit set.

The study of phenology could play an important role in developing sound practices to restore degraded ecosystems such as mangrove and conserve biodiversity. This also enables the identification of "keystone" species, those that flower or fruit at times when other food resources are in short supply, thus supporting a wide range of animal pollinators and seed dispersal agents which in turn are potential to the survival of many other plant species. Knowledge on the seasonality of flowering and fruiting has much to contribute towards the development of effective management strategies for the conservation of forest since phenological data could be used to plan seed collection and nursery work programs (Elliott *et al.* 1993).

MATERIALS AND METHODS

The Study Site

Tabon (Figure 1) is one of the 14 barangays in Quezon, Palawan situated at 118°3'51.5" to 118°4'49" East and 90°18' to 90°16' 42" North, under Philippine climate type I (two pronounced seasons: dry from November to April and wet during the rest of the year). Its total land area is 3,132 ha, of which 2,676 ha is alienable and disposable land, 456 ha terrestrial forestland, and 443 ha mangrove area.

Typical flora found in mangrove swamps is observed in this area. Bakauan bato (*Rhizophora stylosa* Griff.), Tawalis (*Osbornia octodonta* F. Muell.), Tabigi (*Xylocarpus granatum* Konig), and Bakauan lalaki (*Rhizophora apiculata* Bl.) dominated the area (Remegio 1999). Fishpondification, which is a common problem in Philippine mangrove areas is occurring in this site. Likewise, logging of mangrove trees for charcoal production, fuel, and house construction is common.

Selection of Sample Trees

Mangrove species with 10 individuals were selected from three 100m long and 6m wide transects, which were established at right angles from the edge of the seaward zone. Only four mangrove tree species, which were *R. apiculata*, *R. stylosa* and *R. mucronata* of Rhizophoraceae family and *X. granatum* of Meliaceae family were found to have 10 individuals present within the transects. Thus, these were the only species considered for flowering and fruiting phenological studies, and marked as samples.

Observation on the Flowering and Fruiting of Mangrove Species

The sample trees were visited every second Saturday of the month starting from November 1997 until October 1998. They were scanned using binoculars and scored for flowers and fruits using the crown density method (Koelmeyer, 1959; Elliot *et al.* 1993). This method uses a linear scale of 0-4 with 4 representing the maximum intensity of flowers and fruits (usually distributed across the whole crown). Values of 3, 2, and 1 represents three quarters, half and one-quarter of the maximum intensity, respectively. A value of 0.5 was used to indicate the presence of small amounts of flowers and fruits below one quarter of the maximum intensity. All data were recorded for analysis.

Data Analysis

The data were analyzed using the following (Elliot *et al.* 1993):

1. Intensity - means of the maximum monthly flower/fruit scores for all flowering/fruited individuals and converted to percentage of the maximum value of 4;
2. Prevalence - number of individuals that flowered/fruited in a year expressed as percentage of the total sample size of each species; and
3. Fruit set - number of individuals fruiting expressed as percentage of the number of individuals flowering.

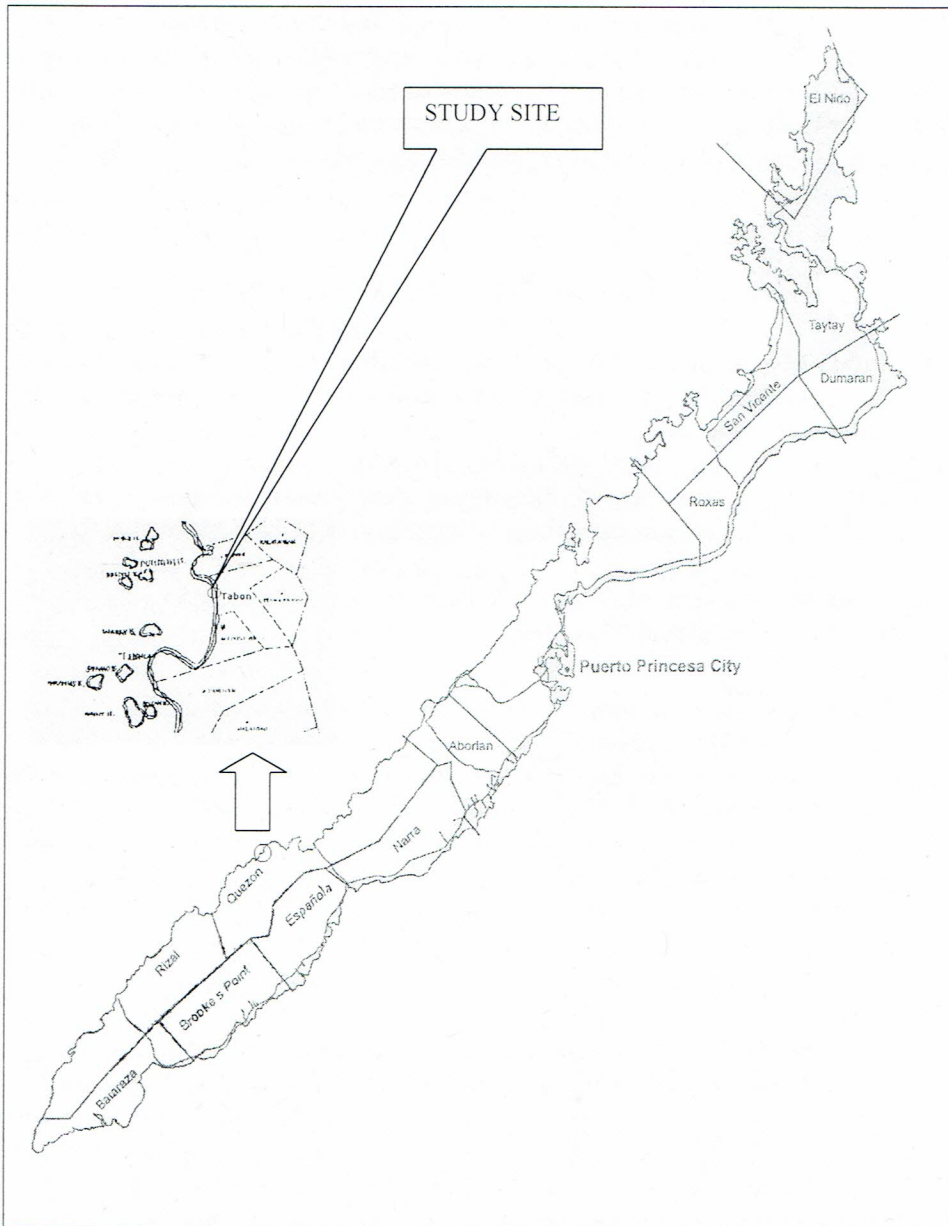


Figure 1. Map showing the study site.

RESULTS AND DISCUSSION

Flowering

The four mangrove species showed a flowering period of 4 months (Figure 2). *R. apiculata* and *X. granatum* synchronously flowered from November to February with flowering peak in January for both species. *R. stylosa* flowered from January to April and attained the peak in March while that of *R. mucronata* occurred from July to October and most flowers were observed in September.

The flowering pattern of *R. apiculata* agrees with that of Bonnittee (1978) who reported that this species starts to flower in November and heavy flowering occurs from December to January while *R. mucronata* flowers in October.

However, the flowering pattern observed in the four mangrove species deviates with the report of Palis *et al.* (1997). Under climate type I, they revealed that *R. apiculata* produces only few flowers throughout the year, although more is produced between October to November while *X. granatum* flowers only from September to November. *R. stylosa* flowers between February to March and between April to July. Its peak flowering occurs in May. In addition, *R. mucronata* flowers throughout the year and most flowers are observed in October.

The reason for flowering pattern inconsistency of the four mangrove species in this study with that of Palis *et al.* (1997) for climate type I is uncertain. However, Murphy and Lugo (1986) stated that no single environmental factor is responsible for the type or timing of phenological events in tropical tree species. Different species probably respond to different environmental factors so that flowering coincides with the most favorable season for sexual reproduction (Janzen 1967). Other factors of probable significance on phenology include day length and plant age (Longman 1978), internal growth correlation (Borchet, 1978), and combinations of biotic and abiotic factors (Frankie *et al.*, 1974).

The flower intensity of the four species was generally lower than 100% (Table 1) because most of the individuals did not consistently attain the maximum intensity when they flowered even in the same length of time (4 months). Among the four species, *R. stylosa* produced flowers as much as 85% of its canopy while *X. granatum* was the least with only 60%. On the other hand, the flowering intensity of *R. mucronata* and *R. apiculata* were 80% and 75%, respectively. According to Gill and Tomlinson (1969), *Rhizophora* flowers fall off the ground 2 days after blooming. Probably, the three species under genus *Rhizophora* had reached their maximum flowering intensity but their flowers had fall on the ground before observation was done. This might also true for *X. granatum*.

There was generally high flower prevalence in the four mangrove species indicating that most individuals produced flowers. In fact, all individuals (100%)

of *R. apiculata*, *R. mucronata* and *X. granatum* and 95% of *R. stylosa*. produced flowers.

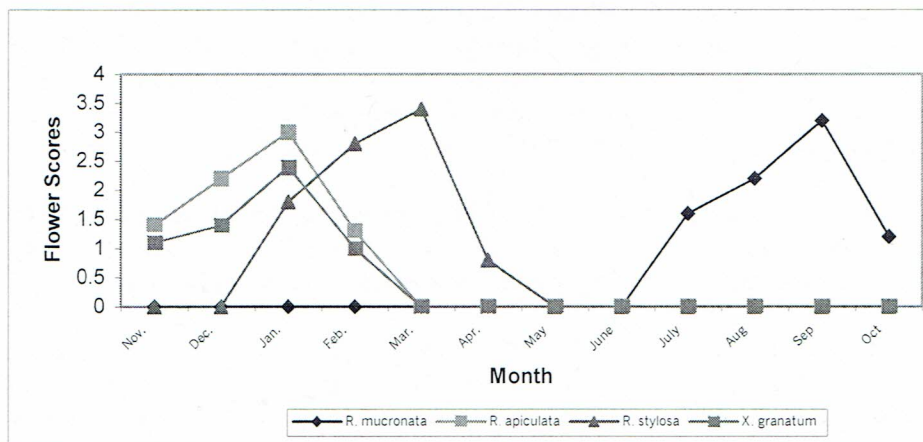


Figure 2. Flowering phenology of the four mangrove species

Table 1. Flowering intensity and prevalence of the four mangrove species.

Species	Intensity (%)	Prevalence (%)
<i>R. apiculata</i>	75	100
<i>R. stylosa</i>	85	95
<i>R. mucronata</i>	80	100
<i>X. granatum</i>	60	100

Fruiting

The four mangrove species showed discrete fruiting patterns during the study period (Fig. 3). The fruiting of *R. mucronata* occurred for 6 months from November to April and peaked in January. *R. apiculata* had fruits for 5 months from March to July with peak fruiting in May. *R. stylosa* fruited also for 5 months from May to September with fruiting peak in July while *X. granatum* fruited only for 4 months from March to June and in April.

Bonnittee (1978) observed the fruiting of *R. mucronata* in November to December. Encendencia (1978) also observed that *R. mucronata* in Pagbilao, Quezon Province had fully developed fruits at 6-8 months but found peak fruiting between May and June. In this study, the peak fruiting of this species was observed in January. This peak fruiting difference is attributed to different climatic pattern of Palawan from that of Quezon Province being different in geographical

location. On the other hand, Encendencia (1978) found that fruits of *R. apiculata* developed fully from 5-7 months with peak between October to November. Difference in peak fruiting of this species is also attributed to difference in geographical location.

It was also noted that the fruiting of the four mangrove species in this study is inconsistent with that of the report of Palis *et al.* (1997) for fruiting phenology under climate type I. In their report, *R. mucronata* bears fruits throughout the year except in July and between August and September with more fruits during October to November. Fruiting of *X. granatum* occurs between August to September and October to December with several fruits between August to October. *R. apiculata* has fruits throughout the year with most fruits between May to June and between December to January. Moreover, fruiting of *R. stylosa* occurs throughout the year except in November with several fruits between August to September.

Again, the reason for inconsistency in fruiting pattern is uncertain. The same possibilities are proposed as in the flowering pattern of these four mangrove species

Fruiting intensity and prevalence values were lower than those of flowering. This is because the former depends to a large extent to the respective flowering values (Elliott *et al.* 1993). The results imply that not all flowers became fruits since as stated, flowers of *Rhizophora* fall off the ground after 2 days of blooming (Gill and Tomlinson 1969). This could be attributed to climatic factors such as wind, which probably disturbed the trees consequently detaching the flowers from the mother trees.

Among the four mangrove tree species, *X. granatum* produced the least fruits, only to a maximum intensity of 32.5% while those of *R. mucronata* produced the most fruits up to a maximum intensity of 77.5%. The maximum fruiting of the *R. stylosa* and *R. apiculata* reached up to 75% and 62.5%, respectively. The result implies that the three species of *Rhizophora* could be the source of propagules being high in fruiting. This could be one of the reasons why Remegio (1999) found *Rhizophora* spp. as the dominant species in this area.

Fruiting prevalence of the four mangrove tree species is generally high. Majority of *R. apiculata* (98%), *R. stylosa* (92%), and *X. granatum* (92.5%) individuals fruited while only 66.7% of *R. mucronata*. Likewise, there was generally high fruit set among the 4 mangrove tree species. This means that most of the trees that bear flowers also bear fruits.

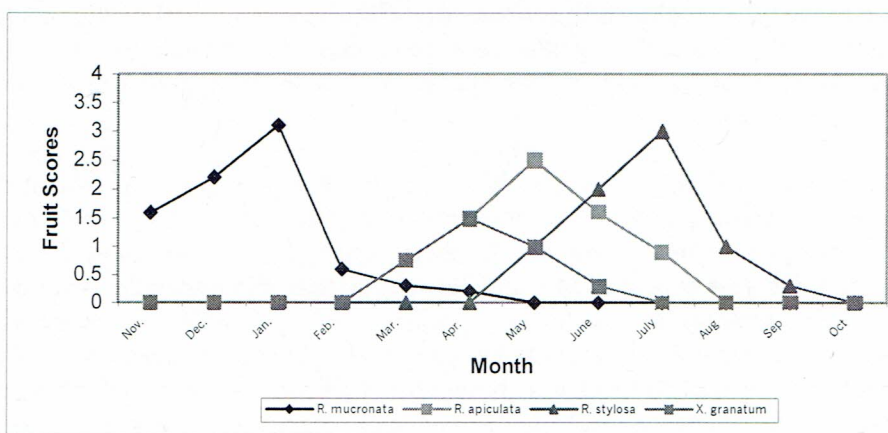


Figure 3. Fruiting phenology of the four mangrove species.

Table 2. Fruiting intensity, prevalence and fruit set of the four mangrove tree species.

Species	Intensity (%)	Prevalence (%)	Fruit Set (%)
<i>R. apiculata</i>	62.5	98.0	98.0
<i>R. stylosa</i>	75.0	92.0	96.8
<i>R. mucronata</i>	77.5	66.7	82.0
<i>X. granatum</i>	32.5	92.5	90.0

RECOMMENDATION

The results of this study revealed that the *Rhizophora* species have high fruiting intensity, prevalence and fruit set. When these species are to be used for rehabilitation of cleared mangrove areas under Philippine climate type I particularly in Rizal and Quezon municipalities, it is recommended to collect seeds during their peak fruiting month (January for *R. mucronata*, May for *R. apiculata*, and July for *R. stylosa*) to obtain abundant propagules.

It is also recommended to investigate the different environmental factors responsible for the timing of flowering and fruiting of mangrove species to be able to answer questions on inconsistencies of phenological events of the same species at the same climate type but at different locations.

The dynamics between flowering pattern and pollinator abundance as well as fruiting timing and frugivore population are interesting areas for further scientific inquiry.

Furthermore, flowering and fruiting phenology of mangrove species in the East site of Palawan under Philippine climate type III is worth investigating.

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Acknowledgment

The authors wish to thank the efforts of Mrs. Lita B. Sopsop in identifying the mangrove species at the study site and for the support of the Brgy. Captain of Tabon, Quezon, Palawan.

**Morphological Characterization of Cashew
(*Anacardium occidentale* L.) Fruits at the Western
Philippines University (WPU) Cashew Plantation**

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ABSTRACT

The cashew plantation of Western Philippines University (WPU) started in 1975. Preliminary characterization of the cashew fruit was conducted based on the International Board of Plant Genetic Resources (IBPGR) Descriptors for Cashew to assess the extent of genetic diversity present within the collection.

The results of the preliminary morphological characterization of 21 cashew fruit trees present in the WPU cashew plantation were presented in a dendrogram. Results revealed that the morphological characterization of the 21 cashew fruit trees differed in terms of apple weight, length, width, shape, color and total amount of soluble solids as well as in the nut and kernel dimensions.

Keywords: *cashew characterization, Anacardium occidentale, WPU*

INTRODUCTION

Cashew is one of the major valued crops with high economic potential. The sap from the bark incision can be used to make indelible ink. Young leaves may be used for salads and condiments. The ripe fruit is eaten raw as dessert. The juice extracted from the fruit may be made into wine and vinegar. Fluid from the fruit shell is used in preserving woodworks and books against termites. The kernel is roasted and eaten and is also used in making candies, cakes and ice cream.

Cashew plantation establishment at the Western Philippines University (WPU), formerly State Polytechnic College of Palawan (SPCP), started in 1975. However, this crop has not been well-studied with regard to its morphological characteristics. It is very important to study the morphological characteristics of the cashew collections to determine its diversity and as basis for further study.

Tabinga and Gagni (1984) reported that systematic classification to varieties is not yet available. This fact is true even up to the present. The

limitations on the lack of quality and high yielding planting materials are still a problem in cashew up to now. Limited or no characterization studies using the International Board for Plant Genetic Resources (IBPGR) Descriptors for Cashew had been conducted in Palawan.

Thus, this study was conducted to fill that gap. It specifically characterized the different cashew varieties at WPU cashew plantation with the hope of identifying high quality varieties with better economic yield. Further, efficient morphological characterization of cashew varieties would help elevate the cashew industry not only in Palawan, Rizal and Zambales but in other provinces as well.

METHODOLOGY

Fruit Collection

Twenty one cashew trees were selected for characterization of fruit and nut at the WPU campus cashew field establishment located at the following areas: cashew plantation (CP₁): N 09°26'50", E 118°33'24", (CP₂): N 09°26'51", E 118°33'27", (CP₃) N 09°26'26.2", E 118°33'38.7" and (CP₄) N 09°26'24.3" E 118°33'36.8". Ten cashew apples and nuts were collected from each chosen tree.

Characterization

The International Board for Plant Genetic Resources (IBPGR, 1986) Descriptors for Cashew was used for the morphological characterization of the cashew apple, nuts and kernel traits. The following character traits were used: for cashew apple; weight, length, width, shape of apple base (Shp), ease of peeling (EOP), color (Clr), cashew apple apex (Apx), ridges on cashew apple (Rdg), cavity at apex of cashew apple (Cav); for flesh of apple: total soluble solids (TSS), color (CLR), softness (Sft), and odor (Odr); for nut and kernel dimension: weight (Wgt), length (Len), width (Wid), and thickness (Thi).

Measurement

The weight and dimension of cashew apple, nut and kernel were measured using analytical balance and Vernier caliper, respectively.

Data Analysis

The data were analyzed using the STATISTICA (1994) program.

RESULTS AND DISCUSSION

From a total of 625 trees, the fruits of 21 cashew trees at WPU campus were morphologically characterized. Results revealed different variety/strains of cashew. The morphological characteristics of cashew apple are presented in Table 1. The weight (Wgt) of apple ranged from 29.4 g to 114.0 g with trees number 20 and 17 having the lowest and highest weight of apple (Plate 1 & 2), respectively.

Table 1. Morphological characteristics of cashew apple of the 21 trees characterized

TREE	CASHEW APPLE									CASHEW FLESH			
	Wgt	Len	Wid	EOP	Shp	CLR	Rdg	Apx	Cav	TSS	Clr	Sft	Odr
1	77.8	51.3	22.8	3	3	1	2	1	3	7.0	2	7	7
2	49.0	55.2	24.7	7	2	2	2	1	7	10.0	2	7	7
3	95.4	69.6	23.1	7	2	1	0	1	7	8.0	2	7	7
4	80.2	84.5	23.5	3	4	3	0	2	7	7.0	3	7	7
5	41.0	54.1	21.0	7	2	2	0	1	3	8.0	2	5	7
6	90.6	70.7	23.2	7	1	3	1	1	7	8.0	3	5	7
7	41.0	52.0	22.7	7	2	3	2	1	2	5.0	3	7	7
8	104.0	81.3	28.0	7	2	1	2	1	3	9.0	1	7	7
9	96.9	72.7	49.5	3	2	2	0	2	3	9.0	2	7	7
10	64.5	57.6	44.3	3	2	2	2	1	3	6.0	3	5	7
11	55.4	57.6	37.8	3	2	2	0	1	3	7.0	2	7	7
12	67.8	58.4	45.0	3	2	1	2	1	3	8.0	2	7	7
13	73.0	55.0	50.1	3	3	1	2	1	3	9.0	1	7	7
14	84.6	62.9	48.8	3	2	2	2	2	3	8.0	2	7	7
15	66.8	62.2	37.8	3	2	1	2	2	3	7.0	3	7	7
16	97.9	82.1	50.2	3	2	3	2	2	3	8.6	4	7	3
17	114.0	87.6	52.6	3	2	3	2	2	3	9.6	4	7	3
18	31.7	48.2	33.9	3	2	2	2	1	3	14.0	2	7	7
19	32.4	49.3	34.9	3	2	1	0	2	0	13.8	3	7	7
20	29.4	47.6	34.9	3	2	3	2	2	3	11.8	3	7	7
21	80.4	79.9	46.9	3	2	3	2	2	3	7.8	4	7	3

The longest (Len) apple came from tree 17 with 87.6 mm and the shortest was from tree number 20 with 47.6 mm. The widest (Wid) cashew apple was from tree number 9 with 49.5 mm and the narrowest from tree number 5 with 21.0 mm. The ease of peeling (EOP) is the same with tree numbers 1, 4 and 9-14 which are easily peeled while tree numbers 2-3 and 5-8 (Plate. 3) were difficult to peel. The color (Clr) of apple is yellow for tree numbers 1, 3, 8, 12-13, 15 and 19 (Plate 4). On the other hand, red apple color can be seen in the tree numbers 2, 5, 9-11, 14, and 18 (Plate 5) while apples from tree numbers 4, 6-7, 16-17, and 20-21 are orange (Plate 6). The shape of apple is variable from cylindrical, round (Plate 7) to conical (Plate 8).

The shape of apple base (Shp) is angular for tree numbers 5 and 12 while rounded on tree numbers 2-3, 8, 10-11, 13, and 15. Flattened shape of apple base is found on tree numbers 4, 6-7 and 16-17 (Plate 9). On the other hand, the shape of the apple base from tree numbers 7, 14 and 18-20 are obliquely flattened.

The ridge on cashew apple (Rdg) is absent in tree numbers 2-5, 9, 11 and 19. On the other hand, tree numbers 1-2, 7-8, 10, 12-18 and 20-21 are entire while tree number 6 have broken ridges on cashew apple (Plate 10). This indicates that the cashew apple have differences in terms of the presence or absence of ridges.

The cashew apple apex (Apx) is level on tree numbers 1-3, 5-8, 10-13 and 18 while the rest are oblique (Plate 11). On the other hand, the cavity of cashew apple (Cav) is absent in tree number 19 and shallow in tree numbers 1, 5, and 8-18 and 20-21. Deep cavity at the apex of cashew apple was also observed on tree numbers 2-4 and 6 (Plate 12). The total soluble solid (TSS) in tree number 18 is highest with 14° brix and lowest on tree number 7 with 5° brix. It has been shown that various cashew apples from different trees have different TSS. This implies that cashew have different TSS and therefore belong to different varieties.

The flesh color (Clr) is white in tree numbers 8 and 13 while tree numbers 1-3, 5, 9, 11-12, 14 and 18 have cream color. On the other hand, the color is yellow in tree numbers 4, 6-7, 10, 15, and 19-20 and orange in tree numbers 16-17 and 21.

The flesh softness (Sft) is high in tree numbers 1-4, 7-9, and 11-21 while intermediate in tree numbers 5-6, and 10. Odor (Odr) is almost uniform except in tree numbers 16-17 and 21 with weak odor while the rest have strong odor.

The dimension of nut shown in Table 2 revealed that the nut weight (Wgt) ranged from 3.6 g to 16 g (Plate 2) with tree numbers 19 and 17 as the lowest and highest respectively. The longest (Len) nut is found on tree number 21 with 45.3 mm and the shortest was in tree number 19 with 25.8 mm. The widest (Wid) nut is in tree number 21 with 33.5 mm and the narrowest is in tree number 18 with 19.5 mm. The thickest (Thi) nut was observed in tree number 21 with 25 mm and thinnest was in tree number 5 with 12.6 mm.

The dimension of the cashew kernel as shown in Table 2 revealed that the kernel weight (Wgt) ranged from 1.4 g to 5.5 g with tree numbers 14 and 16 as the highest and lowest, respectively. The highest length (Len) of kernel was observed in tree number 21 with 33.3 mm and the shortest was found on tree number 19 with 20.2 mm. The widest (Wid) kernel is tree number 16 with 22.6 mm and the narrowest is tree number 18 with 14.1 mm. The thickest (Thi) nut was observed in tree number 16 with 15.3 mm and thinnest was in tree number 20 with 8.8 mm.

Table 2. Morphological characteristics of cashew nut and kernel of the 21 trees characterized.

TREE	NUT				KERNEL			
	Wgt	Len	Wid	Thi	Wgt	Len	Wid	Thi
1	5.6	29.7	22.8	14.9	1.6	23.4	15.5	9.2
2	5.2	32.5	24.7	14.1	2.0	24.3	15.7	9.1
3	5.4	30.5	23.1	15.0	2.0	24.5	16.1	9.3
4	6.0	31.8	23.7	16.0	2.6	24.5	17.2	11.7
5	4.0	28.5	20.4	12.6	1.8	21.4	14.5	9.5
6	5.8	30.7	23.4	16.8	2.0	23.4	16.3	11.3
7	4.8	32.0	22.5	15.0	1.8	25.4	16.8	11.0
8	7.8	36.5	27.8	17.1	3.0	28.7	18.0	11.1
9	5.8	31.9	23.0	15.4	2.0	24.2	15.4	10.2
10	5.6	31.5	23.3	15.2	1.8	24.6	14.3	9.3
11	5.8	30.3	23.7	16.6	2.4	23.5	17.4	11.5
12	6.8	32.7	24.1	16.6	2.4	26.4	17.4	10.6
13	7.6	34.7	26.3	17.8	2.6	27.4	17.3	11.8
14	4.6	32.7	24.0	15.6	1.4	24.0	15.3	9.1
15	7.4	31.5	25.1	16.9	2.4	24.1	19.0	11.8
16	15.0	42.9	31.3	24.4	5.5	25.3	22.6	15.3
17	16.0	44.4	32.0	23.6	5.0	32.5	22.9	15.2
18	4.8	27.3	19.5	16.7	1.75	21.7	14.1	12.1
19	3.6	25.8	20.7	15.7	1.56	20.2	15.2	9.8
20	4.6	29.2	22.4	14.6	1.71	22.4	16.3	8.8
21	15.2	45.3	33.5	25.0	5.00	33.3	22.4	12.1

Cluster Analysis Using Dendrogram of Cashew Varieties/Strains

Associations among 21 cashew varieties/strains as revealed by UPGMA cluster analysis are presented in Figure 1. Genetic distance estimates based on morphological character traits were used for cluster analysis in order to present the relationships as a dendrogram.

The dendrogram revealed that cashew trees could be classified into 2 main clusters at linkage distance of 50. The first cluster consisted of 15 trees accounting to 71.43 % of the total trees characterized. The second cluster consisted of 6 cashew trees comprising 28.57% of the total trees characterized.

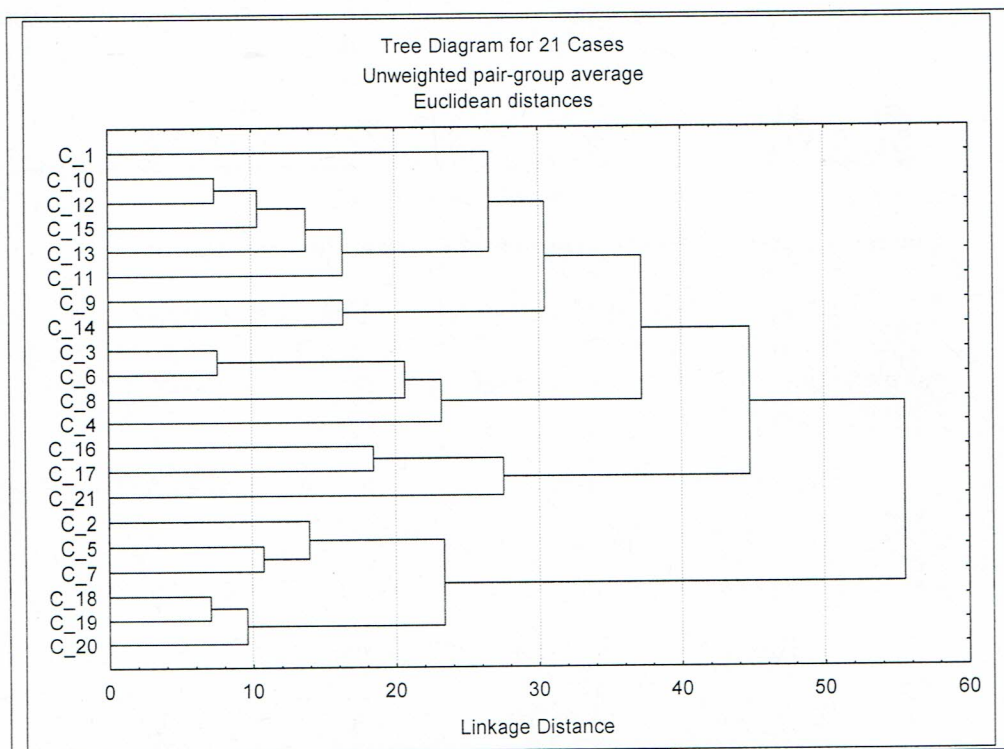
The composition of the subgroups in cluster 1 is heterogeneous at linkage distance of 30, where 4 subgroups can be formed. On the other hand, at linkage distance 20, 7 subgroups can be formed. Cluster 1 is characterized by heavier apple weight, longer length of apple, wider width of cashew apple, ease of peeling varied from easy to difficult, shape of apple is variable from cylindrical, conical to round and pyriform. The apple color is also variable from red, orange to yellow.

The ridges on cashew apple were also variable. Some were absent, broken and entire. The cashew apple apex is either level or oblique. While cavity at apex of cashew apple is either shallow or deep. The total soluble solids is lower, flesh color is variable from white, cream, yellow and orange. Flesh softness is either intermediate or high while flesh odor is either weak or strong.

The dimension is heavier weight, longer length, wider width, and thicker thickness for either nut or kernel.

The second cluster is characterized by lighter apple weight, shorter length of apple, narrower width of apple; ease of peeling varied from easy to difficult, shape of apple is conical. The apple color is also variable from red, orange to yellow. The ridges on cashew apple were either absent or entire. The cashew apple apex is either level or oblique. While the cavity at apex of cashew apple is variable from absent, to shallow or deep. The total soluble solids is high, flesh color is either cream or yellow. As to flesh softness, majority is high and only one is intermediate while flesh odor is strong.

The dimension is lighter weight, shorter length, narrower width, thinner thickness for either nut or kernel.



* Numbers correspond to the numbering of cashew trees in Tables 1 & 2.

Figure 1. Dendrogram.

SUMMARY AND CONCLUSIONS

The study showed variability of the 21 cashew trees characterized from the WPU field establishment in terms of the morphological characteristics. Differences were observed in apple weight, length, width, color of apple, shape of apple, ease of peeling the apple, shape of apple base, ridges on cashew apple, cavity at apex of cashew apple, cashew apple apex, flesh color. The total amount of soluble solids is variable but high at the second cluster, while the nut and kernel dimensions were also variable.

The morphological characteristics provide us with initial information on the diversity of cashew present in Palawan. Some varieties/strains were distinctively heavier in apple weight, heavier nut and kernel weight. The color of apple, apple shape, the flesh softness of apple are also varied with better quality.

From these, the genetic diversity can be assessed which are essential for making cashew products like cashew prunes, and candies. Furthermore, one could distinctively select cashew with good kernel quality and large sizes for roasted cashew nuts/kernel.

RECOMMENDATIONS

1. Collection, characterization and evaluation of promising cashew varieties in research stations and farmers field at varied environmental conditions must be conducted.
2. Conduct test studies on the performance of identified promising cashew strains/variety.
3. Confirm the morphological characterization through molecular analysis for classification purposes.
4. Breeding of promising variety of cashew is highly recommended.

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Acknowledgment

I am grateful to Mr. Roland D. Hipol for the analysis of the data and to Dr. Noel L. Gauran for his support and to his staff Mrs. Maribel B. Peneyra for encoding the data.

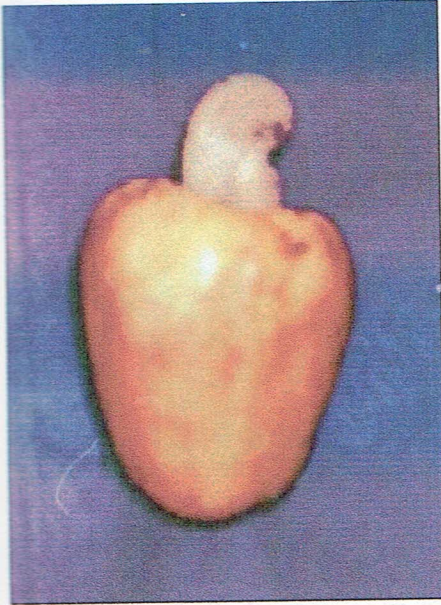


Plate 5. Red color apple.

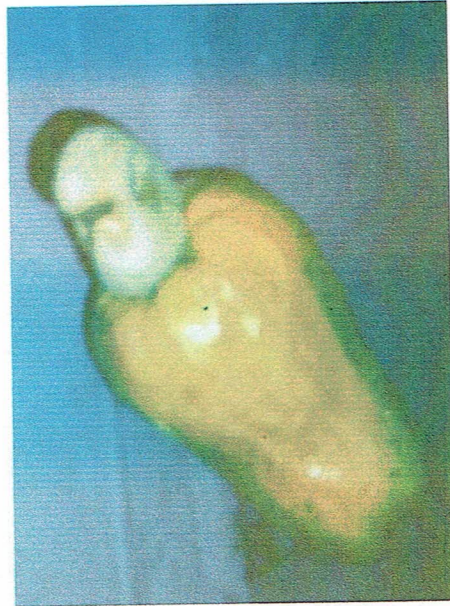


Plate 6. Orange color apple.

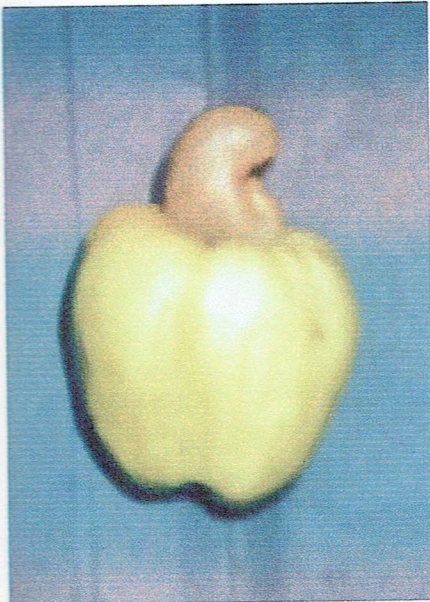


Plate 7. Round shape apple.

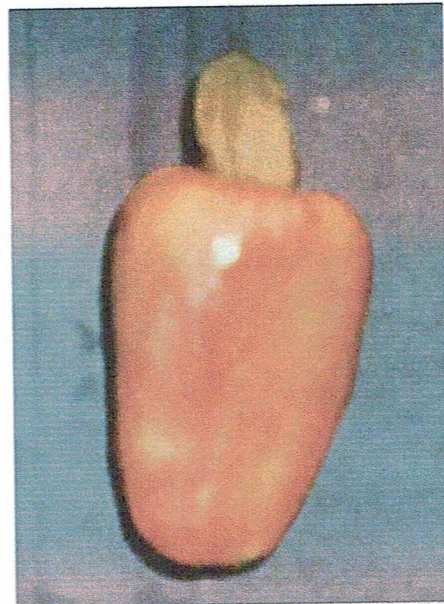


Plate 8. Conical shape apple.



Plate 1. Newly developed apple on tree with highest weight of apple.



Plate 2. Newly developed apple on tree with highest weight of apple & nut.

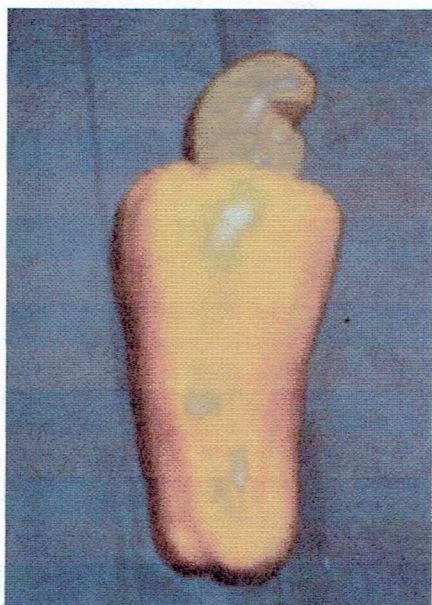


Plate 3. Cashew apple difficult to peel.



Plate 4. Yellow color apple.

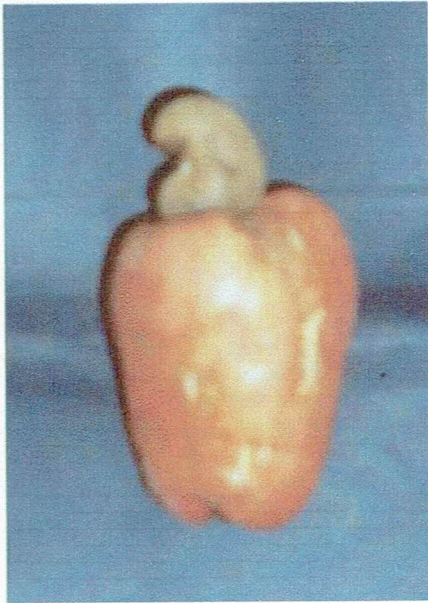


Plate 9. Flattened shape of apple base.

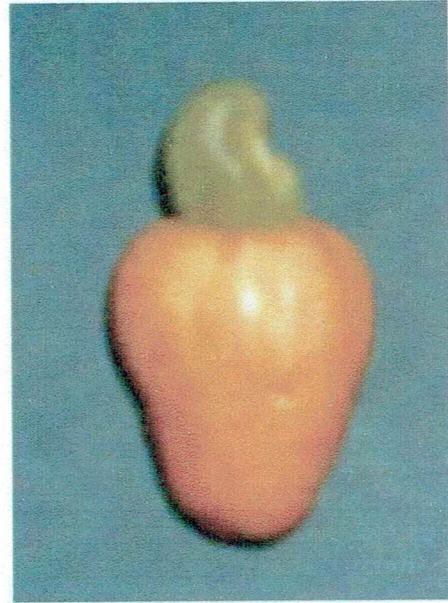


Plate 10. Broken ridges on cashew apple.



Plate 11 Oblique cashew apple base.

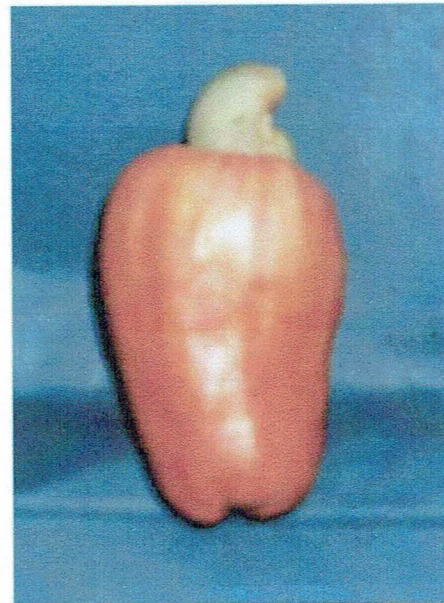


Plate 12. Deep cavity at the apex of cashew apple.

Grouper Culture in Netcages: WPU Experience

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Puerto Princesa City, Palawan, Philippines

ABSTRACT

This paper documents the use of cages for rearing or holding juvenile groupers to marketable size as experienced by the Western Philippines University (WPU) - Puerto Princesa Campus. Groupers were cultured in floating netcages in a brackishwater pond and in floating netcages in the open waters of Puerto Princesa Bay. Both projects, the brackishwater grow-out pond in Sta. Monica and the floating netcages in Puerto Princesa Bay are owned and managed by the University.

The primary and secondary data on grouper culture, either as income-generating or research activity from 1998 – 2000 were used in the study. Discussed in the paper are the guidelines in site selection, cage construction, seed collection, proper stocking, sampling scheme, feeds, feeding and the use of fish aggregating device and lift net to collect trash fish.

Major findings are the performance and survival of the cultured grouper at varying densities. The average growth rate per day of cultured fish range from 0.90 to 1.0g for fish having size of 10-150g, it increases to 1.0 to 4.0g on big sized fish (159-450g) usually on the later part of culture period. The culture period ranged from 7 to 8 months from juvenile stage. Survival ranged from 80% to 95%. Based on a 9-unit netcage measuring 2.5m x 2.5m x 3.0m, an annual net income of PhP70,000.00 is expected with the ROI of 50% with less than 2-year payback period.

Since mortality of small-sized groupers is commonly observed, it is recommended that monthly sorting should be done to attain higher survival.

Keywords: *grouper culture, cage culture, WPU*

INTRODUCTION

Groupers are important highly-priced fishes of the tropics and subtropics and are always in demand in both local and foreign markets. It is a highly esteemed food fish because of its size, good flesh, texture and excellent flavor (Baliao *et al.* 1998, Baliao *et al.* 2000). In many parts of the world groupers have

been cultured intensively in shallow coastal areas. In the Philippines, groupers are mostly cultured in netcages. This provides an alternative means of fish production and supplements income, especially for the coastal communities.

The use of cages for rearing or holding juvenile or young fish to marketable size is an old practice all over the world. Netcaging provides venture for small or large-scale commercial aquaculture production. A netcage can carry about 5 to 15 kg/m³ or even up to 50 kg/m³ (Chua and 1979; Avillanosa 2003).

Based on the Food and Agriculture Organization (1999) the Southeast Asia aquaculture production contributed about 2,291 MT in grouper production. In 1997, the Philippines contributed about 605 MT grouper in the global market.

This paper aims to provide information on the culture of locally caught grouper particularly in the Province of Palawan and in the region.

METHODOLOGY

The WPU Fishcage Project in Tinguiban Cove, Puerto Princesa City is located at approximately 09°33' to 10°5' N latitude and 118°39' to 119°08' E longitude (Figure 1). It serves as an income-generating project and venue for several research activities conducted by the faculty and students of the University. The data resulted from these activities were gathered and documented in this study.

The paper discusses the grouper culture technology adopted by WPU. It includes the guidelines in site selection, cage construction, seed collection, proper stocking, sampling scheme, feeds, feeding and the use of fish aggregating device and lift net to collect trash fish.

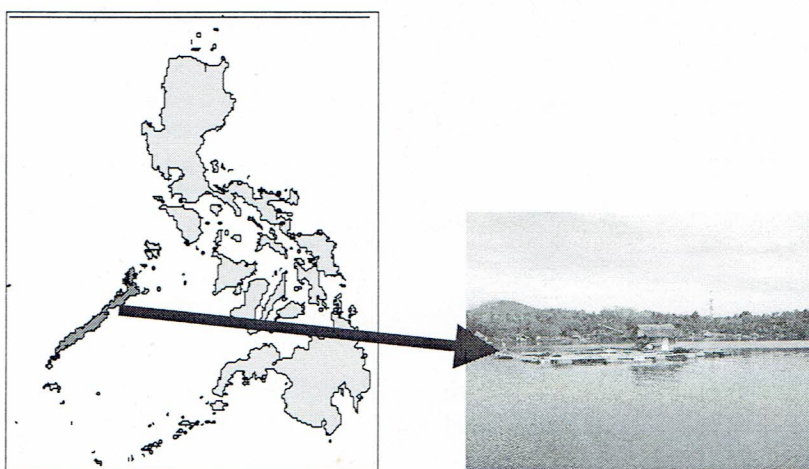


Figure 1. WPU-PPC Fishcage Project.

RESULTS AND DISCUSSION

Description of Cultivable Groupers

The species under the genus *Epinephelus* (Plate 1) are among the most important commercial fishes in the world. They are highly acceptable to consumers and command high market value. In the Philippines, three species of grouper are commonly cultured. These are *Epinephelus coioides*, *E. malabaricus* and *E. tauvina*.

Groupers are fast growing, easy to culture, spawn naturally and artificially, and tolerate a wide range of environmental conditions.

Criteria for Site Selection

The water in the area should be clear, free from pollution and siltation. The temperature and salinity should range from 22 to 31°C and 15 to 45 ppt, respectively. The desirable water pH ranges from 6.5 to 9.0.

The dissolved oxygen should be greater than 4 mg/l and turbidity should not be more than 100 ppm. For floating netcages, a 1.5 m water depth from the sea bottom is recommended.

The area should be protected from strong currents and big waves. The recommended current should be less than 10 cm/sec. A whole year round supply of fry or fingerlings and the area's accessibility to market are also important criteria for site selection.

Construction of Fish Cages

The frame can be made of bamboo (Plate 2), lumber or galvanized iron (G.I.) pipes depending on the initial budget and purpose. Plastic drums, styrofoam coated with cement, and bamboo poles can be used as floats. The anchor can be made either of concrete blocks or steel.

Types of net used in cages are: hapa net for nursery; b-net for transition; polyethylene or pamo net for grow-out.

The design of the netcages depends on the availability of materials. The most common designs are square and circular. The usual sizes for grow-out are 2.0 x 2.0 x 2.5 m, 2.5 x 2.5 x 3.0 m, 5.0 x 5.0 x 3.0 m. The WPU-PPC Fishcage Project adopted the square type of several dimensions as above.

Fingerlings Collection

To collect grouper fingerlings, bamboo traps and nets can be used. Brush lures, rock mounds, bamboo traps and fish pots are also effectively used in collecting grouper fingerlings. Collection can be done along the shoreline, estuary or in mangrove areas.

In Palawan, grouper are collected in Puerto Princesa Bay, Honda Bay, Roxas, Taytay, San Vicente, Araceli, Dumarán, Coron, Quezon, Brooke's Point and Bataraza.

Sorting, Acclimation and Stocking

Fry/fingerlings should be released into the netcage early morning or late afternoon. Prior to release plastic bags with fry/fingerling should be acclimated in the netcage for 30 minutes.

It is also necessary to sort all acclimated grouper fry/fingerlings into three different sizes (small, medium and large) to avoid cannibalism (Table 1). Before stocking, check nets for tears. Stock fry or fingerlings grouper in net with specified mesh size as follows:

Table 1. Recommended mesh size of net for grouper.

Mesh Size (cm)	Grouper size (g)
0.5	3 – 5
1.0	10 – 20
2.0	21 – 100
3.0	101 – 300
4.0	301 – 500

Sampling, Feeds and Feeding

In the present study stocks were sampled every 15 days. This helps to determine the right amount of feeds to be given and to monitor the size and condition of the fish stock.

Fish stock should be fed at 10% of the fish body weight per day during early part of the culture period (Table 2). Chopped trash fish, scrap meats or commercial feeds can be used to feed the cultured grouper. Feeding trays can be used to avoid feed wastage.

Table 2. Recommended stocking densities and feeding rate of grouper.

Size (g)	Stocking Density (pcs/m ³)	Days of Culture	Feeding Rate (% BW)
10-50 (s)	25	60	10
60-200 (m)	20	61-120	8
201-450 (l)	15	120-240	5

To lessen the cost of production having a fish aggregating device (FAD) could help in recruiting trash fish for used as feeds.

Fish Aggregating Device (FAD), Shelter and Liftnet

To lessen the cost of production having a FAD could help in recruiting trash fish in the vicinity. Moreover, it could serve as breeding area of the grouper and help in the recruitment of grouper fry.

It is also recommended that a bamboo or PVC pipes with 10 cm diameter and 10 inches length should be placed inside the netcages to serve as a shelter. This also prevents cannibalism inside the cage.

In catching FAD recruited fish, a lift net or lever net could be installed adjacent the fish cage. A light aided lift net could catch about 0.5 to 15 kg fish a night. This will reduced the expenses for fish feeds (Alcantara *et al.* 1995).

Growth and Survival of Groupers in Netcages

The growth rate (g/day) varies depending on fish size. During the early part of the culture period, 10 to 150g fish has a growth rate ranging from 0.90 to 1.10g/day. When they reached 150 to 450g, their growth rate increases to a range of 1.50 to 4.0g/day (Figures 2-4). The condition factor of the cultured grouper in Tiniguiban and Sta. Monica, Puerto Princesa City ranged from 1.5 to 1.8, while the cumulative Feed Conversion Ratio is from 4.0 to 6.5.

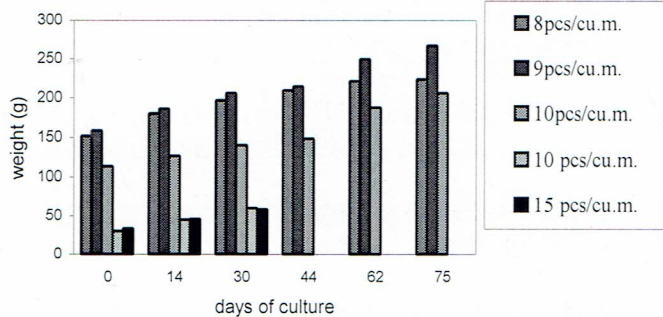


Figure 2. Growth of cultured grouper in floating netcages in Brackishwater Pond at Sta. Monica from 1999 to 2000.

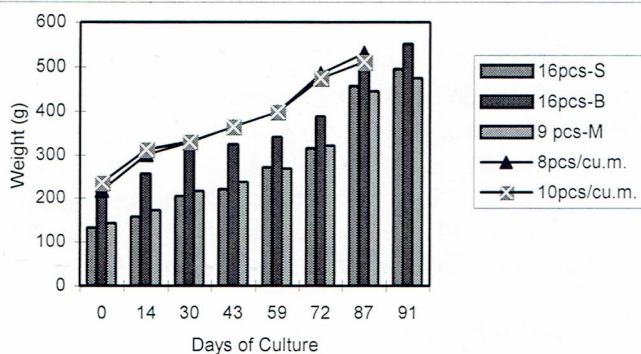


Figure 3. Growth of cultured grouper in floating netcages in Tiniguiban Cove from 1998 to 1999.

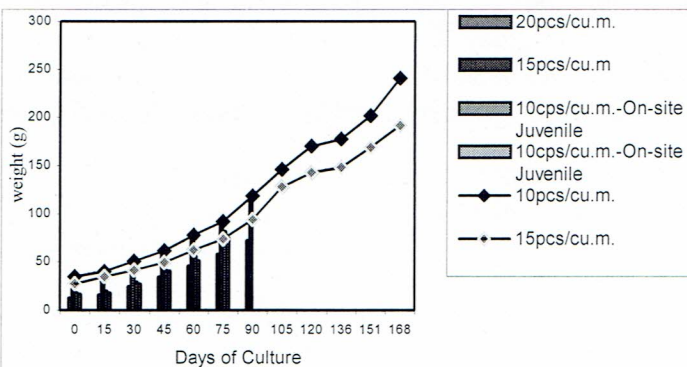


Figure 4. Growth of cultured grouper in floating netcages in Tiniguiban Cove in 1999.

Survival ranged from 80% to 95%. Mortality of smaller sized groupers is commonly observed. It is recommended that monthly sorting should be done to obtain higher survival.

Harvesting and Marketing

Marketable size grouper is about 400 g or more. During marketing, groupers were placed in oxygenated plastic bags with aeration. Ice are placed on top of the plastic bag to reduce temperature during transport. The price of live grouper varies from PhP 180.00 to 400.00/kg depending on the export market demand.

A 9-unit netcage measuring 2.5 x 2.5 x 3.0 m could have an annual net income of PhP70,015.00 with the return of investment of 50% with less than two years payback period (Table 3).

Table 3. Cost and Return of Grouper Cultured in Floating Netcages.

Assumptions:

Netcages:	9 units (2.5 x 2.5 x 3.0 m)	Total harvest:	911 kgs
Stocking Density:	15 pcs/m ³	Average Body Weight:	450 g/pc
Survival rate:	80%	Selling Price (PhP):	225/kg
Culture Period:	8 mos		

Gross Income (PhP) 205,200.00

Variable Cost	Qty	Unit Price	Total Amount (PhP)
Plastic Drum	16	1000/pc	16,000.00
Frame (G.I Pipe & Accessories)			12,800.00
Lumber (2 x 6 x 1")	16	35/bd.ft	6,720.00
Nets and Rope			37,250.00
Monofilament nylon	3	100/kl	300.00
Sinker	4	250/pc	1,000.00
Miscellaneous			330.00
Sub total			74,400.00
Labor (15% of the materials cost)			11,160.00
Total			85,560.00

Operation

Grouper juvenile	2,532	15/pc	37,980.00
Trash fish	4,800	5/kg	24,000.00
Technician	8	3,500/mo	28,000.00
Marketing cost and License			7,000.00

Depreciation, Repair and Maintenance	34,520.00
Total Cost/crop	131,500.00
Net Income	73,700.00
Net Income after Tax (5%)	70,015.00
Return of Investment	53.24%
Payback period (year)	1.88

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Acknowledgment

I thank WPU-PPC Aquaculture students SY 1997 to 2000 for conducting field sampling and Mr. Roche for his assistance. To Berlin Mata for his camera. My wife Arlene helped me through her valuable suggestions and endless encouragement.

Special thanks to Dr. Benjamin Gonzales and Dr. Sabine Schoppe for their review of this paper. To Dr. Concepto B. Magay, President of WPU and my colleagues at WPU-PPC for their support in the project.



Plate 1. *Epinephelus coioides*



Plate 2. Cages used for grouper culture.

**Density of the Porcelain Crab *Petrolisthes teres* Melin
(Anomura: Porcellanidae) in the Intertidal Zone of Cocoy Beach,
Tiniguiban, Puerto Princesa City, Palawan, Philippines**

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ABSTRACT

The present study aimed to assess the monthly density of *P. teres* in intertidal pebble/cobble substrate. The study was conducted from June to November 2004. Density of porcelain crabs was assessed in six stations that were equally distributed over the intertidal area of Cocoy Beach, Puerto Princesa City. In each station two quadrats (0.25m^2) were selected and sampled monthly. Environmental parameters such as water temperature, salinity, substrate temperature and rainfall were also assessed on a monthly basis.

The pebble substrate of Cocoy Beach constitutes an important habitat for *P. teres*. A total of 10,096 individuals were collected with monthly mean density of 369.7, 475.3, 557.7, 631.0, 661.0, 707.6 and 615.2ind./m^2 in June, July, August, September, October and November, respectively, and an overall mean density of 559.4ind./m^2 . Density in June was significantly lower than the other months. It is assumed, that *P. teres* occurs in lower densities in summer compared to the rainy season. Among the stations the highest overall mean density (772.4ind./m^2) was encountered in station IV, followed by stations V, III, II and I. Densities were significantly lower in stations I and II compared to the other stations. The significantly higher density of *P. teres* in stations III-VI in comparison to I and II is assumed to be related to the fact that station I and II are more disturb since they are within a passage for gleaners and boats. Differences in density among stations might also be substrate related.

Monthly water temperature and salinity were within the normal range for the geographic location and season. It is recommended to extend the study to include the dry season.

Keywords: Petrolisthes teres, porcelain crabs, density, Palawan

INTRODUCTION

Porcelain crabs are globally distributed in temperate and tropical marine habitats and are one of the most diverse families of near-shore decapod crustaceans (Haig 1960). They are filter-feeding organisms (Trager and Genin

1993) that often occur in large numbers (Ruppert and Barnes 1994). Many species live in close association with other invertebrates such as corals or algae (Haig 1960), sponges (Morton 1988), sea pens (Jones 1959, Morton 1988, Sankarankutty 1961), sea anemones (Gordon 1960), hermit crabs (Parente and Hendrickx 1999) and sea urchins (Schoppe 1994). Other inhabits intertidal habitats where they are for example associated with rocky or stony beaches (Wear 1964, Jensen and Armstrong 1999), sand reefs built by polychaete worms (Micheletti-Flores and Negreiros-Fransozo 1999) or with mangrove roots (Haig 1988, Dolorosa in prep.).

The genus *Petrolisthes* is the largest in the family Porcellanidae and contains approximately 90 species (Osawa 1995). *Petrolisthes* Melin that is known from the Bonin Islands in Japan, Australia and Singapore (Johnson 1970) has only recently been encountered in the Philippines (Dolorosa in prep). It is an intertidal species commonly encountered in silted areas. In Palawan, it is abundant in decaying mangrove trunks of the genus *Rhizophora* where it occurs in densities of up to 18 ind./liter (Dolorosa in prep.). Recent observations revealed that it also occurs in association with coral rubble, pebble and cobble in Cocoy Beach, Puerto Princesa City, Palawan (Dolorosa in prep). Such substrata are known to offer protection to rupestrine species and they appear to be nursery habitats (Linnane *et al.* 2003). The present study therefore aimed to assess the density of *P. teres* in this kind of substrate and to compare results among months and among stations. The results constitute baseline data for a long-term monitoring of density, and eventual changes of which might be related to climate change as suggested by Stillman (2003). Porcelain crabs have proven to be an excellent study system for examination of physiological adaptation to temperature (Stillman 2002).

METHODOLOGY

The study was conducted along the intertidal area of Cocoy Beach, Purok Sandiwa, Tiniguiban, Puerto Princesa City, Palawan at 9°45.991' N latitude and 118°43.550' E longitude (Figure 1). The substrate is dominated by stony pebbles (4-64mm) that are mixed with oyster shells and cobble (64-256mm). During low tide, this area is exposed and easily accessible. Landward, mangroves (*Sonneratia alba* and *Rhizophora stylosa*) fringe the intertidal. Part of the area is commonly frequented by gleaners and fishermen.

Fieldwork was conducted during the rainy season of 2004 from June to November. The area was divided into six equal parts that were considered sampling stations. In each station, two 50 x 50cm quadrats (replicates) were sampled per month. Sampling was conducted during low tide. Stony substrate within the quadrat was removed one by one down to about 10cm. Each stone was searched for porcelain crabs. The finer substrate within the quadrat was sieved (0.5mm mesh grid) and searched for additional porcelain crabs. Porcelain crabs were preserved in 95% denatured alcohol, vials labeled and brought to the laboratory of WPU for identification and counting. Density data (mean±SD) were

analyzed per station and per month. Results are provided per quadrat (0.25m^2) and

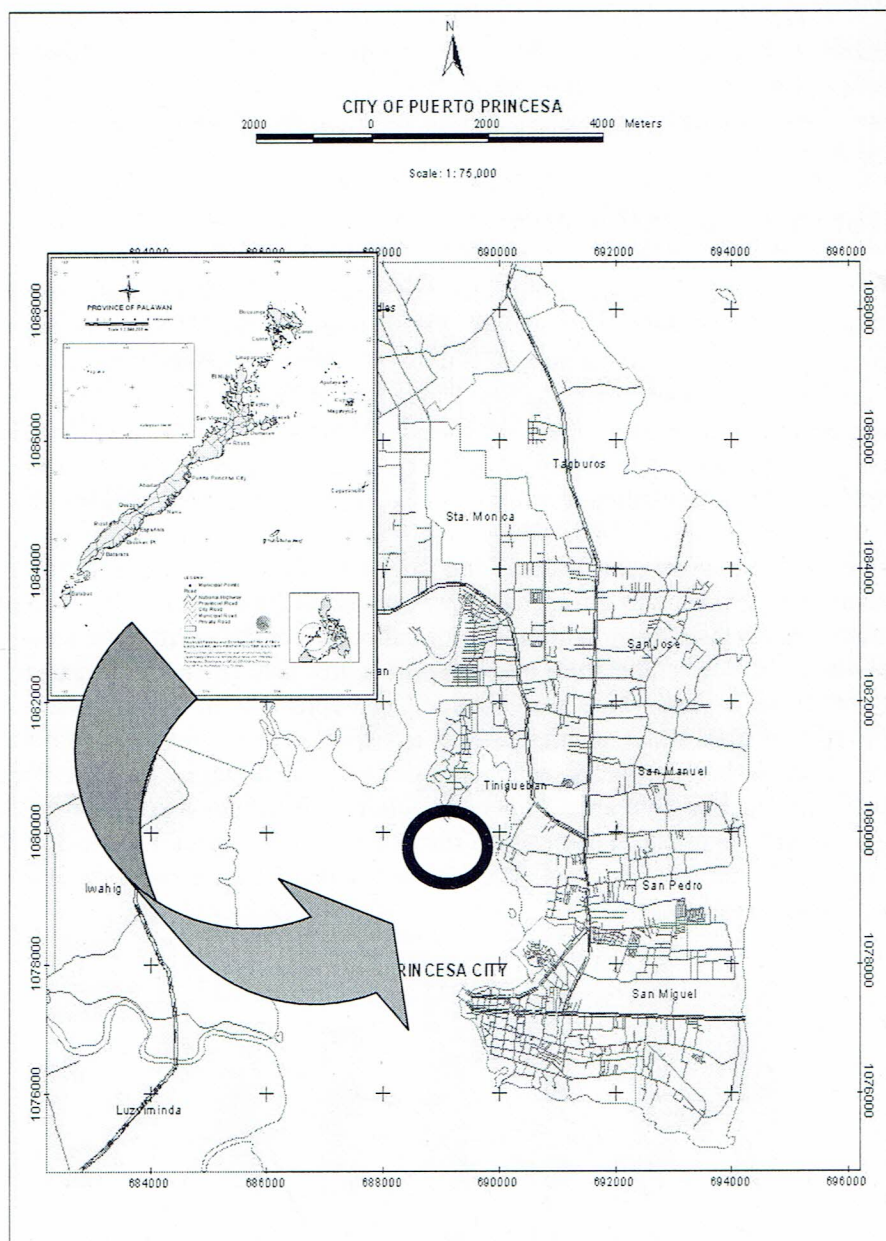


Figure 1. Map of Puerto Princesa City, Palawan wherein the location of Cocoy Beach is indicated.

per m² and were compared using ANOVA. For comparative purposes, the overall mean density was also expressed per liter (1000cm³).

Data on total monthly rainfall were obtained from the PAG-ASA weather station in Puerto Princesa City. Water temperature and salinity were assessed during high tide. This was done thrice a month, each with triplicate readings. The maximum substrate temperature during the months of September to November was determined.

RESULTS AND DISCUSSION

During the six months of the survey a total of 10,069 *Petrolisthes teres* Melin were collected. The genus *Petrolisthes* is the largest in the family Porcellanidae and contains approximately 90 species (Osawa 1995). *P. teres* that is known from Japan, Australia and Singapore (Johnson 1970) has only recently been encountered in the Philippines where Dolorosa (in prep.) found it in decaying mangrove trunks of the genus *Rhizophora* in Puerto Bay, Palawan. The present study is the first published record of the species from intertidal pebble substrate.

The lowest temperature and highest rainfall during the six months occurred in August and lowest salinity occurred in June (Figure 2). Temperature, salinity and rainfall were within the normal range for the geographic location and season. Substrate temperature maxima during low tide emersion ranged from 29-36.0°C. The highest value was obtained in September in accordance with low rainfall and high water temperature. It is expected that substrate temperature is significantly higher during summer months when it might as well reach the maximum thermal tolerance limits of *P. teres*. Stillmann and Somero (2000 as cited by Stillmann 2002) determined for 20 *Petrolisthes* species the temperature at which 50% mortality occurred. They found out that LT₅₀ ranged from 30-40°C for tropical species.

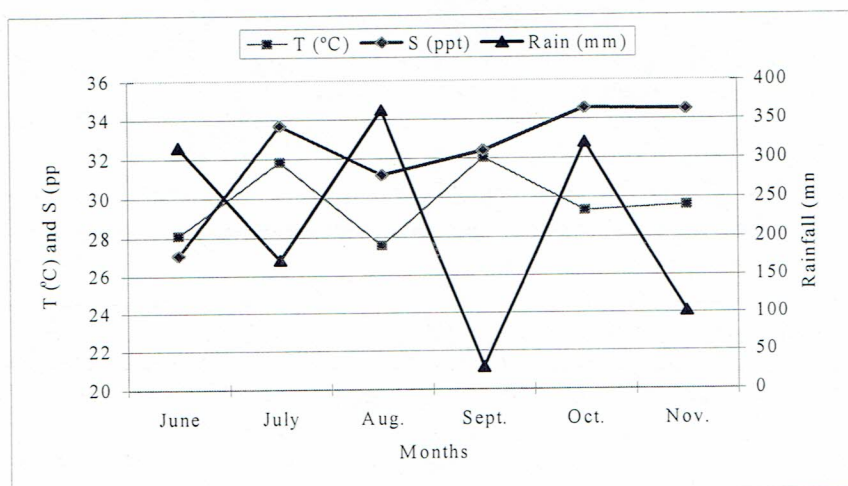


Figure 2. Monthly mean water temperature, salinity and total rainfall.

The monthly mean density of *P. teres* per quadrat of 0.25m² was highest in October, followed by September, November, August, July and June with a mean density of 176.9, 157.8, 153.8, 139.4, 118.8 and 92.4 ind./0.25m², respectively (Table 1). ANOVA revealed a significant difference ($p < 0.05$) between density in June and the densities encountered during all other months. The limited number of months sampled, all of which were during the rainy season, does not provide an explanation for the significantly lower density in June. It is though assumed that the June density is a result of the previous summer months (Jan-May). Considering that in summer temperature is much higher, especially the temperature of the substrate, it could well be probable that this would cause lower density of *P. teres*, at least in the upper intertidal that is exposed for several hours to the heat of the day. With the onset of the rainy season in June, populations recovered and gradually increased until October after which density decreased again. This is especially visible if graphically expressed (Figure 3). For easy comparison density is here shown as the number of individuals per square meter. The overall mean density for all months was 559.4 ind./m².

Table 2. Minimum, maximum and mean ($\pm$ SD) density of *P. teres* per month.

Month	Mean density (ind./0.25m ²)
June	55.0-111.5 (92.4 $\pm$ 35.8) ^a
July	67.5-200.0 (118.8 $\pm$ 58.6) ^b
August	33.0-290.5 (139.4 $\pm$ 100.3) ^b
September	70.0-279.5 (157.8 $\pm$ 85.4) ^b
October	60.0-229.5 (176.9 $\pm$ 72.9) ^b
November	77.5-217.5 (153.8 $\pm$ 50.5) ^b
Overall mean	139.9 $\pm$ 30.3

Note: monthly mean densities with same letter superscripts are not significantly different

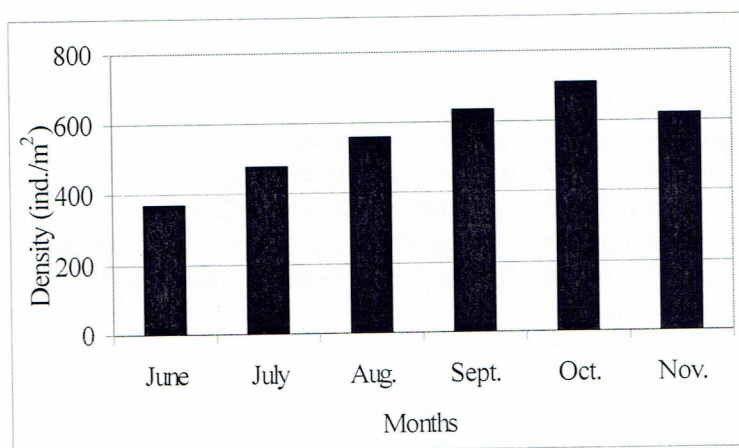


Figure 3. Mean density (ind./m²) of *P. teres* per month.

The findings of Dolorosa (in prep) who studied *P. teres* over a one-year period in a mangrove ecosystem in Sta. Monica, support the above hypothesis. Dolorosa found low abundance of the species from February to June and high abundance from July to January. Peak abundance was encountered in August. The assumption of lower densities in summer is also supported by findings of Micheletti-Flores and Negreiros-Fransozo (1999) who studied porcelain crab density in Brazil. They found higher densities of the species during winter and lower densities during months that were about 5°C warmer. Another possible explanation for significantly higher densities during the rainy season might be recruitment related. In a study on the population dynamics of *P. longicornis* in Europe by Robinson and Tully (2002a as cited by Linnane *et al.* 2003) the highest density was encountered at a time of the year when samples were dominated by newly settled animals. For *P. teres* from Cocoy Beach no final conclusion on this can be drawn since the animals were not measured nor sorted into size classes, it was though observed, that ovigerous females were abundant in August and newly settled crabs outnumbered adults in September and October. Here again, the comparison with the findings of Dolorosa (in prep) can shed more light. He found considerably more juveniles in August and September. This supports the assumption that higher density in September and October is recruitment related.

Among the stations, the highest mean density was encountered in station IV, followed by stations V, III, VI, II and I (Table 2). ANOVA revealed a significant difference ($p < 0.01$) in density among stations. Further testing of differences revealed that the densities encountered in the different quadrats of stations I and II were significantly different from those encountered in the quadrats of all other stations. The conversion into density per square meter revealed a minimum density of 261.2 ind./m², a maximum density of 772.4 ind./m² (Figure 4) and an overall mean density of 559.4 ind./m² (=5.59 ind./l). Though relatively high density values are lower than the known density of the same species in a neighboring mangrove habitat. Here, the species ranged in density over a one-year period from 2.60-51.55 ind./l with a overall mean density of 18 ind./l (Dolorosa in prep.). The comparison with other species under the genus *Petrolisthes* that occur in similar substrata shows that high density is common. The maximum density of *P. cinctipes* has been estimated at nearly 4,000 ind./m² in beds of the mussel *Mytilus californianus* in the northeastern Pacific (Jensen 1990 as cited in Jensen and Armstrong 1991) and at 950 ind./m² in cobble fields and mussel beds in California, USA to British Colombia, Canada (Donahue 2004).

It is believed that the high density of *P. teres* in Cocoy Beach is related to the substrate type whereas substrata with pebble dimension (4-64mm) of stony or shell nature offer the highest number of hiding spaces. Such substrata are known to offer protection to rupestrine species and they appear to be nursery habitats (Linnane *et al.* 2003). Studies of Samuelsen (1970) who assessed the density of the porcelain crab *Pisidia longicornis* on different bottom types over a period of 18 months in Norway support the assumption. He found the abundance of the crab

Table 2. Minimum, maximum and mean ($\pm$ SD) density of *P. teres* per station.

Station	Density (ind./0.25m ²)
I	27-118 (65.3 $\pm$ 23.3) ^a
II	41-135 (92.3 $\pm$ 30.9) ^a
III	57-274 (158.6 $\pm$ 75.7) ^b
IV	45-324 (193.1 $\pm$ 78.4) ^b
V	78-292 (184.6 $\pm$ 69.0) ^b
VI	70-222 (145.3 $\pm$ 50.7) ^b

Note: mean densities with same letter superscripts are not significantly different

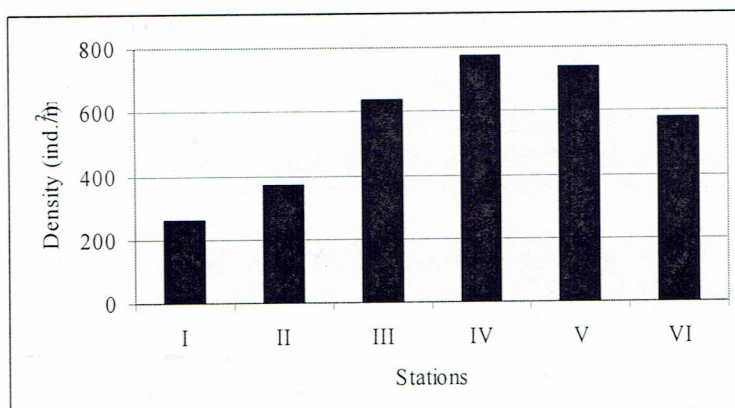


Figure 4. Mean density (ind./m²) of *P. teres* per station.

positively correlated with the amount of coarse substrate. The highest density of the species was encountered in substrate composed of empty shells (>16mm), shell gravel (2-16mm) and pebbles (16-64mm).

The fact that such high densities of a species have been overlooked in the past gives reason to believe that intensive studies of such habitats would bring even more amazing facts to light. It is recommended to continue the study on *P. teres* for a one-year period and thereafter monitor the density on a regular basis. Of especially interest is the comparison of density data during summer months (January to May) with those during rainy months (June to December). It is recommended that such study should include the assessment of the maximum time the habitat is exposed during low tide, and the maximum substrate temperature during low tide. It is further recommended to assess the nature of the substrate of each station in detail. Finally, a continuation of the study should include the sizes and development stages of individuals in order to identify periods of high recruitment.

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Acknowledgement

The authors would like to express their special gratitude to Prof. Roger G. Dolorosa for his scientific and technical support.

**Growth and Survival of Red Spiny Lobster
Panulirus longipes longipes Reared in Floating Netcages
Fed with *Sardinella* spp. at Different Feeding Rates**

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ABSTRACT

This study was conducted to evaluate the growth and survival of *Panulirus longipes longipes* fed with *Sardinella* spp. in floating netcages at different feeding rates and to determine which feeding rate provides the best feed conversion ratio.

Results showed that 20% feeding rate gave the highest growth in terms of final average weight and length increment. Survival rate ranged from 88.66% (20% feeding rate) to 100% (10% and 15% feeding rate).

Feed conversion ratio among treatments was not significant. Among the different treatments however, stocks fed at 15% body weight attained better feed conversion ratio.

Keywords: *feeding rates, Panulirus longiceps longiceps, cage culture*

INTRODUCTION

Lobsters are favored food in many countries because of their fine flavor. Even in this age of abundant food supply, demand for luxury food like this exceeds their supply (Shokita *et al.* 1991). Lobsters have excellent market demand and price. Live lobsters commands an even higher price compared to frozen lobsters (James and Marian 2003) as they are important export items and expensive delicacies (PCARRD 1981). Lobster business today is a lucrative fishing enterprise because of its unlimited demand (Campomanes 1992).

According to Bardach *et al.* (1972), lobster *P. japonicus* can be cultured in ponds and shallow bay. In Guimaras, Philippines, *P. ornatus*, *P. versicolor* and *P. longipes longipes* were cultured in pens (Tambuli 1988). In Palawan, lobsters were temporarily stocked in submerged cages to keep them alive (Gonzales and Taniguchi 1995) before marketing.

According to Gonzales and Taniguchi (1995), lobster with a weight of 100g or less should not be sold to any market to properly benefit man. They should be released in their natural habitat to grow further or grown in cages or in pens until they reach marketable size (150 grams or more). However, knowledge on the biology of many crustacean species is still inadequate and needs to be extended through further information dissemination and experimentation (Gonzales and Taniguchi 1995). Thus, this study was conducted to evaluate the growth and survival of red spiny lobster (*Panulirus longipes longipes*) grown in floating netcages and fed with chopped *Sardinella* spp. at different feeding rates, and to determine which feeding rate provides the best feed conversion ratio.

METHODOLOGY

The lobster culture was conducted near the Western Philippines University-Puerto Princesa Campus Fish Cage Project in Tiniguiban Cove, Puerto Princesa City located 09°46.464 N and 118°43.898 E.

Three treatments with three replicates were used in the study. Each replicate was stocked with 5 pcs of *P. longipes longipes*. Replicates for each treatment were assigned in the netcages using Completely Randomized Design.

Cage Preparation

The floating netcages made up of bamboo poles (3.5m length) were divided into 9 (1m x 1m) cage frames. A polyethylene B-net 1m x 1m x 1.5m with a mesh size of 0.25cm was used as netcages. These netcages were firmly attached to the cage frame. Reinforcement bar measuring 1 x 1 meter was placed inside the cage as sinker.

Transport, Stocking and Monitoring

Red spiny lobsters were collected from Sabang offshore, Puerto Princesa City. Forty five (45) individuals were soaked in iced seawater for 3 to 5 seconds until they stopped moving. The animals were then wrapped individually with newspaper, and arranged inside the styrofoam box. The lobsters were transported early morning to the study area. Upon arrival, the box was opened and the experimental animals were unwrapped individually inside the cage. Lobsters were held at water surface until they swam freely.

Regular monitoring of the raft and cage was carried out to ensure that the set-up was in good condition. Cleaning was done twice a month by brushing the nets. Attached algae were removed to allow smooth flow of water inside the netcages.

Sampling and Feeding

Weight and carapace length of lobsters were measured at the start of the rearing period and every 25 days thereafter for 75 days using Tanita™ weighing scale (500g capacity) and a vernier caliper, respectively. Sampling was done early in the morning. Water temperature and salinity were also determined daily.

The lobsters were fed with fresh or frozen chopped *Sardinella* spp. Feed was broadcasted once a day between 5 pm to 6 pm at feeding rates of 10%, 15% and 20% body weight.

Data Analysis

Mean feed conversion ratio (FCR), growth increment (weight and carapace length) and survival rate were computed and compared using Analysis of Variance.

RESULTS AND DISCUSSION

Weight

The mean body weight of lobster fed with *Sardinella* spp. is shown in Table 1. Initially, stocks at 15% feeding rate had the lowest mean body weight. They however showed an increase in weight gain at the end of 75 days culture period, approximating the weight gain of stocks fed at 20% level. At 50 days of culture, lobsters fed at 20% and 10% feeding rate attained an almost similar weight (55.22g and 59.33g, respectively). But at 75 days of culture, the body weight of stocks at 10% feeding rate was slightly lower compared to those fed at 20% feeding rate though they had the highest weight gain at the start of the culture period.

At the end of 75 days culture period, stocks fed at 20% feeding rate showed the highest mean body weight and percent weight gain (66.13g and 52.85%) followed by those fed at 15% (65.87g and 52.70%). Stocks at 10% feeding rate showed the least mean body weight and % weight gain of 63.73g and 34.14%, respectively. Differences in final weights and % weight gain among treatments are not significant.

The average increase in body weight of *P. longiceps longiceps* in this study (42.23%) is slightly higher than that observed among *Panulirus argus* in Florida which is approximately 40% (Ellis 1991). Further, Ellis (1991) observed that *P. argus* molt every 50 to 60 days and economics of culturing lobster seems favorable towards 60% ROI.

Table 1. Growth (mean body weight (g)) of *P. longipes longipes* at different feeding rates.

Days of Culture	Feeding Rates		
	10%	15%	20%
0	45.80	43.13	43.27
25	49.07	45.53	47.35
50	59.33	51.93	59.22
75	63.73	65.87	66.13
Weight Gain	17.93	22.73	22.87
% Gain	39.14	52.70	52.85

Length

The initial carapace length of lobsters ranged from 3.45cm to 3.56cm (Table 2). Among the different treatments, stocks fed at 15% feeding rate exhibited the longest carapace length (4.06cm), followed by those fed at 20% (4.03cm) and 10% (3.95cm). These results in carapace length are comparable with the findings of Smale (1975) who reported that the juveniles of *Panulirus homarus* in South Africa had attained 6.0cm carapace length in 18 months. Data in this study showed that stocks fed at 15% feeding rate, with initial carapace length of 4.06cm and 16% carapace length can have a carapace length of 7.36cm in 17.5 months.

Table 2. Mean carapace length (cm) of *P. longipes longipes* at different feeding rates.

Days of Culture	Feeding Rates		
	10%	15%	20%
0	3.56	3.51	3.45
25	3.71	3.54	3.62
50	3.91	3.73	3.85
75	3.95	4.06	4.03
length gain	0.39	0.55	0.58

A similar trend was observed on the body weight gain and carapace length increment of the stocks in the different treatments. Highest carapace length increment was observed among stocks at 10% and 20% feeding rates during the first 50 days of culture. However, stocks at 10% feeding rate showed slow growth towards the end of the culture period which could be attributed to molting. Stocks at 15% feeding rate on the other hand initially exhibited low carapace length increment but growth gradually increased towards the later part of the culture period.

After 75 days of culture, the carapace length increment of stocks fed at 20% and 15% feeding rates was almost similar, 0.58cm and 0.55cm, respectively. The stocks at 10% feeding rate showed the least carapace length gain of 0.39cm. The mean carapace length increment and carapace length among different feeding treatments is not significant.

Survival Rate

One hundred percent survival were obtained from 15% and 10% feeding rates while 20% feeding rate had a survival rate of only 86.66%. The survival rate in this study was generally higher compared to the 90% expected survival rate of lobsters grown in netcages (Tambuli 1998).

Growth and survival of lobsters were affected by temperature, salinity and pollutants. Among the three, temperature is the most critical factor that influenced the growth rate of lobsters. (Phillips *et al.* 1980). According to Phillips (1980) water temperature in the culture cage must range from 29 to 32°C with a salinity of 30 to 34 ppt. Temperature higher than 30°C is detrimental for lobster's growth and survival (Aiken 1980), however, Van Olst *et al.* (1980) stated that lobsters can tolerate temperature as high as 31°C. Likewise, *Panulirus* spp. can be cultured as 18°C with a salinity ranging from 30-35 ppt (Lee and Wickins 1992).

Though lobsters could adjust to a wide range of salinity (Stewart 1980), salinity fluctuations are naturally occurring and causing environmental stress to lobsters, even they are euryhaline and osmoconformer species. Phillips (1980) stated that seven percent salinity difference would cause high mortality.

Another notable major cause of mortality in lobsters during and after molting is dissolved oxygen (Radhakrishnan and Vijayakirmaran 1984). Juinio-Menez and Ruinta (1996) as cited by Salvacion (2000) observed that mortality occurred when dissolved oxygen is less than 4.0 mg/l conforming to the statement of Booth and Kittaka (1994), that lethal level of dissolved oxygen for lobster ranged from 0.5 to 3.0 mg/l.

The environmental parameters measured in the study area were within the normal limits as observed in other studies.

Feed Conversion Ratio

During the 25 and 50-day culture period, stocks fed at 20% and 10% showed better feed conversion ratio compared to stocks fed at 15% feeding rate. However at the end of the culture period, stocks at 10% feeding rate showed the best conversion ratio, followed by stocks at 15% and 20%, respectively (Table 3). Though Pascual (1989) stated that low FCR is better because less feed is required per unit weight gain, the trend in FCR showed that 15% feeding rate is better compared to other treatments (Fig. 2). Analysis of variance however indicated that there is no difference in FCR among different feeding rates.

Table 3. Amount of feeds consumed and feed conversion ratio among the different feeding rates.

Days of Culture	Feeding Rates		
	10%	15%	20%
25	1.71750	2.42606	3.25525
50	1.84013	2.56106	3.55125
75	2.22488	2.92106	4.44150
TOTAL	5.78251	7.908	11.238
FCR	22	23	38

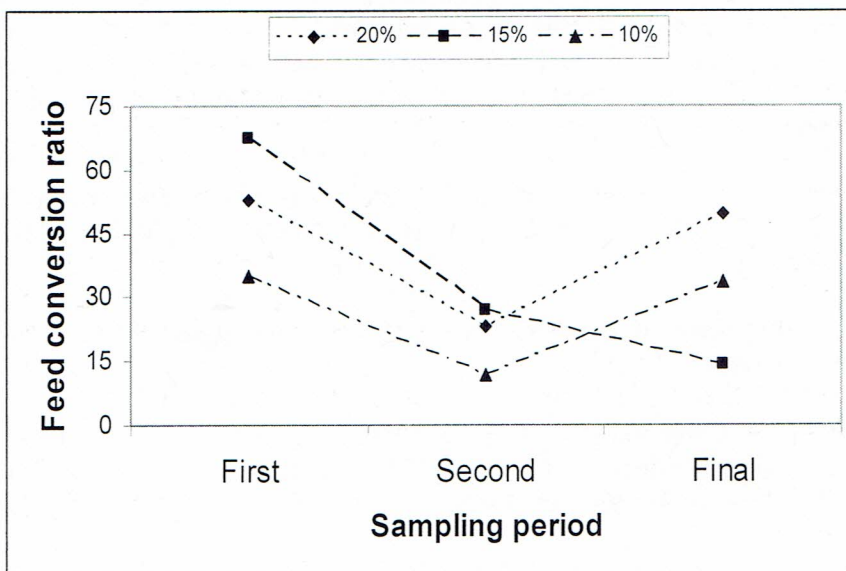


Figure 2. Feed conversion ratio trend of the different feeding rates.

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Small Scale Household Solid Waste Composting

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ABSTRACT

This study was conducted at the Western Philippines University, Aborlan, Palawan from December 2003 to February 2004, to identify the combination of household solid waste and the type of waste container that would promote faster decomposition process.

The containers used (wicker basket, rubber flowerpot, milk can) had no significant effect on decomposition of most waste combinations (paper alone, kitchen waste alone, paper + kitchen waste, paper + leaf litter, leaf litter + kitchen waste) except for leaf litter alone, and paper + kitchen waste + leaf litter combination, which were significantly lower in milk can container than in wicker basket and rubber flowerpot.

Among the waste mixtures, kitchen waste decomposed the fastest while paper was the slowest. When kitchen waste was added to other type of wastes, decomposition process significantly increased.

Key words: household solid waste, composting, waste containers, decomposition

INTRODUCTION

In Palawan, household composting is not a popular practice because most housewives do not have time for the said activity. Palasigue (1998) reported that majority of the housewives in Aborlan, Palawan, regardless of educational attainment and economic status burned their wastes because according to them it is the easiest and the most convenient way of disposing it. However, burning of wastes contributes to the destruction of ozone layer and the global warming.

Environmentalists are campaigning to reduce the generation of wastes, reuse things that are still useful and recycle those that are still valuable to keep things from entering into the waste stream. Composting is one way of recycling household wastes and should be promoted to protect the environment.

One important aspect in household composting that needs scientific investigation is the identification of the correct composition of solid wastes as well

as the appropriate containers that promote decomposition process. This paper attempted to answer such concerns.

METHODOLOGY

Preparation of Materials for Composting

Common household wastes *i.e.* kitchen wastes, leaf litter and newspapers were collected and chopped into small pieces. These were then placed in waste containers (wicker baskets, rubber flowerpots and milk cans) with 6 inches bottom diameter. Milk cans were perforated at the bottom to provide drainage.

Composting Process

Previously chopped wastes were thoroughly mixed following different ratios and placed in the prepared containers with 250 grams soil at the bottom. The different waste mixtures used as treatments were as follows:

T ₁	750 g paper alone
T ₂	750 g kitchen waste alone
T ₃	750 g leaf litter alone
T ₄	375 g paper + 375 g kitchen waste
T ₅	375 g paper + 375 g leaf litter
T ₆	375 g leaf litter + 375 g kitchen waste
T ₇	250 g paper + 250 g kitchen waste + 250 g leaf litter

Each treatment was replicated 3 times and arranged in Completely Randomized Design (Plate 1). The set up was placed in area not disturbed by animals or affected by rain. Watering was done when needed using the same volume for each treatment.

Separation of Decomposed from Undecomposed Material

All experimental units were harvested after two months. Using a sieve with 2 mm opening, undecomposed materials were separated from the decomposed ones and weighed using a triple beam balance (Plate 2).

RESULTS AND DISCUSSION

Evidently, decomposition of leaf litter alone and paper + kitchen waste + leaf litter waste combinations was significantly lower in milk can container than in wicker basket and rubber flowerpot (Table 1). Slow decomposition of such wastes is implicated to the high water retention in milk can, rendering the wastes to be wetter than those in wicker basket and rubber flowerpot. The presence of high moisture content in a compost pile, according to Polprasert (1996), will more or less inactivate pathogen metabolism in the compost pile and too much water blocks the passage of air, which is needed by the decomposer. Finstein *et al.* (1990) stated that degradation of organic matter depends on the presence of oxygen because organic matter generally degrades rapidly and completely if oxygen is plentiful.

Surprisingly, all containers used had no significant effect on decomposition of the rest of the waste combinations, which means that other waste mixtures decomposed at the same rate regardless of the container used. The reason for this is uncertain. Literature on solid waste composting is limited and those available ones discussed general knowledge only. Clearly, there are information gaps in this area and researchers should do more studies to fill in the knowledge gaps.

Table 1. Average weight of undecomposed household waste mixtures placed in different containers.¹

container	Weight of Wastes (g) ²						
	paper alone	kitchen waste alone	leaf litter alone	paper + kitchen waste	paper + leaf litter	leaf litter + kitchen waste	paper + kitchen waste + leaf litter
wicker basket	740.1 ^{a(e)}	29.2 ^{a(a)}	350.2 ^{b(c)}	344.4 ^{a(c)}	503.0 ^{a(d)}	129.8 ^{a(ab)}	210.0 ^{b(bc)}
rubber flowerpot	746.4 ^{a(e)}	32.9 ^{a(a)}	238.3 ^{b(bc)}	355.7 ^{a(cd)}	489.7 ^{a(d)}	173.4 ^{a(b)}	303.1 ^{b(bc)}
milk can	747.0 ^{a(d)}	28.3 ^{a(a)}	509.0 ^{a(c)}	372.9 ^{a(c)}	493.8 ^{a(c)}	182.8 ^{a(b)}	446.6 ^{a(c)}

¹ Average of 3 replications in 2- month decomposition period

² Weight with the same letter superscripts outside and inside parenthesis, which are due to the influenced of containers and the waste mixtures, respectively, are not significantly different at 0.01 level

On the other hand, it was observed that kitchen waste alone decomposed the fastest, while paper alone was the slowest among all waste combinations. This is influenced by the carbon-nitrogen or C:N ratio. Splittstoesser (1990) pointed that kitchen garbage has C:N ratio of 30:1 while leaf litter has 70:1. Deficient supply of N will render the decay of organic materials to be delayed because N is needed to support the growth of decomposers (Brady and Weil 1999). In addition, waste with high C:N ratio decomposes slowly because the oxidation of carbon by decomposers inhibits nitrification (Nahuet and Schneider 1999). Moreover, a research on old landfills has shown that even materials formerly assumed to be

biodegradable e.g. newspaper, wood, and so on, are degraded very slowly if at all (Nebel and Wright 2000).

However, decomposition was hastened whenever kitchen waste was added to other types of wastes. When paper (known to degrade very slowly) was added with kitchen waste, its decomposition was significantly faster than when it was decomposed alone and statistically similar to other waste combinations known to have fast rate of decomposition. This is confirmed by the report of Brady and Weil (1999) which stated that high C:N ratio materials (brown leaves and papers) could be mixed with low C:N ratio materials for best results compost.

With all these findings, it is recommended that kitchen waste must be added to any biodegradable waste pile as it hastens decomposition. In addition, further studies must be conducted to validate the true influence of containers on solid waste decomposition. Lastly, identification of decomposers as well nutrient analysis of composted materials should be done before a large scale solid waste composting could be ventured.

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Plate 1. The different household wastes in different waste containers.



Plate 2. Separation of decomposed materials from undecomposed ones using soil sieve.

Status of Milkfish Fry Industry in Roxas, Palawan

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ABSTRACT

The status of milkfish fry industry in Roxas, Palawan is documented through an interview of 35 respondents in barangays Rizal and Tumarbong, Roxas from June to July 2004. Highlighted in this paper are the socio-economic characteristics of fry gatherers, their fry catching practices, fry catching gears, period of operation, production and marketing. It likewise identifies the main problems encountered by the fry gatherers which include changing climatic condition, financial constraints, low price of catch, and illegal fishing practices in the area.

INTRODUCTION

Milkfish *Chanos chanos* (Forsskal 1775), known by different names in the Philippines as “bangles”, “bangus”, “bangrus”, “banglot”, “sabalo”, “awa” (Bagarinao 1999) is the sole species of family Chanidae. This species has certain desirable qualities such as omnivorous feeding habit, adaptability to crowding, resistance to disease, wide tolerance to environmental factors and fast growth rate. They are considered as a “perfect farmed fish” in Southeast Asia (Bagarinao 1999).

Successful milkfish farming was established in the Philippines for decades. Its popularity in the Philippine aquaculture can be attributed to its being a highly adaptable species. It can be grown in freshwater, brackishwater, and seawater using various farming systems. Statistical records showed milkfish as the main aquaculture commodity. It is being cultured in cages, pens and ponds. In 1998, about 74.71% of brackishwater pond production is attributed to milkfish as the farmed animal. Fish pen and fish cage farming in both freshwater and marine water have milkfish production of 69.59% and 8.17%, respectively.

The availability of milkfish fry from the wild is an important factor to assure sustainability of the milkfish farming industry. During the 1970s, shortage of milkfish fry supply from the wild was reported to have affected the aquaculture production. Fish growers turn to hatchery-bred milkfish fry during that period (Garcia 1996). Despite economic importance of milkfish culture correspondingly of milkfish fry industry, no comprehensive historical data are available on fry catches from wild sources. Bagarinao (1999) cited important fry grounds in the

Philippines based on 1969 surveys. She recommended new surveys to ascertain the condition of these fry grounds. Bangus Fry Resources Assessment study for the period 1996-1998 conducted by BFAR, SEAFDEC and PCAMRD was so far the latest study done on the status of milkfish fry industry.

Although Palawan was identified as one of the productive milkfish fry grounds in the country, an effort to assess the present condition of the fry grounds in the province was virtually none existent. Palawan is not spared from the reported depletion of fisheries resources which is now a critical national concern. For effective and rational management of these resources, the policy makers and managers need to be guided by solid data.

The Office of the "Sangguniang Bayan" of the municipality of Roxas had so far approved only two ordinances pertaining to the milkfish fry industry in the locality. These are Municipal Ordinance No. 11, s.1995, an ordinance regulating the catching of milkfish fry in Roxas, Palawan, and Municipal Ordinance No. 06, s.1999, the granting of preferential rights to marginal fishermen to catch milkfish fry in the municipal waters of Roxas.

The present study aimed to provide information on the socio-economic profile of the fry gatherers in two barangays in Roxas, Palawan; identify primary gears, methods and practices of milkfish fry operation in the area; and ascertain status and difficulty of milkfish fry industry in the locality.

Result of the study will establish better understanding of the status, common operation, and problems encountered by the stakeholders. The data will be made available to serve as guide to the policy makers in the province of Palawan in their formulation of appropriate policies that will address the problems of the milkfish fry industry and likewise improve the standard of living of the fry gatherers in Roxas and other municipalities in Palawan.

METHODOLOGY

The study started in June 2004 with the collection of data on the social and economic status of the fry gatherers in Roxas, Palawan, Philippines and ended in July 2004. The survey was particularly conducted in Bgy. Rizal and Bgy. Tumarbong in Roxas, Palawan. Identification of the two study sites depended largely on the popularity of the area as the productive fishing grounds of milkfish fry (Figure 1).

With the help of the barangay officials, 15 fry gatherers from Bgy. Rizal and 20 from Bgy. Tumarbong were interviewed using guide questionnaires that included queries on the following: a) household information and economic status, b) fry gathering practices and production, and c) problems encountered. Descriptive analyses of the data gathered were done.

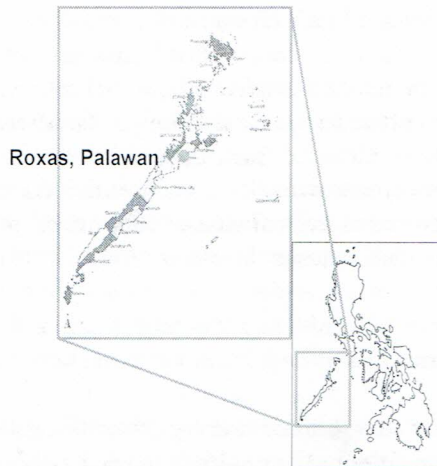


Figure 1. Map of Palawan. The dot indicates the survey site.

RESULTS AND DISCUSSION

Profile of Fry Gatherers

Majority of fry gatherers attained only elementary education. They claimed that they stopped schooling due to financial constraints. About 20% of them, however, were able to reached college. When compared with the educational attainment of the milkfish fry gatherers in Puerto Princesa City, an almost similar trend was noted.

Almost all are married with one to nine children per family. Majority of households for both barangays have three to four children.

No fry gatherers from Bgy. Rizal owned a residential land unlike those from Bgy. Tumarbong where 15% has land ownership. Most of the residents in both barangays rented the land they used.

The native Cuyuno, who are the majority (60% from Bgy. Rizal and 75% from Bgy. Tumarbong) of fry gatherers in the area were engaged in this livelihood for more than a decade. They said that they have learned the fry gathering skills from their parents and grandparents and that they have not availed of any technical assistance from the government. Those who are newly engaged in this activity, stated that they have acquired the skills from private individuals or from the fry buyers themselves.

Based on the resources available in the area, fishing (61.36%), farming (34.09%), and carpentry (4.55%) are other sources of income of the fry gatherers. The agricultural crops produced are corn, rice, and coconut.

The social and economic status of the fish gatherers in the study area substantiate the popular belief and studies about fisherfolks to be occupying the bottom of the economic ladder (Yap *et al.* 1995). They are those who generally exist on a day-to-day basis. Most of them cannot save enough money to buy the materials they need for the construction of their milkfish fry collecting gears. They are just fortunate to be provided with financial support by private individuals who are also their fry buyers. This scheme, however, forced them to sell their collected fry at a lower price.

Fry Collecting Operation

The two barangays are suitable site for fry collection. According to the fry gatherers, they are operating their gears 5-15 m from the shoreline at depth below 1 m and at a distance of 50 to 500 m to an extreme distance of 1.5 km along the shore during low tide.

The fry gatherers are generally males but during the peak season, their wives and children help in the fry gathering operation. They as well assist in the gear management and maintenance, and in the counting and selling of the collected fry.

The ample number of fry gatherers operating in the coastal waters of Bgy. Rizal and Bgy. Tumarbong only proved the sustainability of these fry grounds.

According to Bagarinao (1999), various fine-mesh seines and bag nets of indigenous designs have been used as fry collecting gears for hundred of years in the Philippines. Among these gears, three types were commonly used in the study area. These are fry sweeper, fry bulldozer, and tidal set net. The fry sweeper is the commonly used because it is the easiest to operate. The fry gathering operation lasted from 15 to 120 days for both barangays.

Accessories used during fry gathering operation include pail, white basin, and white scoop bowl. The use of white materials during the operation aids in the easy identification of the milkfish fry.

Despite years of fry gathering operation in the area, fry gatherers claimed that no technical support or training was initiated by any government agency to help them improve the efficiency of the gears they used and the method of operation they practiced. They still depend on the traditional fry gathering techniques they have learned from their ancestors.

As stated almost all of the milkfish fry gathering activities is being conducted in shallow areas of less than 1 m depth, however, an experiment conducted by Encina and Gatus (1977) proved that milkfish gathering should not only be limited to shallow areas. Milkfish fry can be caught in deeper waters using floating trawl towed by a motorized banca.

Collection of milkfish fry in the area is seasonal. Fry season only occurs from three to four months per year, however year round availability of fry has been observed in some areas in the country. Bagarinao (1999) reported fry gathering operation to occur only from March to November, with peaks in May and October for Antique; April to October with peak in June for Ilocos Norte; almost the whole year with peak in April and October for Cotabato. Based on this study, fry season in Palawan is from March to June with peak in May. To support this record, further monitoring of the fry grounds in other municipalities of Palawan needs to be done.

According to Bgy. Rizal fry gatherers, they start collecting fry in March but the peak season is observed in May. Basically fry gathering operation is carried out for 60 days. Days of operation however, is sometimes limited by heavy siltation coming from the river. On the other hand, fry gathering in Brgy. Tumarbong is from March to June and the operation lasted from 60 to 90 days.

Data on milkfish fry catch in Palawan in 1963 and 1973 were 32 and 10 million, respectively (Bagarinao 1997). No recent record is available for comparison of the recent fry catches. The claim of the fry gatherers on the decreasing trend is only based on their personal observations and opinions.

Production and Marketing

The average collected fry per day from both barangays ranged from 200 to 500. The fry gatherers either sell the fry in the locality right after collection or store it until sufficient number is attained for later transport to the city of Puerto Princesa where the market price is higher. Fry are transported using oxygenated plastic bags at the rate of 10 000 fry per 5 liter water. The prevailing price ranged from 12 to 40 cents/pc with the average price ranged from 20-25 cents/pc. Fry commands higher price during the early month of fry collection when production is still low. A typical marketing scheme in the study site is illustrated in Figure 4.

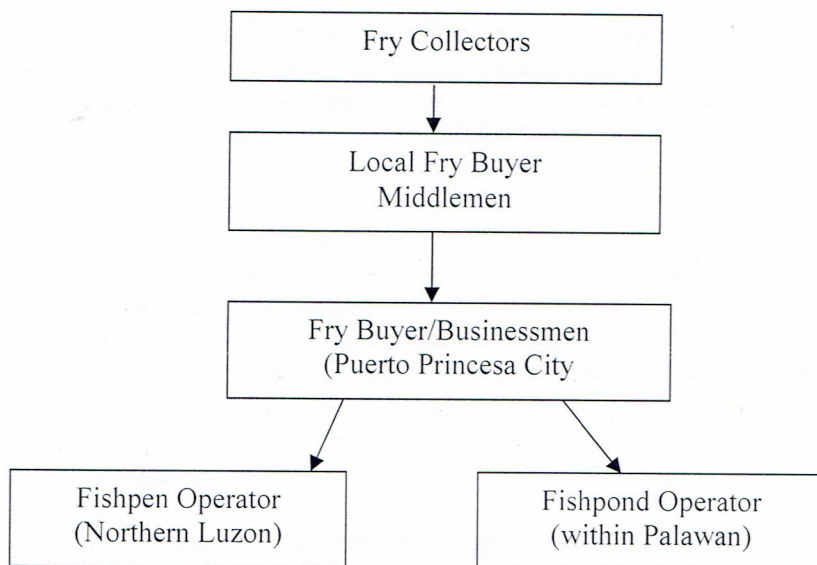


Figure 2. Milkfish fry industry marketing scheme in Roxas, Palawan.

Problems Encountered

There are four major problems encountered by the fry gatherers in the study site. These are: changing climatic condition (38.64%), financial or lack of capital (34.09%), low price of fry (15.91%), and the illegal fishing practices that are rampant in the waters of Roxas, Palawan (11.36%).

Bad weather does not only affect the fry gathering operation but also their other fishing activities. For subsistence, they do carpentry and farming as an alternative source of income. However, such work is seasonal and does not guarantee enough income to support their families. Fry gatherers also do not have enough money to transport their catch to areas where it will command higher price. They are dependent on the wholesalers and traders for capital who consequently demands for low price of their catch. This aggravates further the poor condition of these coastal residents.

Although bad weather condition and the absence of capital are the two main problems of the fry gatherers in the locality, they believed that illegal fishing practices such as the use of cyanide, the application of derris roots, dynamite fishing, and trawl fishing have contributed a lot in the low catch experienced during the recent years. In addition, reported accidental catching of "mother bangus" or "sabalo" by drift net operators and the unsustainable fishing operations specifically the use of illegal means in capture fisheries in the waters of Roxas, Palawan further aggravated the situation because of the destruction of the vital coastal ecosystems.

The fry gatherers are asking support from the local government and line agencies of the national government to support them technically and financially by providing trainings and capital in setting up coastal livelihood activities to include grouper culture, seaweed farming, crab fattening, fish processing, and other sustainable fishing method in order to increase their income.

CONCLUSION AND RECOMMENDATIONS

The low income, lack of ownership of land and fry gears, and dependency on wholesaler and trader for capital indicate that the fish gatherers in Barangays Rizal and Tumarbong in the municipality of Roxas, Palawan are poor. The presence of natural calamity, unsustainable use of natural resources and illegal fishing practices makes their life more miserable.

Fry gathering is the major source of livelihood in locality, hence milkfish fry industry must also be given focus the same way as the milkfish grow-out sector.

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Acknowledgment

This study is an output of WPU and the Kabang Kalikasan ng Pilipinas/World Wildlife Fund (WWF), based in Roxas, Palawan. Special thanks to Mr. Victor Reyes, WWF-Roxas Project Manager for the generous logistic support during the conduct of the study.

The authors would like to acknowledge the active cooperation of the Barangay officials and the people of Bgy. Rizal and Tumarbong, Roxas, Palawan during the interview. The Aquaculture OJT students of Summer 2004 and Lufel Himpolaran were a great help during the interview.

The support of WPU administration is also acknowledged.

Polyculture of Nile Tilapia (*Oreochromis niloticus*) and Black Tiger Prawn (*Penaeus monodon*) in Floating Netcages

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ABSTRACT

Polyculture of Nile Tilapia (*Oreochromis niloticus*) and Black Tiger Prawn (*Penaeus monodon*) was conducted using floating netcages made of B-net at Tiniguiban Cove, Puerto Princesa City. Three different treatments were used. T₁: monoculture of *O. niloticus*, T₂: monoculture of *P. monodon*, and T₃: polyculture of *O. niloticus* and *P. monodon*, at a stocking density of 10 pcs/m³. *O. niloticus* and *P. monodon* were fed with commercial pellets and trashfish, respectively.

Results of the study showed a mean percentage increase in weight and length of *O. niloticus* in mono- and polyculture by 105% and 33%, respectively. *P. monodon* in both culture methods, on the other hand attained a mean percentage weight increase of 200% during the 60 days culture period.

No significant difference between the two culture methods was found for mean body weight gain, total length gain, biomass, specific growth rate, and condition factor of the two species. The FCR of tilapia in polyculture (4.86) however is better than in monoculture (13.85). While the survival rate of *P. monodon* in monoculture (73.33%) was significantly higher than in polyculture (60.0%).

The total yield from polyculture of *O. niloticus* and *P. monodon* was better compared with monoculture of *O. niloticus* but not if compared to monoculture of *P. monodon*. The competition index is not conclusive about the feasibility *P. monodon* and *O. niloticus* polyculture.

INTRODUCTION

The culture of *Oreochromis niloticus* with a combination of *Penaeus monodon* increases fish production. The presence of secondary species generates additional income for fishfarmers, and at the same time, provides a cheaper source of protein for consumers (Gonzales-Corre 1988).

Tilapia production in freshwater ponds, pens and netcages has been gaining popularity in the Philippines. The culture of this fish has gained wide acceptance among fishpond operators in the Philippines (Guerrero and Abello 1976). The tolerance of the species to a wide range of environmental factors is another reason

for its ease in culture. *Oreochromis* spp. is cultured either in marine or in brackishwater (Gonzales-Corre 1988, Sombrero 1993, and Salvador 1992). *Oreochromis* sp. fed with *Gracilariopsis* sp. and commercial pellet and cultured in floating netcages at salinities between 25-35 ppt obtained 44 to 52% weight gain and 68 to 76% survival rate after 75 days culture (Paalan 2001).

Penaeus monodon, which is known in the international trade as Black Tiger Prawn, has been the leading culture species among crustacean (SEAFDEC 1999). In the Philippines, culture of prawns in netcages is not commonly practiced. Although, Sarmiento (2002) observed in Sta. Monica, Puerto Princesa City that hatchery bred *P. monodon* cultured in floating netcages and fed with either commercial pellet or trashfish obtained good growth and survival.

This study attempted to culture *O. niloticus* and *P. monodon* in floating netcages specifically to evaluate their growth and survival in mono- and polyculture, and to determine their competition index.

METHODOLOGY

Study Site

The study was conducted in Tiniguiban Cove, Puerto Princesa City at 09°33' to 10°5' N latitude and 118°39' to 119°08' E longitude (Fig. 1).

Experimental Animals

Two species were used in the study: the Nile Tilapia (*Oreochromis niloticus*) (Plate 1) and the Black Tiger Prawn (*Penaeus monodon*) (Plate 2). *O. niloticus* was taken from the Western Philippines University -Puerto Princesa Campus fishpond project while *P. monodon* was obtained from local fishermen in Tiniguiban Cove, Puerto Princesa City.

Experimental Set-up

Nine netcages measuring 1.0m x 1.0m x 1.5m made of B-net were tied within a bamboo raft and covered with polyethylene nets to avoid loss of stocks. The same polyethylene net was used as perimeter net.

O. niloticus and *P. monodon* were randomly distributed in Completely Randomized Design. Three treatments with three replicates were used; T₁ - monoculture *O. niloticus*, T₂ - monoculture *P. monodon* and T₃ - polyculture of *O. niloticus* and *P. monodon* at stocking density of 10pcs/m³.

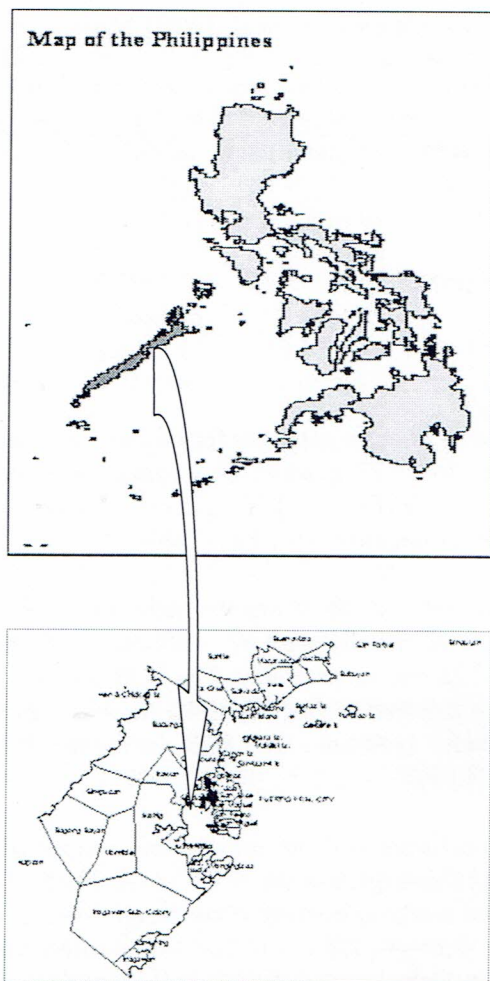


Figure 1. Map of the Philippines indicating the study site.

Feeds and Feeding

O. niloticus and *P. monodon* were fed with commercial pellet and trashfish, respectively. A feeding tray made of B-net was used for the shrimps to prevent feed wastage. The feeds were given between 4:00 to 5:00 p.m. at feeding rate of 10%, 8%, 6% and 4% of their body weight from 1st to 15th, 30th, 45th, and 60th days of culture, respectively.

Sampling

The growth and survival of *O. niloticus* and *P. monodon* were monitored every 15 days. The growth (increase in weight and length) was determined using

Yamato weighing scale and digital weighing scale, and measuring board and Vernier caliper, respectively.

Data Analysis

The data gathered were analyzed using ANOVA (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Growth and Survival

O. niloticus cultured in floating netcages for 60 days with an initial average body weight of 9.93 g grew to 19.22 g while *O. niloticus* in polyculture with *P. monodon* grew from 8.9 to 19.32 g (Figure 2). Tilapia obtained better weight gain in polyculture (10.41 g) than in monoculture (9.29 g) (Table 1).

O. niloticus in polyculture obtained highest mean final length of 10.14 cm, and length gain of 2.65 cm compared with *O. niloticus* in monoculture which obtained only 9.87 cm and 2.28 cm, respectively. The SGR and K of *O. niloticus* in monoculture and polyculture cultured in floating netcages was 1.21 to 1.43% g/day and 1.77 to 1.97, respectively. However, the FCR in monoculture (13.85) was higher than the polyculture (4.86).

P. monodon in monoculture with an initial body weight of 7.61g grew to 21.79g while those in polyculture grew from 7.07 to 22.29g/pc (Figure 2). The polyculture (15.23g) obtained a higher average body weight gain compared with *P. monodon* in monoculture (13.86g) (Table 1). The same result was recorded by Gonzales-Corre (1988) in brackishwater pond. She attributed the better growth of *P. monodon* in polyculture to the undigested food particles excreted by *O. niloticus* that served directly as food for *P. monodon*.

Further, *P. monodon* in polyculture obtained higher final total length, and length gain, 13.92cm and 4.83cm, compared with those in monoculture which obtained 13.68cm and 4.22cm, respectively. The carapace length of *P. monodon* in monoculture increased from 2.0cm to 3.25cm. In polyculture, carapace length increased from 2.04cm to 3.32cm. The SGR and FCR of *P. monodon* in monoculture and polyculture was 1.70 to 1.92%/g/day and 4.05 to 4.92, respectively (Table 1).

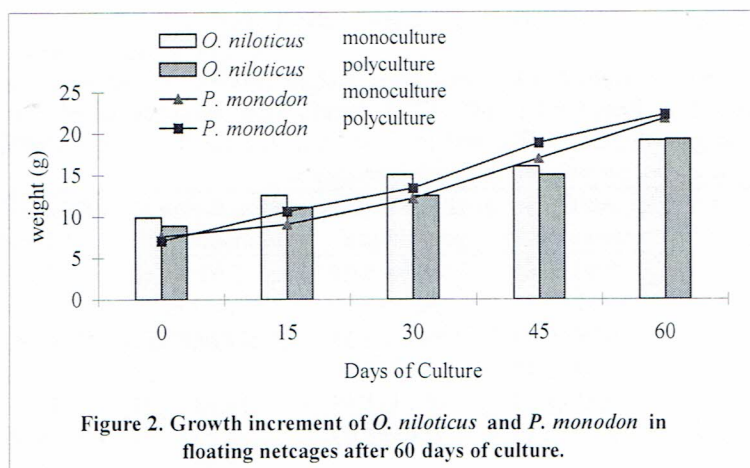
Table 1. Initial body weight (IBW), final body weight (FBW), weight gain, initial body length (ITL), final total length (FTL), length gain, carapace length gain (CLG), specific growth rate (SGR), and feed conversion ratio (FCR) of *O. niloticus* and *Penaeus monodon* cultured in floating netcages.

	<i>O. niloticus</i> monoculture	<i>O. niloticus</i> polyculture	<i>P. monodon</i> monoculture	<i>P. monodon</i> Polyculture
IBW (g)	9.93±5.86	8.9± 6.04	7.61± 1.11	7.07± 1.99
FBW (g)	19.22±5.71	19.32±8.02	21.79±1.3	22.29±5.75
Wt. gain (g)	9.29±0.34	10.41±27.51	13.86±1.57	15.23±3.78
ITL (cm)	7.58±1.45	7.49±1.85	9.46±0.89	9.08±0.59
FTL (cm)	9.87±1.15	10.14±1.45	13.68±0.05	13.92±1.15
Length gain (cm)	2.28±0.33	2.65±0.93	4.22±0.90	4.83±0.64
CLG (cm)	-	-	1.25±0.22	1.28±0.41
SGR (%g/day)	1.21±0.34	1.43±0.56	1.70±0.27	1.92±0.05
FCR	13.85±2.60	4.86±16.79	4.05±2.00	4.92±7.72

The initial body weight, final body weight, weight gained, final total length, length gain, SGR and K of *O. niloticus* and *P. monodon* showed no significant differences between monoculture and polyculture.

The biomass of *O. niloticus* in polyculture was 125.03 g/m³ greater than in monoculture which obtained only 156.12 g/m³. While *P. monodon* biomass in monoculture was 152.56g/m³ which is significantly higher than in polyculture (133.75 g/m³).

The survival of *O. niloticus* ranged from 66 to 83% in monoculture and polyculture. The maximum % survival in this study is better than Paalan (2001) which is only between 68.88 to 76.66%. The survival rate of *P. monodon* ranged from 60 to 73.33% (Figure 2). The low survival of *P. monodon* is attributed to loss (jumping) during sampling. According to Gonzales-Corre (1988) tilapia with the combination of shrimp has a survival rate of up to 75%. While Sarmiento (2002) found out that the survival of shrimp cultured in floating netcages within the period of 60 days is 85 to 90%.



Competition Index

The competitive correlation between *O. niloticus* with *P. monodon* at same stocking density of 10pcs/m³ is positive (+0.12). It was observed that *O. niloticus* competed in terms of food and space with *P. monodon*. In contrast, the competition index of *P. monodon* and *O. niloticus* is negative (-0.24) indicating that *P. monodon* did not affect the growth of *O. niloticus*.

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Acknowledgment

The authors express their genuine and deepest gratitude to the following: Ms. Arlene Avillanosa for the helpful insights and suggestions in refining this paper; Mr. Romulo Roche, Ricson Faderanga, Maricelle Sarmiento and Francis Mar Badenas for their assistance during the construction of the fishcages and actual conduct of the study.

The WPU-PPC faculty for the support and encouragement. Special mention to Dr. Sabine Schoppe for patiently reviewing this paper.

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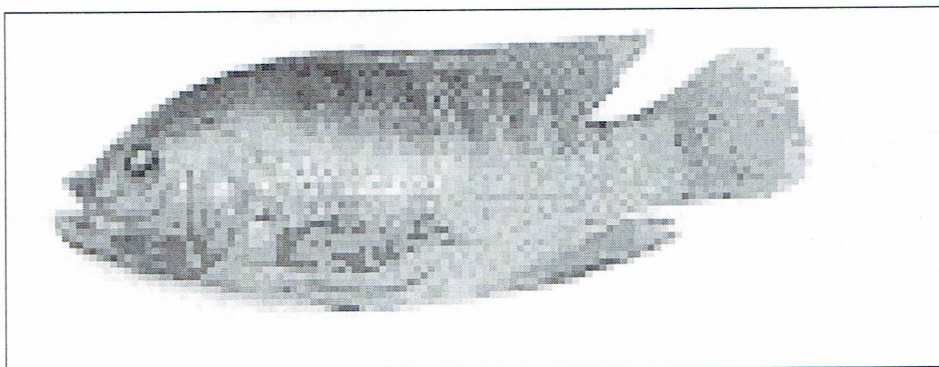


Plate 1. *Oreochromis niloticus*

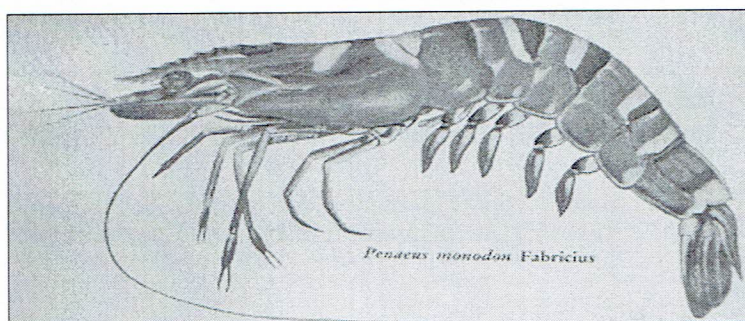


Plate 2. *Penaeus monodon* (adopted from SEAFDEC)

Effects of Different Dietary Protein Levels for Maximum Growth of Rabbitfish (*Siganus guttatus* Bloch) Reared in Floating Netcages

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ABSTRACT

A 60-day feeding trial was conducted in 12 units of cages measuring 1.0 x 1.0 x 1.5 m installed at South Sea AquaVenture Fishcage Project, Tiniguiban Cove, Puerto Princesa City, Palawan to determine the growth and survival rates of wild rabbitfish (*Siganus guttatus* Bloch) fed with formulated diets with protein levels ranging from 20% to 30% with 5% interval. "Lumut" (*Chaetomorpha* spp.) was also used as feed to serve as the control. Rabbitfish with a mean initial body weight ranging from 5.73 ± 0.30 g to 6.05 ± 0.14 g and mean total length from 8.11 ± 0.18 cm to 8.58 ± 0.34 cm., were randomly distributed at a stocking density of 20pcs/m³. The stocks were fed at 10% body weight thrice daily.

The fish fed with 20 and 30% crude protein showed significantly higher FCR, final weight, and biomass than those fed with "lumut". Moreover, the FCE of rabbitfish fed with formulated diets was highly significant than those fed with "lumut". There were no significant differences in terms of K, weight gain, SGR and survival among treatments.

The better biomass, FCR and FCE obtained from treatments with formulated feeds suggest improved growth response of rabbitfish with high protein diet. It is recommended that a longer culture period and higher protein level be used on further study for optimum fish growth.

Keywords: *Siganus guttatus*, rabbitfish, aquaculture, feeds and feeding, cage culture

INTRODUCTION

Aquaculture became a growing industry in both local and global scale. Researches on fish nutrition aim to help support the aquaculture development in the production of high quality and healthy fish.

Protein is indispensable in fish nutrition. It comprises about 70% of the dry weight of fish muscle (Robinson and Li 2003). Protein is digested and broken down to its component amino acids basically for the body maintenance and growth of the

fish. The excess however can be converted to energy to fuel fish activity. It is very important therefore that the protein requirement of the cultured fish be determined accurately to attain fish optimal growth.

Rabbitfish (*Siganus guttatus* Bloch) belonging to family Siganidae, is one of the potential species for aquaculture in the Philippines. This species can be distinguished from other species of the same genus largely by its color pattern. Orange spots cover the entire body of the fish.

Duray (1998) cited that some rabbitfishes are traditionally farmed either monoculture or polyculture with milkfish in ponds in the Philippines. It can also be reared in floating cages and fed with commercial diets. Although siganids are primarily herbivores, some species are capable of omnivory (Lam 1974) as cited by Duray (1998).

The market value of rabbitfish is generally high. It can be a promising alternative to milkfish culture considering that milkfish fry from the wild is now declining. To encourage fish farmers to venture into culturing this species, a quality and well-balanced feed and cost effective diet must be developed.

The present study aimed to determine the growth and survival of rabbitfish (*Siganus guttatus* Bloch) fed at different protein levels and to calculate its feed utilization.

METHODOLOGY

Experimental diets

Diets with protein levels ranging from 20% to 30% with 5% interval were formulated at the Western Philippines University (WPU) freshwater hatchery in Puerto Princesa City.

The composition of the experimental diets is shown in Table 1. The formulated feeds were stored in an individual plastic bag and stored inside the

Table 1. Ingredients of the Experimental Diets.

Ingredients (g/100 wet matter)	Protein Level (%)			
	Control	20	25	30
Fish meal	0	1.6	14.1	26.6
Copra meal	0	93.4	80.9	68.4
Corn Meal	0	2.0	2.0	2.0
Rice bran	0	1.0	1.0	1.0
Bread flour	0	1.0	1.0	1.0
Vitamin-mineral mix	0	1.0	1.0	1.0

freezer (0°C). The natural food known as “lumut” (*Chaetomorpha* spp.) that serves as the control was collected from the water near the experimental site.

Experimental fish and treatments

Juvenile rabbitfish collected within Puerto Princesa Bay and conditioned at South Sea Aqua Venture fish cage project (Figure 1) were used in this study. Fish were subjected to feeding trial from August 19-October 19, 2004.

The 60-day feeding trial followed a Completely Randomized Design with three replicates per treatment. Fish were fed with natural food (“lumut”) for Treatment I and with formulated diet at 20%, 25% and 30% protein levels for Treatments II, III and IV, respectively.

Fish stocking, rearing, and sampling

The 240 pieces of rabbitfish were randomly distributed into 12 units of cages measuring 1.0 x 1.0 x 1.5m installed at Tiniguiban Cove, Puerto Princesa City with a stocking density of 20pcs/m³, mean initial body weight ranged from 5.73±0.30g to 6.05±0.14g and the mean total length from 8.11±0.18cm to 8.58±0.34cm.

One week prior to experiment, the fish were fed with a mixture of natural food and commercial feeds at 10% body weight thrice daily. Then the fish were given the experimental feed at the same feeding rate and frequency for 60 days.

Sampling was conducted every 15 days. Fish were weighed in bulk during early samplings (1st and 2nd) but thereafter individual sampling of fish was done using Yamato weighing scale (100g capacity) and a measuring board for body weight and total body length measurement, respectively.

Water parameters

Water parameters such as dissolved oxygen, pH, temperature and salinity were determined using the portable dissolved oxygen analyzer, portable pH meter, laboratory thermometer and refractometer, respectively.

Statistical analysis

Weight gain (WG), specific growth rate (SGR), feed conversion ratio (FCR), condition factor (K), biomass, survival rate, and feed conversion efficiency (FCE) were calculated following Saitoh *et al.* (2003), Serrano and Apines (1996), and Bai *et al.* (1999). Comparison of treatment means for each trial was carried out

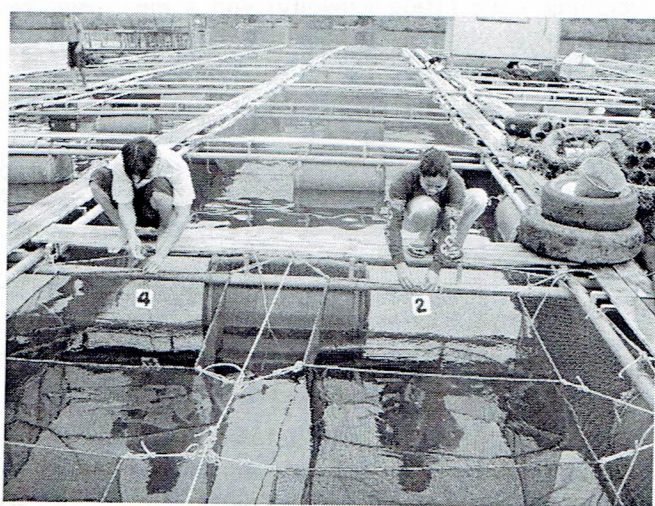
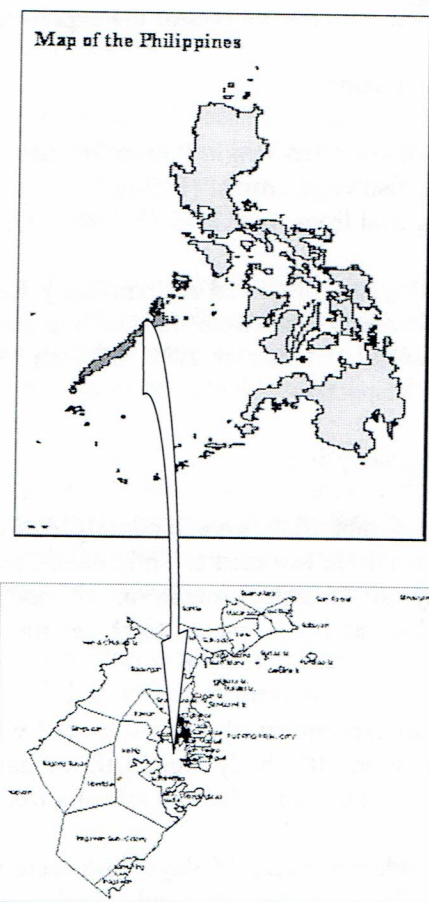


Figure 1. The experimental site and set-up.

using one-way Analysis of Variance. Duncan Multiple Range Test was used to determine differences between treatment means.

RESULTS AND DISCUSSION

Growth Performance and Survival

The performance of rabbitfish fed with various experimental diets for 60 days is shown in Table 2. The trend in growth as seen in average body weight of the species during entire culture period is in general increasing, however, a slight decrease is noticed for Treatment III (25% crude protein) as shown in Figure 2. This decreased can be attributed to the presence of a competitor inside the cage and the fish survival (88.33 ± 7.64). No significant difference was recorded in terms of the fish total length (Tab. 2; Fig. 2).

Table 2. Growth performance of *Siganus guttatus* cultured in floating netcages.

Indicator	Treatments			
	I	II	III	IV
Feed Conversion Efficiency**	5.50 ± 2.08^c	12.18 ± 0.37^a	9.08 ± 0.52^b	14.41 ± 1.37^a
Feed Conversion Ratio*	0.34 ± 8.67^a	8.21 ± 0.25^b	11.04 ± 0.63^b	6.99 ± 0.70^b
Initial Weight ^{ns}	5.97 ± 0.39	6.05 ± 0.14	5.73 ± 0.30	5.78 ± 0.01
Final Weight*	$9\ 630.40^b$	$10\ 530.46^{ab}$	$9\ 830.55^b$	$11\ 781.77^a$
Final Total Length ^{ns}	8.11 ± 0.18	8.38 ± 0.12	8.17 ± 0.07	8.58 ± 0.34
K ^{ns}	1.81 ± 0.07	1.79 ± 0.01	1.80 ± 0.09	1.85 ± 0.08
Weight Gain ^{ns}	3.67 ± 0.74	4.47 ± 0.28	4.10 ± 0.85	5.99 ± 1.82
SGR ^{ns}	0.80 ± 0.19	0.92 ± 0.07	0.90 ± 0.21	1.17 ± 0.28
Biomass*	157.46 ± 11.51^c	200.00 ± 8.66^a	173.33 ± 12.58^{bc}	192.78 ± 24.29^{ab}
Survival ^{ns}	81.67 ± 2.89	95.00 ± 0.0	88.33 ± 7.64	88.33 ± 5.77

ns – not significant; *-significant at .05; **- significant at .01

values within the same row not sharing common superscript letters are significantly different

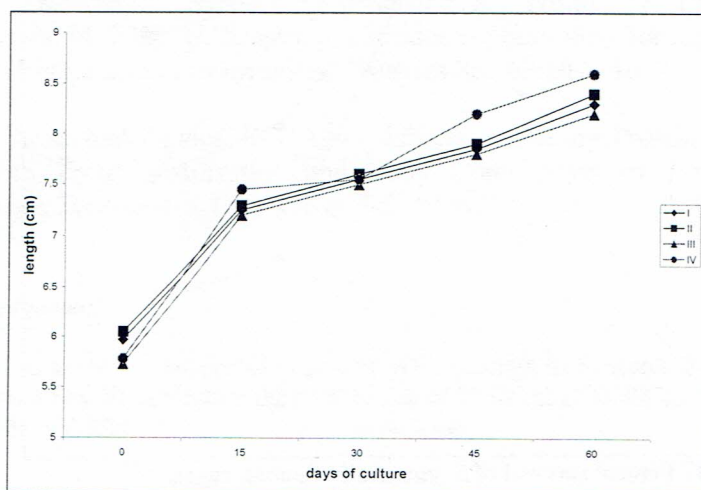


Figure 2. Mean body length increment of *S. guttatus* in floating cages.

Within 60-day culture period, the fish fed with 20 and 30% crude protein showed significantly higher ($p<0.05$) final weight, and biomass than those fed with "lumut". Moreover the FCE of fish fed with formulated feeds was significantly ($p<0.01$) better than those fed with "lumut". However no significant differences were observed in terms of K, weight gain, SGR, and survival among treatments.

Among the formulated diets, although not significantly different from the rest, the best growth performance was exhibited by the fish fed with highest level of protein (30%). This finding is in accordance with the observation of Perazo (1989) that the specific growth rate of juvenile *S. guttatus* increases with protein and energy levels. *Siganus guttatus* fed with "lumut" supplemented with 30% protein obtained highest weight gain in the pond (Ganzon-Naret 1991 as cited by Duray 1998).

From the results, the low biomass, FCR and FCE attained by fish fed with "lumut" can be explained by the observation of Tobias (1976) and Tsuda and Bryan (1973) as cited by Duray (1998) that the algal species consumed by the adult fish were rejected by the juveniles. Further, that "lumut" has a low protein digestion coefficient especially when fresh (Duray 1998) as the one used to feed the rabbitfish in this study. Further, Duray (1998) cited the observation of Westernhagen (1973b, 1974) that natural food is preferred by juvenile *S. guttatus* in the laboratory condition but take this only in small amount in nature.

Survival of fish ranged from 81.67 ± 2.89 to 95.00 ± 00 but not significantly different among treatments. Figure 3 indicated an almost similar trend among treatments wherein mortality started to occur only after 45 days of culture.

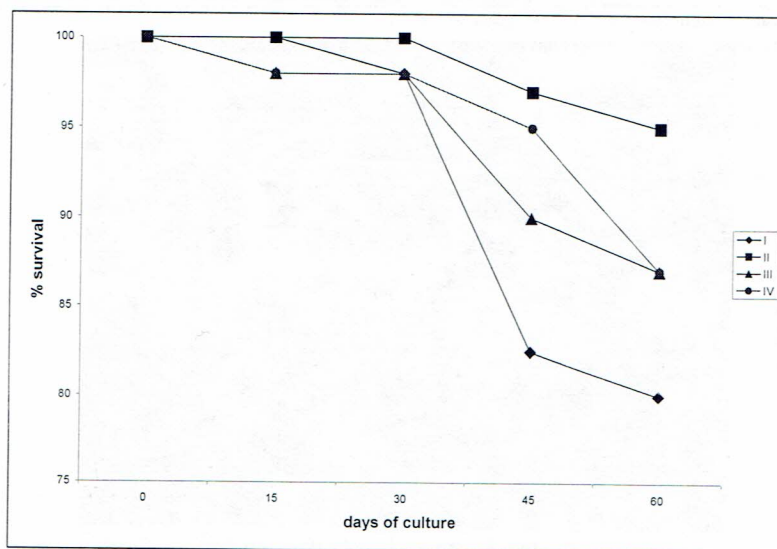


Figure 3. Percent survival of *S. guttatus* in floating cages.

According to Duray (1998) for cage culture of rabbitfish, the water temperature should be 28 to 32°C and salinity of 15 to 27ppt. For this study, water temperature range from 29 to 30°C. The salinity however is higher at 33 to 35ppt. The dissolved oxygen and pH of water in the study site are within the normal range for fish growth and survival, 6.4 to 7.5 and 7.4 to 8.6, respectively.

Results of this study indicated that juvenile rabbitfish growth performance is influenced by the level of crude protein in the diet. This study established better response of fish with 30% protein level. Compared with the other formulated diets used in this study, no significant differences were recorded in general, however, it is recommended that a longer culture period and higher protein level be used for further study to be able to determine the protein level for the optimum growth of rabbitfish.

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Acknowledgement

This study was supported in part by WPU through its Research Department, and in part by South Sea Aqua Venture through the use of its fish cage facilities, service motorboat and juvenile rabbitfish.

We express our sincerest thanks to Prof. Ria S. Sariago, University Research Director of WPU and Prof. Rosario J. Bundal, Dean of WPU-PPC for the support and encouragement. We are graciously thankful to Mr. Henry Teh of South Sea Aqua Venture for his indispensable support.

We are very grateful also to the staff of South Sea Aqua Venture and our students for their assistance during the conduct of the study.

Growth, Survival and Feed Conversion Efficiency of Grouper (*Epinephelus* sp.) Fed with Locally Available Feeds

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²South Sea Aqua Venture, Tiniguiban, Puerto Princesa City, Palawan

ABSTRACT

A preliminary study was conducted on the use of locally available cheap protein sources as feeds for grow-out culture of groupers in floating netcages. Feeds used were golden snail, fish waste and trash fish fed *ad libitum* to groupers once every two days.

Results indicated a daily feed consumption of 4.15 to 4.59 percent fish body weight during the culture period. A significantly higher FCE, FCR, biomass, weight gain, and total length were observed among groupers fed with trashfish and fish waste compared to those fed with golden snail feed. A significantly higher length gain was also noted among groupers fed with trashfish.

Both trashfish and fishwaste are recommended as feeds for groupers. Golden snails can be utilized as a feed ingredient but not as a sole protein source.

Keywords: cage culture, Epinephelus sp., grouper, feeds and feeding, trash fish, golden snail, fish waste

INTRODUCTION

Groupers are popular marine food fishes of high market value in Southeast Asia and they are found to be suitable in intensive cage culture (Chen 1979). Groupers have been farmed in net cages in coastal waters for a long time (Tookwinas 1989) because they are fast growing, euryhaline, hardy and disease resistant (Tamaru 1995). Pascual (1993) stated that groupers comprise about 4.2% of aquaculture fish production in the Philippines in 1991.

The decreasing supply of fish meal concomitant with the rise in price and the increased competition from other livestock feed, manufacturer has made it necessary to seek for an efficient replacement to supply dietary protein in aquaculture feeds (Wee 1991). For some large scale operators, the volume of trashfish needed on daily basis was high and the source becomes a problem (Silapan 1997). The current trend in fish culture is towards the intensification of culture systems whereby provision of feeds becomes necessary.

METHODOLOGY

The study was conducted at the Western Philippines University-Puerto Princesa Campus Fishcage Project at Tiniguiban Cove, Puerto Princesa Bay located at 09°53' to 10°5' N and 118°39' to 119°08' E (Figure 1).



Experimental Treatments

Nine netcages measuring 1.0 x 1.0 x 1.5m made of B-net were prepared and installed into a floating bamboo raft framework. A perimeter net made of Amazon plastic eyerib and sinkers had been provided in every cage.

Three treatments were used in the experiment: Groupers fed with golden apple snails (Treatment I); groupers fed with fish wastes (Treatment II) and groupers feed with trashfish (Treatment III). Each treatment was replicated three times using Complete Randomized Design.

A total of 90 juvenile groupers (*Epinephelus* sp.) ranging from 52 to 76g were conditioned to the new types of feeds for a week. The grouper were then randomly distributed to the nine cages at a stocking density of 10pcs/m³.

Feeds and Feeding

Golden apple snails collected from rice fields were cleaned thoroughly with water before cooking for 15 minutes. Snails were removed from the shell. The visceral parts were separated from the meat before rinsing with water. The snail meat were chopped before feeding.

The fish wastes composed of head, entrails and other internal organs were cleaned several times with water until the unpleasant odor was removed. These were then chopped prior to feeding.

Likewise, fresh trashfish caught from beach seine and lift net operated near the study site were chopped prior to feeding.

Experimental groupers were feed to satiation between 6-9 am or 3-5 pm once every two days. The feeds left in feeding trays were weighed and recorded to determine the amount of feeds consumed.

Fish Sampling

Groupers were sampled individually every month for three months to determine weight and length increase using a Yamato weighing scale and measuring board, respectively.

Data Analysis

Data were analyzed using Analysis of Variance (ANOVA).

RESULTS AND DISCUSSION

Table 1 shows the differences between variables measured for groupers fed with golden snail, fish waste and trash fish. The data revealed that the total feeds consumed were significantly higher for trashfish and fish waste compared to golden snail. Likewise, the feed conversion efficiency and feed conversion ratio of groupers fed with trashfish and fish wastes were significantly higher as compared to groupers fed with golden snails.

In terms of growth, groupers with an initial average body weight of 60.37-68.13 grams grew to a final average body weight of 194.54-272.17 grams after 93 days of culture. The final body weight and weight gain of fish fed with fish wastes and trashfish are significantly higher compared to groupers fed with golden snails (Figure 2). The same trend was observed in the final total length wherein fish fed with fish wastes and trashfish are significantly bigger than those fed with golden snails. In terms of length gain, those fed with trashfish has significantly higher length increment compared to fish fed with fish waste and golden snails. The biomass of groupers fed with trashfish was not significantly different from groupers fed with fish wastes but it is significantly different when compared to groupers fed with golden snails. Daily feed consumption of groupers observed during the culture period ranged from 4.15-4.59%.

No significant difference between treatments was observed on the specific growth rate, condition factor and survival rate.

Cost and return analysis indicated the profitability of the grouper culture in netcages using trashfish and fishwaste (Table 2).

Recommendation

Based on the above findings, the culture of groupers floating netcages fed with fish wastes and trashfish is more feasible compared to groupers fed with golden snails. A longer feeding experiment however is recommended to validate the results.

Table 1. Total Feed Consumed (TFC), Feed Conversion Efficiency (FCE), Feed Conversion Ratio (FCR), final body weight (FBW), weight gain (WG), final total length (FTL), length gain (LG), condition factor (K), specific growth rate (SGR), biomass and survival of groupers fed with locally available cheap protein feeds.

	Golden Snail	Fish wastes	Trash fish
TFC (g)	15,652.5 ^b	19,125 ^a	19,217 ^a
FCE (%)	20.62±0.56 ^b	30.94 ± 3.56 ^a	32.80 ± 4.46 ^a
FCR	4.85±0.13 ^b	3.26 ± 0.42 ^a	3.09 ± 0.45 ^a
FBW (g)	194.54±1.77 ^b	261.22±28.77 ^a	272.17±17.25 ^a
WG (g)	133.54 ^b	200.85 ^a	204.03 ^a
FTL (cm)	20.96±3.02 ^b	23.39±2.17 ^a	24.12±1.88 ^a
LG (cm)	4.48 ^a	8.10 ^b	4.29 ^a
K	2.11±0.02 ^a	2.03±0.02 ^a	1.94±0.08 ^a
SGR (%g/day)	1.25±0.12 ^a	1.57±0.05 ^a	1.49±0.14 ^a
Biomass (g/m ³)	1,815±217.03 ^b	2,418±144.70 ^a	2,721±172.51 ^a
Survival rate (%)	93.33 ^a	93.33 ^a	100 ^a

*mean values followed with similar superscripts are not significantly different at 0.05 level of significance.

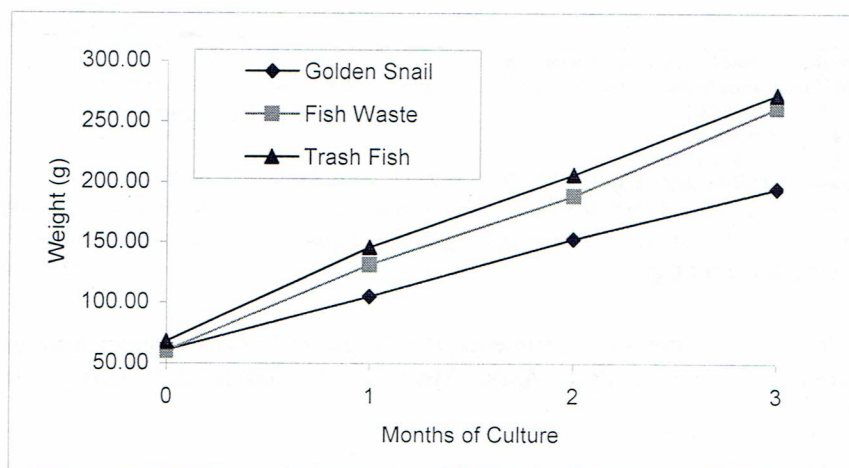


Figure 2. Growth trend of groupers in floating netcages fed with golden snail, fish waste and trash fish.

Table 2. Cost and return analysis of groupers in floating netcages fed with locally available cheap protein feeds.

	Treatments		
	Golden Snail	Fish Waste	Trash Fish
Gross Income			
Biomass (kg) ^a	41.85	41.85	45.00
Price (kg/pc)	400.00	400.00	400.00
Gross Sales (P)	16,740.00	16,740.00	18,000.00
Expenses			
Feeds (P) ^b	1,623.76	2,046.45	2,502.00
Labor & marketing (5% gross)	837.00	837.00	900.00
Depreciation (P) ^c	6,637.57	5,041.19	4,856.35
Total Expenses	10,898.33	9,724.64	10,058.35
Net income ^d	5,841.67	7,015.36	7,941.65
Net profit margin ^e	34.90	41.91	44.12
ROI ^f	25.37	32.10	35.79

a. Based on the computed weight-day relationship.

b. Based on the obtained FCR.

c. Adopted from Palao (2001).

d. Gross sale-Total expenses

e. Net income/Gross sales x 100

f. Net income/Total investment x 100

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Acknowledgment

The researchers would like to express their sincere gratitude to the following persons who contributed in this research.

To the faculty of BS Fisheries, especially to Ms. Arlene Avillanosa and Dr. Sabine Schoppe for checking the manuscript, and to Mr. Yutaka Kizaki for his comments on this paper and for analyzing the data and to the Bgy. Tagburos rice farmers for the provision of golden snails.

Author's Guide for Submission of Manuscripts

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