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Temporal and Spatial Diet Content Analysis of Introduced Rice Paddy Eel (*Monopterus albus*) in the Philippines

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Abstract: The *Monopterus albus*, or the rice paddy eel, is one of Asia's most economically important freshwater-farmed species and is found in various aquatic settings. They have a unique adaptation that allows them to thrive in different environments. However, as predators, the *M. albus* is considered a threat to their environment and biodiversity. The study aims to further investigate the impact of the presence of the introduced *M. albus* species in the rice paddies of Luzon Island by looking into the diet composition and feeding habits of the species. It is important to understand how the species survives in its new environment based on feeding habits, as such studies in the Philippines are limited. The feeding behavior and food intake of the species through gut content analysis were employed to investigate the diet composition in complexity. The role of diet analysis can simply identify the constant consumed prey in the stomach. Hence, the current study was conducted to investigate *M. albus'* diet composition and habits in Northern and Southern Luzon at different seasons. In this study, a random sampling of a total of 167 *M. albus* specimens was collected from two sites in Luzon: (1) Mexico, Pampanga province (N=85), and in Victoria, Laguna province (N = 82), and were sampled once in October 2022 and March 2023. The gut content analysis showed that *M. albus* feeds mostly on snails, fish, insects, and debris. However, most of the collected specimens contain debris that may be composed of mud and partially digested materials. In order to determine if there is a significant difference in the gut contents between the two sites (Pampanga and Laguna) and between the two seasons (wet and dry), this study utilized inferential statistics using a 2-tailed independent T-test and one-way ANOVA. The findings of the study provided important evidence that shows that the distribution of gut content in Pampanga and Laguna is affected by the season. Results show that a higher number of gut contents (snail, fish, insect, and debris) can be seen during the wet season, with a p-value of 3E-6 for Mexico, Pampanga, and 4E-23 in Victoria, Laguna. The t-test results showed that in Pampanga, there is a significant difference in the gut contents between seasons with a t-value of 4.5312 and a p-value of 9.74427E-06. Similarly, the t-test result showed that in Laguna, there is a significant difference in the gut contents between seasons with a t-value of 3.6320 and a p-value of 0.000247415. In conclusion, the food intake *of M. albus* was more pronounced during the rainy season in both Pampanga and Laguna, owing to the abundance of food supplies and favorable natural conditions for both prey and *M. albus*. The food availability varies depending on location and climatic factors such as temperature and water level. The result of this scientific study may contribute to the information needed in the proper management of *M. albus* as an introduced species in the Philippines.

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I. INTRODUCTION

Monopterus albus, commonly known as rice paddy eel and locally as "igat," "palos," or "kiwit", is an invasive species that was originally recorded in the Philippines in 1918 (Herre, 1953). The rice paddy eels have become one of Asia's most economically important freshwater farmed species due to their great nutritional and therapeutic value, as this species is mostly utilized for food and is widespread throughout Asia (Liang et al., 2016; Joseph, 2021). They have the capacity to be bred for culture, as seen in Thailand, Vietnam, and China. However, there is a chance that their spread has unintended consequences, such as biodiversity loss and habitat degradation, as it primarily affects the agricultural sector through the creation of dug holes in the soil, and plant destruction due to golden apple snails feeding that are attached to the rice stalk (Ame and Mayor, 2021).

According to Erzen (2019), rice paddy eels grow up to 40 cm in length, and their color in majority is predominantly dark brown or green. On the ventral side of their necks, they usually have a single V-shaped gill hole. Individuals have two

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rows of mandibular teeth and thin skin covering their eyes. The species is scaleless and finless, and it has glands on its skin that secrete a protective mucus all over its body.

The species being investigated are found all the way from Beijing, China, through Malaysia, Indonesia, and the Philippines. Although endemic to much of southern and eastern Asia, the rice paddy eel has been imported to Florida, Georgia, and Hawaii (Erzen, 2019; Hill & Watson, 2011). In both their native and other ranges, rice paddy eels may be found in a variety of aquatic settings, and they also have a unique adaptation that allows them to travel short distances across land, which can aid in the movement of appropriate habitats (Erzen, 2019). According to Bricking (2002), in dry weather, they nest in wet ground and survive for long durations without water in swampy ponds, wetlands, and waterways.

According to Khanh (2010), rice paddy eels are robust competitors in the environment; they are strong due to their nature of being carnivorous. Knowledge of their nutrition provides additional support for aquatic management strategies, particularly agricultural production, fisheries, and preservation (Thilsted et al., 2016). In feeding ecology studies, investigating a species' food and feeding behavior patterns is important to determine the species' ecological role and position in the food chain of ecosystems (Saikia, 2016). Among those organisms in the aquatic environment, fish are major top predators with a predetermined position in the freshwater ecosystem's trophic series (Vegenas et al., 2022). This study aims to know the gut contents of *M. albus*, as it will help the researchers determine their mechanisms in feeding ecology, specifically in the two seasonal variations in the Philippines. This study hopes to establish the foundation of content in the spatial dietary analysis of *M. albus* between the two seasonal variations (wet and dry seasons) in the Philippines. The main objective of the study is to investigate *M. albus'* diet composition and feeding habits, and to further investigate if the feeding habit is affected by season at two different breeding sites. Specifically, it aims to: 1. Identify the gut contents of the diet composition of rice paddy eels; 2. Determine the variation of diet compositions of rice paddy eels located in selected areas in Central Luzon and South Luzon Islands; 3. Determine the variation of diet compositions of rice paddy eels between 2 seasons (wet and dry seasons).

II. MATERIALS AND METHODS

➢ *Research Design*

This study is descriptive research, aiming to understand the feeding ecology of rice paddy eel (*Monopterus albus*): temporal and spatial diet composition analysis. This study used a random sampling method. The descriptive analysis was used to determine the different gut contents from the rice paddy eel (*M. albus*) gut. Statistical treatments were used in order to generate inferences from the gathered data.

➢ *Collection Site/Study Site*

The researchers' study sites are in Victoria, Laguna (14°14'8" N, 121°20'3" E), and Mexico, Pampanga (15°7'11"N, 120°40'37" E), during the wet season and March as the dry season. Two seasons are involved because seasonal fluctuations are needed in determining changes in the diet and feeding habits of the rice paddy eel. These two study sites are considered natural habitats of *M. albus.* In Victoria, Laguna, the collection site is an Inland water lake, located near Laguna de Bay. It is a wide area of water that ranges in water depth from 1 foot to 3 feet. In Mexico, Pampanga, the collection sites are in a wide farm with shallow water and in a muddy rice field. Permit letters were submitted to their respective Offices of the Municipality Mayor and Municipal Agriculturist. The duration of the collection of specimens from the two study sites was from October 2022 to March 2023.

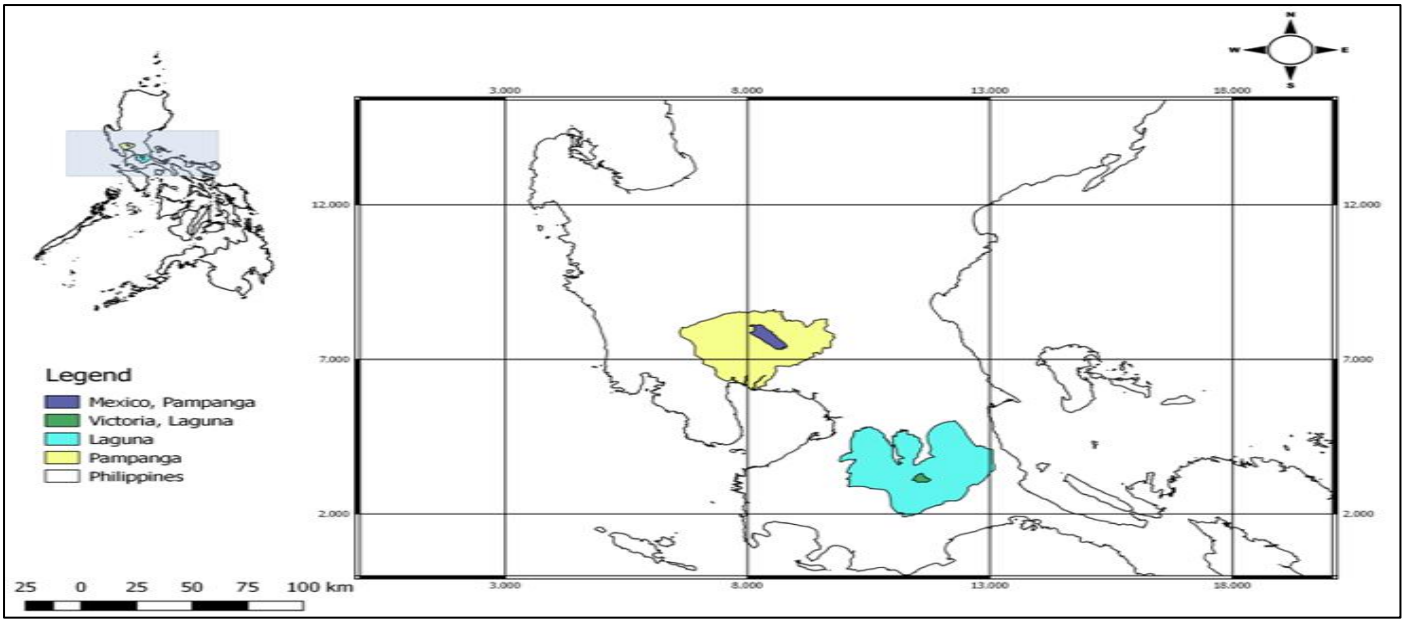

Fig 1 QGIS Map of the Province of Pampanga (Yellow) and the Collection Site Municipality of Mexico (Blue). Province of Laguna (Teal), and the Collection Site Municipality of Victoria (Green).

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Fig 2 (left) Collection Site at Victoria, Laguna; (Right) Collection Site at Mexico, Pampanga.

➢ *Sampling Method*

The researchers used the convenience sampling method, wherein the data collection depended on the quantity, accessibility, and availability of rice paddy eels in the two collection sites. Sampling was conducted within six hours in Mexico, Pampanga, and eight hours in Victoria Laguna, with five farmers involved in the collection. The farmers used improvised containers and the Electrofishing method to collect *M. albus,* and the specimens were placed and stored in a cooler with ice to preserve the fish, whose size ranges from 32 to 96 cm in length. Also, the researchers used the cluster sampling method to randomly choose the specimens from the widely dispersed geography of Luzon. Specifically, this type of method helped the researchers to analyze the stomach content of the rice paddy eel in two seasonal variations from different areas in the North and South Luzon. Determining the rice planting window helped researchers to determine the season of planting for rice, since the habitat of most rice paddy eels is in rice paddies found in those localities.

➢ *Data Collection Method*

The researchers used string and masking tape in labeling the *M. albus* specimen in the mouth part. The labels include the sample code, date, and place of collection. Proper documentation was taken using an iPhone camera with a white background. The price per kilogram varies from one region to the other depending on the season, because it is harder to catch *M. albus* during the dry season because of the insufficient water supply in rice paddies. Specimens were stored in solutions; they shrivel much less and remain pliable enough for dissection (Earthguide & Scripps Institution of Oceanography, 2013).

The body weight of each sample was measured in g, and the total length was measured in cm by a tape measure. A 70% ethanol solution was used for the stomach preservation, and 10% formaldehyde solution for the preservation of specimen samples.

The data collection to study the gut content and diet composition of rice paddy eels requires accurate quantitative data. Collection of the species is the primary method of determining the gut content of the rice paddy eels.

The fish sample was identified based on the characteristics and morphology described by previous researchers, and was verified as *Monopterus albus.* The specimens were stored and preserved in the refrigerator at the Far Eastern University science laboratory, and the specimens were placed inside an ice box (cooler) where they were sedated by freezing their body temperature, organs, and gut content.

In collecting species specimen samples of *M. albus,* the researchers asked for the assistance of local farmers from Victoria Laguna and Mexico Pampanga to catch and use an electrofishing gadget in the wet and dry seasons. The samples were immediately collected and placed inside a cooler box with ice cubes to sedate their body. Moreover, yarn, tape, and an analytical balance were the materials for the division of measuring body length, body size, and markings of each species specimen. Hence, the dissecting materials were a scalpel and scissors, while the storage of organs and gut content was sterile test tubes and sterile plastic bags with 70% alcohol inside. After the removal of the gut content of *M. albus*, the sample specimens were preserved inside the ice box with a 10% formalin solution for further inspection. The researchers determined the sex of the collected *M. albus* based on the study of Chan and Phillips (1967), whether they are male, female, or intermediate. It was discussed in the

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study that *M. albus* transitions into male as they grow. According to Khanh and Ngan (2010), a mature *M. albus* that has not yet undergone sex reversal has a mean body weight of 250 g or higher for males and has a 50 cm total length. In contrast, the female mean body weight is about 40 – 100 g and 30 – 40 cm total length.

The researchers also recorded the environmental parameters, such as temperature and amount of precipitation in Laguna and Pampanga at the time of collection (October and March). The weather from October 2022 in the Province of Pampanga reported that out of the 31 days in this month, 24 days were reported to have recorded rainy weather. While in Pampanga in March 2023, the weather was mostly clear and sunny, and the highest temperature recorded was 92F during the day and 76F during the night (World Weather, n.d.).

Based on World Weather (n.d.), the weather in Laguna in September 2022, 21 days were recorded to have precipitation, while there were no sunny days during this month. The highest temperature recorded was 86°F during the day and 77 °F during the night. In March 2023, there were only 3 rainy days, 13 sunny days, and 14 cloudy days. The highest recorded temperature recorded during the day was 91°F and 77°F during the night.

Fig 3 Materials that were Used to Catch the Species: (Left) Electrofishing Gadget, (Right) Ice Cooler for Storage, Test Tubes and Petri Dish for Gut Storage, Dissecting Kit for Dissection of Species, Tape and String for Species Label, and 70% Alcohol for Preservation of the Gut.

➢ *Data Analysis*

The researchers gathered data and used quantitative analysis methods to get accurate results in analyzing the gut contents of rice paddy eels. The methods include numerical methods, frequency of occurrence, 2-tailed independent t-test, and one-way ANOVA. The Frequency method analyzes the measurement of the food intake of *M. albus*. It measures the different occurrences of the wet and dry seasons and the expected frequency. It indicates the number of observations with an exact value of a certain sample.

➢ *Frequency of Occurrence*

The importance of Frequency occurrence in determining the gut contents of rice paddy eels is that it examines the individual food organisms sorted and identified. It consists of the number of stomachs (fish) in which each item occurs, which is recorded and expressed as a percentage of the total number of stomachs (fish) examined.

$$Frequency\ of\ Occurrence = \frac{O_i}{P}\ x\ 100$$

Where, O_i Is the number of fish containing a specific prey, and P is the total number of fish with food in their stomach.

➢ *Statistical Treatment of Data*

For the statistical analysis, the researcher used a one-way analysis of variance (ANOVA) to test the differences in the gut content and to detect the feeding biology of the rice paddy eel in different seasonal variations between two collection sites in Luzon (Victoria, Laguna, and Mexico, Pampanga) and their significant differences at a 0.05 level of significance. The researchers also used 2-tailed independent t-test in order to identify the if there are significant differences between the collection sites and the seasons.

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III. RESULTS

➢ *Results*

Fig 4 Adult M. albus, 47 cm in Length and 111.6 g in Weight.

Note on the morphology of the *M. albus* that the sampled fish have an anguilliform body, are scaleless, have no presence of pectoral and pelvic fins, and the caudal fins are confluent. The collected data from both the collection sites and for both seasons had a length size ranging from 32 cm to 96 cm. The collected data also had a range of weights from 11g to 630 g.

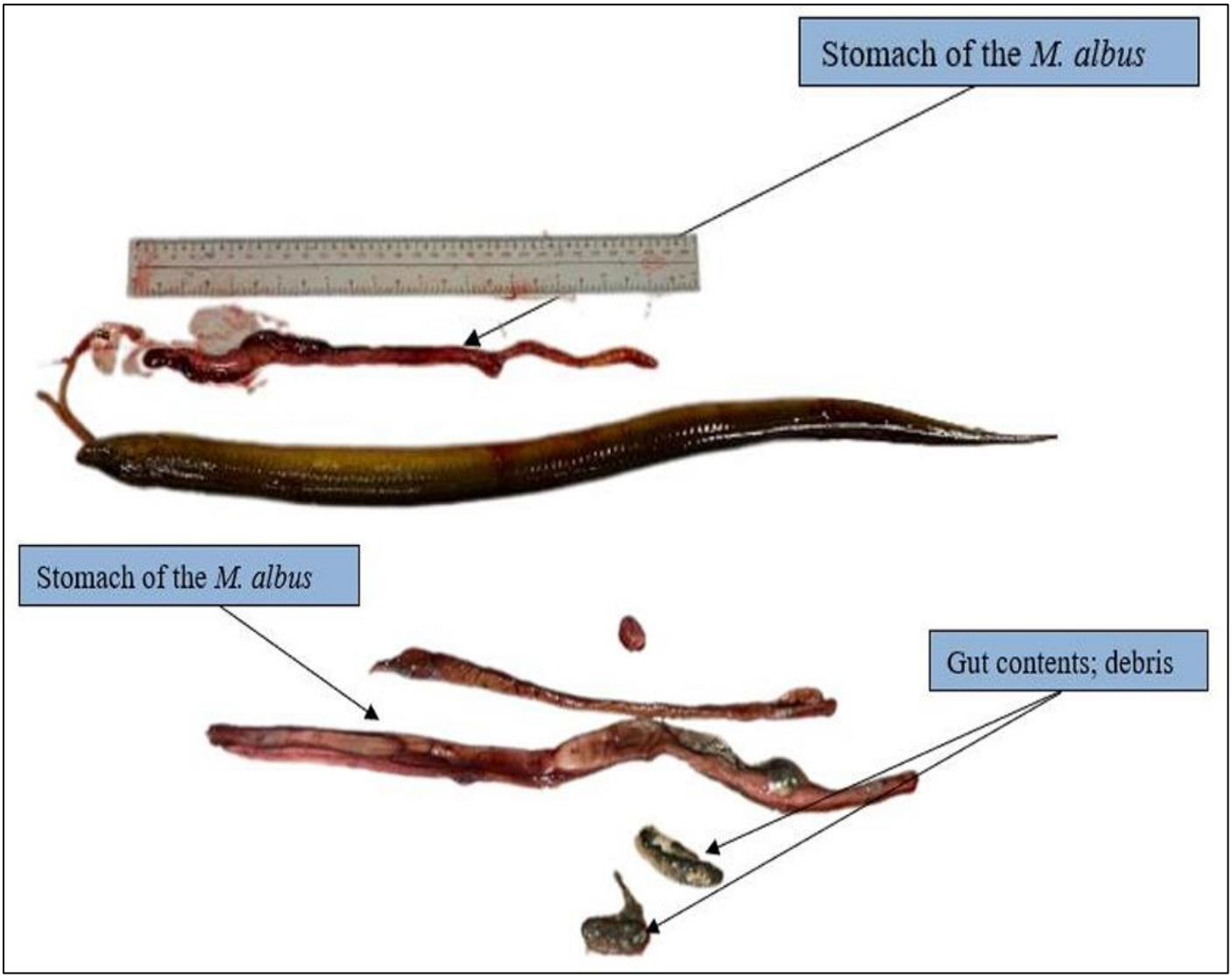

Fig 5 Sample Pictures of Dissected M. albus with Gut.

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Specimens were collected from 2 different sites (Mexico, Pampanga, and Victoria, Laguna) at 2 different seasons (October and March). A total of 58 samples of *M. albus* were collected in Mexico, Pampanga, during the wet season (October 2022), and 27 samples of *M. albus* in the dry season (March 2023). For the second location, which was in Victoria, Laguna, a total of 52 samples of *M. albus* were collected during the wet season (September 2022), and 30 samples of *M. albus* during the dry season (March 2023).

Fig 6 Snail Shell

Fig 7 Snail Shell

Fig 8 Snail Egg

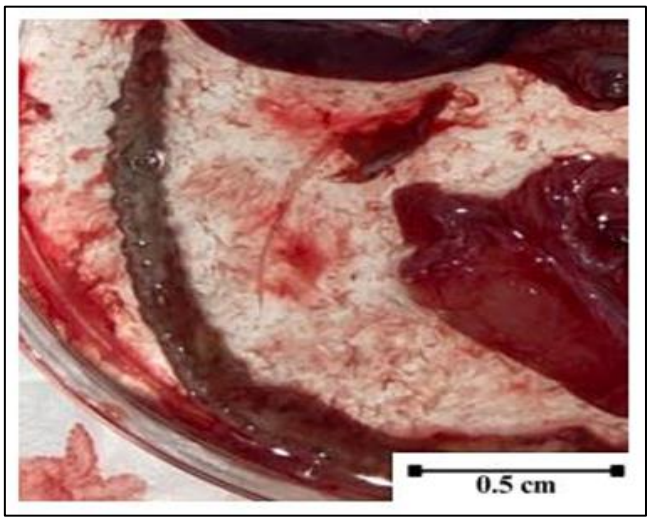

Fig 9 Partially Digested Bone (Fish)

Fig 10 Insect

Fig 11 Insect

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Fig 12 Debris or Semi-Digested Material

Fig 13 Debris or Semi-Digested Material

Table 1 Measures of Central Tendency (Mean, Median, and Standard Deviation) of the Body Length and Weight of the Samples Collected from Pampanga and Laguna in October 2022 and March 2023.

Site/season	Mean	Median	Standard Deviation
Pampanga wet season Length (cm)	50.9138	50.5	9.9382
Weight (g)	176.274	154.2	109.748
Pampanga dry season Length(cm)	56.7037	55.5	9.3988
Weight (g)	236.7481	189.5	143.9412
Laguna wet season Length (cm)	44.2	41.5	10.8935
Weight (g)	90.5865	72	62.4043
Laguna dry season Length (cm)	42.2667	47.5	5.2468
Weight (g)	16.7233	14.9	5.1979

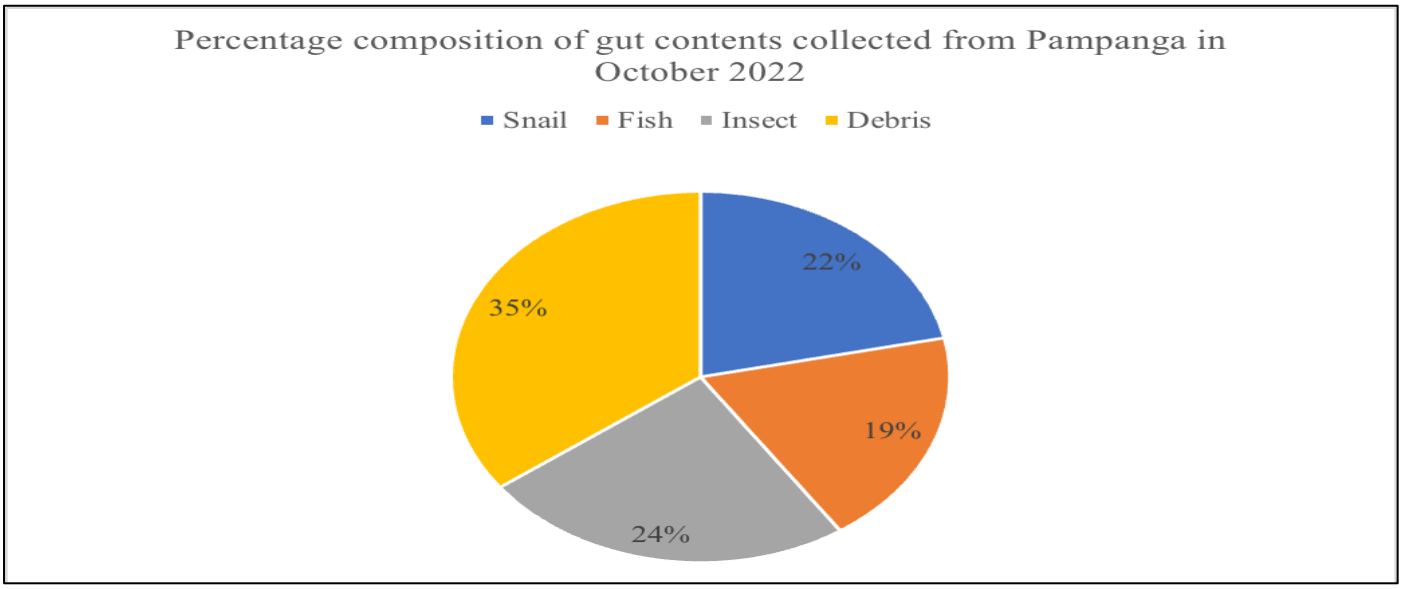

Fig 14 Percentage Composition of Gut Contents of *M. albus* Collected from Pampanga in October 2022, with 35% Debris as the Highest and 19% of Fish as the Lowest.

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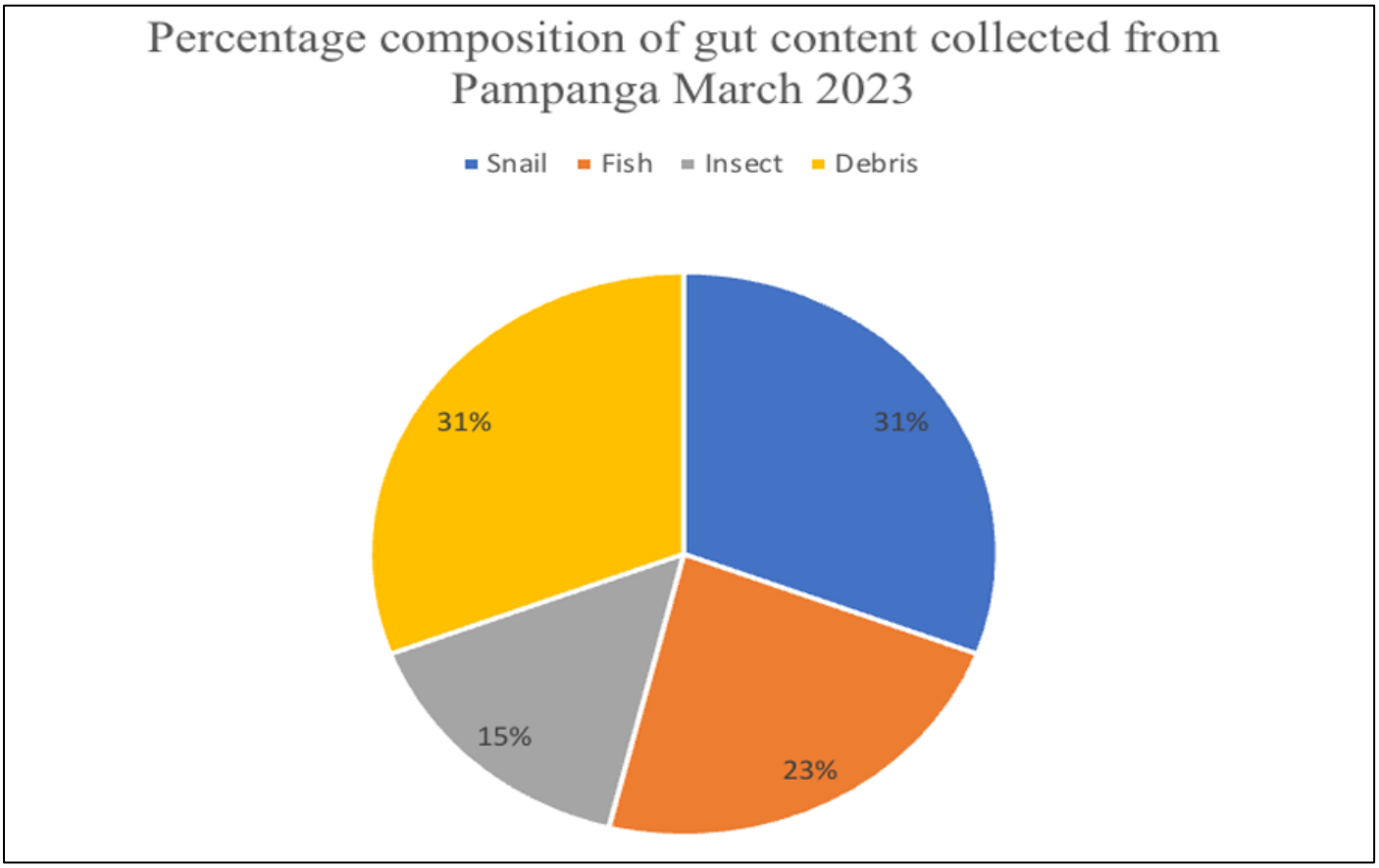

Fig 15 Percentage Composition of Gut Contents of *M. albus* Collected from Pampanga in March 2023; Debris and Snail were the Highest with 31%, and Insect was the Lowest with 15%.

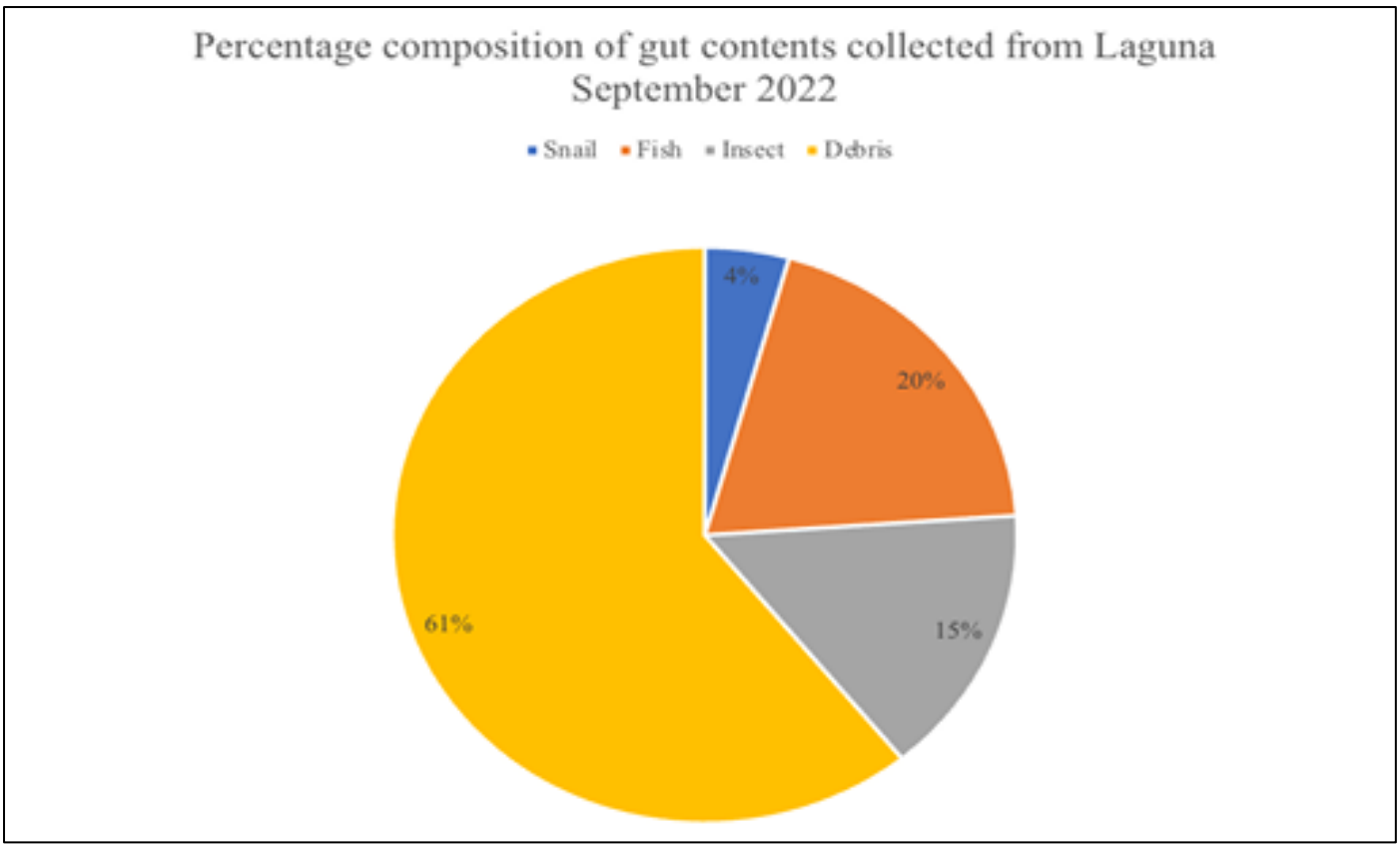

Fig 16 Percentage Composition of Gut Contents of *M. albus* Collected from Laguna in September 2022; Debris was the Highest with 61%, and 4% with Snail.

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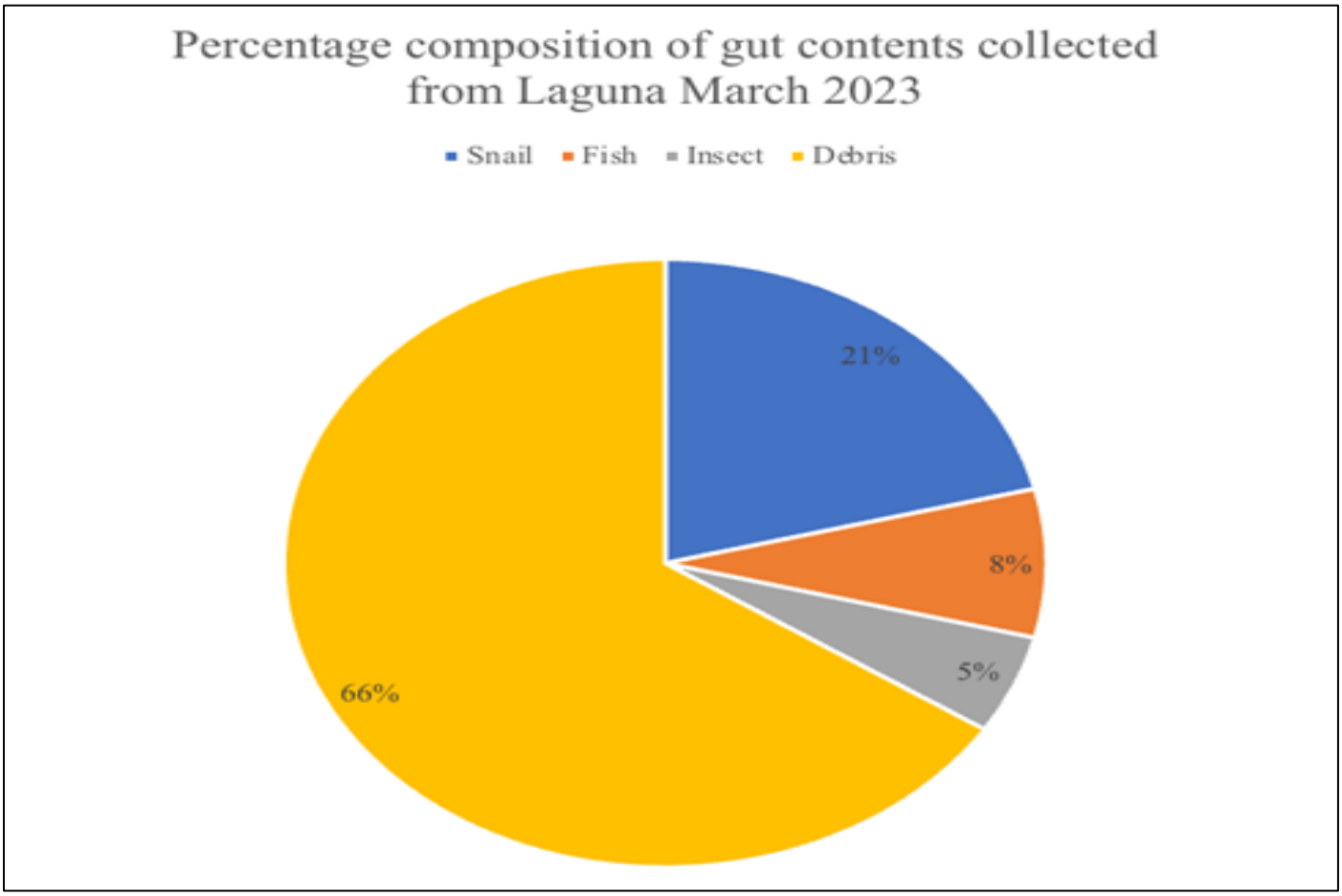

Fig 17 Percentage Composition of Gut Contents of *M. albus* Collected from Laguna in March 2023, with Debris as the Highest with 66% and Insect as the Lowest with 5%.

Table 2 Frequency and Percentage of Gut Content Occurrence in Pampanga Wet Season

Gut content	No. of gut content	FO	%
Gastropoda (Snail)	8	0.2162	21.62
Osteichthyes (Fish)	7	0.1892	18.92
Insecta (Insect)	9	0.2432	24.32
Debris (unidentified)	13	0.3514	35.14
Total	**37**		**100.00**

Table 2 Frequency of Occurrence and Percentage of gut contents of *M. albus* in Pampanga during the wet season (October 2022), shown above are the gut content percentages of *Gastropoda* (Snail), *Osteichthyes* (Fish), *Insecta* (Insect), and debris (unidentified).

Table 3 Frequency and Percentage of Gut Content Occurrence in Pampanga Dry Season

Gut content	No. of gut content	FO	%
Gastropoda (Snail)	4	0.3077	30.77
Osteichthyes (Fish)	3	0.2308	23.08
Insecta (Insect)	2	0.1538	15.38
Debris (unidentified)	4	0.3077	30.77
Total	**13**		**100.00**

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Table 3 Frequency of Occurrence and Percentage of gut contents of *M. albus* in Pampanga during the wet season (March 2023), shown above are the gut content percentages of *Gastropoda* (Snail), *Osteichthyes* (Fish), *Insecta* (Insect), and debris (unidentified).

Table 4 Frequency and Percentage of Gut Content Occurrence in Laguna Wet Season

Gut content	No. of gut content	FO	%
Gastropoda (Snail)	2	0.0435	4.35
Osteichthyes (Fish)	9	0.1957	19.57
Insecta (Insect)	7	0.1521	15.21
Debris (unidentified)	28	0.6087	60.87
Total	**46**		**100.00**

Table 4 Frequency of Occurrence and Percentage of gut contents of *M. albus* in Laguna during the wet season (October 2022), shown above are the gut content percentages of *Gastropoda* (Snail), *Osteichthyes* (Fish), *Insecta* (Insect), and debris (unidentified).

Table 5 Frequency and Percentage of Gut Content Occurrence in Laguna Dry Season

Gut content	No. of gut content	FO	%
Gastropoda (Snail)	8	0.2106	21.06
Osteichthyes (Fish)	3	0.0789	7.89
Insecta (Insect)	2	0.0526	5.26
Debris (unidentified)	25	0.6579	65.79
Total	**38**		**100.00**

Table 5 Frequency of Occurrence and Percentage of gut contents of *M. albus* in Laguna during the wet season (March 2023), shown above are the gut content percentages of *Gastropoda* (Snail), *Osteichthyes* (Fish), *Insecta* (Insect), and debris (unidentified).

- *Descriptive Analysis and T-Test of Collection Sites*

Table 6 Descriptive Analysis Between Mexico, Pampanga, Wet and Dry Seasons.

	Pampanga (Wet)	Pampanga (Dry)
Mean	29.5	14
Variance	285.1666667	63
Observations	58	27
Pooled Variance	215.5722892	
Hypothesized Mean Difference	0	
df	83	
t Stat	4.531287806	
P(T<=t) one-tail	9.74427E-06	
t Critical one-tail	1.663420175	
P(T<=t) two-tail	1.94885E-05	
t Critical two-tail	1.98895978	

Table 7 T-Test: Two-Sample Assuming Equal Variances

Pampanga (WET)		Pampanga (DRY)	
Mean	29.5	Mean	14
Standard Error	2.217355783	Standard Error	1.527525232
Median	29.5	Median	14
Mode	#N/A	Mode	#N/A
Standard Deviation	16.88687854	Standard Deviation	7.937253933
Sample Variance	285.1666667	Sample Variance	63
Kurtosis	-1.2	Kurtosis	-1.2
Skewness	-1.61386E-17	Skewness	3.68936E-17

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Range	57	Range	26
Minimum	1	Minimum	1
Maximum	58	Maximum	27
Sum	1711	Sum	378
Count	58	Count	27

Tables 6 – 7 exhibits the population size of collection in Pampanga wet (M = 29.5, SD = 16.8, n = 58) was hypothesized to be greater than the population size of Pampanga dry (M = 14, SD = 7.93, n = 27), having no signfinicant difference of t (83) = 4.531287806, p = 9.74427E-06 (one tail), p =1.94885E-05 (two tail).

Table 8 Descriptive Analysis Between Victoria, Laguna, Wet and Dry Seasons.

	Laguna (Wet)		**Laguna (Dry)**
Mean	26.5	Mean	15.5
Standard Error	2.101586702	Standard Error	1.607275127
Median	26.5	Median	15.5
Mode	#N/A	Mode	#N/A
Standard Deviation	15.15475723	Standard Deviation	8.803408431
Sample Variance	229.6666667	Sample Variance	77.5
Kurtosis	-1.2	Kurtosis	-1.2
Skewness	7.24475E-17	Skewness	6.56289E-17
Range	51	Range	29
Minimum	1	Minimum	1
Maximum	52	Maximum	30
Sum	1378	Sum	465
Count	52	Count	30

Table 9 T-Test: Two-Sample Assuming Equal Variances

	Laguna (Wet)	**Laguna (Dry)**
Mean	26.5	15.5
Variance	229.6666667	77.5
Observations	52	30
Pooled Variance	174.50625	
Hypothesized Mean Difference	0	
df	80	
t Stat	3.631972614	
P(T<=t) one-tail	0.000247415	
t Critical one-tailed	1.664124579	
P(T<=t) two-tail	0.000494829	
t Critical two-tailed	1.990063421	

Tables 8 – 9 exihibits the population size of collection in Laguna wet (M = 26.5, SD = 15.15, n = 52) was hypothesized to be greater than the population size of Laguna dry (M = 15.5, SD = 8.80, n = 30), having a significant difference of: t (80) = 3.631972614, p = 0.000247415 (1 tail), p = 0.000494829 (two tail)

Table 10 Descriptive Analysis Between Mexico, Pampanga, and Victoria, Laguna Wet

	Pampanga (Wet)		**Laguna (Wet)**
Mean	29.50	Mean	26.50
Standard Error	2.22	Standard Error	2.10
Median	29.50	Median	26.50
Mode	#N/A	Mode	#N/A
Standard Deviation	16.89	Standard Deviation	15.15
Sample Variance	285.17	Sample Variance	229.67
Kurtosis	-1.20	Kurtosis	-1.20
Skewness	0.00	Skewness	0.00
Range	57.00	Range	51.00
Minimum	1.00	Minimum	1.00
Maximum	58.00	Maximum	52.00
Sum	1711.00	Sum	1378.00
Count	58.00	Count	52.00

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Table 11 T-test: Two-Sample Assuming Equal Variances

	Pampanga (Wet)	***Laguna (Wet)***
Mean	29.5	26.5
Variance	285.1666667	229.6666667
Observations	58	52
Pooled Variance	258.9583333	
Hypothesized Mean Difference	0	
df	108	
t Stat	0.976170401	
P(T<=t) one-tail	0.165580753	
t Critical one-tailed	1.659085144	
P(T<=t) two-tail	0.331161506	
t Critical two-tailed	1.982173483	

Tables 10 – 11 exhibits the population size of collection in Pampanga wet (M = 29.50, SD = 16.89, n = 58) was hypothesized to be greater than the population of Laguna wet (M = 26.50, SD = 15.5, n = 52), having no significant difference of t (108) = 1.982173483, p = 0.165580753031182 (one tail), p = 0.331161506 (two tail)

Table 12 Descriptive Analysis Between Mexico, Pampanga, and Victoria, Laguna Dry

	Pampanga (Dry)		**Laguna (Dry)**
Mean	14	Mean	15.5
Standard Error	1.527525232	Standard Error	1.607275127
Median	14	Median	15.5
Mode	#N/A	Mode	#N/A
Standard Deviation	7.937253933	Standard Deviation	8.803408431
Sample Variance	63	Sample Variance	77.5
Kurtosis	-1.2	Kurtosis	-1.2
Skewness	3.68936E-17	Skewness	6.56289E-17
Range	26	Range	29
Minimum	1	Minimum	1
Maximum	27	Maximum	30
Sum	378	Sum	465
Count	27	Count	30

Table 13 T-Test: Two-Sample Assuming Equal Variances

	Pampanga (Dry)	**Laguna (Dry)**
Mean	14	15.5
Variance	63	77.5
Observations	27	30
Pooled Variance	70.64545455	
Hypothesized Mean Difference	0	
df	55	
t Stat	-0.672750809	
P(T<=t) one-tail	0.251961349	
t Critical one-tailed	1.673033965	
P(T<=t) two-tail	0.503922698	
t Critical two-tailed	2.004044783	

Tables 12 – 13 exihibits the population of collection in Pampanga dry (M = 14, SD = 7.93, n = 27) was hypothesized to be less than the population size of Laguna dry (M = 15.5, SD = 8.80, n = 30), having a no significant difference of t (55) = -0.672750809, p = 0.251961349 (one tail), p = 0.503922698 (two tail).

Descriptive analysis and t-test tables exhibit the collection population distribution in Mexico, Pampanga, and Victoria Laguna in two seasonal variations. The results show that there is no significant difference in the population of Pampanga and Laguna, and the only significant difference is the Laguna wet and Laguna dry two-tailed value.

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➢ *Analysis of Variance of Gut Content*

Table 14 One-Way ANOVA of the Gut Content of Two Different Seasons (Wet and Dry) and Two Different Sites (Pampanga and Laguna).

Source of variations	SS		df	MS	F	p-Value	F-crit
Wet Season							
Mexico, Pampanga	30.741		399	0.077	6.244	3E-06	2.121
Victoria, Laguna	30.346		357	0.0850	23.216	4E-23	2.124
Dry season							
Mexico, Pampanga	14.148		182	0.078	2.068	0.0591	2.149
Victoria, Laguna	24.590		202	0.122	22.72	1.97E-20	2.144

SS=Sum of Squares/df=degrees of freedom/ MS=mean squares / F=F-value/ p-Value=null sampling F-crit = F- Stats.

Table 14 reveals the p-value of Mexico, Pampanga, and Victoria, Laguna during the wet season, having no significant difference, while in the dry season having a significant difference.

IV. DISCUSSION

➢ *Wet Season*

Pampanga's wet season gut content table exhibits that *Gastropoda* (snail), *Osteichthyes* (fish), and *Insecta* (insect) were the most significant among the class that can be identified in the location of rice paddy in Mexico, Pampanga, whereas *Crustacean* (shrimp), *Clitellata* (worm) and *Amphibia* (frog) were not visible during the dissection of stomach. Similarly, the distribution of gut content quantity class in Victoria, Laguna, during the wet season. Fish and insects were the most noticeable food for the *M. albus* gut content; the distribution of *Gastropoda* (snail) significantly differed in Laguna due to the presence of a lake near the rice paddy location.

➢ *Dry Season*

Pampanga and Laguna's dry season gut content table exhibits the decreased distribution of *Osteichthye*s (fish) and *Insecta* (insect). Surprisingly, the *Gastropoda* (snail) distribution for both Pampanga and Laguna has significantly increased in percentage compared to the distribution of fish and insects. Still, the presence of shrimp, worm, and frog was not seen in the stomach content of *M. albus*

The decrease in food distribution during the dry season is caused by the inefficient external factor including rainfall. Fishes that they feed on, spawn rapidly during the beginning of the rainy seasons until the end of it (Setiati et al., 2021). This explains why there is an increase in food distribution during the wet season compared to the dry season. Previous studies from Palasari Aquamarine (n.d.), it was discussed that there is really an inefficient supply of rice paddy eels during the hot season; in accordance with this, there is a limited availability of food from the environment of the species.

The previous chapter dealt with the analysis and interpretation of data obtained from the gut contents of the *Monopterus albus* through dissection. This chapter contains an overall summary of the research study, the findings from both location sites by temporal variation, and the recommendations that will serve as guidelines to assist future researchers.

V. SUMMARY OF FINDINGS

The objectives of this research are to determine and analyze the gut contents of the rice paddy eels. The researchers have dissected 167 *M. albus* species and have identified contents as fish eggs, snail eggs, insects, and debris. From the previous study of Nath et al. (2015), fish species' diet and feeding habits can often be determined by analyzing the contents of their guts. Fish diets are a composite of numerous significant ecological factors, including behavior, health, habitat utilization, energy intake, and interactions between and within species. Based on their observation, there is a difference in food availability depending on the demand of the environment. In the same study about the feeding ecology of *M. albus* from Herewati et al. (2018), golden snails and eggs, silkworms, and earthworms were found in the *M. albus'* stomach during a 60-day observation.

In both wet and dry, the researchers collected both Pampanga and Laguna. 51 in Pampanga wet and dry season has gut content of the following: snail, fish, insects, and debris. And 84 in Laguna for both wet and dry seasons, containing the following: snail, fish, insects, and debris.

Most noticeable food content from the *M. albus* stomach during the wet season was fish and insects; however, in the Laguna wet season, a significant number of snails were determined due to the lake nearby. A significant amount of debris was also determined during the analysis, which is because there is a large number of farms surrounding the location. However, in the dry season, there was a decrease in the distribution of food.

The One-way ANOVA of Pampanga for the wet season had a p-value of 3E-06, which is less than 0.05. The dry season for Pampanga had a p-value of 0.0591, which is greater than 0.05. This indicates that there is a significant difference between the frequencies of food that is available in two seasons in the same location. The Laguna wet season shows that the p-value is 4E-23, which is lower than 0.05; however, in the dry season for Laguna, the p-value is the same as the wet season, which is 1.97E-20. With that, there is no significant difference between the two seasons. The 2-tailed independent t-test was used to determine the significant

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difference between the two collection sites. In the t-test, the result for the Pampanga wet season has a greater number than the dry season, which implies a significant difference with a t-value of 4.5312 and p-value of 9.74427E-06 at one tail, which is less than 0.05. Whereas the Laguna wet season has a greater population than the dry season, which also implies a significant difference with a t-value of 3.6320 and a p-value of 0.000247415 at one tail, which is less than 0.05.

A previous study from Marquez (2015) stated that on their observation during the wet season of 2014, there was a prevalent increase in the number of *M. albus* around the area of an irrigated lowland rice field. However, the dry season of the same year had a smaller number of *M. albus* species observed. According to a study of Ame et al. (2021), the farmers stated from an interview that the wet season was the season when *M. albus* species comes out of its hiding place to feed or to spawn. Comparing the catch from Ame et al. (2021), during the wet and dry seasons, there is a difference in the number of catches. It was discussed that there was a lot more catch during the wet season than the dry season.

VI. CONCLUSION

This study aimed to understand the stomach content of *M. albus* in two seasonal variations in the Philippines by analyzing the gut content of the stomach and identifying each solid food material inside the stomach. *M. albus* is an invasive species that eats smaller prey in paddies. The results of the study demonstrated the higher amount of food availability of *Osteichthyes* (fish), *Gastropoda* (snail), and *Insecta* (insect) in the wet season compared to the dry season, and with the addition of a nearby lake, the food availability of smaller prey is much more accessible to *M. albus.* However, there is a significant difference between the food availability of the two locations due to their geographic arrangement. Victoria Laguna is close to Laguna de Bay, where there is more food available even during the dry season, and snails are still viable for rice paddy eels. Compared to Mexico, Pampanga's topographic arrangement has no nearby bodies of water other than paddies. Therefore, Pampanga has a lower rate of food availability compared to Victoria, Laguna's geographic location.

RECOMMENDATIONS

After validating the results, summarizing the findings, and formulating the conclusion, the researchers recommend increasing the sample size of the *M. albus* that will be used as data for future research. It will also serve as a reference for future researchers to know the principles of diet composition of *M. albus* to improve the proposed study of the difference in diet between wet and dry seasons. The collection of data and dissection of the gut content requires the necessary materials and facilities to have a precise and accurate measurement for the data analysis. This feeding ecology study may contribute to the management of the artificial breeding of this species.

Future researchers can enhance the study by adding the volumetric method, which will improve the data collection in terms of food volume and the occupancy of the *M. albus* in its ecosystem. The researchers recommend further identifying the species in a zoology laboratory for molecular identification for more accurate identification of the species.

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