

Determination of the correlation between length and weight and analysis of the diet spectrum of the Asiatic painted frog (*Kaloula pulchra*)

¹Vu H. Le, ²Trang C. Nguyen

¹ Faculty of Agriculture and Aquaculture, Bac Lieu University, Bac Lieu, Vietnam; ² Faculty of Agriculture and Food Sciences, Tien Giang University, Tien Giang, Vietnam.
Corresponding author: T. C. Nguyen, nguyencongtrang@tgu.edu.vn

Abstract. The Asiatic painted frog, *Kaloula pulchra*, is widely regarded as a food source. The current study is a preliminary investigation aiming at identifying the most suitable live food for farming *K. pulchra* in Vietnam. *K. pulchra* were collected in two provinces, Tien Giang and Ben Tre, during two seasons (dry and rainy). A total of 400 samples were collected for the study, including 202 small frogs (<10 g ind⁻¹) and 198 large frogs (≥10g ind⁻¹), with an average body length of 38.28±1.12 mm and an average weight of 14.64±0.77 g. The research determined the correlation between the average weight (X) and average total body length (Y) of *K. pulchra*. The stomach content analysis of the frogs revealed a diet spectrum consisting of 18 types of organisms belonging to the phyla Arthropoda, Mollusca, Annelida, as well as some food sources derived from other animal species, plants, gravel, sand, and stones. Among these, food from the insect class within the Arthropoda phylum dominated, with a frequency of 80.52%. Ants and winged ants were the most frequently found food items in the stomach of the frogs, with a presence frequency of 87.75%. There were differences in the diet spectrum between the different sizes of frog and across the two seasons. The food group belonging to the class insect was present in all frog stomach samples (100%) regardless of size or seasons.

Key Words: dietary, froglet, food item, food type, weight.

Introduction. The Asiatic painted frog, *Kaloula pulchra*, is an amphibian species belonging to the order Anura. It is widely distributed across the world, particularly in Southeast Asia (Raju & Parasharya 2004; Emerson & Pernia 2021). It inhabits moist environments such as rice fields, forests, and swamps. These frogs are capable of living in tree hollows up to 2.5 m high and can climb as high as 3 m (Sengupta et al 2009). *K. pulchra* is widely recognized as a food source. Dishes made from this species are considered unique delicacies in restaurants, attracting many diners (Huynh 2017a). Additionally, *K. pulchra* is regarded as a natural predator, often released into agricultural areas to control insects and crop pests. However, in recent years, the natural population of *K. pulchra* has been declining due to overharvesting for food, combined with the widespread use of pesticides and environmental pollution, which have further depleted its wild populations (Patrick & Massam 2008). Therefore, artificial breeding and farming of *K. pulchra* are necessary to ensure its conservation and to meet the increasing demand from humans. Globally, as well as in Vietnam, research studied mainly its distribution, habitat, feeding habits, and morphological characteristics (Raju & Parasharya 2004; Patrick & Massam 2008; Sengupta et al 2009; Nguyen & Phung 2016; Ghose et al 2017). In Vietnam, initial studies had been conducted on artificial propagation of *K. pulchra* (Vo 2006; Huynh 2017b; Nguyen & Huynh 2018). However, after metamorphosis from tadpoles to froglets, the lack of understanding of the species' nutritional characteristics and primary food sources has led to a very low survival rate during the rearing process. Therefore, investigating the dietary composition of *K. pulchra* is essential. The results of this study will determine suitable live food for Asiatic painted frog, in order to facilitate its culture in Vietnam. Furthermore, the results of this study will serve as a foundation for future research on the domestication, seed production, as well as commercial farming of this species in Vietnam.

Material and Method

Study location. The study was conducted at the General Laboratory, Faculty of Agriculture and Food Technology, Tien Giang University, from January to August 2017.

Frog samples. Adult frogs (≥ 10 g ind⁻¹) (Figure 1a) and froglets (< 10 g ind⁻¹) (Figure 1b) were directly collected from the wild in Ben Tre and Tien Giang provinces.

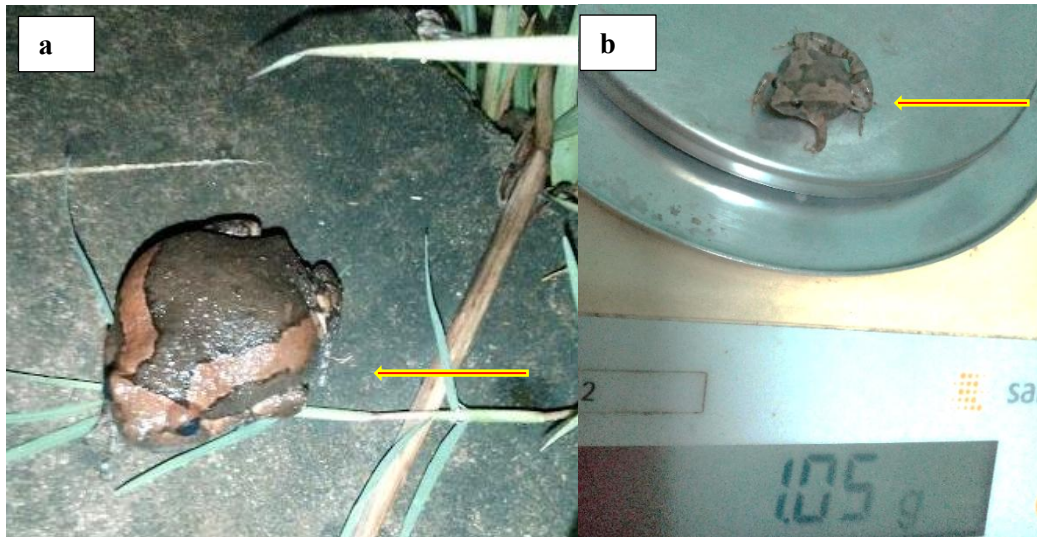


Figure 1. *Kaloula pulchra*. a: adult, b: froglet.

Sampling method. Frogs were collected using hands or a mesh net with an appropriate mesh size during the evening hours from 5:00 PM to 9:00 PM. The samples (Figure 2) were collected during two months of the dry season (February and March) and two months of the rainy season (May and June). Each month, two collection sessions were conducted, with each session lasting three nights. Sampling was carried out on the 13th, 14th, 15th, 28th, 29th, and 30th of each month (except for February 2017, when samples were collected on the 13th, 14th, 15th, 26th, 27th, and 28th).



Figure 2. *Kaloula pulchra* sampled for this study.

Samples processing. After the frogs were collected, they were immediately weighed to determine their total body weight (g) using an electronic scale with two decimal places and measured for total body length (mm), from the head to the tail stub, using a caliper. After measurement, the frogs were immediately dissected to extract the stomach. The stomachs were then preserved in a 70% ethanol solution before being transported to the laboratory for dietary analysis.

Samples analysis. After each sample collection, the dietary analysis of the frogs was conducted in the laboratory. The food items in the frogs' stomachs were washed into test tubes using distilled water. The samples were then prepared into slides and examined under a microscope to identify the types of food components. For larger food items, a magnifying glass was used for observation, while smaller food items were observed under a microscope.

All food types present in the stomach of the frogs were recorded, and the frequency of their occurrence was calculated based on the total number of stomachs observed. Frequency Calculation Formula was based on the study of Perpetua et al (2013):

$$P_i (\%) = (N_i \times N^{-1}) \times 100$$

Where:

P_i - frequency of occurrence of food item i (%);

N_i - number of occurrences of food item i;

N - total number of stomachs observed.

The analysis of the food spectrum of *K. pulchra* was based on the studies of Nguyen (2002), Nguyen (2005), Nguyen (2007), and Tran (2017).

Statistical analysis. The study used SPSS 16.0 and Excel 2010 software to analyze the data. The correlation between body weight and body length was analyzed using a linear regression equation of the form $Y=aX+b$.

Results and Discussion

Correlation between total body length and weight of the *K. pulchra*. Large frogs (≥ 10 g ind⁻¹) and froglets (< 10 g ind⁻¹) were collected directly from nature in Ben Tre and Tien Giang provinces. The results of the total body length and weight of the frogs sampled in the study are presented in Table 1: of the total 400 frogs collected (202 small size frogs, 198 big size frogs), the average total body length was 38.28 mm (per individual), with the smallest being 10 mm (per individual) and the largest being 82 mm (per individual). The average weight of the frogs in the sampling sessions was 14.64 g (per individual), with the smallest being 0.17 g (per individual) and the largest being 54.76 g (per individual). The results of weighing and measuring the samples indicate that the total body length and weight of the frogs in the study show significant size variation. Therefore, the food items found in the stomachs of the collected frogs will represent the natural food spectrum of frogs in the wild.

Table 1

Total length and weight of *Kaloula pulchra* in this study

<i>Parameters</i>	<i>Mean (± S.D.)</i>	<i>Smallest</i>	<i>Biggest</i>
Total body length (mm)	38.28±1.12	10	82
Weight (g)	14.64±0.77	0.17	54.76

The values in the table represent the mean and standard deviation

The study developed a linear regression equation between total body length and body weight, where Y represents the total body length (mm) and X represents the body weight (g). The results of the regression analysis identified the correlation between total body

length (Y) and body weight (X) of *K. pulchra* using the following equation: $Y=1.17X+23.19$ (with $R=0.903$, $R^2=0.82$). In the equation above, the total body length is positively correlated with the body mass. When the body mass of the frog is known, the total body length can be predicted, and vice versa. For example, if the body mass of the frog is 1g, the predicted total body length is 24.36 mm.

The food spectrum of *K. pulchra*

Some types of food. After analyzing 400 stomach samples of *K. pulchra* in two size groups, small size ($<10\text{g ind}^{-1}$) and large size ($\geq 10\text{g ind}^{-1}$), the data on the types of food, food groups, and the frequency of occurrence of each food type were recorded and are presented in Table 2 and Figure 3.

Table 2

Types of food in the stomach of *Kaloula pulchra*

<i>Types of food</i>	<i>Type</i>	<i>Individuals</i>	<i>Frequency (%)</i>	<i>Percentage (%)</i>
Ants, winged ants	Insect	351	87.75	45.29
Beetles	Insect	162	40.5	20.9
Plant	Plant	46	11.5	5.94
Cockroaches	Insect	44	11	5.68
Millipedes	Other	35	8.75	4.52
Stone worm	Other	31	7.75	4.0
Centipedes	Other	21	5.25	2.71
Earwigs	Insect	17	4.25	2.19
Termites, winged termites	Insect	14	3.5	1.81
Maggots (insect larvae)	Insect	13	3.25	1.68
Spiders	Other	10	2.5	1.29
Black soldier fly larvae	Insect	9	2.25	1.16
True bugs	Insect	7	1.75	0.9
Snails	Other	6	1.5	0.77
Crickets	Insect	4	1	0.52
Earthworm	Other	2	0.5	0.26
Flies	Insect	2	0.5	0.26
Woodboring beetle	Insect	1	0.25	0.13
Total		775 feed samples		

The results in Table 2 show that from 400 stomach samples of *K. pulchra*, 18 different food types were identified, which are preliminarily classified into three groups: the insect class, the plant kingdom, and the other food types, which appeared with a low frequency (Figure 4). The insect type includes ants, winged ants, beetles, bugs, termites, flies, maggots (insect larvae), woodboring beetles, crickets, caterpillars, cockroaches, and beetles; the plant type consists of plant leaves, algae, grass, rice grains, and seeds; and the other types includes food types such as millipedes, spiders, centipedes, snails, stone worms, earthworms, gravel, sand, stones, soil, and some unidentified food items (Figure 3).

In addition, the study discovered the presence of stones, sand, rocks, and soil in the frogs' stomachs. This observation raises certain hypotheses: the frogs might ingest these materials directly when they are unable to find their preferred food due to hunger, or they might consume them indirectly when stones, sand, or soil adhere to other food items listed in Table 2.

Overall, the food types found in the stomach of *K. pulchra* were diverse and varied, reflecting the different habitats and behaviors of prey animals. Some prey species, such as ants, millipedes, and centipedes, live on the ground, while others, such as earthworms, crickets, and termites, reside in moist soil crevices. Meanwhile, beetles, caterpillars, spiders, and earwigs are typically found on trees or in bushes, and others, such as cockroaches and maggots, live near damp drainage areas.



Figure 3. Some basic food types found in the stomach of *Kaloula pulchra*.

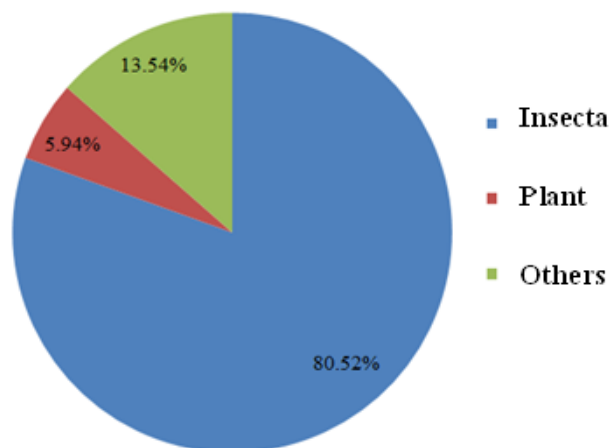


Figure 4. Composition of food groups in the stomach of *Kaloula pulchra*.

K. pulchra is able to consume these prey species because of its excellent nocturnal hunting ability and capacity to prey in low-light environments, which are habitats favorable to the prey species. Interestingly, cockroaches (Figure 5), known for their agility, excellent hiding abilities, and capacity to fly, were still preyed upon by *K. pulchra* (frequency: 44/400). This demonstrates the frogs' highly effective hunting skills.



Figure 5. Ants (a) and cockroaches (b, c) found in the stomach of *Kaloula pulchra*.

Table 2 also shows that the results of this study share similarities with the findings of Nguyen & Vo (2013) on the nutritional characteristics of tree frogs (*Polypedates leucomystax*) in Dak Lak province. Both studies analyzed the natural diet and were conducted during two seasons (rainy and dry). The results showed some common food items, such as ants, crickets, cockroaches, spiders, centipedes, and termites, as well as stones, rocks, and plant matter. In general, the preferred food items of *K. pulchra* and tree frogs in the two studies belonged to the insect type. However, the study by Nguyen & Vo (2013) identified only eight food types including grasshoppers, crickets, cockroaches, caterpillars, spiders, centipedes, termites, cicadas, and ants. Among these, grasshoppers and crickets had the highest frequency of occurrence, at 53.33%, while centipedes, termites, ants, and cicadas had the lowest frequencies, of 3.33%. In contrast, this study found a wider variety of food items in the stomachs of *K. pulchra*, with 18 basic types. Among these, ants and winged ants had the highest frequency of occurrence, at 85.75%. The broader and more diverse diet of *K. pulchra* compared to that of tree frogs might be due to the former's superior hunting and food utilization abilities or differences in the terrain and habitats of the two species, which affect the composition of available food items. However, the overall differences are not significant. Furthermore, a study on the nutritional characteristics of the granular spiny frog (*Quasipaa verrucospinosa*) in Hue province by Ngo & Ngo (2009) also produced results that align with this study. The food items found in the digestive tract of the granular spiny frog were mostly from the phylum Arthropoda and included insects from the order Orthoptera, such as crickets and cockroaches, or the order Hymenoptera, such as ants and winged ants, as well as the order Coleoptera, such as beetles and weevils. Additionally, food items from the order Araneae (spiders) and Diptera (flies) were also present. Other food types included organisms from the phyla Mollusca and Annelida. Among these, food items from the phylum Arthropoda dominated, with a frequency of 68% in the stomachs of granular spiny frogs.

In general, the two studies mentioned above and this study share similarities in the diet composition of amphibians. Food items from the phylum Arthropoda consistently exhibited higher frequencies of occurrence compared to other types of food. However, the dietary diversity of *K. pulchra* and granular spiny frogs is broader compared to tree frogs, likely due to the former species' better hunting abilities. Based on these studies, the diet of *K. pulchra* is generally consistent with that of other amphibians. It was observed that most of the food items belonged to the insect type, accounting for 80.52% of the diet composition. The remaining portions were plant-based food and food items with low frequencies of occurrence, temporarily categorized as "Others" (Figure 4). These results indicate that insects, which can have capabilities of moving fast, hiding, and flying, were

the primary prey of *K. pulchra*. This could be because the frogs are skilled at capturing insects, or simply because insects are more abundant than other animal groups in the frogs' habitats. The frequency of occurrence and the diversity of insect species within this group are shown in Table 3.

Table 3

Composition of insect food items

<i>Insect type</i>	<i>Quantity</i>	<i>Frequency (%)</i>	<i>Proportion (%)</i>
Ants, winged ants	351	87.75	56.25
Beetles	162	40.5	25.96
Cockroaches	44	11	7.05
Earwigs	17	4.25	2.72
Termites, winged termites	14	3.5	2.24
Maggots (insect larvae)	13	3.25	2.08
Black soldier fly larvae	9	2.25	1.44
True bugs	7	1.75	1.12
Crickets	4	1	0.64
Flies	2	0.5	0.32
Woodboring beetle	1	0.25	0.16
Total		624 food samples	

The diversity of species of the insect food type is relatively complex, consisting of 11 species, which are abundant in the habitat of *K. pulchra*. The size of insect species is highly diverse, making it a significant food source for frogs of various sizes. Among them, ants and winged ants had the highest occurrence frequency at 87.75%, followed by beetles at 40.5%. These may be the two most preferred food items for *K. pulchra*. Cockroaches ranked third with an occurrence frequency of 11%, while woodboring beetle had the lowest frequency at only 0.25%. Interestingly, some insects that live at higher elevations, such as earwigs and true bugs, were also found in the analyzed stomachs but with low occurrence frequencies. Additionally, certain insect larvae such as maggots and black soldier fly larvae were part of the frog's diet. Other insects, such as termites, flies, and crickets, collectively accounted for a 5% occurrence frequency (Table 3). Although the insect food type is diverse in terms of species composition, *K. pulchra* tended to prefer ants and winged ants as their main food source. This preference may be attributed to the small size of ants, which suits the mouth size of froglets. Furthermore, ants live in dense colonies and are easily encountered in nature, resulting in their highest frequency (87.75%) among the 400 stomach samples. On the other hand, other animals such as flies and woodboring beetle, which tend to fly or burrow, are harder for the frogs to catch or may not be their preferred food items, thus explaining their low occurrence in the stomachs.

Food composition by weight groups of frogs. The frogs were divided into four weight groups, and the food composition corresponding to each weight group is presented in Table 4.

Table 4

Food groups by size (weight) of *Kaloula pulchra*

<i>Group</i>	<i>Size classification</i>	<i>Food groups by occurrence frequency</i>		
		<i>Insect (%)</i>	<i>Plant (%)</i>	<i>Others (%)</i>
1	<10 g ind ⁻¹	100 ^a	13.37 ^b	5.45 ^a
2	10 – 20 g ind ⁻¹	100 ^a	24.32 ^a	29.73 ^b
3	>20 – 40 g ind ⁻¹	100 ^a	5.71 ^c	32.14 ^b
4	>40 g ind ⁻¹	100 ^a	9.52 ^{bc}	33.33 ^b

Values in the same column sharing the same letters do not significantly differ ($p > 0.05$).

For all frog size groups, there were three main food categories: insects, plants, and others. Within each size group, insects consistently had the highest occurrence frequency, with an

absolute rate of 100%, and there were no significant differences between weight groups. This is likely because insects are abundant in the frogs' natural environment, come in various sizes, and are suitable for different mouth sizes, enabling frogs to consume a wide variety of insect species (Table 4).

The plant-based food group showed different occurrence frequencies, with statistically significant differences ($p < 0.05$) between weight groups. In the stomachs of frogs weighing 10–20 g, plant-based food accounted for the highest proportion at 24.32%. Conversely, in frogs weighing >20–40 g, plant-based food had the lowest proportion at 5.71%. Table 4 indicates statistically significant differences ($p < 0.05$) in plant-based food between group 3 and groups 1 and 2, but no significant differences ($p > 0.05$) between groups 3 and 4. For plant-based food, there were no statistically significant differences ($p > 0.05$) between groups 1, 2, and 4.

For the "Others" food group, the occurrence frequency increased gradually with the increase in frog weight (Table 4). There were statistically significant differences ($p < 0.05$) in the "Others" food group between frogs weighing <10 g and the remaining weight groups. However, no significant differences ($p > 0.05$) were observed among groups 2, 3, and 4. Larger frogs, having larger mouths, have more diverse food choices, which expands their dietary range.

Seasonal variation in frog diet. The frequency of food groups corresponding to different seasons (dry and rainy) is shown in Table 5.

Table 5

Seasonal variation in frog food groups

<i>Food group (by occurrence frequency)</i>	<i>Dry season</i>	<i>Rainy season</i>
Insect (%)	100 ^a	100 ^a
Plant (%)	15.61 ^a	8.37 ^b
Others (%)	4.05 ^b	29.52 ^a

Values in the same row sharing the same letters do not significantly differ ($p > 0.05$).

As shown in Table 5, insect food was found in both seasons with an absolute rate of 100%, and there were no significant differences ($p > 0.05$) between the dry and rainy seasons. This may be because insects are diverse, widely distributed, and active in the frogs' natural habitat, making them easily accessible and a preferred food source for *K. pulchra*.

The plant-based food group showed significant differences ($p < 0.05$) between the two seasons, with a higher frequency in the dry season (15.61%) compared to the rainy season (8.37%). This may be because the rainy season offers a greater diversity of animal-based food, causing frogs to shift their dietary preference toward animal sources. Additionally, the plant material found in the stomachs may have been consumed incidentally while hunting for prey.

The "Others" food group showed an increasing trend from the dry season (4.05%) to the rainy season (29.52%), with significant differences ($p < 0.05$) between the two seasons (Table 5). During the rainy season, larger frogs were collected more frequently, and with their larger mouth sizes, they were able to consume larger and more diverse food items. Moreover, the rainy season is a critical time for frog reproduction, requiring more energy for mating, growth, and development, which may drive frogs to consume more food during this period (Sengupta et al 2009).

Conclusions. The body length and body weight of *K. pulchra* were correlated. The basic diet of *K. pulchra* consisted of 18 types of food, including arthropods, mollusks, annelids, as well as plant material, gravel, sand, stones, and soil. Insect (Arthropoda phylum) dominated with a proportion of 80.52%. Ants and winged ants were the most frequently occurring food items, with a frequency of 87.75%. The food spectrum of *K. pulchra* differs between the rainy and dry seasons. During the rainy season, *K. pulchra* tends to consume more insects compared to other food types. In contrast, while insects remain the dominant food type during the dry season, the proportion of plant-based food is significantly higher

than that consumed in the rainy season (15.61% in the dry season compared to 8.37% in the rainy season). Differences in the food spectrum across sizes of *K. pulchra* were observed, specifically between plant-based food and other food types. However, the consumption of insect-based food showed no significant differences across size classes of *K. pulchra* or between the rainy and dry seasons.

Conflict of interest. The authors declare that there is no conflict of interest.

References

- Emerson Y. S. Y., Pernia M., 2021 First record of Asiatic painted frog *Kaloula pulchra* on Samar Island, Philippines. SEAVR 2021:1-2.
- Ghose A., Deb J. C., Dakwa K. B., Ray J. P., Reza A. H. M. A., 2017 Amphibian species assemblages in a tropical forest of Bangladesh. Herpetological Journal 27:318-325.
- Huynh H. N. N., 2017a [Study on food spectrum of Asiatic painted frog]. Scientific Research Report, Tien Giang University, 61 p. [in Vietnamese]
- Huynh T. D., 2017b Study on artificial breeding of *Kaloula pulchra*. Scientific Research Report, Tien Giang University, 79 p. [In Vietnamese]
- Ngo D. C., Ngo V. B., 2009 Nutritional, reproductive, and metamorphic characteristics of the granular spiny frog (*Paa verrucospinosa*, Bourret, 1937) in A Luoi region, Thua Thien Hue province. Hue University Journal of Science 55:47-49.
- Nguyen C. T., Huynh T. D., 2018 [Study on artificial seed production Asiatic painted frog (*Kaloula pulchra*).] Journal of Science, Dong Thap University 32:85-92. [in Vietnamese]
- Nguyen D. K., 2005 [Insects in agriculture. Technical guide book.] University of Agriculture of Ha Noi, Viet Nam, 232 p. [in Vietnamese]
- Nguyen Q. T., Phung M. T., 2016 [Vietnam wild animals: E book.] University of Agriculture and Forestry of Ho Chi Minh City, Vietnam. [in Vietnamese]
- Nguyen T. C., 2007 [Morphology and taxonomy of insects.] University of Agriculture and Forestry of Ho Chi Minh City, Vietnam, 232 p. [in Vietnamese]
- Nguyen V. K., 2002 [Invertebrate animals: Book 2] Hai Phong Publishing house, Vietnam, 249 p. [in Vietnamese]
- Nguyen V. L., Vo D. N. Q., 2013 Morphological and nutritional characteristics of the tree frog (*Polypedates leucomystax*) in M'Drăk district, Dak Lak province. Proceedings of the 5th Scientific Conference on Ecology and Biological Resources, Tay Nguyen University, pp. 1140-1144.
- Patrick K. W., Massam M., 2008 Asiatic painted frog (*Kaloula pulchra*) risk assessment for Australia. Amanda Page, Department of Agriculture and Food, Western Australia University, pp. 1-13.
- Perpetua M. D., Gorospe J. G., Torres M. A., Demayo C. G., 2013 Diet composition based on stomach content of the Streaked spinefoot (*Siganus javus*) from three coastal bays in Mindanao, Philippines. Advances in Environmental Sciences 5(1):49-61.
- Raju V., Parasharya B. M., 2004 Asiatic painted frog (*Kaloula pulchra*) from Anand and Sura, Gujarat, India. Zoo's Print Journal 19(4):1444.
- Sengupta S., Abhijit D., Sandeep D., Bakhtiar H., Nripendra K. C., Sushil K. D., 2009 Taxonomy and biogeography of *Kaloula* species of Eastern India. Natural History Journal of Chulalongkorn University 2009:209-222.
- Tran L. V., 2017 General entomology. Technical guide book. Tien Giang University, Vietnam, 150 p. [in Vietnamese]
- Vo T. G., 2016 Study on the use of LH-RHa+Domperidone to induce artificial breeding in Asiatic painted frog (*Kaloula pulchra*). Scientific Research Report, Tien Giang University, 78 p.

Received: 29 December 2024. Accepted: 22 June 2025. Published online: 21 July 2025.

Authors:

Le Hoang Vu, Faculty of Agriculture and Aquaculture, Bac Lieu University, 97000 Bac Lieu, Vietnam, e-mail: lhvu.blu@gmail.com

Nguyen Cong Trang, Faculty of Agriculture and Food Technology, Tien Giang University, 84000 Tien Giang, Vietnam, e-mail: nguyencongtrang@tgu.edu.vn

This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

How to cite this article:

Vu L. H., Trang N. C., 2025 Determination of the correlation between length and weight and analysis of the diet spectrum of the Asiatic painted frog (*Kaloula pulchra*). AACL Bioflux 18(4):1709-1718.