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EFFECT OF VARIOUS FOOD ON THE GROWTH OF *Gryllus bimaculatus* De Geer, 1773 AND PROPOSAL OF A BREEDING PROCESS

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Abstract. Biological characteristics including growth and reproduction of crickets (*Gryllus bimaculatus* De Geer, 1773) bred on three types of food: 100% vegetables, 100% grass, and 100% synthetic feed under laboratory conditions (25°C temperature and 75% humidity) has been determined. Crickets' largest reproductive phase size was observed with those reared on synthetic feed and the smallest on grass. When raised on synthetic feed, the crickets had a life cycle of around 96.5 days with the egg phase lasting 9.49 ± 0.40 days, while the nymph phase of 42.08 ± 3.57 days consisting of 8 stages and the adult phase with a completion time of 48.86 ± 2.94 days. As for those reared on grass, the egg phase has a completion time of 9.79 ± 0.35 days, whereas the nymph phase prolonged 46.52 ± 2.12 days for 8 stages the adult phase of 52±2.24 days within the life cycle of 108.5 days. When crickets breed on grass feed, their life cycle is longer than when they breed on synthetic feed. As a result, a process for breeding crickets (*Gryllus bimaculatus*) in the laboratory with three types of food has been established.

Keywords: *Gryllus bimaculatus* De Geer, 1773, morphological, biological characteristics, breeding process, food.

1. Introduction

The Orthoptera has up to 20,000 species including well-known representatives such as grasshoppers, crickets, and mole crickets. The Gryllidae family belongs to the Othoptera order and is used as food and medicine. Cricket meat is rich in protein and contains many essential minerals. In 100g of dried crickets, there are 26.2 mg of albumin, 4.7 mg of fiber, 0.03 mg of vitamin B1, 1.04 mg of vitamin B2, 7.5 mg of various sugars, 120 mg of calcium, 30.7 mg of iron, 26.71 mg of zinc [1].

In Vietnam, the demand for dishes made from crickets in restaurants has increased significantly. Cricket farming has just been developed in Vietnam for about 10 years and brings high profits since they are easy to raise and especially the initial investment cost is low. Recently, the government has had a number of preferential policies for insect

farming, because of its sustainability and high economic benefits. In Vietnam, cricket farming has developed strongly in the southern provinces like Ho Chi Minh city and Da Nang city. In addition to being used to make delicious dishes, crickets can be used as food for ornamental birds, fish, or baits for fishing. Not only as food, crickets are also utilized in medicine, entertainment, and cultural beliefs [2].

According to Tu VD and Nguyen VH (2008) crickets (*Gryllus bimaculatus*) raised in greenhouse conditions showed a life cycle average of 64.3 days including the egg incubation of 9.8 days, the larval stage with eight instars of 42.3 days, and the adult longevity of 35.8 days for male and 28.7 days for female. The mated female started to lay eggs 13.2 days after the adult emergence and the average number of eggs was 836 with a hatchability of 92.1% [3]. The research of Dinh TPA and Phan TTH (2013) on the nutritional characteristics of coal cricket populations at the larval stage in farming conditions at SonTra District, Danang City, indicated that the food ingredients of crickets included 14 types of green and 3 types of concentrate. The demand for average food volume increased rapidly during the larval stage of ages 4 - 8. The correlation between the demand for the consumption of food and with temperature environment was negatively correlated [2]. Ngo VT et al. (2021) have raised crickets (*Gryllus bimaculatus*) on 9 types of food and reported that food had a great influence on the reproductive and development ability of crickets under farming conditions in Kien Giang [4].

Currently, cricket farming is becoming more and more popular since it brings high economic efficiency to farmers. Crickets can be raised in a small area, are easy to care for, have a short harvest time, and have no pollution problem. This paper provides insight into the effects of three types of food on the growth and development of crickets (*Gryllus bimaculatus*) and proposes the rearing process of crickets.

2. Content

2.1. Materials and methods

2.1.1. Food for crickets

To study the nutritional characteristics of crickets reared under laboratory conditions, three types of food are used as follows: 100% grass (*Cynodon dactylon*); 100% vegetables composed of cabbage (*Brassica oleracea*), pumpkin (*Cucurbita moschata);* 100% synthetic food.

A total of 50g of food was applied for each box per day. Depending on the age of the crickets, the amount of food is increased gradually as the crickets grow larger.

2.1.2. Rearing equipment

Crickets were raised in transparent plastic boxes of 185×122×128 mm, with surrounding perforations to provide adequate ventilation. Inside the box, a plastic tray with a diameter of 5 cm was arranged for feeding, a plastic container of 2 cm in diameter for water drinking, and a coconut coir for crickets to have hiding spaces and climbing areas. Handheld magnifying glasses and a micrometer (panme ruler) are used to measure the size of crickets.

2.1.3. Breeding process

For each type of food, 30 pairs of mature male and female individuals were raised in 30 insect rearing boxes. Depending on the type of food, different feeding trays were arranged. Food and water were replaced once a day, and the rearing container was cleaned thoroughly. When transferring crickets for cleaning the rearing container, suitable tools such as nylon bags, plastic boxes with a diameter of 10 cm, clamps, cloth covers, and nets were used.

2.1.4. Examination of cricket growth (*G. bimaculatus* De Geer, 1773)

The growth characteristics of crickets including duration of hatching from egg to nymph were examined.

All trays of food were placed inside the rearing container for crickets in the evening of the previous day and removed the next morning. The time for eggs to hatch into nymph was calculated from the moment the egg trays were removed until the first cricket nymph appeared. The egg-laying trays had dimensions of 10 cm, with coconut coir used as a substrate for cricket egg-laying. During the incubation, misting is performed to keep the egg-laying trays moist. The humidity of the egg trays was checked daily, and misting was done twice a day. When misting, if the color of the substrate turns darker, it indicates sufficient moisture. Excessive misting may cause damage to the eggs.

2.1.5. Determination of the life cycle of *Gryllus bimaculatus* De Geer, 1773

To determine crickets' life cycle, 30 pairs of mature males and females were raised in 30 insect breeding boxes containing respective types of food. After a time, a total of 30 eggs were selected on the same day and placed into separate breeding boxes with different types of food. Then, the time of each phase was recorded.

Egg phase: it is the duration from egg laying to hatching.

Nymph phase: it is the duration from egg hatching to nymph. The first instar stage was observed from the time the egg hatched until the first instar nymph molted. The subsequent instar stage was recorded from the time the previous instar nymph molted until the subsequent instar nymph molted. The third instar nymph is the time from when the 2nd instar nymph molt until the 3rd instar nymph molt. The fourth instar nymph is the time from when the 3rd instar nymph molt until the 4th instar nymph molt. The fifth instar nymph is the time from when the 4th instar nymph molt until the 5th instar nymph molt. The sixth instar nymph is the time from when the 5th instar nymph molt until the 6th instar nymph molt. The seventh instar nymph is the time from when the 6th instar nymph molt until the 7th instar nymph molt. The eighth instar nymph is the time from when the 7th instar nymph molt until the 8th instar nymph molts into adults.

Adult phase: it is the duration from molting into the adult stage until pairing and laying the first egg.

Data is statistically processed using Microsoft Excel and SPSS software version 20.0 including one-way ANOVA.

2.2. Research results

2.2.1.The sizes of crickets (*G. bimaculatus* De Geer, 1773) at the reproductive phases

Food and temperature are important factors affecting the growth and development of crickets when reared in the laboratory. Previous studies have also shown that diets rich in organic matter increase the longevity, reproductive capacity, and size of crickets. Therefore, we conducted a study on the impact of different diets on the growth and development of crickets. The cricket rearing experiments were conducted in the animal biology laboratory under conditions of 25°C temperature and 75% humidity. The results on the size of eggs, nymphs at different ages, and adults are presented in Tables 1, 2, and 3, respectively.

With 100% types of grass and reared at 25 °C with 75% humidity, the lengths, and widths of crickets at the reproductive phases (eggs, nymph, and adults) varied as shown in Table 1. The average length of eggs was 1.93 ± 0.33 mm, and their average width was 0.88 ± 0.21 mm. The first instar had an average length of 2.72 ± 0.21 mm and an average width of 1.06 ± 0.14 mm. The average size of the second, and third instar was 3.66 ± 0.33 mm in length and 1.42 ± 0.12 mm in width. The other instars' sizes were 4.85 ± 0.39 mm × 1.68 ± 0.21 mm, 6.71 ± 0.22 mm × 2.82 ± 0.10 mm, 8.52 ± 0.44 mm ×3.42 ± 0.15 mm, 11.07 ± 0.99 mm × 4.38 ± 0.20 mm and 11.88 ± 1.03 mm × 4.45 ± 0.12 mm, respectively. The eighth instar's average size reached 19.96 ± 1.21 mm in length and 6.55 ± 0.32 mm in width.

There was a clear difference in the size of adult males and females, with the average length of adult females being 26.12 ± 1,08 mm, greater than that of adult males, which was 25.52 ± 1.52 mm. The average width of adult females was 8.94 ± 0.50 mm, more than that of adult males, which was 8.33± 0.57 mm.

Table 1. Size of G. bimaculatus reared on grass at different reproductive phases

Phase	Length (mm)			Width (mm)		
	Min	***Max***	***Medium***	***Min***	***Max***	***Medium***
Egg	1.4	3.0	1.93 ± 0.33	0.7	1.0	0.88 ± 0.21
Nymph						
First instar	2.5	3.1	2.72 ± 0.21	0.8	1.3	1.06 ± 0.14
Second instar	3.2	4.1	3.66 ± 0.33	1.0	1.7	1.42 ± 0.12
Third instar	4.2	5.5	4.85 ± 0.39	1.4	2.1	1.68 ± 0.21
Fourth instar	6.4	7.0	6.71 ± 0.22	2.6	3.0	2.82 ± 0.10
Fifth instar	7.6	9.1	8.52 ± 0.44	3.0	3.9	3.42 ± 0.15
Sixth instar	9.0	12.6	11.07 ± 0.99	3.9	4.8	4.38 ± 0.20
Seventh instar	10.9	16.4	11.88 ± 1.03	4.2	5.0	4.45 ± 0.12
Eighth instar	17	22	19.96 ± 1.21	6.1	7.0	6.55 ± 0.32
Adult						
Female	25	29	26.12 ± 1.08	8.0	10	8.94 ± 0.50
Male	25	28	25.52 ± 1.52	7.0	10	8.33± 0.57

The total number of individuals measured n = 30

The size of crickets bred on 100% vegetable (cabbage, pumpkin) at different reproductive phases are presented in Table 2.

Table 2. Size of G. bimaculatus reared on vegetables at different reproductive phases

Phase	Length (mm)			Width (mm)		
	Min	***Max***	***Medium***	***Min***	***Max***	***Medium***
Egg	1.4	3.1	1.95 ± 0.30	0.7	1.1	0.92 ± 0.20
Nymph						
First instar	2.6	3.2	2.80 ± 0.20	1.0	1.5	1.18 ± 0.15
Second instar	3.4	4.3	3.75 ± 0.21	1.6	1.9	1.68 ± 0.12
Third instar	4.5	6.4	5.18 ± 0.35	2.1	2.8	2.36 ± 0.20
Fourth instar	6.5	7.8	7.15 ± 0.32	3.0	3.4	3.22 ± 0.14
Fifth instar	8.0	9.6	8.92 ± 0.52	3.5	4.4	3.72 ± 0.20
Sixth instar	10	14	12.14 ± 0.68	4.4	5.8	5.40 ± 0.18
Seventh instar	14.5	17.2	15.05 ± 1.02	6.0	6.5	6,31 ± 0.12
Eighth instar	18	25	20.05 ± 1.16	6.7	7.6	7.46 ± 0.20
Adult						
Female	25	31	27.06 ± 1.05	8.0	11	9.45 ± 0.30
Male	25	30	26.25 ± 1.32	8.0	10	9.05 ± 0.22

The total number of individuals measured n = 30

For the cricket fed on vegetables, the eggs had an average length of 1.95 ± 0.30 mm and an average width of 0.92 ± 0.20 mm while the first instar's average size increased to 2.80 ± 0.20 mm in length and 1.18 ± 0.15 mm in width; the second instar had an average length of 3.75 ± 0.21 mm and an average width of 1.68 ± 0.12 mm; the third instar had an average length of 5.18 ± 0.35 mm and an average width of 2.36 ± 0.20 mm; Fourth instar had an average length of 7.15 ± 0.32 mm and an average width of 3.20 ± 0.10 mm; Fifth instar had an average length of 8.92 ± 0.52 mm and an average width of 3.72 ± 0.20 mm; Sixth instar had an average length of 12,14 ± 0.68 mm and an average width of 5.40 ± 0.18 mm; Seventh instar had an average length of 15.05 ± 1,02 mm and an average width 6.31 ± 0.12 mm; When it grew to the eighth instar stage, the average size elevated approximately 7 times with an average length of 20.05 ± 1.16 mm and an average width of 7,46 ± 0.20 mm. There was a clear difference in the size of adult males and females, with the average length of adult females being 27.06 ± 1.05 mm, larger than that of adult males, which was 26.25 ± 1.32 mm. The average width of adult females was 9.45 ± 0.30 mm, larger than that of adult males, which was 9.05 ± 0.22 mm.

With 100% synthetic feed and reared at 25°C and 75% humidity, the length and width dimensions of the reproductive phases (eggs, nymph, adults) of crickets varied. The results are presented in Table 3.

Table 3. Size of G. bimaculatus reared on synthetic feed at different reproductive phases

Phase	Length (mm)			Width (mm)		
	Min	***Max***	***Medium***	***Min***	***Max***	***Medium***
Egg	1.4	3.2	2.03 ± 0,09	0.7	1.0	0.92 ± 0.20
Nymph						
First instar	2.8	3.4	3.13 ± 0.14	1,2	1.8	1.32 ± 0.15
Second instar	3.4	4.5	4.15 ± 0.12	2.0	2,3	2.21 ± 0.10
Third instar	4.7	6.9	5.71 ± 0.31	2.6	3.0	2.82 ± 0.20
Fourth instar	7.0	8.1	7.49 ± 0.32	3.2	3.8	3.50 ± 0.12
Fifth instar	8.1	10	9.29 ± 0.55	4.0	5.1	4.22 ± 0.16
Sixth instar	10.2	15.5	9.89 ± 0.52	5.4	6,1	5.66 ± 0.33
Seventh instar	17	19.5	15.88 ± 1,20	6.5	6.9	6.65 ± 0.30
Eighth instar	21	25.1	24.20 ± 1.12	7.2	7.8	7.60 ± 0.20
Adult						
Female	26.5	33	28.50 ± 1.10	8.0	11	10.15 ± 0.20
Male	26	31	27.50 ± 1.21	8.0	11	9.52 ± 0.22

Total number of individuals measured n = 30

The eggs had an average length of 2.03 ± 0.09 mm and an average width of 0.92 ± 0.20 mm. First instar had an average length of 3.13 ± 0.14 mm and an average width of 1.32 ± 0.15 mm; the Second instar had an average length of 4.15 ± 0.12 mm and an average width of 2.21 ± 0.10 mm; Third instar had an average length 5.71 ± 0.31 mm and an average width of 2.82 ± 0.20 mm; Fourth instar had an average length of 7.49 ± 0.32 mm and an average width of 3.50 ± 0.12 mm; Fifth instar had an average length of 9.29 ± 0.55 mm and an average width of 4.22 ± 0.16 mm; Sixth instar had an average length of 9.89 ± 0.52 mm and an average width of 5.66 ± 0.33 mm; Seventh instar had an average length of 15.88 ± 1.20 mm and an average width of 6.65 ± 0.30 mm; Eighth instar had an average length of 24.20 ± 1.12 mm and an average width of 7.60 ± 0.20 mm. There was a clear difference in size between adult males and females. The average length of adult females was 28.5 ± 1.10 mm, larger than that of adult males at 27.5 ± 1.21 mm; the average width of adult females was 10.15 ± 0.20 mm, larger than that of adult males at 9.52 ± 0.22 mm.

Among the three types of food, the synthetic diet resulted in the largest size, with adult males averaging a length of 27.50 ± 1.21 mm and a width of 9.52 ± 0.22 mm, while adult females averaged a length of 28.50 ± 1.10 mm and a width of 10.15 ± 0.20 mm.

2.2.2. Life cycle and reproductive time of *G. bimaculatus* De Geer, 1773

Crickets are insects that reproduce and develop rapidly everywhere. Therefore, we examined the reproductive time and life cycle of crickets raised on three types of food: grass, vegetables, and synthetic feed. The results are shown in Table 4.

Table 4. Duration of Reproductive phases and life cycle time of G. bimaculatus reared on 3 types of food (day)

Phase	100 % Synthetic feed			100% Vegetable			100% Grass		
	Min	***Max***	***Medium***	***Min***	***Max***	***Medium***	***Min***	***Max***	***Medium***
Egg	9	11	9.49 ± 0.40	9	12	9.63±0.40	9	11	9.79±0.35
Nymph									
First instar	4	5	4.46 ± 0.39	4	6	4.86±0.46	4	7	4.91±0.40
Second instar	4	6	4.86 ± 0.46	4	7	4.92±0.30	4	7	5.05±0.21
Third instar	4	6	5.06 ± 0.50	4	7	5.20±0.22	4	8	5.30±0.15
Fourth instar	4	6	4.46 ± 0.60	4	7	4.96±0.30	4	7	5.26±0.30
Fifth instar	4	5	4.26 ± 0.30	4	6	4.96±0.40	4	7	5.20±0.20
Sixth instar	4	6	5.26 ± 0.50	4	6	5.92±0.30	4	8	6.20±0.31
Seventh instar	5	7	5.86 ± 0.32	5	7	6.05±0.50	4	8	6.24±0.25
Eighth instar	7	9	7.86 ± 0.50	7	9	8.02±0.40	8	10	8.36±0.30
Mature	30	57	48.86±2.94	32	61	50 ±2.1	34	65	52±2.24
Medium	75	118	96.5± 0.60	77	128	102.5± 0.80	79	138	108.5±0.90
Life cycle (day)	**96.5 ± 0.60**			**102.5± 0.80**			**108.5 ± 0.90**		

Total number of individuals measured n = 30

When crickets were raised at a temperature of 25°C and humidity of 75%, the reproductive time and life cycle were determined as follows:

For those who had 100% synthetic feed:

Egg phase: The shortest completion time was 9 days, and the longest was 11 days, with an average of 9.49 ± 0.40 days.

Nymph phase: The shortest completion time for the first instar was 4 days, and the longest was 5 days, with an average of 4.46 ± 0.39 days. For the second instar, the shortest completion time was 4 days, and the longest was 5 days, with an average of 4.86 ± 0.46 days. For the third instar, the shortest completion time was 4 days, and the longest was 6 days, with an average of 5.06 ± 0.50 days. For the fourth instar, the shortest completion time was 4 days, and the longest was 6 days, with an average of 4.46 ± 0.60 days. For the fifth instar, the shortest completion time was 4 days, and the longest was 5 days, with an

average of 4.26 ± 0.30 days. For the sixth instar, the shortest completion time was 4 days, and the longest was 6 days, with an average of 5.26 ± 0.5 days. For the seventh instar, the shortest completion time was 5 days, and the longest was 7 days, with an average of 5.86 ± 0.60 days. For the eighth instar, the shortest completion time was 7 days, and the longest was 9 days, with an average of 7.86 ± 0.50 days.

Adult phase: The shortest completion time was 30 days, and the longest was 57 days, with an average of 48.86 ± 2.94 days.

Life cycle: The shortest completion time was 75 days, and the longest was 118 days, with an average of 96.5 ± 0.6 days.

For those fed on 100% vegetables, the egg phase was prolonged for an average of 9.63 ± 0.40 days. Different instar stages of the nymph phase lasted for around 5 - 6 days The shortest completion time for the first instar was 4 days, and the longest was 6 days, with an average of 4.86 ± 0.46 days. For the second instar, the shortest completion time was 4 days, and the longest was 7 days, with an average of 4.92 ± 0.30 days. For the third instar, the shortest completion time was 4 days, and the longest was 7 days, with an average of 5.20 ± 0.22 days. For the fourth instar, the shortest completion time was 4 days, and the longest was 7 days, with an average of 4.96 ± 0.30 days. For the fifth instar, the shortest completion time was 4 days, and the longest was 6 days, with an average of 4.96 ± 0.40 days. For the sixth instar, the shortest completion time was 4 days, and the longest was 6 days, with an average of 5.92 ± 0.30 days. For the seventh instar, the shortest completion time was 5 days, and the longest was 7 days, with an average of 6.05 ± 0.50 days. For the eighth instar, the shortest completion time was 7 days, and the longest was 9 days, with an average of 8.02 ± 0.40 days. The adult phase had an average time of 50 ± 2.10 days. Life cycle time of crickets ranged from 77 to 128 days, with an average of 102.5 ± 0.8 days.

For those bred on 100% grass, the egg phase time ranged from 9 to 11 days, with an average of 9,79 ± 0.35 days. The nymph phase consisted of different instar stages from the first to the seventh lasting an average of 5 – 6 days whereas The shortest completion time for the first instar was 4 days, and the longest was 7 days, with an average of 4.91 ± 0.40 days. For the second instar, the shortest completion time was 4 days, and the longest was 7 days, with an average of 5.05 ± 0.21 days. For the third instar, the shortest completion time was 4 days, and the longest was 8 days, with an average of 5.30 ± 0.15 days. For the fourth instar, the shortest completion time was 4 days, and the longest was 7 days, with an average of 5.26 ± 0.30 days. For the fifth instar, the shortest completion time was 4 days, and the longest was 7 days, with an average of 5.20 ± 0.20 days. For the sixth instar, the shortest completion time was 4 days, and the longest was 8 days, with an average of 6.20 ± 0.31 days. For the seventh instar, the shortest completion time was 4 days, and the longest was 8 days, with an average of 6.24 ± 0.25 days. For the eighth instar, the shortest completion time was 8 days, and the longest was 10 days, with an average of 8.36±0.30 days. The adult phase went on with an average of 52 ± 2.24 days and the crickets' life cycle took around 108.5 ± 0.9 days on average.

Monitoring the life cycle of crickets revealed that they underwent incomplete metamorphosis with three incomplete stages (egg, nymph, adult). The adult stage had the longest time, reaching up to 65 days with grass. The completion time of each reproductive

phase of crickets raised on three types of food was diverse. The shortest life cycle was 96.5 days with synthetic feed, while the longest was 108.5 days with grass feed. Our research findings are consistent with the studies by Dinh TPA, Phan TTH, (2013) [2]; Tu VD, Nguyen VH, (2008) [3]; Asnath MF et al., 2015 [5]; Dobermann D, et al., 2018 [6]; Ngo VT et al., 2021 [4] regarding the influence of food on the life stages of *Gryllus bimaculatus.*

The introduction of the aforementioned food types in our study, combined with their practical significance, inevitably involves limitations in terms of the diversity of food sources compared to those available in the natural habitat. This could somewhat affect the nutritional quality of the body and consequently impact the growth and development of the crickets. However, the inclusion of these food components led to interesting findings, allowing us to suggest the rearing of crickets under laboratory conditions.

A cricket breeding process has been developed including the following steps:

Commercial cricket farming process:

Insect rearing enclosure → Raising equipment → Selecting breeds → Food → Care and raising crickets → Raising commercial crickets → Stocking→ Incubating eggs → Exporting commercial breeds → Cleaning

Cricket breeding process:

Insect rearing enclosure → Raising equipment → Selecting breeds → Food → Care and raising crickets → Raising crickets → Stocking → Incubating eggs → Choosing breed → Cleaning

3. Conclusions

The size of the sexual phases of coal crickets fed on three types of food has been measured. Among the three types of food, synthetic food gave crickets with the largest size, 28.5 ± 1.10 mm long and 10.15 ± 0.20 mm wide for adult females and 27.5 ± 1.21 mm long and 9.52 ± 0.22 mm wide for adult males. Grass resulted in the smallest crickets with adult females' size of 26.12 ± 1,08 mm long, 8.94 ± 0.50 mm wide, and adult males' size of 25.52 ± 1.52 mm long, 8.33± 0.57 mm wide on average.

With a 100% vegetable, the eggs had an average length of 1.95 ± 0.30 mm and an average width of 0.92 ± 0.20 mm.The nymph phase lasts 8 ages. The Nymph stage had an average length of 9.38 ± 0.56 mm and an average width of 3.91 ± 0.16 mm. The average length of adult females was 27.06 ± 1.05 mm, larger than that of adult males at 26.25 ± 1.32 mm; the average width of adult females was 9.45 ± 0.20 mm, larger than that of adult males at 9.05 ± 0.22 mm.

With 100% grasses, the average length of eggs was 1.93 ± 0.33 mm, and the average width was 0.88 ± 0.21 mm. The nymph phase lasts 8 ages. The Nymph stage had an average length of 8.67 ± 0.60 mm and an average width of 3.22 ± 0.12 mm. The average length of adult females was 26.12 ± 1,08 mm, larger than that of adult males, which was 25.52 ± 1.52 mm. The average width of adult females was 8.94 ± 0.50 mm, larger than that of adult males, which was 8.33 ± 0.57 mm.

With a 100% synthetic feed, the eggs had an average length of 2.03 ± 0.09 mm and an average width of 0.92 ± 0.20 mm. The nymph phase lasts 8 ages. The Nymph stage

had an average length of 9.96 ± 0.54 mm and an average width of 4.25 ± 0.20 mm. The average length of adult females was 28.5 ± 1.10 mm, larger than that of adult males at 27.5 ± 1.21 mm; the average width of adult females was 10.15 ± 0.20 mm, larger than that of adult males at 9.52 ± 0.22 mm.

Breeding crickets (*Gryllus bimaculatus* De Geer, 1773) on three types of food: 100% vegetables, 100% grass, and 100% synthetic feed under laboratory conditions (25°C temperature and 75% humidity) has been determined morphological, biological characteristics, and commercial breeding and reproduction processes. The largest reproductive phase size fed on synthetic feed and the smallest on grass; raised on synthetic feed: The egg phase has a completion time of 9.49 ± 0.40 days. The nymph phase lasts 8 ages, with a completion time of 42.08 ± 3.75 days. The adult phase has a completion time of 48.86 ± 2.94 days. The life cycle of the cricket is 96.5 days; Raised on grass feed: The egg phase has a completion time of 9.79 ± 0.35 days. The nymph phase lasts 8 ages, with a completion time of 46.52 ± 2.12 days. The adult phase has a completion time of 52 ± 2.24 days. The lifespan of the cricket is 108.5 days. When breeding crickets on grass feed, the life cycle of the crickets is longer than when breeding crickets on synthetic feed.

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