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Life history of the Hog Plum Beetle, *Podontia quatuordecimpunctata* (Linnaeus, 1767) (Coleoptera: Chrysomelidae) with photographs of each developmental stage

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Abstract

Hog plum beetle (*Podontia quatuordecimpunctata*) is a serious pest of hog plum tree and both their adults and larvae defoliate the hog plum tree. However, its developmental information and proper identification as well as precise photographs of each developmental stages have not been well studied and recorded. Thus, the goal of this research was to establish the developmental characteristics of *P. quatuordecimpunctata*. Life history was conducted in laboratory conditions at an average temperature 28 °C ± 1.2 an average 65 ± 5% relative humidity (RH), and a light: dark ratio (12L : 12D). The female beetles were laid clusters of eggs in numerous layers, with 9 to 53 eggs in each cluster. The durations of each developmental stage were 6.16±0.93, 3.16±0.24, 3.29±0.25, 3.21±0.33, 4.54±0.33, 5.54±0.49, and 20.92±2.7 days for the incubation, 1st instar, 2nd instar, 3rd instar, 4th instar, pre pupa, and pupa, respectively. The longevity of male and female adult beetles was found to be 42.33±6.6 days and 50.66±9.8 days, respectively. Results revealed that this study will be a valuable source of biological information for a better understanding and management of this pest species.

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Introduction

Podontia is the largest genus of flea beetles belonging to the order Coleoptera under the family Chrysomelidae and the subfamily of Alticinae (Dalman, 1824). The genus *Podontia* consists of 14 Asian species that range from Indonesia to Indo-China (Salleh and Sadi, 1989; Deka and Kalita, 2002).

Adult *Podontia* are recognized by having a bifurcate prosternum, a mesosternum in the shape of a saddle, and strongly inward-curving bifid tarsal claws (Medvedev, 1999; Becerra, 2004). Meso- and metathoracic tubercle occurrence and forms differ among *Podontia* larvae (Kimoto and Takizawa, 1997).

The most well-known *Podontia* species is *Podontia quatuordecimpunctata* (known as a hog-plum beetle) which defoliates hog plum both as adults and larvae (Prathapan and Chaboo, 2011; Rani *et al.,* 2021; Deka and Kalita, 2003). In Bangladesh, there are two types of hog plum trees: one is cultivated (*Spondias pinnata* Kurz), while the other is native (*Spondias mangifera* Wild). Hog plum belongs to the Ancardiacae family and is a deciduous perennial tree with large succulent leaves.

Locally, hog-plum known as "amra" is the most popularly consumed fruit in Bangladesh (Khan, 2016). All over the tropics, *Spondias pinnata* is grown as an edible fruit (Maniruzzaman, 1988; Verheij and Cornel, 1991), but in Bangladesh, the Barisal and Patuakhali areas are renowned for their high-quality harvest (Rahman *et al.,* 2022). *Spondias pinnata* cultivation is seriously hampered by the hog-plum beetle. In India and Malaysia, *Spondias mangifera* and Spondias dulcis are both highly vulnerable to *P. quatuordecimpunctata* (Salleh and Sadi, 1989).

The first life cycle of *P. quatuordecimpunctata* was studied by (Pramanik and Basu, 1973). Few studies have contributed perspectives about the biology of *P. quatuordecimpunctata* to investigate its complete biology and proper identification and description of the developmental stages. Therefore, we were interested in addressing the biology of this beetle.

Materials and method

Experimental site

The study was conducted in the Laboratory of Radiation Entomology and Acarology Division, Institute of Food and Radiation Biology (IFRB), Atomic Energy Research Establishment (AERE), which is located at 23°51′30″N and 90°16′00″E with an altitude 15m above sea level.

Adult insect collection and rearing

To investigate the biology under laboratory conditions, 100 adult male and female beetles were collected from the host plant, and kept in a rearing cage (44cm × 38cm × 38cm) covered with a net. The beetles were fed with leaves. To keep the leaves fresh, a moist piece of cotton was placed around the cut tip and wrapped with aluminum foil. The leaves were changed at an interval of 12 hours during the rearing.

Oviposition

For oviposition, young branches with leaves of the host plant are placed inside the cage. Eggs were collected with leaves or branches following oviposition, and maintained in a plastic container (26cm × 17cm × 7cm) for hatching. Newly hatched larvae were separated and placed in 10 plastic containers (21.5cm ×13.5cm ×10.5cm) and each container contained 10 larvae with leaves. The leaves were changed at an interval of 8 hours during the rearing. The adults and larvae of *P. quatuordecimpunctata* were placed in a cooled incubator (VS-3250BipC-L, KTR Europe GmbH, Vision Scientific Co., Ltd, Made in Korea).

Characteristics of pupal development

Matured larvae wriggle on soil and enter at a depth of about 3 inches of soil, creating a small depression on the surface and gathering soil particles from around the body and manipulating these with the legs and mouthparts to provide a cage for pupation.

Field observation

In addition to the laboratory biology, we also observed the host plant in the field from the month of April, when the adult beetle makes its appearance in nature until the December. Population abundance were observed (April 2019 to December 2021) at one-day interval (10 a.m. and 5 p.m.).

Morphometric measurements and duration of different stages

Morphometric analysis of different life stages and measuring different body parts was carried out by taking 10 replications of each stage, viz. egg stage, larval stages (first to fourth instar), pupal stage, and adult stage for linear measurements. The egg, larval instar, pupal stage duration, and life span of the adult beetles were observed daily and recorded. The length and width were measured using a Vernirer caliper (Mitutoyo, Model 500-196-20, Japan), while the weight was measured using an electronic balance (HT224RCEN, Shinko Co., Ltd., Made in Japan). In addition to the above parameters, color, shape, size, moulting and feeding behavior were also recorded.

Temperature and humidity maintenance

The entire experiment was maintained at an average temperature of 28°C±1.2 with an average 65±5% relative humidity (RH), and a light: dark ratio (L: D) of 12:12. The RH and temperature were maintained by using a digital Max-Min Thermo Hygro and Clock (Zeal).

Results and discussion

Mating and oviposition

Mating did not occur immediately after emergence. Adult *Podontia quatuordecimpunctata* did not exhibit any courtship behavior before maturation. When the male and female attained maturity, both individuals were observed to participate equally in the courtship process before commencement of mating. Male and female come into close contact physical contact before copulation. Males moved around the females and utilized their antennae to trap the females.

The male attempted to climb onto the female's back several times before finally succeeding in climbing to the top of the female and initiating copulation by fixing this posterior end with the female (Fig. 2A). The duration of the mating is 31.5±4.61 hours on average. Throughout its life span, the mating frequency was 2-3 times, and the average mating interval was 119.57±73.98 hours (N = 10). The findings of this investigation support previously published hog plum beetle copulation observations (Khan 2017; Uddin et al. 2014).

The female beetles deposit clustery eggs in multiple layers on the dorsal and ventral surfaces of leaves, leaf rachis, and top shoots, and we found they mostly choose stem bark for egg laying. (Fig. 2B). According to (Khan, 2017) heavy-bodied adult female beetles probably feel comfortable laying their eggs on stem bark near the leaves. The number of eggs in each cluster varied from 9 to 53 (Fig. 1). Eggs were elliptical in shape and newly deposited eggs were soft, light golden, and slightly translucent following oviposition.

Table 1. Developmental period of different life stages of *P. quatuordecimpunctata*.

Developmental stages	Duration (Days)		
	Minimum	Maximum	Mean±Sd
Incubation period	3.5	6.0	6.16±0.93
First instar	3.0	3.5	3.16±0.24
Second instar	3.0	3.5	3.29±0.25
Third instar	2.5	3.5	3.21±0.33
Fourth instar	4.0	5.0	4.54±0.33
Total larval period	12.5	15.5	14.21±0.66
Pre-pupa	5.0	6.0	5.54±0.49
Pupa	15.0	22.0	20.92±2.7
Egg to adult emergence period	38.5	51.5	46.83±7.2
Adult Longevity (♂)	35.0	53.0	42.33±6.6
Adult Longevity (♀)	39.0	64.0	50.66±9.8
Total Life period (♂)	73.5	104.5	89.16±3.2
Total Life period (♀)	77.5	115.5	97.49±2.7

Table 2. Morphometric measurement of different developmental stages of *P. quatuordecimpunctata* (Mean±Sd).

Stages	Length (mm)	Breadth (mm)	Weight (mg)	
Egg	2.02±0.03	0.98±0.07	0.65±0.15	
Larval stages			With fecal pellet	Without fecal pellet
I- Instar	4.29±0.54	1.15±0.24	6.16±1.1	3.15±1.2
II- Instar	8.58±0.52	3.80±0.67	101.68±17.3	47.02±9.4
III- Instar	14.50±1.3	6.45±0.76	251.77±50.9	155.91±19.5
IV- Instar	19.20±1.7	6.75±0.67	500.1±0.09	369.0±0.09
Pupa	10.8±0.78	6.85±0.77	235.18±51.38	
Cocoon	18.35±1.25	13.65±1.84	877.00±0.14	

After oviposition, the eggs begin to harden and turn a dull, yellowish white (Fig. 2C). There is a dark brown tip at the terminal apex of each egg, and a circular break forms around the apex of each egg prior to larval eclosion (Fig. 2D). The female beetle deposited eggs on average 8 time (N=5 pairs) in their life time (Fig. 1). Eggs size were an average of 2.02±0.03mm long and 0.98±0.07mm wide, and weight 0.65±0.15mg (N = 10) (Table 2).

The incubation period (the number of days from egg mass oviposition to larval eclosion) was 6.16±0.93days (Table 1). Similar egg size and incubation periods were found by (Deka and Kalita, 2002).

Larval stages

P. quatuordecimpunctata has four larval instars, each of which has a black head and three pairs of thoracic legs, with the exception of size all larval features are being the same. The body (thorax to abdomen) is yellowish in color with a ventral sucker at the end of the abdomen, black-spotted spiracle opening on the dorsal surface, and with covered with fecal pellet (Fig. 3A-D, 4A-D). The neonate larvae resembled wood louses and were bright yellow in color with an average body length, body wide 4.29±0.54mm, 1.15 ±0.24mm (Table 2) and a life span of 3.16±0.24 days (Table 1).

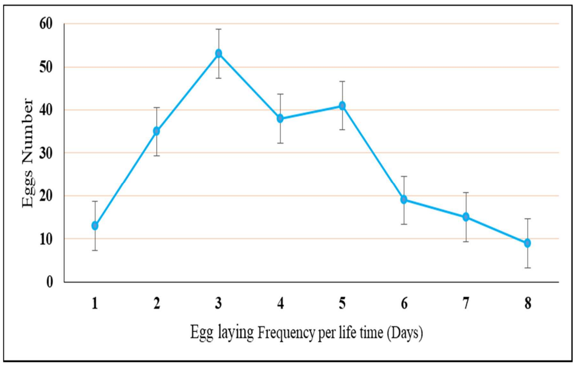

Fig. 1. Ovipositional patterns of *P. quatuordecimpunctata* (average from five pairs couple).

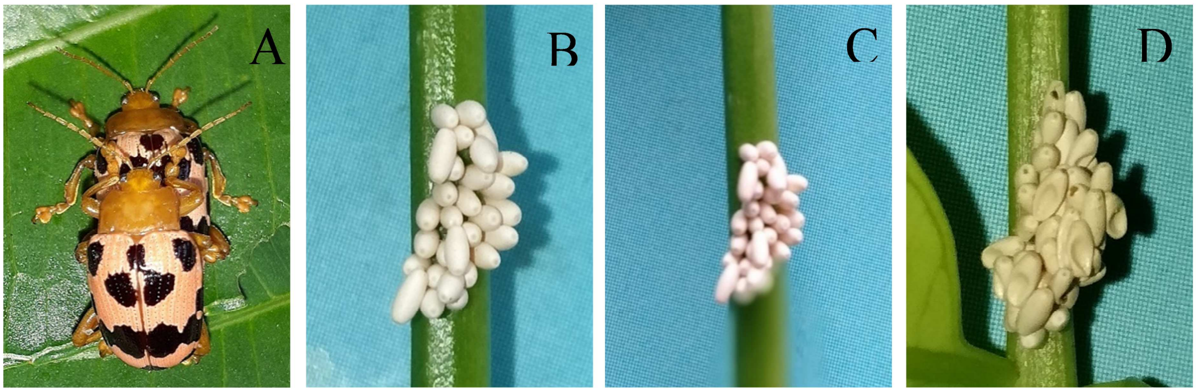

Fig. 2. Mating and oviposition of *Podontia quatuordecimpunctata*: A: Mating of adult male and female beetle; B: Oviposited eggs on petiole of host plant leaf; C: Colour change after oviposition; D: Egg shell after eclosion larvae.

The weight of first instar larvae with and without fecal pellet was 6.16±1.1mg and 3.15±1.2 mg respectively (Table 2). The second instar larvae measured 8.58±0.52mm in body length and body wide was 3.80±0.67mg (Table 2), had a lifespan of 3.29±0.25 days (Table 1), and were around 4mm larger than the first instar. The weight of second instar larvae with and without fecal pellet was 101.68±17.3mg and 47.02±9.4 mg respectively (Table 2). The third instar larvae measured 14.50±1.3mm in body length 6.45±0.76mm in wide (Table 2), and were about 6mm larger than the second instar, and lived for 3.21±0.33 days (Table 1). The weight of third instar larvae with and without fecal pellet was 251.77±50.9mg and 155.9±19.5 mg respectively (Table 2). The fourth or final instar larvae were distinct from the other instars by their greenish hue and bigger size on average 19.20±1.7mm long and 6.75±0.67 in width (Table 2), as well as the fact that they were around 5mm larger than the third instar and had a lifespan of 4.54±0.33 days (Table 1). The weight of fourth instar larvae with and without fecal pellet was 500.1±0.09mg and 369.0±0.09 mg respectively (Table 2). Larval period ranged from 12.5 to 15.5 days, with an average of 14.21±0.66 days (Table1). According to (Deka and Kalita, 2002), the overall hog plum beetle larval period was 12 to 15 days in Assam, India and 11-18 days in the Malay States (Corbet and Yusope, 1921). The findings indicated that the hog plum beetle larval growth pattern was dependent on food intake and time, which is supported by (Khatun *et al.*, 2016), who mentioned that the rate of leaf consumption increased with the increase in age of the larvae due to the size of the larvae, which needs enough food for voracious and random feeding on leaves.

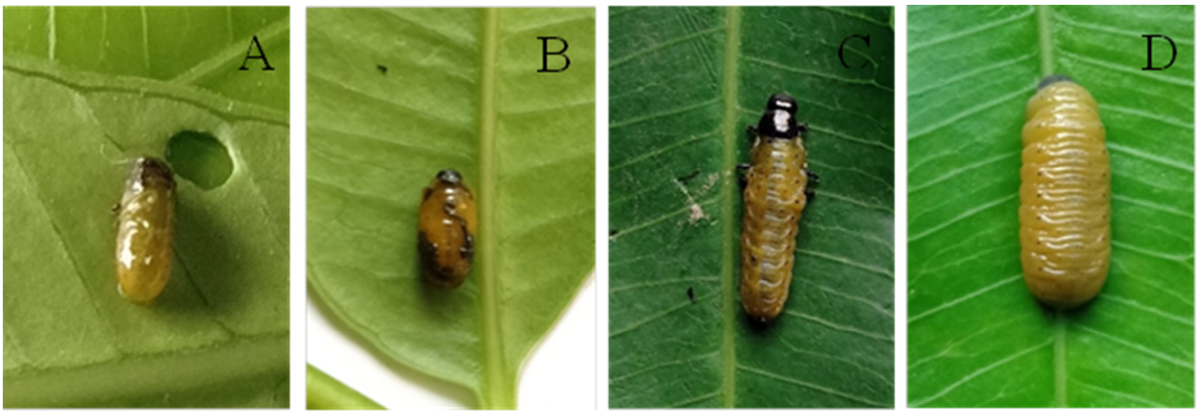

Fig. 3. Larval stages of *Podontia quatuordecimpunctata*: A, 1st Instar; B, 2nd Instar; C, 3rd Instar; D, 4th Instar.

Larval fecal coat

The fecal coat is present in all larval stages. Larval excrement and exuviae covered their bodies completely, gave them the appearance of bird droppings (Barlow, 1900; Stebbing, 1914; Baksha, 1997) called a fecal coat. This observation of larval fecal coats possibly mimicking bird droppings. This made it easier for the larvae to flee from attacks by their prey. Larvae completely reconstruct their fecal coat with fresh fecal material added after old fecal material is worn away by natural abrasion.

Exuvae are only incorporated into the fecal coat during transformation into a new larval instar. *Chelymorpha alternans* larvae have been seen to incorporate plant chemical into their fecal shield, according to (Vencl *et al.,* 2009). They observed that as chlorophyll precursors in *Merremia umbellata* host plant tissues transit through the larval gut and later collect in the fecal shield, they are changed into chlorophyll catabolites. Immature *Chrysomelids* typically use exuviae and enteric products as barriers for defense, according to (Nogueira and Trigo, 2002).

Vincl *et al.,* 2005 showed that *Chelymorpha alternans* employs its fecal barrier as a physical and chemical protection against natural predators or to lessen the effects of abiotic stresses like wind and ultraviolet light (Olmstead and Denno, 1992). When the larval fecal coats were removed, it took the larvae between 30 and 60 minutes (on average 47.90±10.39 minutes) (N = 10) to create a new coat, and *P. quatuordecimpunctata* larvae entirely reassemble their fecal coat with new fecal material in between 6.6 and 8.0 hours (7.17±0.42 hrs. on average) (N = 10). We found that younger larvae (first and second instars) had light green coloring and wet mushy/soft fecal coat, whereas older larvae (third and fourth instars) had dark green or black coloring and what appeared to be a drier, hard fecal coat, indicating that they were eating mature older leaves. This shows that the *P. quatuordecimpunctata* larval fecal coat color is dependent on how mature the leaf is that it consumes.

Pupal formation process

The formation of pupae was observed in the laboratory. *P. quatuordecimpunctata* larvae typically pupate on the ground. Quiescent larvae wriggle on the ground and enter at a depth of about 3 inches of soil, creating a small depression on the surface and gathering soil particles from all around the body and manipulating these with the legs and mouthparts to provide a cage for pupation, eventually making an oval cocoon (Fig. 5A-D). In our observation we found that single larval cocoon, and combined larval cocoon (Fig. 5E). In combined larval cocoon, we found that they shared common hole in between combined joint.

Pre-pupal characteristic

Prepupae, the first stage of the pharate pupal life cycle, is where fully fed larvae descend the tree, lose their fecal coat, penetrate the soil, and create an earthen cell. In the cell where it pupates, the larva-pupal ecdysis takes place. Larvae went through a transitional stage known as the pre pupal stage before pupating, which caused them to become quiescent, shorter, and slightly assume a C-shape with cut inwards (Fig. 5F). This stage lasted on average 5.54±0.49 days (Table 1).

Pupal characteristic

Pupae were bright yellow, noticeable, ovular, and sturdy (Fig. 5G). The average body length and breadth of pupae was 10.8±0.78mm and 6.85±0.77mm as well as weight was 235.18±51.38mg (Table 2). The average number of days from pupation to adult eclosion (pupal period) was 15.0-20.0 days (20.92±2.7: N=10) (Table-1).

In contrast of (Deka and Kalita, 2002) observed that the average length of male and female hog plum beetle pupae was 9.0mm and 11.5mm, respectively, and pupal period 18 to 20 days. Length, breadth and weight of earthen cocoon were 18.35±1.25mm, 13.65±1.84mm, 877.00±0.14mg, respectively. The extension of the genital tract near the end of the abdomen during the pupal stage could be used to detect gender. Fig. 6C shows that the end of the abdomen of males has a rounded protusion, but that of females does not (Fig. 6A).

Fig. 4. Fecal coat of *P. quatuordecimpunctata* larvae stages: A- 1st Instar; B- 2nd Instar, C- 3rd instar; D- 4th Instar.

Fig. 5. Pupa formation process of *P. quatuordecimpunctata*: A- Larvae dropping in soil for pupation; B- Larvae making pupation chamber; C- larval cocoon in earthen pot; D- Single larvae cocoon; E- Combined larval cocoon; F- Prepupa; G- Pupa.

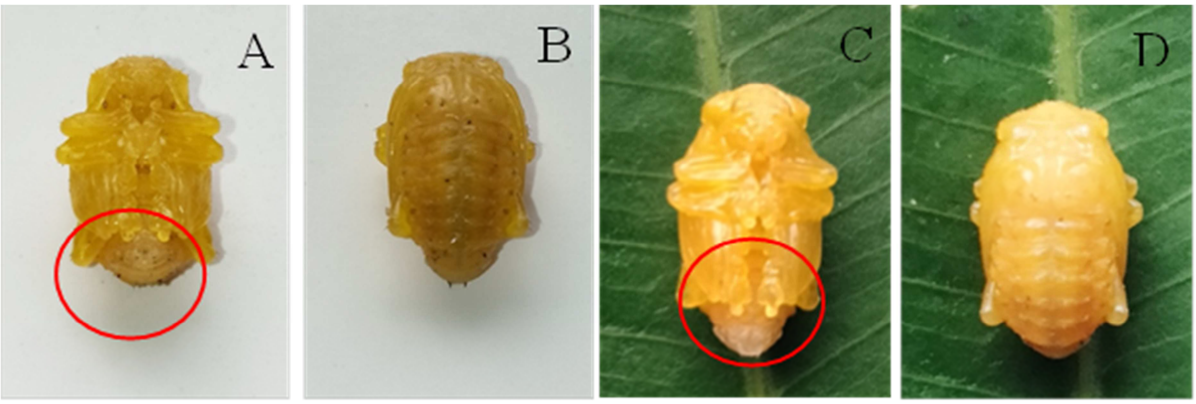

Fig. 6. Pupal stage of *P. quatuordecimpunctata*: A-B, Female pupa (A- ventral view: B- dorsal view); C-D, Male pupa (C- ventral view: D- dorsal view).

Adult Stage

Male and female beetle characteristics

The adult beetle emerges from the pupa with natural abrasion of the wall of the earthen cage. Adults are oblong, the thickest, and have shiny head, pro-thorax, antennae, and leg. The elytra are vivid salmon pink in color with eight dots on each one, and the mouthparts are black. When the elytra closed, the upper and lower ones combined, creating fourteen spots. The males are a little bit more slender than the females. The initial segment of the anterior and middle tarsi in males is dilated and convex (Fig. 7C), whereas it is triangular in shape in females (Fig. 7F) but not as dilated towards the base.

Males have a deep, thin constriction on each side of the posterior edge of the final abdominal sternite (Fig. 7B) but females do not have this constriction. The center of the posterior femura's dental expansion is less prominent in male than the female (Fig. 7C and 7F).

Beetles, both male and female are polygamous. Adults employ a variety of defense mechanisms to stay away from dangers or unwelcome objects. They stubbornly cling to surfaces. When disturbed, they retreat all appendages under the elytra and act dead as they flee from predators at fast speed, or adults stumble or hesitantly jump.

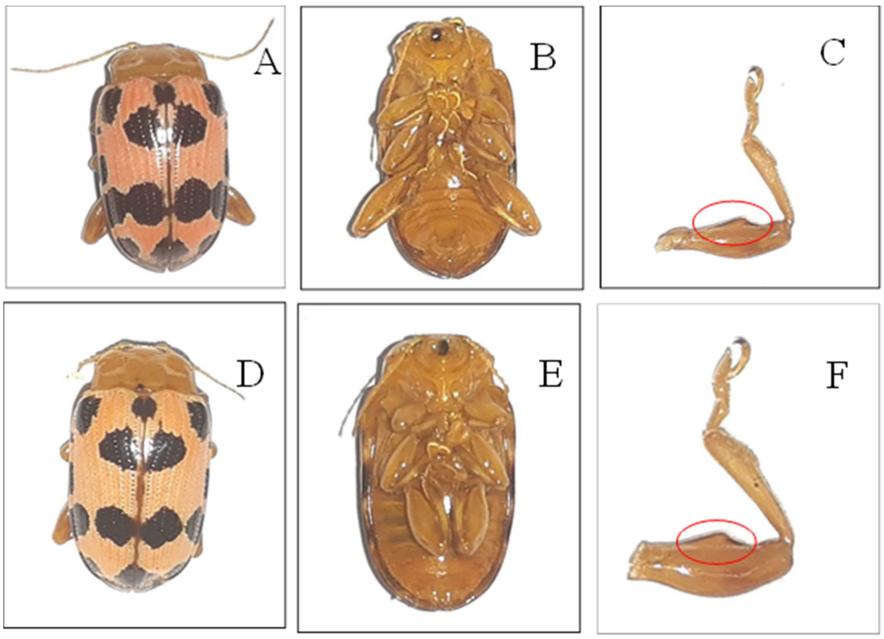

Fig. 7. Adult stage of *P. quatuordecimpunctata*: A-B. Male beetle (dorsal and ventral view); C- leg of male beetle; D-E, Female beetle (dorsal and ventral view); F- leg of female beetle.

Entire life period of male and female beetle

The range of the longevity of an adult male is from an average of 42.33±6.6 days. Similarly, the range of the longevity of an adult female an average of 50.66±9.8days (Table 1).The entire life period (egg to adult death) of a male and female was 89.16±3.2 days and 97.49±2.7days, respectively. Results of the longevity of adult male and female beetles show that the hog plum beetle may be multi-voltine in nature and that they may have three generations during the reproductive season. Deka and Kalita, 2002 observed that *P. quatuordecimpunctata* is multivoltine with 5 overlapping generations, but Sardar and Mondal, 1983 reported the species without any overlapping generations.

Morphometric measurements of male and female beetle

Morphometric measurements of male and female beetle were shown on Table 3. Mature male beetles weighed an average of 226.1± 0.03mg, whereas females were 240.9± 0.04mg. On average, the body length and breadth of male beetles were 13.05±0.49mm and 7.17±0.58mm. On the other hand, the average body length and breadth of female beetles were 14.45±0.59mm 7.25±0.54mm. The average length of the antennae was 7.40±0.46mm for male, and 7.20±0.42mm for female beetle, respectively. The average length of the fore, middle, and hind legs was 8.50±0.33mm, 9.70±0.54mm and 11.80±0.26mm for male beetle, as well as 9.45±0.59mm, 11.15±0.24mm and 12.50±0.33mm for female beetle, respectively.

Similarly, the average length and breadth of the elytra (forewing) was 11.35±0.41mm and 4.80±0.26mm for male and 11.73±0.64mm and 4.90±0.39mm for female beetle. In contrast, the average length and breadth of the hind wing of the male beetle were 15.95±0.89mm and 6.10±0.32mm, as well as the female beetle was 15.75±0.89mm and 6.03±0.51mm, respectively. The hind wings were about 4mm longer and 2mm broader than the fore wings. Results revealed that all morphometric measurements of male beetles were a little smaller than female beetles. This observation is supported by previously reported morphometric observations of hog plum beetle (Khan *et al.*, 2017).

Table 3. Morphometric measurements of different body parts of adult *P. quatuordecimpunctata* (Mean±Sd).

Body Parts	Male (♂)	Female (♀)
Adult length	13.05±0.49mm	14.45±0.59mm
Adult weight	226.1±0.03mg	240.9±0.04mg
Adult width	7.17±0.58mm	7.25±0.54mm
Antennal length	7.40±0.46mm	7.20±0.42mm
Fore wing length	11.35±0.41mm	11.73±0.64mm
Fore wing width	4.80±0.26mm	4.90±0.39mm
Hind wing length	15.95±0.89mm	15.75±0.89mm
Hind wing width	6.10±0.312mm	6.03±0.51mm
Fore leg length	8.50±0.33mm	9.45±0.59mm
Middle leg length	9.70±0.54mm	11.15±0.24mm
Hind wing length	11.80±0.26mm	12.50±0.33mm

Table 4. Survivability and Mortality rate of *P. quatuordecimpunctata*.

n=51	Egg	I Instar	II Instar	III Instar	IV Instar	Pre-Pupa	Pupa	Adult
Individuals	51	46	43	41	40	37	33	32
Death	5	3	3	2	3	4	1	2
Survive	46	43	40	39	37	33	32	30
Survival rate (%)	90.19	93.48	93.02	97.14	79.42	100.0	88.46	95.66
Mortality rate (%)	9.81	6.52	6.98	2.86	20.58	0.0	11.54	4.34

Survival and Mortality rate

For the investigation survival and mortality rate 51 *P. quatuordecimpunctata* were kept in indoor conditions, and observed egg to adult stage. The mortality rates at immature stages were 9.81% (egg), 6.52% (first instar), 6.98% (second instar), 2.86% (third instar), 20.58% (fourth instar), and 0% at pre-pupal stage (Table 4). The mortality rate of pupal stage was 11.54%, and 4.34% in adult stage. Among 51 individuals, 30 survived in the adult stages, and survival rate of 58.82% (Table 4). Roh *et al.,* 2021 found 39 survived through the stages of egg, larva, pupa, and adult, for a total survival rate of 63% among 60 individuals in *Leptaulax koreanus* (Korean endemic species).

Feeding behaviors of grubs and adults of P. quatuordecimpunctata

We saw that *P. quatuordecimpunctata* grubs (larvae) and adults both consumed leaves from the hog plum plants. Hsiao, 1986 made comparable findings about the species of the subfamily Chrysomelinae eating habits. Larvae and adults always stay on the host plants while feeding takes place at all times. For two to three days, the freshly hatched grub gathered on fragile leaves and scratched their upper surface. Larvae in their first instar typically start eating leaves from the ventral cuticle. Later, they cause a distinctive circular ring-like damage on the leaf surface (Fig. 8A). Larvae in their second instar are likewise fed gregariously, and when they feed, they move outward and toward the edge of the leaf, creating erratic patches (Fig. 8B).

First and second instar larvae didn't eat the midribs and veins in the early stages of development. This might be because the leafy materials can't be chewed or because leaf veins are nutritionally deficient. Third and fourth instar larvae, which are the later instars, like to be alone and eat the dorsal surfaces of leaves. All the leaf layers are consumed by the larvae starting in the third instar, when they turn into ravenous feeders. The center and edge are where feeding begins. Larvae were more ravenous in their fourth or final instar.

A larva's mandibular strength increases to the point where it can completely chew through leaves in both the third and fourth instar larvae. They eventually defoliated the entire plant's shoots by eating old leaves, veins, fragile stem sections, and even the green bark of the plants (Fig. 8C & 8D). HPB feeding increased with larval age and that older larvae fed more than younger larvae (Uddin and Khan, 2014). HPB larvae in the field can be recognized by this distinctive type of leaf damage. Adult beetles eat ferociously as well, and they favor eating young leaves. Beetles attack along the leaf margin, creeping inward, and eat at all times (Fig. 9D). Feeding can occasionally result in uneven wounds that leave leaves skeletonized. Young trees with severe infestations lose all of their leaves except for the midribs, which results in defoliation of the trees (Fig. 9C).

Young trees with severe infestations lose all of their leaves except for the midribs, which results in defoliation of the trees. Leaves that are severely impacted shrivel and drop to the ground. Although the trees are not completely destroyed, there are unquantifiable effects on their growth and fruiting.

On any leaf, adult beetles have never been seen eating alongside larvae. However, the HPB life cycle is completed on the same host plant, and beetles and larvae can be seen feeding on different leaves of the same host plant. The feeding habits of hog plum beetle larvae and adults (Asaduzzaman *et al.,* 2018; Uddin and Khan, 2014; Howladar, 1993) and tortoise beetles (Chaboo, 2007) are consistent with those observations.

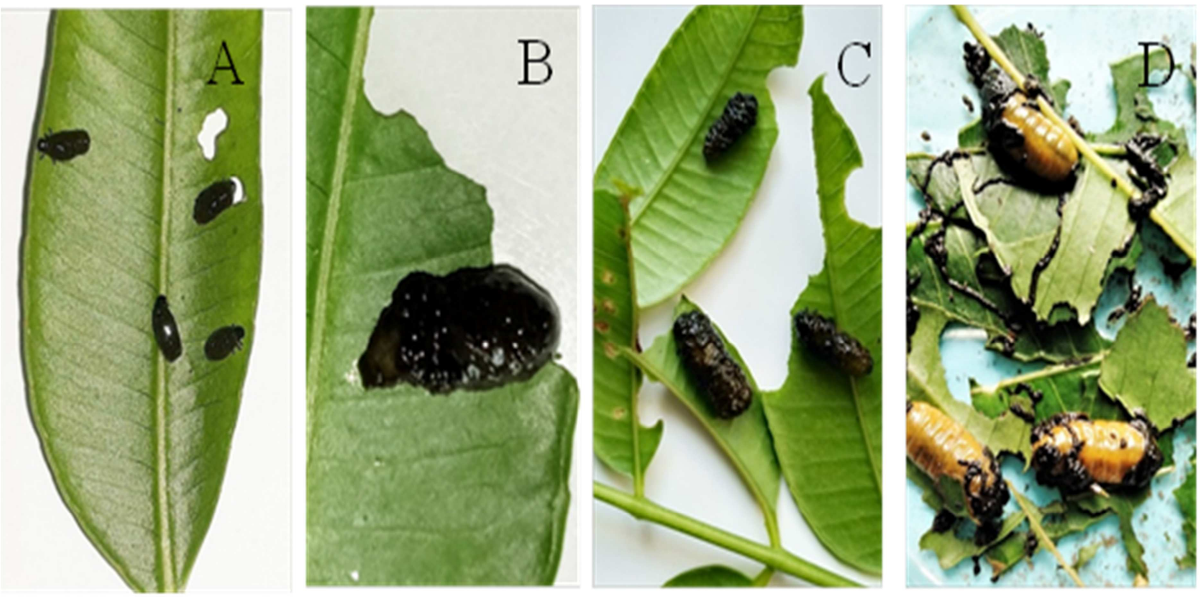

Fig. 8. Feeding behavior of *P. quatuordecimpunctata* (larval stages); A: 1st- Instar grub feed characteristic with circular ring like injury; B: 2nd- Instar larvae feed the leaves from the edge; C- 3rd- Instar larvae feed the leaves from the edge and middle; D- 4th- Instar larvae feeding voraciously.

Fig. 9. A: Host plant naturally defoliated in dry season (January to March); B: New leaves appeared in wet season (April to December); C: 3rd- Host plant defoliated by larvae and adults; D: Adult beetles feed the leaf margin and proceeds inward.

Appearance and abundance of P. quatuordecimpunctata

Where host plants have survived for a number of years, *P. quatuordecimpunctata* are frequently abounding. Except for the dry season (January to March) months, they were active all year (Fig. 9A). The adult beetles start to emerge around the end of April and are active until the beginning of December (wet season). The larvae also start to show in the middle of May and continue to be active until December. At the beginning of May, when the new shoots first sprouted, the eggs were discovered on the hog plum tree's leaves or branches (Fig. 9B). Larvae and adults made up the population, which started to grow in May and picked up in July when the trees were fully leafed (Fig. 10). The potential that beetles might go into diapause at that time and remain hidden beneath dirt, dead stems, bark, or branches deserves additional investigation. In April, the adult population emerged, resuming the breeding season (Fig. 10). Results of the hog plum beetle population abundance indicated that the onset of spring (April-May), followed by the rainy season, offered favorable conditions for the appearance of this pest, with the increasing temperature, humidity, and extended day length providing these conditions (June-September). Young and mature leaves are present throughout the year, with the exception of January to March (Fig. 9A), according to research on the host plant's phenology (the cold and dry season).

Due to the total defoliation in winter, hog plum beetle doesn't obtain enough leaves during that time. As a result, it appears that the environment and the availability of host plants or leaves influence the hog plum beetle population abundance patterns. Similar patterns of population abundance have been observed by (Deka and Kalita, 2002). They discovered that the population peaked in June and July, when the temperature, humidity, and rainfall were at their highest, and that the population peaked at its lowest in October and November, possibly as a result of a drop in temperature, humidity, and rainfall. Also noted were the insect's adult stages hibernating at the end of November. (Khan, 2016) shown, however, that it vanishes in October. *Platyphora* and *Proseicela* beetle species have had their dynamics of natural population's researched (Medeiros and Neto, 1989), and they found that both species exhibit seasonal fluctuation, being active in the spring and summer and going dormant in the cold and dry season.

Rainfall can have a significant impact on the dynamics of tropical insects, according to (Denlinger, 1986; Wolda, 1988) reports. Rainfall is the cue for many insect species to emerge from dormancy at the start of the rainy season, according to (Pullin and Knight, 1992) analysis of anecdotal data.

On the other hand (Janzen, 1973) found that the population dynamics of herbivorous insects may be significantly influenced by host plants and that wetness is the primary cause of diapauses in the neo-tropical region where from the beetle originated (Hsiao, 1986).

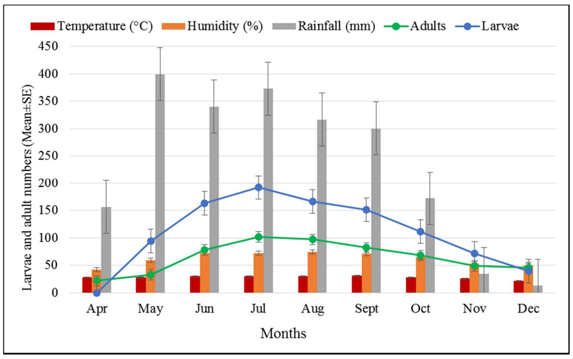

Fig. 10. Monthly population abundance of *P. quatuordecimpunctata*.

Conclusion

The principal focuses of this study were to investigate the biology, proper identification and description of immature and adult stages, feeding behavior and population abundance provided with photographs. We believe that these investigations will provide a better understanding for sound management of this pest species.

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