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Bioecology and prevalence of giant scale insect, *Perissopneumon ferox* Newstead (Homoptera: Monophlebidae) in Jahangirnagar University, Bangladesh

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Abstract
The giant scale insect, *Perissopneumon ferox* Newstead is a major destructive, polyphagous, monophlebid pest that causes significant plant yield loss, typically found on woody plants, and is challenging to control. As a newly documented pest in Bangladesh, the present study deals with its biology, incidence, and ecological impacts both in the laboratory and in the field of Jahangirnagar University Campus (JUC), Dhaka, Bangladesh. Study of biology was conducted at room temperature, and a two-year field sampling was carried out on eight marked host plant species by visual counting in regular fortnightly surveys. A total number of 8028 insects in 2004-2005 on 5 host plant species and 1914 individuals in 2023-2024 on an equal number of host plant species, including three new plants were recorded. The host *Albizia procera* was the highest-infested tree. The pest insect peaks in June and gradually decreased to the end of the rainy season. No male was observed, and the female reproduced by thelytokous parthenogenesis, with laying eggs from mid-November to mid-December. Then the eggs hatched under the soil after more than two months of diapause in winter. In the laboratory study, its lifespan was recorded from 227-263 days including the nymphal period of 158.20±2.54 days. Its fecundity was 231±7.09. There were 13 types of ants found to be associated with this scale colony. The host plants and insect individuals declined in the latest study up to 19.5% and 76.16%, respectively, due to gradual deforestation. The current research will help understand the biology and ecological fitness of this insect, which is essential to figuring out its field management system.

Keywords: Scale insect, *Perissopneumon ferox,* Biology, Ecological fitness, JU, Bangladesh

Introduction

Plants, the dominant living biomass, are vital to life on Earth, providing food, oxygen, and other resources thus the primary determinants of ecosystem structure and consequent biodiversity (Duncer *et al*. 2025) [14]. Insects, indispensable to ecosystems, play varied roles that derive environmental balance and linked to our lives. In addition, these most successful living organisms harmful in various ways, such as nuisance, spreading diseases, being herbivores, etc. (Sharma *et al*., 2021) [39]. The insect genus *Perissopneumon* New stead (Homoptera: Monophlebidae: Monophlebinae: Monophlebini) is a poorly studied group. Among six species of this genus, *P. ferox* is known as the Late Mango Mealybug (Das & Das, 2022) [13]. This species is distributed throughout the Indian subcontinent (Varshney, 1992) [46] and Australia (Ben-Dov *et al*., 2006) [5]. Their secretions are used to make useful products including lacquer, red dye, and waxes. The giant scale's sugary waste product or honeydew is a vital food source for other insects, such as bees and wasps (Kondo & Gullan, 2022) [24]. They also spread plant pathogens, which results in indirect damage by lowering production and market value.

This insect feeds on a variety of host plants and causes severe damage to yield production. Thus, causes significant economic losses to numerous host woody plant species under 16 families (Garcia-Morales *et al*., 2016; Jose, 2017; Pathan *et al*., 2018; Das & Das, 2022) [15, 20, 32, 13]. Therefore, it is considered an important pest insect. This insect pest is found on all plant strata, mainly the stem. They insert their stylets into the plant tissues and suck off the phloem sap that causes substantial leaf, flower, and fruit loss as well as lower fruit weight. Their severe infestation can also kill off plants (Pathan *et al*., 2018) [32].

The mealy, waxy coating on the dorsal side of the scales helps to spread out the individuals within the colony and shield them from ambient pollutants, insecticides, natural adversaries, defensive exudates, and other factors that can cause death (Kenneth & Jayashankar, 2020) [22]. When threshold levels are exceeded do insect turn into problem. To manage this pest insect with an appropriate ecosystem-based IPM strategy, its prevalence, precise peak activity and free times, distribution, vulnerable life stages, fecundity, and relationship with plants and environmental factors are must know (Jayakumar & Rajavel, 2019) [18].

Among so many factors to explore, the first is biology, which has been poorly studied earlier (Gavrilov-Zimin, 2021) [16] throughout the world including Bangladesh, where its population density is higher than other scale species (Reza & Hasan, 2020) [35]. Jahangirnagar University Campus (JUC), is an unofficial sanctuary known as a "heaven for biodiversity" (Khan *et al*., 2021) [23], which is deemed an ideal location for this study. Therefore, the biology of this pest species, both in lab and field conditions; its abundance; seasonal incidence on different host plants; impact of environmental factors, and effect of weather have been observed which, in the field, can be a helpful guideline for controlling these pest insects when the infection rate surpasses the threshold level.

Materials and Methods

P. ferox prevalence on host plants

Site description: The experimental work was conducted at JUC in Dhaka, Bangladesh, which is located in the center of Bangladesh, at 23.8824ºN and 90.2671ºE, 32 km to the northwest of Dhaka, the country's capital. It occupies 697.56 acres of land and is situated on the west side of the Dhaka-Aricha Highway (Figure 1). This region has a somewhat undulating terrain with red lateritic acidic soil, rising to a height of roughly 6 meters above mean sea level (Khan *et al*., 2021) [23].

Population studies, sampling, and examination: For 12 months between September 2004 and August 2005 and a further period from March 2023 to February 2024, the JUC was observed fortnightly (Chowdhury *et al*., 2022, Chowdhury & Rahman, 2024) [10, 11]. A plant taxonomist from the same university's Botany Department assisted in the identification and labeling of five major host plant species in 2004 and five plant species in 2023 at the beginning of the study. The plant species used in the experiment; shrub (*Aegle marmelos* (L.) Corr., Trans Linn.) and trees (*Albizia procera* (Roxb.) Benth., *Albizia lebbeck* (L.) Benth., *Albizia saman* (Jacq.) Merr., *Artocarpus heterophyllus* Lam., *Bombax ceiba* L., *Acacia auriculiformes* A. Cunn. ex Benth., *Lagerstroemia speciosa* (L.).

Using a 4-10x magnification lens, the insect-infested plants were examined visually up to two meters from the ground and recorded the data (Prasanna & Balikai, 2015; Akter *et al*., 2017) [33, 1]. Leaves, barks, and cracks of branches, rootstock, and stems of all the plants were searched for the presence of nymphs and adults of the test insects. In the field, some of them were preserved in plastic containers containing 70% alcohol with the right tags holding plant species, dates, and other necessary details. Then, they were brought to the Department of Zoology's IRES (Insect Rearing and Experimental Station) of JU. The samples were counted and then sent to the Pampel's fluid for additional research. The scale insects were identified by using standard keys (Rao, 1950; Ullah, 1987; Tang & Hao, 1995; Pathan *et al*., 2018; Das & Das, 2022) [34, 45, 43, 32, 13] up to the species level.

- **Documentation of meteorological aspects:** The Climate of Bangladesh is distinguished by hot, humid summers (March to May), a wet monsoon (June to October), and a dry, chilly winter (November to February). Monthly average relative humidity (RH%), average maximum temperature (T_{max}), average minimum temperature (T_{min}), average temperature (T_{avg}) in °C, and monthly average rainfall (RF) in mm were collected for the JU area throughout the study period from the Geography and Environment Department weather station of JU, which is located behind the JUC Central Cafeteria.
- **Analytical statistics:** Using IBM SPSS Statistics 28.0.0.0, the data were classified in an Excel spreadsheet and subjected to a one-way ANOVA analysis. The least significant differences in pest occurrence on different plants and in different months, as well as the combined influence of climatic conditions on the *P. ferox* bug, were determined using LSD tests at 0.05 probabilities. Then, when there was a significant difference between the means, Duncan's test was run at 5% to isolate the means. Using the statistical program JASP 0.16, simple correlation (r) values were tallied to learn more about the relationship between giant scale incidence and the mean records of the three examined meteorological conditions.

Life cycle parameters of *P. ferox*

- **Collection, mass culture, and study of biology:** A mass-rearing *P. ferox* began from the collection of twenty live adult female *P. ferox* from *A. procera* tree in JU kept on wet filter paper (1 female/petri dish) in a glass petri dish (11x1 cm) to lay eggs in the entomology net house of IRES, Department of Zoology of JU. After hatching the eggs, nymphs were transferred to 30-day-old food plants *(A. procera*) grown on earthen pots placed on a tray containing fresh water in nylon netted wood-framed cages (90x45x90cm). Pre-oviposition, oviposition, and incubation period, fecundity, and hatchability were determined from adult females and eggs laid on Petri dishes, while the nymphal period and mortality, adult emergence, and adult longevity was examined on potted plants by placing one newly emerged nymph on each food plant per cage. After anaesthetizing in 70 percent alcohol, the length and breadth measurements of freshly emerging nymphs and eggs were computed with the help of a Leica microscope. There were 5 replications in each experiment. In each replication, one insect was experimented. Room temperature and relative humidity were recorded daily throughout the experimental period, and the average temperature and relative humidity calculated were 29.3°±1°C and 78.4%, respectively. Necessary precautions were taken to keep the insects free from parasites and pathogens. The experiments were carried out according to the protocol of Chowdhury *et al*. (2008) [12].
- Seasonal population dynamics and field observation on habits and biological aspects including variations in the duration of developmental stages of test insects were also made on ten randomly selected infested plants of *A. procera* and *A. lebbeck* on both aerial parts and roots by regular inspection during the study period (Mahore & Pandey, 2023) [27]. The presence of natural enemies and other organisms near the *P. ferox* life stages and colony

was also reported.

- **Analytical statistics:** The collected data of various developmental stages were analyzed by one-way analysis of variance (ANOVA) with a 95% significance level. Biological parameters of *P. ferox* were expressed as range, Mean ± SE, and Coefficient of Variation (CV). Statistical analysis was done by R programming where necessary.

Results and Discussion

Results

Biology of giant scale, *P. ferox*

The biology of female *P. ferox* was studied and observed higher reproductive rate (Plate 1-3; Table 1, 2). The findings are presented below.

Taxonomic characteristics in laboratory study

Eggs: The average longevity of Pre-oviposition and oviposition period was 125.7±1.9 days and 7.67±1.05 days, respectively. Eggs were laid in cottony ovisacs, and not all eggs were laid at a time. A single female laid 231±7.09 eggs during the lifetime of the study period. The newly laid eggs were observed as oval, minute, light white that changed into light yellow when matured with an average length and width of 0.4mm and 0.2mm, respectively. Color became black when it was damaged. The females were found to die soon after laying all their eggs. The average incubation period was observed as 78.4±1.33 days. The average per cent of eggs hatched 69±12.5 (Plate 2f, g; Table 1).

Nymphal stages: After hatching the eggs, nymphs emerged and spread their appendages, then remained near the eggshell with the ventral side upper. Finally, they started to move about on the Petri dishes. Nymphs began to suck the sap of host tissue within 2 to 3 hours after hatching. Laboratory observations confirmed that there were 3 nymphal instars. The total nymphal period was about 158.20±2.54 days. The 2^{nd} and 3^{rd} instars completed their development in a relatively short period (Plate 2h-j; Table 1).

The first instar nymph was light brown, more or less elliptical, measured 4mm in length and 3mm in width (before molting), 10-segmented body, 6-segmented antennae with numerous setae. Eye, stylet, and legs were prominent. The first instar nymphal period lasted 87.60±1.44 days, which is significantly longer (F=589.9, DF=2, P<0.001) than other nymphal stages, inversely significantly shorter (F=177.3, DF=1, P<0.001) than adults' lifespan of 131.60±2.98 days (Plate 2h; Table 1).

The 2^{nd} instar nymph was 6mm in length and 4mm in width. Its body color is light brown to brown, and white waxy powder deposits on the body surface within 2-3 days of molting. Antennae are eight-segmented and narrower than the 1^{st} instar. The antennae, legs, and labium were larger than the 1^{st} instar. Setae were present in all segments of the leg, but the 2^{nd} segment contained the largest setae. Labium and body were divided into 3 and 11 segments, respectively. The 2^{nd} instar lasted for 30.80±0.86 days on average. This period also individually differed significantly (F=30.22, DF=2, p<0.001) from the developmental period of the rest of the instars including adults (F=1058, DF=2, p<0.001) (Plate 2i; Table 1).

The early 3^{rd} instar nymph was 8mm in length and 5mm in width. Their shape was almost adult-like and brown with 12-segmented bodies and 3-segmented labia. Antennae 9-segmented, 1^{st} segment was the broadest, the 9^{th} was the longest with long setae at the tip, and the 8^{th} antennal segment was the smallest. The antennae, legs, and labium were longer than the 2^{nd} instar. The largest seta is present in the 2^{nd} segment of the leg. The third instar period persisted at 39.80±1.39 days and exhibited a significant (F=780.3, DF=2, p<0.001) difference with adult longevity. After the third instar, the nymphs of scale could not molt in the laboratory (Plate 2j; Table 1).

The average rate of nymphal survivability (%) was 73.68±2.33, and the mortality (%) was 26.32±2.33. There is a very significant difference (F=205.9, DF=1, P=<0.001) between the percentage of nymphal survivability and mortality (Table 1).

Adults: The average longevity of adult females was 131.60±2.98 days, which is significantly highest (F=640.1, DF=3, P=<0.001) among different life stages of *P. ferox*. In the present study, only one generation was observed in its lifespan or in a single year (Table 1). The adult female was bilaterally symmetrical, red-brown in color, 13-segmented body, wingless, well-developed black legs, and two 10-segmented antennae. The body is cottony, oval, soft and covered with slight white wax. Adult female had ventral derm with multilocular pores. Each loculi contains 4-8 rim. The length and width of newly emerged females varied from 12-15 mm and 7.5-9 mm, respectively (Plate 1a-d, 2c-d; Table 1).

Field study

Biology of *P. ferox*: In the field, the biology of *P. ferox* was observed on *A. procera* and *A. lebbeck* plants. They were found to reside in the protected areas as cracks and crevices in bark (Plate 2e) and on roots. Usually, they do not form any colony but singly move slightly to find a good hiding location on the host and firmly establish themselves until dropping into the earth (Plate 2n). The female forms a cottony ovisac or egg-laying chamber around her body and remains motionless (Plate 2b).

The ovisac was found during mid-November-mid-December, and the egg hatched from mid-February to the end of March, after more than two months of diapause. Almost all eggs of a female hatched within 15 days (Table 2). The first instar nymphs crawled up the tree by the end of February-mid-April when temperatures rise and eventually settle on the bark and crevices of host plants. The 2^{nd} and 3^{rd} instar were found from middle May-middle June and middle June-middle July respectively. Adult females were found by the end of July, and almost all species fell into the soil before the beginning of November (Table 2). *P. ferox* prefers to live near the base of the host plant, and many insects also live at or underneath the junction of the plant root and soil from March to September. Crawlers and adults travel for suitable shelter until to develop the soft ovisac.

Association of different organisms in the field: There was a mutualism relationship was observed in the *P. ferox* colony, where thirteen different types of ant species namely, *Camponotus pennsylvanicus*, *Camponotus consobrinus*, *Camponotus floridanus*, *Camponotus vicinus*, *Solenopsis invicta*, *Formica rufa*, *Dorylus gribodoi*, *Monomorium minimum*, *Iridomyrmex purpureus*, *Lasius alienus*, *Nylanderia fulva*, *Lepisiota canescens*, *Crematogaster cerasi* were found to eat the body wax and honeydew of *P. ferox* besides they protect its colony from predation (Plate 2k-m, 3a-b). On the other hand, different kinds of predators were observed close to the eggs and first instar of *P. ferox*; *i.e.*, *Trigoniulus corallinus* (millipede), *Scolopendra* sp. (centipede), several beetle species including *Rodolia fumida*, *Harpalus pensylvanicus*, *Pterostichus melanarius*, *Cryptolaemus montrouzieri*, *Coccinella septempunctata*, *Melanotus* sp., *Apogonia* sp., *Leptus* sp. (mites), *Periplaneta americana* (cockroach), *Hemidactylus* sp. (small house lizard) (Plate 3c-g, r). Besides predators such as two tailed spiders, small house lizards (*Hemidactylus* sp.), oriental garden lizards (*Calotes versicolor*), birds; parasites including wasps (*Specius* sp.) and other organisms like bees, dragonflies, butterflies, moth (*Siccia guttulosana*), stink bug (*Tessaratoma papillosa*, *Halyomorpha halys*, *Urolabida histrionica*, Pentatomidae, *Brochymena* sp.), squirrels were also discovered in the trunk near to further life stages of this insect (Plate 3h-r).

Prevalence of *P. ferox*

Invasion during 2004-05: A total of 8028 *P. ferox* individuals were recorded from 102 plants out of a total of 323 plants in JUC under 5 different species in a year (Figure 2). The tree, *A. procera* attracts the highest (F=3.738, DF=4, P=0.009) *P. ferox* insect. The insect was absent from November to January, and a significantly higher number (F=3.574, DF=11, P=0.001) of them was found from March to June. The average monthly population of this pest was very low to moderate (0-427) on different plant species. The mean number varied from 47-336 insect/plant species/month (Figure 3).

Invasion during 2023-24: A total of 1914 *P. ferox* individual was recorded from 41 plants out of 166 under 5 species from the same study area in 2023-24 (Figure 2). The same tree, *A. procera* was the most preferred plant for this insect (F=2.757, DF=4, P=0.0367). The insect was absent from November to February, but the highest (F=1, DF=4, P=0.454) was in June. In this latest study, among the plant species, each hosted a comparatively fewer number of (2-55) insects/month, where the average monthly insect population ranged from 0-97/plant species (Figure 4).

The insect population (F=4.443, DF=1, P=0.0467, 76.16%) and host plants (F=0.142, DF=1, P=0.712, 19.5%) substantially decreased from 2004 to 2023, though three species of host plant were added newly (Figure 2-4).

Impact of weather on *P. ferox*

The weather had a significant impact (2004-05: F=6.347, DF=3, P=0.016; 2023-24: F=5.378, DF=3, P=0.025) on *P. ferox* population abundance in both study years. Temperature (r=0.65) played the most important role followed by humidity (r=-0.49) and rainfall (r=0.04) in 2004-05 and in 2023-24 rainfall (r=0.77) was the most significant factor, followed by temperature (r=0.64) and humidity (r=0.59).

Discussion

- **Biology of *P. ferox*:** The giant scale insect, *P. ferox* is little-studied invasive insect pest that is easy to establish when brought to a new nation because of its cryptic and polyphagous habits, smaller size, and higher reproductivity (Table 1). Their propensity to spread through wind, rain, splashing water, arthropods, infected plants, bed soil and different animals is higher. Adult *P. ferox* is elliptical, 10-15 mm in length and up to 6mm in width as reported in previous studies (Rao, 1950; Pathan *et al*., 2018) [34. 32]. Their flexible body structure and sensitivity to light, temperature, and rain have adapted them to reside in protected areas as cracks, crevices in barks and roots (Arora & Nath, 1960) [2].

  Insects of this genus were observed to lay their eggs in soil within an ovisac and then die, as found in India (Srivastava & Verghese, 1985) [41], similar to *Perissopneumon tectonae* (Kumar *et al*., 2017) [26]. The eggs were found to a depth of 5-20 cm in soil within a few feet in diameter around the base of the host plant, as well as a diapause of about two months in the winter season. A narrower range but equal depth (15-20 cm in silken purses) was reported for *Drosicha mangiferae* (Nair, 1975; Sathe *et al*., 2014) [31, 38]. A similar diapause period was observed in the same species (Srivastava & Verghese, 1985) [41] and *D. mangiferae* (Smith *et al*., 2016; Akter *et al*., 2017) [40, 1]. After hatching, the crawlers climb on trees as observed by Bodenheimer (1951) [7].

  The first instar nymphs crawled up the tree by the end of February to mid-April when the temperature rises, which is a normal trend of this group of insects, for example, the nymphs of *p. ferox* and *P. tectonae* hatched in summer (Arora & Nath 1960; Srivastava & Verghese 1985) [2, 41]. Almost all crawlers hatched in the nearable period in a suitable environment (Sathe *et al*., 2014) [38], and they did not have a waxy coat after hatching, which made them more susceptible to natural enemies and insecticides. This information can help to determine the best timing of control operations. Gradually waxy coating developed. Once crawlers settle to feed, they become immobile. However, the size of immature stages is almost equal to *Perissopneumon tamarindus* (Kumar *et al*., 2018) [25].

  The longevity (131.60±2.98) of adult *P. ferox* is considerably longer than other mango mealy bugs, namely *D. mangiferae* (39-69 days) (Bhau *et al*., 2017) [6]. Adult females were found by the end of July, and almost all species fell into the soil before the beginning of November (Arora & Nath, 1960; Kumar *et al*., 2018) [2, 25]. This insect prefers to live near the base of the host plant like other scale insects and mealybugs. They also live at or underneath the junction of plant roots and soil from March to September (Mani *et al*., 2016) [28]. Generally, this species has one generation in a year and three nymphal instars (Srivastava & Verghese, 1985) [41]. The male is rare to be found in the field. So, females perform parthenogenesis reproduction (Maruthadurai & Karuppaiah, 2014) [29] as seen in *P. tectonae* (Arora & Nath, 1960) [2].

  In the present study, 13 types of ant species (Hymenoptera: Formicidae) were found with *P. ferox* that give them protection from predators (e.g. beetles, mites, spiders, birds, etc.), parasites (e.g. wasps), and other natural enemies. Ants, bees, etc. retain their colony pure from detritus, which allure sooty mold fungi (Plate 2o) (Jose, 2017; Kumar *et al*., 2018; Kenneth and Jayashankar 2020) [20. 25, 22]. The presence of ants, preferred hosts, and a lack of natural enemies might contribute to the higher population of *P. ferox*.
- **Effects of ecology on *P. ferox*:** The present study observed the declining trend of the insect *P. ferox* due to the decline of old host plants by gradual deforestation, fire incidents, clearing forests, plant death, fuel wood collection, applying lime from the base of the plant upwards, lack of awareness, insufficient tree plantation, etc. Generally, the decline of the insect population is attributed to competition and remoteness of the host plant (John *et al*., 2022) [19], which are analogous to the present situation as well as the scenario all over the country. The insects mostly resided beneath the loose bark and in the cracks and fissures of the stem but the newly identified

host had fewer bark and cracks and carried a few number of insects. The test insect prefers to survive in the soil when the conditions are unsuitable. The factors listed above as well as the shortage of new plantations could be contributing to the *P. ferox* population decline (Reza & Hasan, 2019; Hoque, 2023; Sathe & Rahman, 2023) [35, 17, 37]. To maintain ecological balance, the authority needs to take proper action for the restoration of conservation and practice eco-forestry, punishing rule breakers harshly, building social movement and raising awareness about deforestation, fight against corruption, and ensure transparency (Roy *et al*., 2014; Reza & Hasan, 2019; Hoque, 2023) [36, 35, 17].

- **The impact of weather on *P. ferox*:** Climate variables including rainfall, relative humidity, and temperature are interrelated. The population of *P. ferox* exhibited a substantial positive association with the T_{max}, T_{min}, and T_{avg}. This insect is known as a tropical and subtropical pest throughout the globe including Bangladesh (Varshney, 1992; Ben-Dov *et al*., 2006; Mondol *et al*., 2019) [46, 5, 30]. The test insect, *P. ferox* was found to be more common during the pre-monsoon (F=3, DF=2, P=0.08), followed by monsoon, and post-monsoon periods, which was also observed in a previous study in Bangladesh for *D. mangiferae* (Akter *et al*., 2017) [1] and for *P. tamarindus* (Uddin *et al*., 2012; Banik *et al*., 2015) [44, 4]. Previous studies also found a significant positive link between weather factors to *D. mangiferae* in India (Chakraborty *et al*., 2015) [9] and in Indonesia (Supriadi *et al*., 2015) [42]. In addition, a negative link between humidity and temperature, and no correlation of rainfall to *P. tamatrindus* population density (Banik *et al*., 2015) [4], besides the detrimental impact of heavy rain and the beneficial link of light rainfall was observed (Karthik *et al*., 2021) [21].

Additionally, scale insects can overwinter as eggs, immature, or adults (Smith *et al*., 2016) [40]. They were absent in the winter months on a stem. Then, they may have hidden and taken refuge under the soil close to the roots for pupation and protected their generation from natural enemies, inter-or intraspecific competition, and unfavorable climate. It first appeared in March, then began to rise and peaked in June. Then began a dramatic declined in July through October. The current results are consistent with those of Pathan *et al*. (2018) [32] in India, who stated that the highest population of *P. ferox* was observed during June on *Emblica officinalis*. They infest woody plants during periods of rapid growth, budding, flowering, and fruiting of plants in summer and monsoon (Ullah, 1987; Azam *et al*. 2009) [45, 3].

Conclusion

The biology of *P. ferox* was studied both in the laboratory and in the fields in JU. Its pre-oviposition, oviposition, and incubation period, fecundity, hatchability, duration of nymphal instars, nymphal survivability, mortality, and adult longevity were determined on *A. procera* plant under laboratory conditions. Habit and some aspects of biology and natural biota related to this species in the field were also noted. The present findings regarding the life cycle study indicate its higher fecundity and good adaptation. The population incidences of *P. ferox* on 8 plant species in different months of the recent year and twenty years back were also studied. Its field incidence declined in the recent study due to environmental degradation as well as varied in different seasons, and plant species. Generally, in a world of diverse herbivores, the sap sucker scale insects can be often neglected in many ecological studies, and they become pests when their population exceeds a certain threshold. Their miniature sizes can make us overlook their existence, yet their presence can be linked to many other organisms including smaller life forms like ants, and bees to larger forms like birds, which play a noteworthy role in an ecosystem. The number of host plants and insect biota especially herbivores reduced drastically mainly due to defective urbanization. Unfortunately, human interference through their activities has adversely affected biodiversity both for plants and animals. However, to control the population of scale, the present study recommends *P. ferox* can be checked by integration of banding of plant trunks with polythene sheet, grease or glue should be applied at the lower edge of band, put soil at the base of plants will prevent nymphs crawling up the plant, destruction of eggs by soil working, application of not attacked plant (e.g. *Polyalthia longifolia*, *Swietenia mahagoni* etc.) extracts such as plant sap, leaf or bark juice, flower, and seed or leave dust as their repellants, action of natural enemies and application of insecticides (Akter *et al*., 2017) [1]. Finally, this kind of study should be more and more, which may be beneficial to predict pest outbreak time and Integrated Pest Management practices to protect the relevant crops.

Table 1: Statistics of biology of different life stages of *P. ferox* in the laboratory

Life stages	Duration of days		Mean ± SE	CV (%)
	Min.	Max.		
Pre-oviposition period	122	132	125.67±1.86	3.62
Oviposition period	5	12	7.67±1.05	33.68
Incubation period	75	83	78.4±1.33	3.78
1st nymphal instar	83	91	87.60±1.44	3.66
2nd nymphal instar	29	34	30.80±0.86	6.25
3rd nymphal instar	35	43	39.80±1.39	7.83
Total nymphal period	154	168	158.20±2.54	3.59
Adult longevity	126	143	131.60±2.98	5.06
Fecundity	210	260	231±7.09	7.52
Hatchability (20 eggs/rep.)	30	95	69±12.5	40.48
Survivability (%)	66.67	78.95	73.68±2.33	7.08
Mortality (%)	21.05	33.33	26.32±2.33	19.83

Table 2: Different life stages of *P. ferox* on above ground in different months of JU

Dates	Nymphal Instar			Adult	Dates	Nymphal Instar			Adult
	1st	2nd	3rd			1st	2nd	3rd	
H1 of Jan	x	x	x	x	H1 of Jul	x	x	✓	x
H2 of Jan	x	x	x	x	H2 of Jul	x	x	x	✓
H1 of Feb	x	x	x	x	H1 of Aug	x	x	x	✓
H2 of Feb	✓	x	x	x	H2 of Aug	x	x	x	✓
H1 of Mar	✓	x	x	x	H1 of Sep	x	x	x	✓
H2 of Mar	✓	x	x	x	H2 of Sep	x	x	x	✓
H1 of Apr	✓	x	x	x	H1 of Oct	x	x	x	✓
H2 of Apr	✓	x	x	x	H2 of Oct	x	x	x	✓
H1 of May	✓	x	x	x	H1 of Nov	x	x	x	x
H2 of May	✓	✓	x	x	H2 of Nov	x	x	x	x
H1 of Jun	✓	✓	x	x	H1 of Dec	x	x	x	x
H2 of Jun	x	x	✓	x	H2 of Dec	x	x	x	x

*✓ & x indicate present & absent respectively; H1=1st Half, H2= 2nd Half

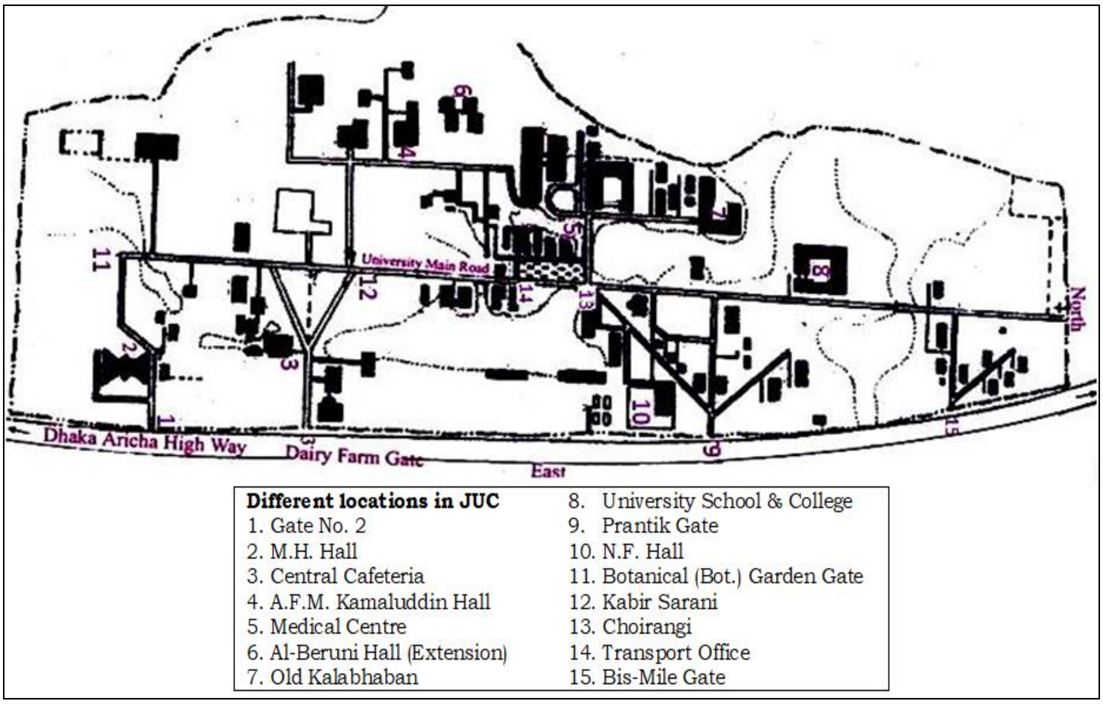


Fig 1: Study area

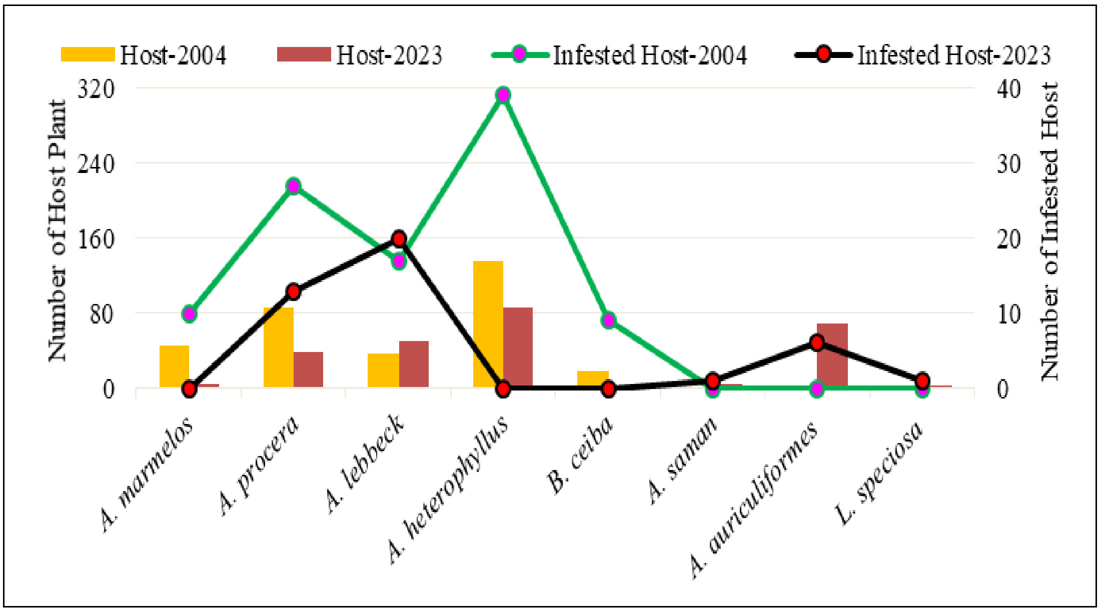


Fig 2: Comparing the host and infected host plants in 2004 and 2023

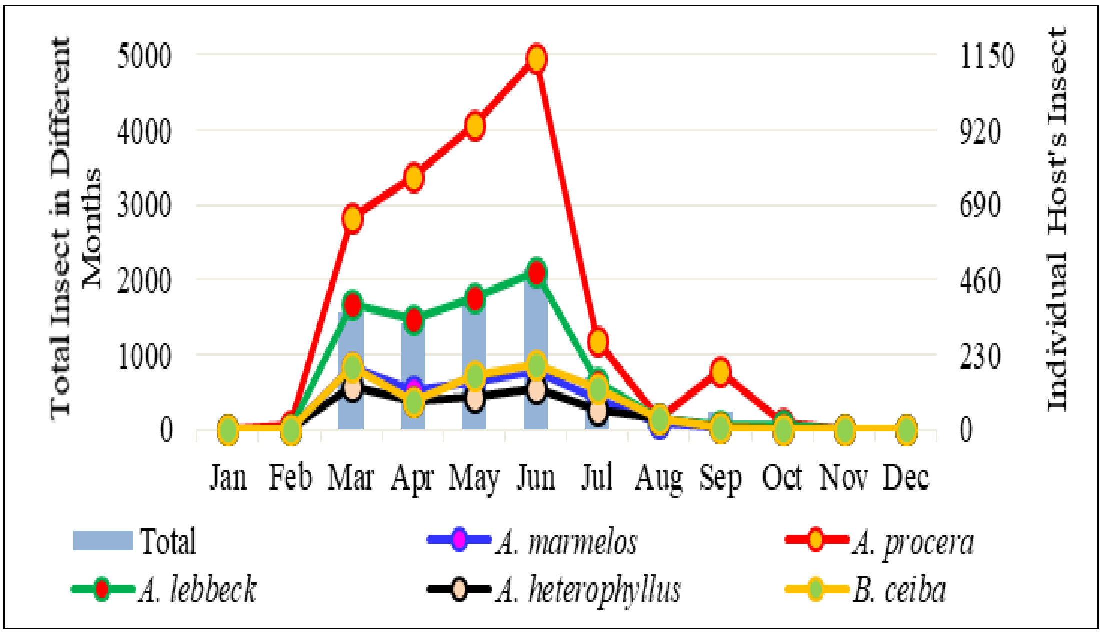


Fig 3: Monthly pest incidence in JUC during 2004-05

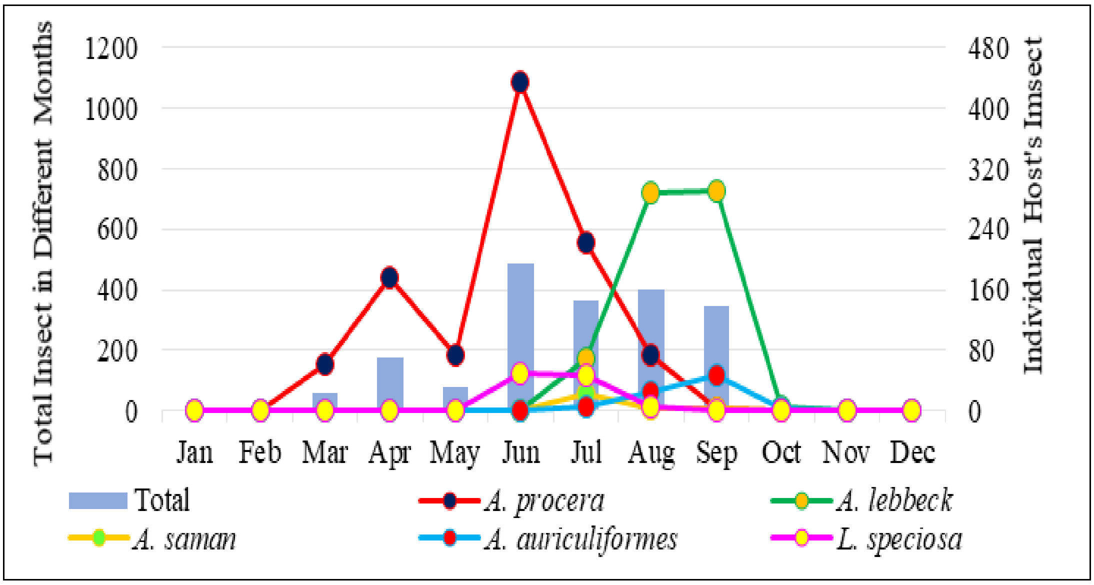


Fig 4: Monthly pest incidence in JUC during 2023-24

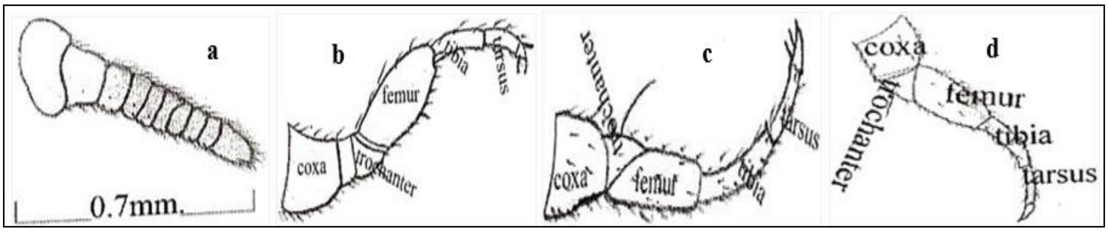
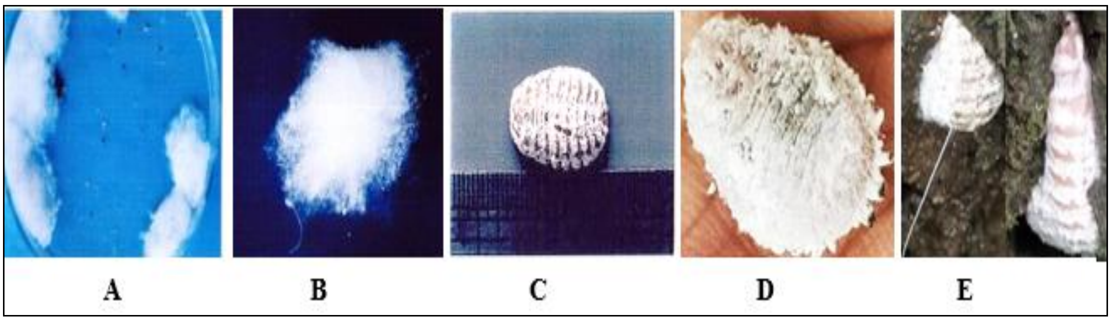


Plate 1: Morphological structure of adult *P. ferox*: a Antenna; b Leg of 1st pair; c Leg of 2nd pair; d Leg of 3rd pair



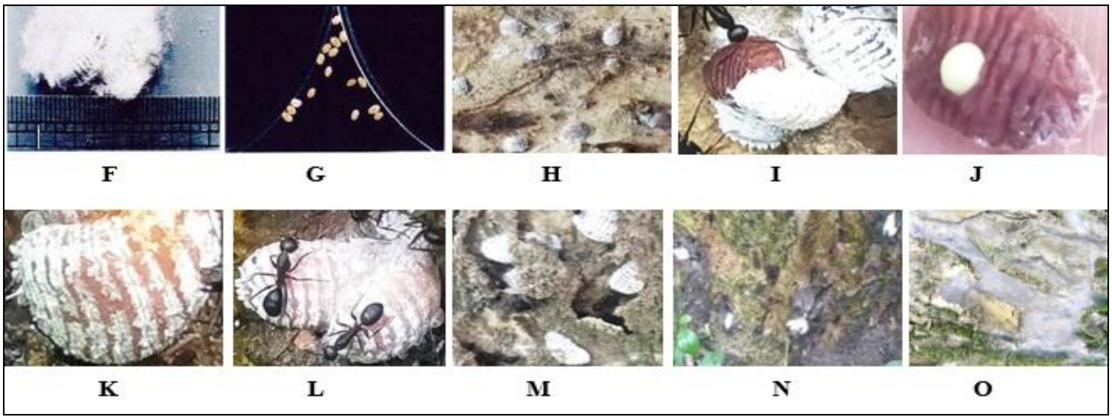


Plate 2: Life stages of *P. ferox*: a Laboratory rearing; b White cottony ovisac; c Adult (Dorsal view); d Adult (Ventral view); e Adults in host's cracks; f Oviposition; g Eggs; h 1st instar in *A. procera*; i 2nd instar & their molting; j Injured 3rd instar after molting; k Honeydew discharge by adult; l Mutualism with ants; m Adult insect in ant nest made by clay in *L. speciosa*'s bark; n Adult insect on *A. procera*; o Sooty mold fungi on *A. lebbeck'*s stem

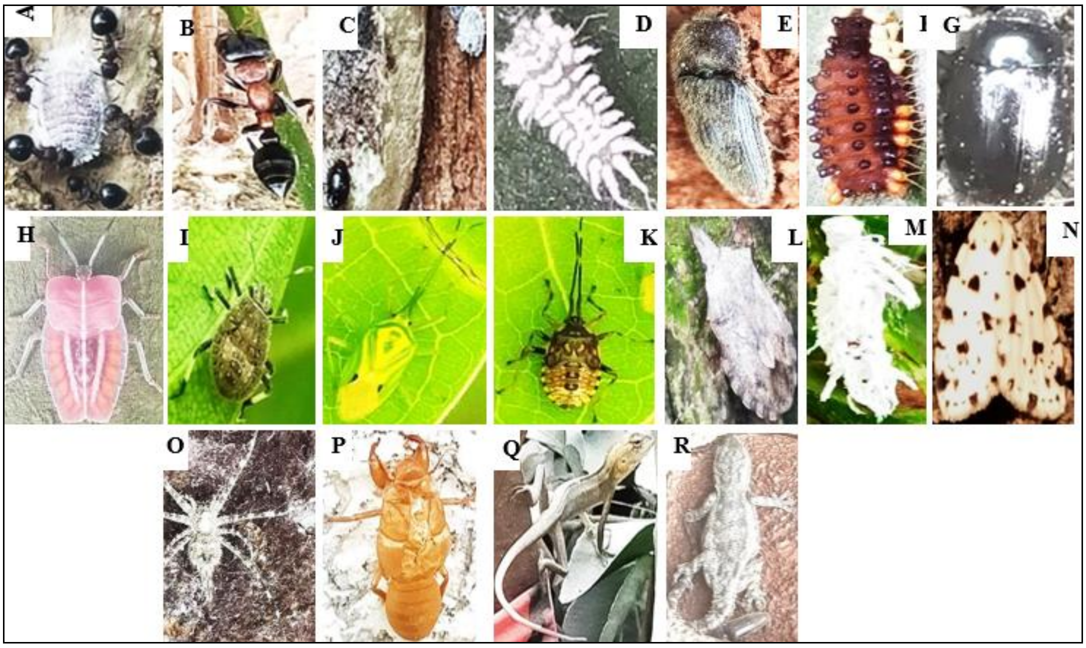


Plate 3: Various organism available with *P. ferox*: a-b Ants (*C. cerasi*, *C. vicinus*); c-g Beetles (Coccinellidae, *C. montrouzieri* larva, *Melanotus* sp., Ladybird beetle larva, *Apogonia* sp. respectively); h-l Sting bug (*T. papillosa*, 4th instar nymph of *H. halys*, *U. histrionica*, Pentatomidae, *Brochymena* sp. respectively); m Caterpillar (*G. thyrsis*); n Moth (*S. guttulosana*); o Two Tailed Spider's camouflage; p Cicada wasp exuviae (*Specius* sp.); q *C. versicolor* (camouflage with bark); r *Hemidactylus* sp. (Camouflage with bark)

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