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ECOLOGICAL IMPACT ON THE PREVALENCE OF GIANT SCALE INSECT (HOMOPTERA : MONOPHLEBIDAE) IN JAHANGIRNAGAR UNIVERSITY CAMPUS, BANGLADESH

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Abstract

Most monophlebid insects are highly polyphagous, dimorphic, and well-known sap-sucking plant pests throughout the world. To determine their abundances, distribution, incidences, seasonal dynamics, feeding nature and the effects of ecological changes on their populations, an initial study (September 2004–August 2005) and a review study (March 2023–February 2024) were carried out in Jahangirnagar University Campus (JUC), Savar, Dhaka, Bangladesh. The host plants (trees and shrubs) were examined through biweekly visual counts. In the initial investigation, 14,802 monophlebid insects from three species (Biodiversity Index or BI = 0.002, H = 1, D = 0.387, 1-D = 0.613, 1/D = 2.58, and E_H = 0.91) were documented from 10 plant species. In the review study, a total of 423 insects under five species (two previously identified and three new) (BI = 0.141, H = 0.22, D = 0.917, 1-D = 0.083, 1/D = 1.1, and E_H = 0.14) detected from five plant species, including one new species. Within around 20 years from the first study, the percentage of total plants and infested plants decreased significantly by 47.14% and 92.96%, respectively. The amount of insects decreased by 2.86%, while 87.67% of shrubs decreased (F = 5.8, df = 1, P = 0.07). The pest insects from trees and shrubs reduced by 3.67% and 0.45%, respectively. The identified most suitable host plant was *Ficus benghalensis* for sheltering maximum scale insect in both studies. The only insect pest, *Icerya aegyptiaca* was consistently abundant throughout the period in both studies. The insect, *I. aegyptiaca* was found available on every part of the plant, though the majority of them survived on leaves. The present findings might contribute understanding ecological imbalances and helpful for developing effective management strategies against these insect pests.

Keywords: Prevalence, Ecology, Scale insects, Plant pests, Bangladesh.

Introduction

A major share of insects often poses a threat by destroying and damaging our economically important plants as well as injuring humans and animals (Allison *et al*., 2023). The giant scale insect is a notable soft-bodied commercial pest that causes significant damage to a variety of host plants, primarily woody ones. It is dimorphic, polyphagous, extremely fecund, and cryptic. Giant scales live in protected habitats such

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as bark cracks and crevices, at the base of leaf petioles, on the underside of leaves, within fruit bunches, in the plant crown, in branch crotches, on stems near soil, and they infest all parts of host plants. Their wax-coated bodies shield them from contact insecticides and other mortality factors. Despite their apparent monophyletic grouping, the giant scales exhibit diversity in both morphology and biology (Mani *et al*., 2011; Morales *et al*., 2016).

Certain scale insects provide benefits to humanity by producing valuable products like wax and dyes (Kondo and Gullan, 2022). But the majority is significant plant pests including transmission of fungal, bacterial and viral pathogens (Allison *et al*., 2023). Bangladesh has few records on its total scale insect species and their pest association with different host plant species (Chowdhury *et al*., 2023). In addition, our flora and fauna is continuously decreasing due to our environmental changes by gradual deforestation to meet the need of over burden human population (Reza and Hasan, 2020; Brandão *et al.*, 2022). So, continuous study is essential to update the status of our pest population.

As Jahangirnagar University Campus (JUC) is a protected area with rich biodiversity (Khan *et al*., 2021), any kind of changes on its environment and plant pest association can be understood easily. Therefore, it was selected to conduct the present study to estimate the population abundance of giant scale, their seasonal richness, feeding habit and ecological impacts on their population fluctuation and feeding nature. To assess the above-mentioned factors including influence of major climatic factors on monophlebid population also studied to determine the ideal time for operating pest management activities.

Materials and Methods

Study area: The study was conducted in Jahangirnagar University Campus (JUC), Savar, Dhaka. The campus is located on an area of 282.29 hectares. It is situated on the western side of the Dhaka-Aricha Highway (Fig. 1) of 32 km northwest of Dhaka City (23.8671°–23.8977° E and 90.2588°–90.2731° N) having iron rich fertile soil (Khan *et al*., 2021).

Methods: Study sites were visited in an interval of twice in a month for both studies of September 2004 to August 2005 and March 2023 to February 2024 to monitor the occurrence and field adaption of giant scales. The last study was conducted mainly to compare the changes in the habitat, abundance and diversity of test insects. At the start of the study, ten major plant species in 2004 and five plant species in 2023 were identified and labeled as host plants with the aid of a plant taxonomist from the same university's

Botany Department. The experimental plant species included both trees and shrubs. The trees were *Albizia procera* (Roxb.) Benth., *Albizia lebbeck* (L.) Benth., *Mangifera indica* L., *Artocarpus heterophyllus* Lam., *Ficus benghalensis* L., *Achras sapota* L., *Alstonia scholaris* (L.) R. Br., and *Cassia javanica* L., while the shrubs were *Citrus medica* L., *Citrus grandis* (L.) Osbeck, and *Psidium guajava* L.

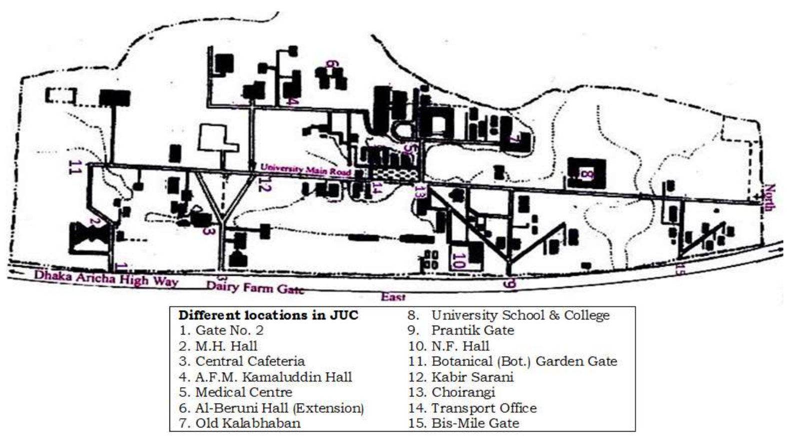

Fig. 1. Study area.

Using a 4–10x magnification lens, the extent of insect infestations on plants was evaluated visually, and data were recorded using standard procedures (Ullah, 1987; Prasanna and Balikai, 2015; Akter *et al*., 2017). Scale nymphs and adults were found on the surfaces of leaves, bark, and in the crevices of stems, branches, and rootstock of every plant, extending up to an average height of two meters from the ground. In the field, a few scales were preserved in plastic containers with 70% alcohol and appropriately labeled with information on the plant species, date, and other details. They were then transported to the laboratory. The samples were counted and then sent to Pampel's fluid for further research. The samples were picked out to the species level using standard keys (Ullah, 1987; Morales *et al*., 2016; Tian *et al*., 2018).

Monthly weather data, including average maximum temperature (T_{max}), minimum temperature (T_{min}), average temperature (T_{avg}) (°C), average relative humidity (RH%), and average monthly rainfall (RF) (mm), were obtained for the JU area from the Geography and Environment Department weather station of JU, located behind the Central Cafeteria of JUC. Bangladesh has three distinct seasons: the scorching summer season (March – May), the cool, dry winter season (November – February), and the rainy monsoon season (June – October).

Data analysis: Using IBM SPSS Statistics 28.0.0.0, the data were organized in an Excel spreadsheet and subjected to a one-way ANOVA analysis. To determine significant differences in pest occurrence on various plants, across different months, and in the combined effect of climatic conditions on giant scales in hosts, Least Significant Differences (LSD) tests at a 0.05 probability level were employed. Simple correlation (r) values were calculated to examine the relationship between scale occurrence and the number of individual trees, as well as the mean records of the three investigated weather parameters, using the statistical program JASP 0.16. The Duncan Multiple Range Test (DMRT) was used to differentiate the means at the 0.05 significance level.

To explain the diversity of species, the Biodiversity Index (BI) was computed by dividing the number of species present by the total number of individuals in the area (AMNH, 2020). The Shannon and Simpson diversity indices were computed as described by Shannon and Weaver (1949) and Simpson (1949). The Shannon Index (H) quantifies species diversity by accounting for both the number of species and the distribution of individuals among them. Simpson's Index (D) evaluates diversity by considering species richness and evenness. The Simpson's diversity index (or Gini-Simpson index) = 1-*D*, and Simpson's reciprocal index is 1/D. Shannon's equitability (Evenness Index) (E_H) (Magurran, 2013) is used to measure degree in abundance of species. Sorenson's Coefficient (CC) was also calculated (Sorensen, 1948) using to gauge the similarity of two study years. Statistical analysis was done by R, a statistical programming language.

Results and Discussion

Monophlebids insect infestation in 2004-2005: A total of 14,802 giant scale insects, representing three types of monophlebid insects, were reported from 142 afflicted plants out of 490 woody plants under ten host plant species during a year-long study conducted at JUC starting in September 2004 (Table 1, Fig. 2). The mean number of different insects in different months did not differ significantly (F=0.871, df = 2, P=0.428). *Icerya aegyptiaca* (52.14%) was the most prevalent among the monophlebids, followed by *Crypticerya jacobsoni* (25.76%) and *Icerya minor* (22.1%). For scale insect occurrence in various months, *F. benghalensis*, *P. guajava*, *A. procera*, *A. heterophyllus*, and *M. indica* were shown to be more suitable hosts than other plants (F=2.599, df = 9, P=0.009). Among the ten plant species, there was no discernible variation in the mean infestation of giant scales (F=0.9, df = 9, P=0.543). Insect frequency on trees was greater than on shrubs (F=3.422, df = 1, P=0.138) (Table 1, Figs. 3-5, and Plate 1).

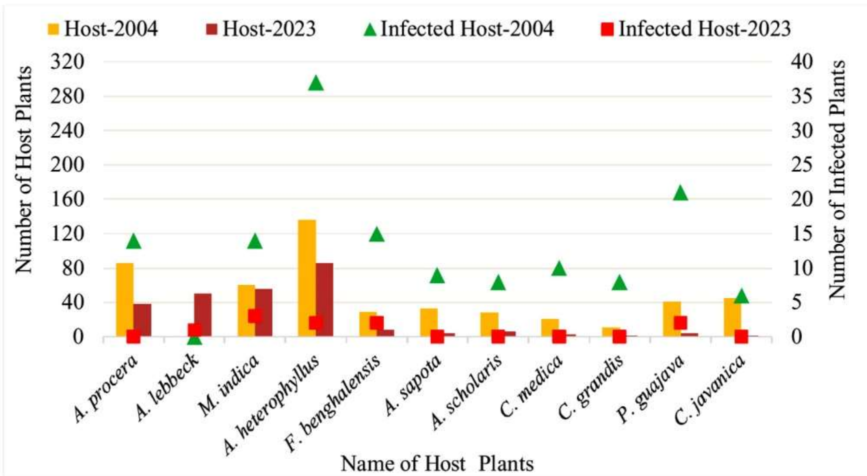

Fig. 2. Comparing the host and infected host in 2004 and 2023.

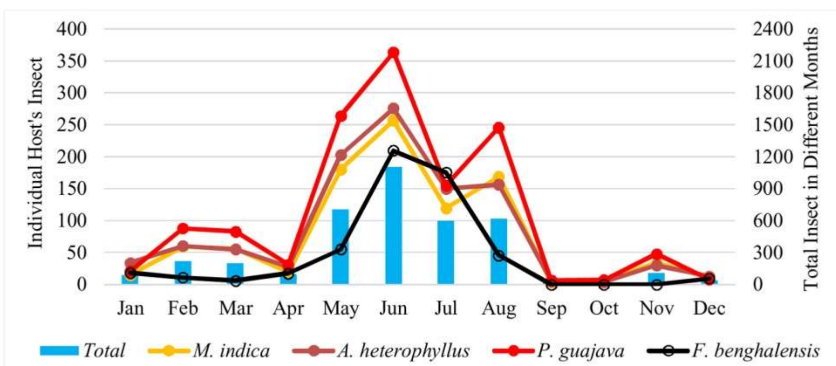

Fig. 3. Incidence of *C. jacobsoni* in various months during 2004-05.

C. jacobsoni: A total of 3,813 *C. jacobsoni* individuals were found on 40 plants out of 265 plants belonging to 4 species in JUC over a single year (Fig. 2, 3). June showed a substantially higher pest population (F=17.07, df = 47, P < 0.001) compared to other months. The frequency of *C. jacobsoni* on various plants did not differ significantly (F=0.975, df = 47, P=0.413), with each plant species hosting an average of 46–110 insects per month (Table 1 and Fig. 3).

I. aegyptiaca: A total of 7,717 *I. aegyptiaca* individuals were recorded on 57 plants out of 188 plants across 4 species in JUC over a single year (Fig. 2, 4). No specific plant species was particularly preferred by these insects (F=0.742, df = 47, P=0.533). The mean number of pest insects per month for each plant species ranged from 63 to 234. The insects were absent from October through January, with April and May producing the significantly highest populations (F=12.46, df = 47, P<0.001). Outside these months, the population was generally low (Table 1, Fig. 4).

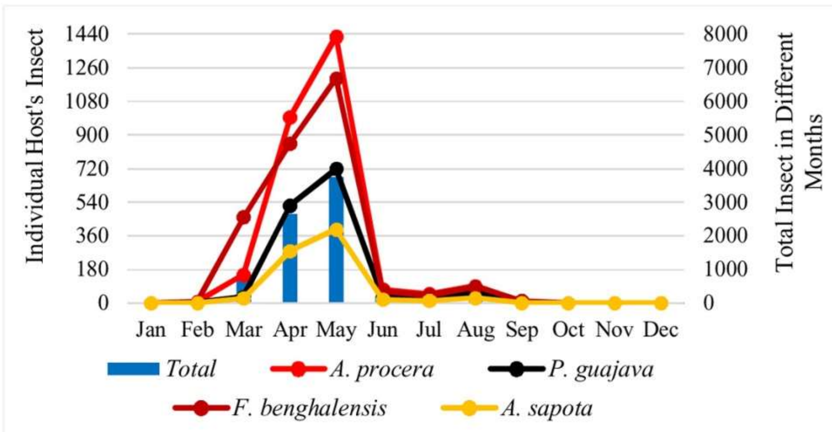

Fig. 4. Incidence of *I. aegyptiaca* in various months during 2004-05.

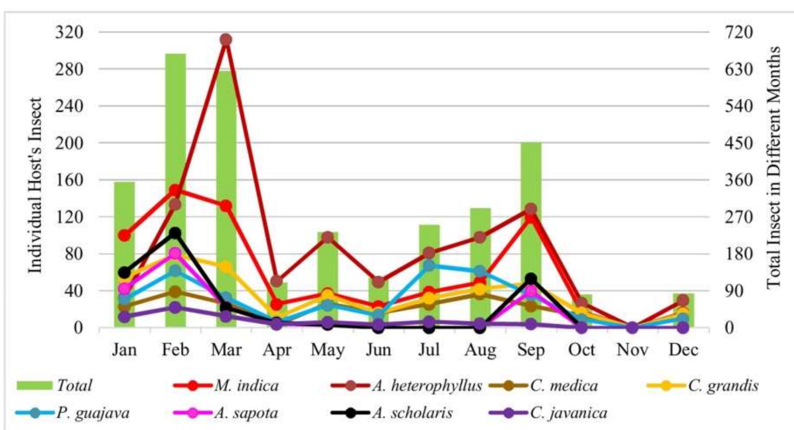

Fig. 5 Incidence of *I. minor* in various months during 2004-05.

I. minor: A total of 3,272 *I. minor* individuals were recorded in a year from 107 plants out of 375 plants across 8 species in JUC (Fig. 2, 5). This species was absent in November. Its monthly population was generally moderate to low, with February and March having the highest populations (F=3.723, df = 95, P=0.000). Each plant species hosted an average of 6–87 insects per month, with *A. heterophyllus* significantly harboring the highest quantity of insects (F=5.314, df = 95, P<0.001) (Table 1, Fig. 5).

Monophlebids insect infestation in 2023-2024: In a review conducted in the same study region during 2023–2024, 423 insects from 5 different Monophlebid species were discovered over a 12-month period. Of the 259 plants across 11 species that were examined, the pest insects were found on 10 plants belonging to 5 plant species (Table 2, Fig. 2). The mean number of different insects varied significantly across months (F=4.51, df = 4, P=0.003). The highest mean density was observed for *I. aegyptiaca* (95.74%), followed by *I. minor* (2.84%), *Drosicha corpulenta* (0.71%), *Icerya seychellarum* (0.47%), and *Drosicha mangiferae* (0.24%). For scale incidence across different months, *F. benghalensis* and *M. indica* were identified as the most suitable hosts (F=3.496, df = 4, P=0.013) compared to other hosts. Five plant species had similar average levels of scale insect contamination (F=0.778, df = 4, P=0.552). The incidence of various insects was significantly greater on trees compared to shrubs (F=1.014, df = 1, P=0.343) (Table 2, Plate 1).

I. aegyptiaca: A total of 405 *I. aegyptiaca* individuals were detected on 4 infected plants out of 68 host plants belonging to 3 species in JUC over a year (Table 2, Fig. 2). Among the plant species, *F. benghalensis* was preferred (F=2.729, df = 35, P=0.08) by these insects. The mean number of pest insects per plant species per month ranged from 1 to 24. Generally, its monthly population was low or absent, except in January and February (F=2.166, df = 35, P=0.0551) (Table 2).

The incidence of other scale species was extremely low during 2023–2024 (Table 2).

Comparative analysis of two studies: In the research area, the number of host plants decreased from 2004 to 2023 (F=2.093, df = 1, P=0.163, 47.14%), and the number of infested plants also decreased (F=16.64, df = 1, P=0.001, 92.96%). The reduction rate of shrubs (F=5.8, df = 1, P=0.07, 87.67%) was significantly higher (F=5.826, df = 1, P=0.0733) compared to that of trees (F=1.266, df = 1, P=0.279, 40%). Additionally, one species of host plant was recently introduced (Table 1-2, Fig. 2). Due to the declining number of host plants, pest insects decreased to 2.86% (F=9.582, df = 1, P=0.005).

Table 1. Incidences of monophlebid fauna on host plant species at JUC in 2004 - 2005.

	Tree							Shrub			
	A. procera	*M. indica*	*A. heterophyllus*	*F. benghalensis*	*A. sapota*	*A. scholaris*	*C. javanica*	*C. medica*	*C. grandis*	*P. guajava*	Total
Host/ Insect	86 (14)	60 (14)	136 (37)	29 (15)	33 (9)	28 (8)	45 (6)	21 (10)	11 (8)	41 (21)	490 (142=28.98%)
C. jacobsoni	0	928	1014.5	548	0	0	0	0	0	1322	3813
I.aegyptiaca	2808	0	0	2734.5	766	0	0	0	0	1408.5	7717
I. minor	0	706.5	1040	0	192.5	245.5	75	245.5	414.5	352	3272
Total	2808	1634.5	2054.5	3282.5	958.5	245.5	75	245.5	414.5	3082.5	14802
	11058.5 (74.71%) [BI=3/(11058.5/12)=0.003]							3742.5 (25.29%) [BI=0.009]			[BI=0.002]

*Data in the parenthesis show the number of host plants with scales.

Table 2. Incidences of monophlebid fauna on host plant species at JUC, 2023 - 24.

Host/ Month	*I. aegyptiaca*				*I. minor*			*I. seychellarum*	*D. corpulenta*	*D. mangiferae*	Total	Total (2004-05)
	M. indica 56 (1)	*F. benghalensis* 8 (2)	*P. guajava* 4 (!)	Total 68 (4)	*M. indica* (1)	*A. heterophyllus* 86 (2)	*P. guajava* (1)	*M. indica* (1)	*A. heterophyllus* (1)	*A. lebbeck* 50 (1)		
Jan	27	94	12	133	0	0	0	0	0	0	133	444
Feb	44	110	0	154	0	0	0	0	0	0	154	910
Mar	0	0	0	0	2	6	0	2	0	0	10	1496
Apr	4	6	0	10	0	2	0	0	3	1	16	2859
May	2	5	0	7	0	0	0	0	0	0	7	4682
Jun	12	28	0	40	0	0	0	0	0	0	40	1425
Jul	0	0	0	0	0	0	0	0	0	0	0	980
Aug	0	0	0	0	0	0	0	0	0	0	0	1171
Sep	0	0	0	0	0	0	0	0	0	0	0	499
Oct	0	0	0	0	0	0	0	0	0	0	0	98
Nov	2	4	0	6	0	0	0	0	0	0	6	112
Dec	16	36	3	55	0	0	2	0	0	0	57	126
Total		405				12		2	3	1	423	14802

*Data in the parenthesis show the number of host plants with scales

Specifically, pests were reduced to 3.67% (F=8.473, df = 1, P=0.008) in trees and 0.45% (F=13.15, df = 1, P=0.001) in shrubs. Between 2004–05 and 2023–24, *I. aegyptiaca* and *I. minor* decreased to 5.25% (F=2.932, df = 1, P=0.101) and 0.367% (F=18.87, df = 1, P=0.000), respectively. One insect species disappeared completely, while three new insect species were introduced, resulting in a Sorenson's Index or Community Coefficient (CC) value of 0.444. The diversity indices of insects (from 2004–05: Insect Biodiversity Index or BI = 0.002, H = 1, D = 0.387, 1-D = 0.613, 1/D = 2.58, E_H = 0.91; to 2023–24: BI = 0.141, H = 0.22, D = 0.917, 1-D = 0.083, 1/D = 1.1, E_H = 0.14) reflect this deteriorating trend (Tables 1-3, Fig. 2).

Table 3. Different insect diversity indices are shown in both studies.

Diversity Indices	2004-05	2023-24	Comments
Total Number of Individuals (N)	14802	423	Number of individual insect decreases
Number of Species	3	5	Number of species increases
H (Shannon Index)	1	0.22	Insect diversity decreases
D (Simpson Index)	0.387	0.917	Insect diversity decreases
1-D (Simpson's diversity index)	0.613	0.083	The community diversity decreases
1/D (Simpson's reciprocal index)	2.58	1.1	Species diversity decreases
E_H (The Shannon Equitability Index)	0.91	0.14	The insect abundances far differed
CC (Sorenson's Coefficient)	0.444		The communities overlapped slightly

Plant specific interaction: Between 2004 and 2005, each insect pest survived on four to eight host plants. Furthermore, *P. guajava* served as the host plant for the highest number of three Monophlebid species and did not show any additional preference for competing pest insects (F=1.184, df = 2, P=0.319). This was followed by *M. indica* (F=0.42, df = 1, P=0.524), *A. heterophyllus* (F=2.387, df = 1, P=0.137), *F. benghalensis* (F=2.387, df = 1, P=0.137), and *A. sapota* (F=1.55, df = 1, P=0.226), which were hosts for two species each. The next five plant species hosted a single insect species each. The variety of host plants explains the abundance of specific insect species (r = 0.2) (Table 1, Fig. 3-5). In 2023–24, many host plants lost their previous insect biota and attracted new insect species. For example, in *M. indica*, *I. aegyptiaca* was significantly more abundant compared to the other two species (F=4.718, df = 2, P=0.0158), followed by *A. heterophyllus* and *P. guajava* for two insect species each, while each of the remaining plant species hosted only one insect species (Table 2).

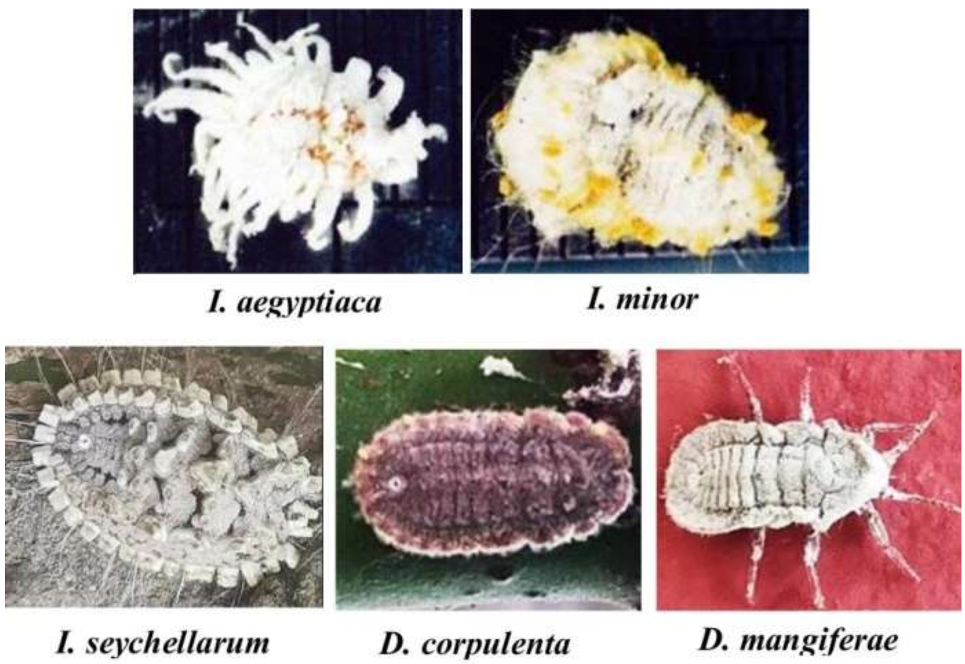

Plate 1. Different giant scales found in JUC.

Plant parts infestation: In 2004–2005, almost all Monophlebid species significantly took refuge on plant leaves (F=4.899, df = 3, P=0.0322; 66.96%). Although *I. aegyptiaca* and *I. minor* also favored other regions, *C. jacobsoni* only consumed the leaves of plants. In our study from 2023–24, the largest number of insects was also found on leaves (F=0.962, df = 3, P=0.434; 43.01%), and *I. aegyptiaca* predominantly favored leaves. *I. minor* was absent from stems in both studies (Table 4).

Table 4. Nature of monophlebid insect infestations in the study area over the two study years.

Insect	Stem	Branch	Twig	Leaf	Total	Insect	Stem	Branch	Twig	Leaf	Total
C. jacobsoni	0	0	0	3813	3813	*I. minor* (2023-24)	0	2	3	7	12
I. aegyptiaca (2004-05)	2808	219	326	4364	7717	*I. seychellarum*	0	2	0	0	2
I. aegyptiaca (2023-24)	0	12	36	357	405	*D. corpulenta*	0	0	0	3	3
I. minor (2004-05)	0	686	851	1735	3272	*D. mangiferae*	1	0	0	0	1

Weather effect on monophlebids: The weather had a significant influence on the population fluctuations of Monophlebid insects. The insect populations were negatively affected by both exceptionally high and low temperatures. During the 2004–05 study, the insect population was influenced by mean temperature, humidity, and rainfall, with impacts of up to 54.31% (F=3.17, df = 3, P=0.085). Among these factors, temperature played the most important role, followed by humidity and rainfall. However, due to the brief winter season, the average minimum temperature was a key factor in the increase of these insects. Among the three individual pests, maximum and minimum temperatures had the least impact on *I. minor* and *I. aegyptiaca*, respectively. For *C. jacobsoni*, average humidity had the least effect, while for *I. aegyptiaca*, average rainfall had the minimal impact. In 2023–24, the average temperature, humidity, and rainfall negatively impacted the insect population by up to 67.2% (F=5.463, df = 3, P=0.02445), with rainfall and humidity being the next most significant factors, in order of importance, after temperature (Table 5).

Table 5. Correlation (‘r’ value) of abiotic factors with monophlebid in different months.

Weather Factors	Correlation	Total (2004-05)	Total (2023-24)	*I. aegyptiaca* (2004-05)	*I. aegyptiaca* (2023-24)	*I. minor* (2004-05)	*I. minor* (2023-24)	*C. jacobsoni*	*D. corpulenta*	*D. mangiferae*	*I. seychellarum*
T_{max}	r	0.5	-0.6	0.5	-0.6	-0.0	0.2	0.4	0.5	0.5	0.2
T_{min}	r	0.5	-0.8	0.3	-0.8	0.2	-0.2	0.6	0.1	0.1	-0.1
T_{avg}	r	0.5	-0.8	0.4	-0.8	0.2	0.0	0.5	0.3	0.3	0.0
RH	r	-0.4	-0.4	-0.3	-0.4	-0.4	-0.6	-0.2	-0.4	-0.4	-0.5
RF	r	-0.0	-0.6	-0.1	-0.6	0.1	-0.2	0.2	-0.1	-0.1	-0.1

Bionomic impact on Monophlebids: Between 2004 and 2023, the insect and plant biota in the study region steadily declined 97.14% and 47.14%, respectively and old plant biota's declined rate 57.35% (Table 1-2, Fig. 2). The plants that were present in early study were between five and twenty years old, although their typical lifespan is about 30 years. Insects were predominantly observed at heights of less than 25 feet, the study focused on populations up to head level. The remaining old trees have grown significantly taller and larger over the past twenty years, making it difficult for the scale insect population to be maintained. This factor led to the migration or decline of the Monophlebid population (Ullah, 1987; Jackson, 2024).

Additionally, biotic factors such as long distances between host plants and intraspecific and interspecific competition contribute to the decline of insect species (Allison *et al*., 2023). In this study, anthropogenic activities, including tree cutting, fires, fuel wood collection, pollution (air, water, light, and soil pollution), application of lime to plants, plant death, lack of new plantings and awareness, and improper maintenance, were primarily responsible for increasing distances between host plants. This situation, characterized by rapid population growth such as the expansion in staff, student list, and faculty activities; enhanced intervention efforts, and the impact of faulty urbanization, building temporary shops and global warming, is not unique to the current study area but is observed nationwide and globally. Authorities need to address this trend by planting trees, conducting workshops and seminars on forest management, implementing effective policies and regulations, allocating funds and resources for conservation, and enforcing penalties for rule violations. A healthy atmosphere and protection of natural habitats are essential for the survival of all living things that is essential for stable ecosystem (Allison *et al*., 2023; Malanson and Alftine, 2023).

Infestation Nature of Monophlebids: D. corpulenta, *D. mangiferae*, and *I. seychellarum*, three of the six detected polyphagous monophlebid insect species (Morales *et al*., 2016) in the current study region, were observed feeding on a single plant species. In contrast, the other three species attacked at least four to eight plant species (Tables 1, 2). Prior research has revealed that a larger percentage of economically significant scale insect species are associated with a broad range of host plants, and many pests can be raised or survive on alternative hosts that they had not previously colonized. For instance, among the identified species, *I. aegyptiaca* infested the highest number of host plant genera—at least 129—across 65 families, while *I. minor* invaded the fewest, with 3 host genera from 3 families (Morales *et al*., 2016). In addition to their frequent consumption of leaves, many of these insects (Table 4) also commonly reside on stems and other plant parts (Morales *et al*., 2016). *I. aegyptiaca* was observed feeding on nearly all surface plant components in the current study, demonstrating its greater flexibility, higher reproductive capacity, and abundance in Bangladesh (Bragard *et al*., 2023).

Most insects documented on leaves are likely found in the soft tissues, where they can easily infiltrate and feed on the sap, which is preferred by scales (Hsu, 2019). Additionally, since practically all Monophlebids are highly polyphagous, the fluctuation in the number of scales on different portions of the host plants is related to their polyphagous and phytophagous nature (Friedrichs *et al*., 2022). The resistance and diverse morphological, physiological, and chemical characteristics of different plants are key determinants of their polyphagous nature. Certain plants have up to four times higher concentrations of chemical components (Awmack and Leather, 2002). According to He *et al*. (2015), the concentration of nitrogen, proteins, minerals, and water is greatest in leaves and lowest in stems and branches. Elevated levels of nitrogen, minerals, and water result in the development of succulent, juicy, and relatively smooth leaves. Furthermore, the area and quantity of leaves attracts sucking insects, such as scale insects (Huang *et al*., 2021; Huntley, 2023).

Weather Effect on Monophlebids: Climate variables affecting giant scale infestation include temperature, relative humidity, and rainfall. These variables can be interconnected and have positive, negative, or negligible impacts on infestation rates (Bashir *et al*., 2022). Giant scales primarily inhabit regions with tropical and subtropical climates (Bragard *et al*., 2023). The current study region is characterized by a tropical climate with both dry and rainy seasons and significant humidity during certain periods (Mondol *et al*., 2019). Giant scales respond differently to these meteorological conditions, which may explain the variation in insect population density observed across plants. *C. jacobsoni* was present year-round among the Monophlebid species, while other species were only present during specific seasons. The seasonal climate was conducive to the growth of host plants, and in most cases, giant scale incidences were positively associated with various seasons (Chrysantus, 2012; Nandi and Chakraborty, 2015) (Table 5).

C. jacobsoni peaked in June. Yukawa (1984) observed that a large number of leaves and twigs from different plant species positively affected *C. jacobsoni* during the monsoon season in Indonesia. *I. minor* reached its peak in February 2005 during the cooler months. The highest incidence for *I. aegyptiaca* occurred in May 2004 and February 2024. These findings align with those of Awadalla and Ghanim (2016) and Helmy (2021), who also recorded peaks for *I. aegyptiaca* in summer and winter. The study's conclusions indicate that the Monophlebid population on host plants was either nonexistent or very low depending on the season. In such cases, the insects may have taken refuge underground, under bark, or inside the trunk for pupation, thereby protecting themselves from predators, unfavorable climate conditions, and other threats. Downward migration also depends on mutualistic relationships with ants and the availability of food. The population is influenced by seasonal, biotic, abiotic, and anthropogenic factors, as well as the substrates they feed on and their movement (Allison *et al*., 2023).

Conclusion

To sum up, plants are fundamental elements of the planet and the living world. They are connected to specific insect species, either directly or indirectly. Insects provide valuable services to mankind and the environment (Allison *et al*., 2023). They become pests only when their population exceeds a certain threshold. Monophlebids are widespread pests affecting many species of trees and shrubs, as they feed on plant parts and carry various bacteria and viruses that cause diseases. For instance, *I. purchasi* is a pest affecting 65 families of woody plants (Morales *et al*., 2016). Regular and thorough research is required to understand their dispersal, distribution, involvement in various habitats, and ecosystem roles, areas that remain underexplored in Bangladesh.

Because JUC is a small, isolated ecosystem, it provides a unique opportunity to understand the roles of different pest insects in various host plants and seasons, as well as the effects of ecological changes. A preliminary investigation into the population dynamics of monophlebids was conducted earlier (Chowdhury *et al*., 2022). The current study, involving a year-long investigation from 2004–05 and a twelve-month review from 2023–24 in the same region, has revealed the feeding patterns and the impact of human activities on Monophlebid habitats and survival.

In the previous study, ten plant types, including both trees and shrubs, were found to be attacked by three monophlebid species. In the current investigation, however, only *I. aegyptiaca* and *I. minor*, along with three new insect species, were detected on five host plant species, including one new plant species. This shift is attributed to a significant reduction in the number of host plants and insect biota. According to this study, *I. aegyptiaca* can persist longer in an unstable environment due to its varied feeding habits. Furthermore, the rapid loss of flora and fauna is causing environmental changes and deterioration. A diverse biotic flora is essential for sustaining a rich biotic fauna. Therefore, taking preventative measures is crucial for maintaining a healthy ecology and environment.

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