Investigations on Biology and Life cycle ~~Developmental Stages~~ of Pear Psylla, ~~(~~*Cacopsylla pyricola* Foerster~~)~~ ~~in Kashmir~~

KEYWORDS

Cacopsylla pyricola
Pear psylla
Biology
Life cycle

ABSTRACT

Pear psylla (*Cacopsylla pyricola* Foerster) is a significant pest of pear trees (*Pyrus communis*), causing extensive damage to pear orchards through feeding and the secretion of honeydew. A laboratory study was conducted at SKUAST - Kashmir to examine the biology and life cycle of Pear psylla. *Cacopsylla pyricola* Foerster. ~~Eggs were collected from unsprayed pear orchards, and various developmental stages were observed~~ under controlled conditions (32±2°C, 12:12 photoperiod). The results ~~study~~ revealed that the incubation period lasted for 13.27 days. The insect~~pest~~ undergo~~nces~~ five nymphal instars, with a total nymphal period of 38.55 days. Adult psyllids exhibited a pre-oviposition period of 7.9 days, followed by an oviposition period of 28.6 days, with fecundity ranging from 400 to 650 eggs~~/ per~~ female. Male psyllids lived slightly longer (62.55 days) than females (61.35 days). ~~These findings align with previous research and provide critical insights into the developmental stages, fecundity, and longevity of Pear Psylla.~~ The study contributes valuable data for better understanding the biology of pear psylla, facilitating more effective pest management strategies in pear-growing regions.

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1 Introduction

Pear (*Pyrus communis*, family Rosaceae) is one of the most significant pome fruits, grown in many temperate countries. Pear consumption is valued for its high content of vitamins (ascorbic acid), minerals (potassium and calcium), soluble and insoluble dietary fiber, and antioxidants (phenolic compounds and flavonoids) (Ziaaddini *et al.,* 2022; Zambounis *et al*., 2020; Tang *et al*., 2022; Ghazouani *et al.,* 2020). Pear can also be used in various processed foods, such as canned fruit, baby food, glazes, vinaigrettes, and fruit bars. In 2021, China was the world's largest producer of pears, followed by the United States of America and Argentina. According to the Food and Agriculture Organization of the United Nations (2021), Belgium, the Netherlands, and Spain were the top three producers in Europe.

Insect infestations can result in large financial losses in the production of pears. The psyllid genus *Cacopsylla* is responsible for the majority of pear pests. Pear fruit and leaves can sustain damage and quality losses from the pear psylla (*Cacopsylla pyri*), pear sucker (*C. pyricola*), and other psylla species (*C. pyrisuga, C. bidens*). They can also spread phytoplasmas (*Candidatus Phytoplasma pyri*), which contribute to pear decline disease in pear orchards across Europe and North America.

There are two morphologically distinct adult phases of the pear psylla *(Cacopsylla pyricola)*: a larger, darker winterform that overwinters, and a smaller, reddish-brown summerform. One generation of winterform psylla and four or five generations of summerform psylla exist. While the winterform is found from September to May, the summerform is found from June to October. From September to the beginning of November, the summerform and the winterform overlap. For the remainder of the year, one kind or another is more common. The winterform adult psylla develops from the eggs laid by the summerform psylla in late summer as the days grow shorter. A fraction of the winterform psylla stays in the pear orchards throughout the winter, although some of these winterform adults depart in late fall and overwinter on other adjacent vegetation. The ovarian diapause that winterform female psylla experience prevents the development of their eggs, necessitating a period of low temperatures. The female psylla returns to pear trees to lay her eggs on the budding pear leaf buds when the diapause period ends and the weather starts to warm. The summerform psylla subsequently develops from these eggs. The nymphal instar has five stages. At moderate temperatures (21–27 ºC), nymphs need 3–

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4 weeks to complete their development (Georgala, 1957; Mc Mullen and Jong, 1977). There are equal amounts of male and female offspring produced (Burts and Fischer, 1967).

This study aims to investigate the developmental biology and life cycle of pear psylla (*Cacopsylla pyricola* Foerster) under controlled conditions in Kashmir. The research seeks to provide insights into the pest's reproductive behavior and lifespan to support the development of more effective pest management strategies for pear orchards

2 Material and Methods

The present study ~~research~~ on the developmental biology and life cycle of Pear Psylla was conducted in the laboratory of SKUAST-Kashmir. This study was designed to observe and document the various developmental stages of insect ~~stages of the pest's development~~ under controlled conditions (mention conditions). To achieve this, leaf samples containing eggs of pear psylla were collected from unsprayed pear orchards to ensure that chemical pesticides did not influence the natural biology of the pest. The collection process was carried out ~~with utmost~~ carefully to avoid damage to ~~ing~~ the eggs. The leaves with attached psylla eggs were carefully pruned from different parts of the pear tree canopy to capture a representative sample of the population.

The collected leaves were immediately transferred to the laboratory in sealed containers to minimize exposure to environmental factors that might affect the eggs' viability. The leaves were placed in Petri dishes lined with moist-blotting paper to maintain adequate humidity. This setup was critical in preventing the desiccation of the eggs and ensuring proper observation conditions. The Petri dishes were stored in a climate-controlled chamber, maintained at an ambient temperature of 32±2°C, RH?, with a photoperiod of 12 hours of light and 12 hours of darkness. This temperature and photoperiod were chosen to simulate typical environmental conditions during the pear psylla's active season in Kashmir.

The eggs were observed daily under a stereo microscope, and their development was monitored closely. The duration from egg deposition to the emergence of the first instar nymph was recorded as the incubation period. For accuracy and precision, each observation was replicated ten times, ensuring that the data collected was statistically robust. The number of nymphal instars was counted, and the duration of each instar was recorded. The nymphal instars were differentiated based on changes in size, color, and behavior, and the developmental stages were categorized accordingly.

The total nymphal period was determined by summing the duration of all five nymphal stages. Nymphs were reared to adulthood under the same controlled conditions to monitor their progress through the life cycle. Once the adult psyllids emerged, they were separated by gender, and daily observations were made to assess their longevity. Adult males and females were housed separately in Petri dishes, which were also lined with moist-blotting paper to maintain adequate moisture. Each adult was provided with fresh pear leaves daily to mimic the natural feeding environment and support their survival.

The fecundity of female psyllids was determined by counting the number of eggs laid during their lifetime. Females were kept in pairs with males to allow for mating, and egg deposition was monitored regularly. To ensure accurate fecundity data, eggs were counted daily and the cumulative egg count was used to determine total fecundity per female. The sex ratio of the psyllid population was calculated by determining the proportion of males to females in the adult population.

3 Results and Discussion

3.1 Biological ~~Aspects~~ of Pear Psylla (*Cacopsylla pyricola* Foerster)

3.1.1 Egg i/Incubation period

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The eggs of Pear Psylla were initially small, elongated, and pale in color. As they approached hatching, the eggs underwent a noticeable color change, turning deep yellow. This color shift is indicative of embryonic development and is an important visual marker in the biological monitoring of the species. The incubation period, which is defined as the duration between egg deposition and the hatching of the first instar nymph, varied slightly depending on individual eggs but consistently ranged between 12 and 14 days, with a mean of 13.27±0.36 days. These findings are in close agreement with Simionca *et al*. (2022), who reported a similar duration for *C. pyricola* eggs. The incubation period is strongly influenced by temperature, as observed by Mc Mullen and Jong (1977), who found that eggs laid in warmer spring and summer conditions tend to hatch more quickly, taking between 6 and 10 days. However, in this study, the controlled temperature of 32±2°C extended the incubation period slightly, supporting the notion that environmental conditions play a critical role in egg development.

3.1.2 Nymphal Period

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After hatching, the psylla nymphs passed through five distinct nymphal instars, each with specific characteristics and durations. The first instar nymphs were soft-bodied and white in color, secreting copious amounts of honeydew, which is characteristic of early nymphal stages. This instar lasted between 5 to 7 days, with an average of 6.2±0.25 days. The second instar was distinguished by a slight increase in body size and lasted between 7 to 9 days, averaging 8.33±0.37 days. As the nymphs progressed through the third instar, their bodies darkened slightly, and this stage lasted 6 to 8 days, with a mean of 7.25±0.26 days.

The fourth instar nymphs exhibited more pronounced development of wing pads, indicating their transition toward adulthood. This instar lasted for an average of 9.2±0.25 days, ranging from 8 to 10 days. The fifth and final nymphal instar, often referred to as the "hardshell" stage due to its dark brown coloration and hardened wing pads, lasted an average of 9.95±0.68 days. The duration of the nymphal period was consistent with findings from other studies, such as those by Husain *et al*. (2018) and Akbar *et al.* (2017). The total nymphal period, encompassing all five instars, ranged from 35 to 41 days, with a mean duration of 38.55±0.72 days. These results align closely with Simionca *et al.* (2022), who observed similar developmental timelines in psylla nymphs.

3.1.3 Pre-oviposition period

The pre-oviposition period, which represents the time from adult emergence to the laying of the first egg, lasted between 7 to 10 days, with an average of 7.9±0.31 days. This period is critical as it reflects the maturation time required for females to become reproductively active. The duration of the pre-oviposition period in this study is consistent with Simionca *et al.* (2022), who reported similar findings of 6–10 days. The pre-oviposition period is influenced by several factors, including temperature, availability of food, and mating success, all of which were controlled in this laboratory study to ensure accurate results.

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3.1.4 Oviposition period

Following the pre-oviposition period, the oviposition phase began, during which the females laid eggs. The oviposition period in *C. pyricola* varied from 23 to 32 days, with a mean duration of 28.6±1.34 days. During this time, females were highly prolific, laying eggs in clusters on the leaves and stems of pear plants. These results are comparable to those of Simionca *et al.* (2022), who found that the oviposition period typically lasts between 25 and 30 days. Environmental factors, particularly temperature and food quality are known to influence the length of the oviposition period and the controlled conditions in this study provided a consistent environment for optimal egg-laying activity.

3.1.5 Fecundity

The fecundity of Pear Psylla females, which refers to the total number of eggs laid over their lifespan, was found to range from 400 to 650 eggs, with an average of 481.40±28.32 eggs per female. These findings are in line with previous studies, such as those by Stratopoulou and Kapatos (1992), and Mc Mullen and Jong (1977), who reported egg counts ranging from 140 to 600. However, it is important to note that fecundity can vary depending on the generation and environmental conditions. Horton and Lewis (1997) noted that the fecundity of overwintered adults could reach as high as 1000 eggs per female, particularly when conditions are favorable.

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3.1.6 Longevity of adults

The longevity of adult psyllids was found to differ slightly between males and females. Males lived for an average of 62.55±1.83 days, with a range of 60 to 67 days. Females, on the other hand, had a slightly shorter lifespan, ranging from 60 to 65 days, with a mean of 61.35±0.91 days. These findings are consistent with previous research by Simionca *et al.* (2022), who reported that adults of the new generation typically live for 60 to 65 days. The controlled laboratory conditions provided optimal longevity for the psyllids, as natural factors such as predation and fluctuating environmental conditions were excluded.

Table 1: Duration of different life stages of Pear Psylla (*Cacopsylla pyricola* Foerster)

Life Stages	Periods (days)	
	Range	**Mean±S.E~~D~~**
Egg Period or Incubation Period	12-14	13.27±0.36
Nymph Period		
First Nymphal Instar	5-7	6.2± 0.25
Second Nymphal Instar	7-9	8.33 ± 0.37
Third Nymphal Instar	6-8	7.25±0.26
Fourth Nymphal Instar	8-10	9.20±0.25
Fifth Nymphal Instar	9-10	9.95±0.68
Total Nymphal Period	35-41	38.55±0.72
Pre-oviposition Period	7-10	7.90±0.31
Oviposition Period	23-32	28.6±1.34
Fecundity	400-650	481.40±28.32
Adult Longevity		
Male	60-67	62.55±1.83
Female	60-65	61.35±0.91
Sex ratio	_	1.28:1

Mean±S.E of 10 replication

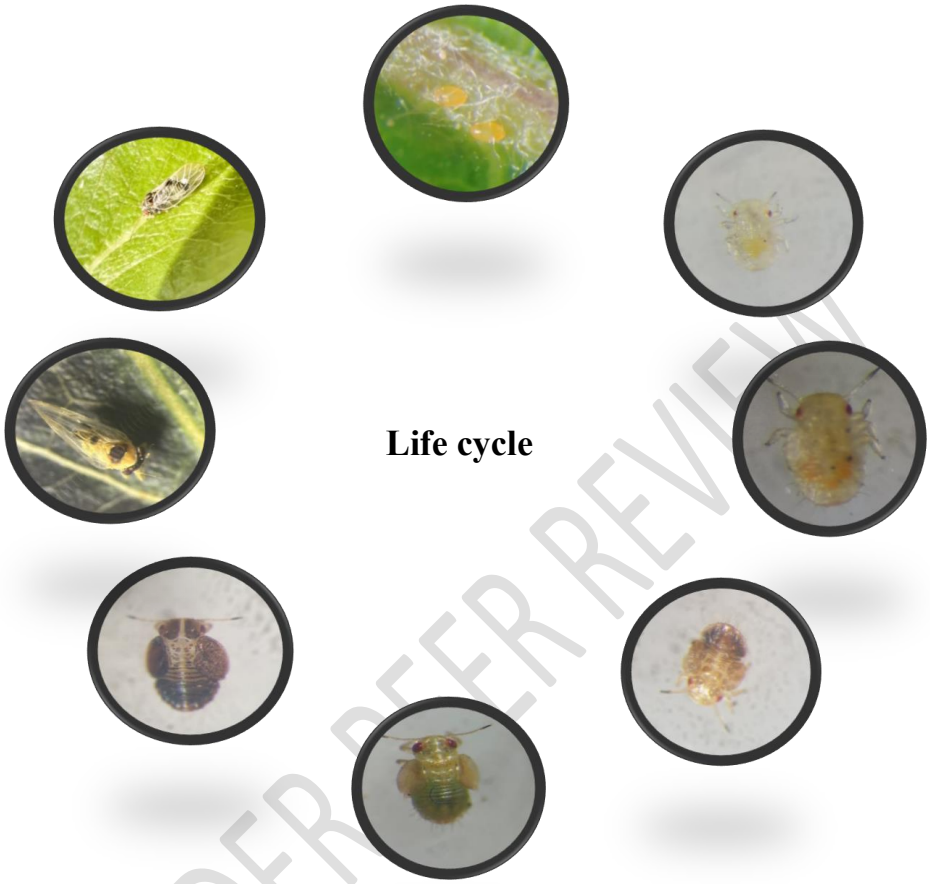

Figure 1: Life cycle of Pear Psylla (*Cacopsylla pyricola* Foerster)

4 Conclusion

This study provides valuable insights into the biology and life cycle of Pear Psylla under controlled laboratory conditions. The data on the developmental stages, fecundity, and longevity of this pest contribute to the understanding of more effective pest management strategies in pear-growing regions. With Pear Psylla being an emerging threat to pear orchards, the findings are critical for mitigating the impact of this pest on pear production in Kashmir and beyond.

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