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Periodic infestation and biology of gall psylids, *Pauropsylla tuberculata* (Crawford) on Saptaparna plant, *Alstonia scholaris*

Arun B Sawarkar*, Gayatri S Mahajan
Department of Zoology, Entomology Division, BP Arts, SMA Science & KKC Commerce College, Chalisgaon, Jalgaon Maharastra, India

Abstract
The aim of this study was to evaluate periodical infestation of gall psyllid, *Pauropsylla tuberculate* (Order- Hemiptera) on the Saptaparna plant, *Alstonia scholaris* during the month of August, 2023 to March, 2024. Around 50 infected leaves of Saptaparna plant were randomly selected from Chalisgaon region (Jalgaon, India) and prepared monthly report on leaf size, location and number of galls per leaf, nymphal development and temperature. It was noticed that the galls frequency was higher on the leaf surfaces compared to another tree parts i.e. branches, stems, fruits and inflorescence of *A. scholaris* infested by nymphal stages of *P. tuberculate*. Upper surface of leaf bears green immature galls while underneath surface had brownish-black open mature galls from where the adult emerge out. Intensity of galls was highest in the central area (inner and midribs) of leaf than the outer surface. It was found that low temperature (winter season) influence to increase the rate of oviposition, gall formation and nymphal development while high temperature (summer season) reduced the populations and intensity of the galls. During study, multiple and overlapping generation of *P. tuberculate* were observed during the period.

Keywords: Periodic infestation, leaves of *Alstonia scholaris*, gall insect, *Pauropsylla tuberculate*

Introduction

Alstonia scholaris (L.), commonly known as the "Devil tree" or Saptaparna, is an ornamental tree with a large canopy, due to which it become a beautiful foliage tree popular in gardens, roadside and plantations and landscapes. The evergreen Saptaparna tree, which may grow to a height of 40 to 80 feet, blooms from October to December. The tree parts as leaves, petioles, branches and barks are completely filled with milky latex which can be poisonous.

In traditional medical systems, Saptaparna is valued as a medicinal tree in addition to its aesthetic value. Bark of the plant is the most valuable plant part which has a bitter flavor and shows alterative, astringent, thermogenic, stomachic, digestive, laxative, anthelmintic, antipyretic and cardiotonic properties (Arulmozhi *et al*., 2007) [2]. The milky secretion of bark is also effective against the oral diseases, abdominal disorders, diarrhea, dysentery, malaria, leprosy, skin diseases, asthma and bronchitis (Arulmozhi *et al*., 2008) [3]. Picrinine, an alkaloid found in flowers, has beneficial effects on the central nervous system (Dutta *et al*., 1976) [12]. The bark paste is also used to heal chronic skin ulcers, and its frequent use is advised to reduce postpartum weakness and enhance milk in women (Nadkarni, 1976) [22]. According to Baliga (2010) [5], *A. scholaris* possess inflammatory, antimutagenic, immunomodulatory, radiomodulatory, chemomodulatory, chemopreventive and antioxidant properties which are effective for the treatment and prevention of cancer.

The wood of Saptaparna tree is used to make wooden slates for writing and black boards for classrooms as well as pattern making, plywood and carving also. Earlier research stated that avenue tree, *Alstonia scholaris* is preferred for roadside vegetation because it require minimum water and maintain a pollution-free surrounding area (Mandal Biswas et. al. 2014) [20]. It act as bioindicator help to detect the culminating pressure of aerial pollution by studying visible leaf damages, morphology, anatomy and biochemical changes (Bhatnagar *et al*., 2022 [6]; Talukdar *et al*., 2016 [31]; Muhammad *et al*., 2014) [21].

Many insect and mite pests target *A. scholaris*, causing damage to their flowers, developing fruits, petioles and leaves. They include lactid borer, leaf skeletonizer and leaf gall former (Raman, 2003; Tripathi *et al*., 2018). Gall development represents an outgrowth of plant tissues which caused by the interaction between gall-inducing insect and host plant. Changes in the gall tissues are related with the changes in the cellular contents such as carbohydrates, proteins, nucleic acids, phenols, IAA and enzymes (Arya *et al*. 1975) [4]. Leaf gall psylids, *Pauropsylla tuberculata* Crawford is one of the major insect pests of *A. scholaris* belongs to family Psyllidae (Homoptera) (Hodkinson, 1984 [17]; Mandal Biswas *et al*., 2014) [20]. *P. tuberculata* infest and create deformities in the form of green galls on various tree parts (Albert *et al*., 2011 [1]; Sharma and Raman, 2022) [28]. They completely inhibits sexual reproduction of the host tree (Chauhan *et al*., 2020) [9], showed deformity in leaves and affects economic value (Dhiman *et al*., 2012 [11], Chander, 2014 [7]; Pandey, 2023) [23]. According to Yang *et al*. (2015) [33], noticed that secondary metabolites and defensive enzymes were shown to accumulate in galls by *A. scholaris* while the leaves were injured by nymphs of *P. alstonium*.

As the plant is popular for beautification in gardens, landscapes and even roadside plantations but shows ugly appearance when it was infected with gall psyllid, *P. tuberculate*. The gall psyllid is species specific which

remains throughout the year and infect frequently to the saptaparna tree, *A. scholaris*. The present study is undertaken to determine the periodic infestation and biology of gall psylids, *P. alstonium* on saptaparna plant, *A. scholaris*.

Material and methods

During fieldwork around 42 Saptaparna plants, *Alstonia scholaris* (Family- Apocynaceae) were noted in and around Chalisgaon region (Jalgaon), Maharashtra, India (20°28'12.00"N **7**5°01'12.00"E) during the month of August, 2023 to March, 2024. The study were carried out by collection and observation of the infected leaves of Saptaparna plants (Fig. 1). Every month, total 50 infected leaves were brought in the laboratory, wash with tap water and then clean and dried with cotton cloth. Prepared monthly observations about measurement of leaf size (length and breadth), number of galls per leaf (immature and mature) and location of galls on leaf, temperature (maximum and minimum). To study the biology of gall psyllid, *P. tuberculate*, a horizontal cut was made from the adaxial surface of the leaves to reveal the nymphs within galls. Separate the nymphal stages from the galls for identification. For photography and identification, Trinocular Stereo Zoom (CZM 5 with 5.3 MP Camera) was used.

Results and discussion

According to the current investigation, it can be seen that nymphal stages of *P. tuberculate* were formed pouch-like globular galls of different size and shape on leaves, branches, stems, fruits and inflorescence of *A. scholaris*. More frequently, the galls were observed on the upper and underside of the leaves in the form of immature and mature galls due to which leaves became crumbled and deformed (Fig. 1). It was found that the immature galls are small, green in colour and globular in shape while the mature galls are large, brownish-black in colour and woody. The mature gall had an opening on the undersurface of the leaf from where the adult escape out (Fig. 2). Earlier findings also noticed that the nymphal stages are the primary cause of gall formation were observed on the leaves, stems, fruits and inflorescence (Albert *et al*., 2011 [1]; Krishnan *et al*., 2011 [19]; Sharma and Raman, 2022 [28]; Pandey, 2023) [23].

It has been shown that there is no any uniformity of galls on the surface of leaves. However, the greatest number of galls on leaves can be seen in the vicinity of the midrib and side veins rather than the outer surface or margin of leaves (Fig. 1) (Table 1). The findings are supported by Patankar and Andrew (2015) [25] where the infestation of *P. tuberculate* is higher at inner and midrib region as compare to outer region of leaves. The preference for deposition of eggs by the female as well as further development of life stages of *P. tuberculate* may correlate with the high nutritive level in the vicinity of the midrib and side veins of leaves. Even if the leaf is damaged by other herbivores, the probability that the gall will be affected is lower than on outer surface of leaves.

The similar results were observed in many gall forming insect species where the galls are formed at leaf portion with highly nutritive content, which is necessary to ensure that the developing larvae will get required amount of essential nutrients (Hartley 1998 [16]; Jankiewicz *et al*. 2017) [18]. According to Guzicka *et al*. (2017) [14], galls embedded directly on the vein through which the nymphal stages taking the glucose, which is a product of photosynthesis. Giertych *et al* (2013) [13] stated that the female *Cynis quercusfolii* prefer large leaves of Oak plant, *Quercus petraea* and precisely choose the location on a leaf where to deposit their eggs which may ensure that the developing gull obtains required amount of nutrients. The selected site for oviposition is a key determinant of the survival and fertility of the offspring (Sitch *et al*., 1988 [30]; Raman, 2007 [27]; Zargaran *et al*. 2011) [34].

According to the monthly report, the winter season's three months of September (80%), October (86%) and November (92%), had the highest percentage of galls on leaves. However, lowest number of galls were observed in the month of summer season i.e. January (56%), February (50%) and March (54%) (Table 2). The greatest number of mature and open galls (21.16) were observed in the month of March, indicating that adults arise from mature galls while the galls remain open. However, in the month of November exhibited highest number of immature galls (23.12), which could be related to the ideal time for nymphal development (Fig. 3). According to the result, it was confirmed that low temperature (winter months) influence to increase the rate of oviposition, gall formation and even suitable for nymphal growth. During the summer months, high temperature showed adverse effect on the intensity of galls. It was also noticed that Psyllid, *P. tuberculate* takes more than one generation in a year and the length of each generation was influenced by temperature. Similar results were observed by earlier researchers (Chatterjee *et al*., 2019 [8]; Dhar 2017 [10]; Haldar *et al*., 2018 [15]; Singh and Sangha, 2018) [29]. Development and reproduction rate was greatly higher during winter months while reduced their populations during summer months. Similar results were also observed by Pasayat and Tripathy (2020) [24, 32] in Bhubaneswar (Odisha). According to the findings, psyllid, *P. tuberculate* had taken 27-28 days for the completion of the life cycle, however the temperature and relative humidity influenced the length of each developmental stage. The average length of nymphal period was higher in summer (26.72 days) than in rainy season (18.35 days). Tripathi *et al*. (2018) had noticed that the gall infestation by gall Forming Psyllid *Pseudophacopteron tuberculatum* and their intensity per leaf on branches of *A. scholaris* was maximum in the month of October (86.18% and 65.6 galls/leaf respectively).

Conclusion

It was conclude that the gall insect, *P. tuberculate* is species specific to the host plant, *A. scholaris* and completes its life cycle in the form of egg, nymphs and adult. The nymphs and adults were formed the galls on leaves, branches, stems, fruits and inflorescence of the host plant but galls frequency was higher on the leaf surfaces. Upper surface of each leaf bears green immature galls with developmental stages while underneath surface had brownish-black open mature galls from where the adult emerge out. Intensity of galls was highest in the central area of leaf than the outer surface. The nymphs takes nutrients from the leaves due to which leaves became crumbled and deformed. Low temperature (winter season) influence to increase the rate of oviposition, gall formation and nymphal development while high temperature (summer season) reduced the populations and intensity of the galls. Multiple with overlapping generations of gall psyllid were observed in a year.

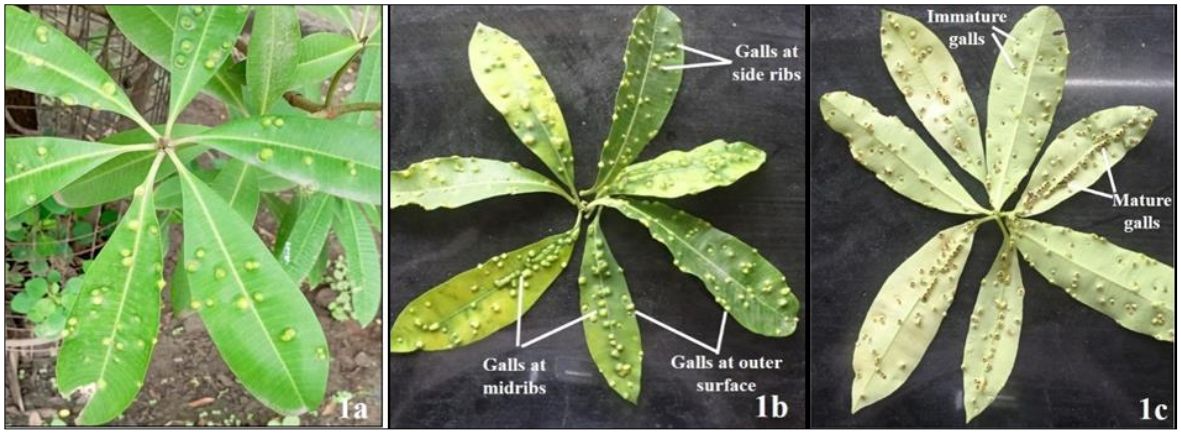

Fig 1: Morphological pattern of infected leaves of Saptaparna plant, *A.* (a) infected leaves, b) galls on midrib, side ribs and outer surface of leaves c) immature and mature galls observed on underneath surface of leaves)

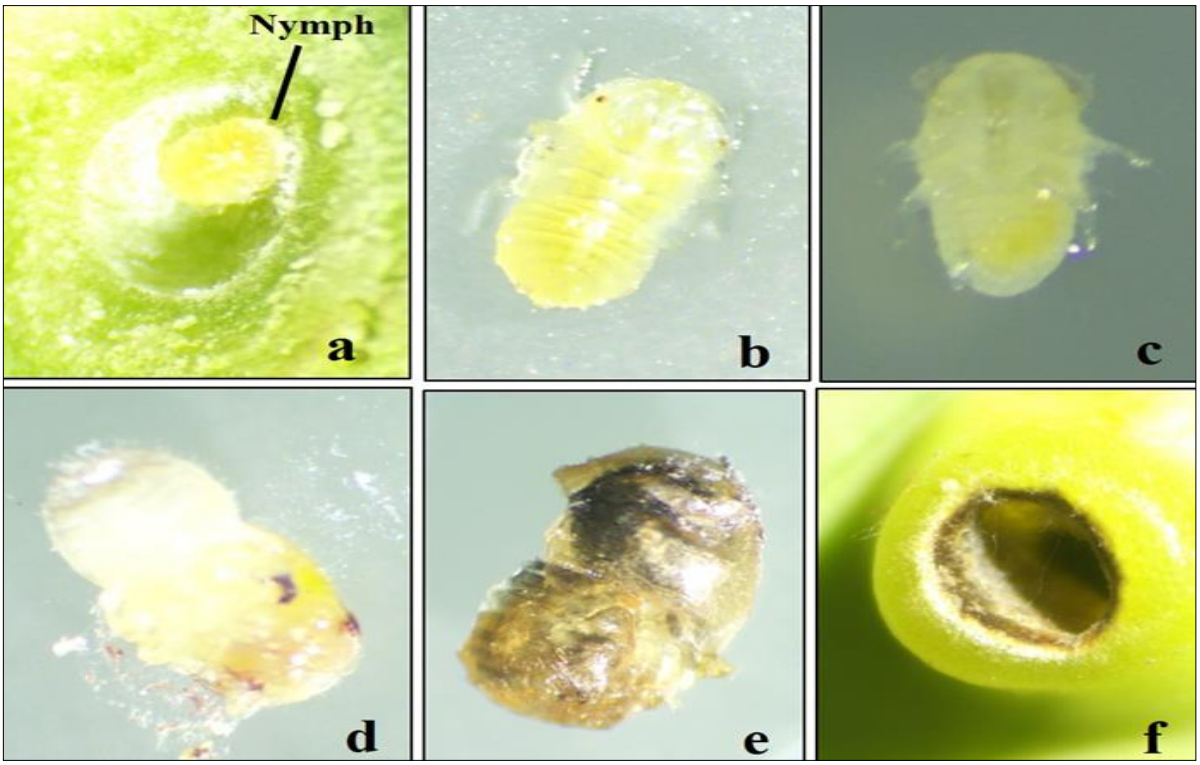

Fig 2: Development of Nymphal stages of *P. tuberculatum* (a) Ist Instar b) 2nd instar, c) 3rd instar, d) 4th instar e) 5th instar and f) adult escape from open gall

Table 1: Average leaf area and gall located at leaf surface of Saptaparna plant, *Alstonia scholaris*

parameter	Leaf area (cm2)	Galls at midrib area	Galls at siderib area	Galls at outer surface
mean	57.41	3.16	4.3	2.33
SD	15.32	3.09	4.2	2.27
Maximum	94.55	14	21	10
Minimum	31.31	4	7	2

Table 2: Monthly observation of infected leaves with gall intensity *of Alstonia scholaris* by *P. tuberculatum*

Months	Total no. of leaves examined	Total no. of leaves infested	%age of infestation	open galls	close galls	Total Galls/ leaf
August (2023)	50	34	68	1.32	9.64	10.96
September	50	40	80	5.28	14.56	19.84
October	50	43	86	12.08	22.68	34.76
November	50	46	92	16.2	23.12	39.32
December	50	32	64	16.96	21.84	38.8
January (2024)	50	28	56	17.48	19.96	37.44
February	50	25	50	19.36	12.36	31.72
March	50	27	54	21.16	3.04	24.2
Mean ± SD	50	34.375	68.75	13.73	15.9	29.63

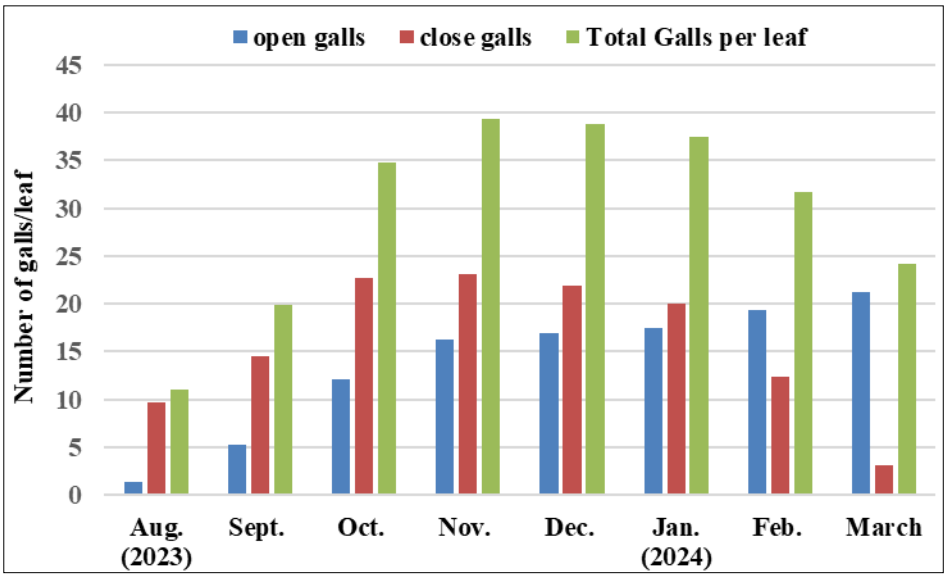

Fig 3: Periodic intensity of galls i.e. open galls (mature), close galls (immature) and total number of galls

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