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Biology of psyllid, *Pauropsylla tuberculata* Crawford infesting the devil tree *Alstonia scholaris* (L.) R.Br. studied at Bhubaneswar, Odisha

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Abstract
Studies based on biology of psyllid, *Pauropsylla tuberculata* Crawf. in *Alstonia scholaris* (L.) R. Br. revealed that the life cycle of the psyllid passes through egg stage, five nymphal instars and then the adult stage. The egg have a minimum incubation period of 2-3 days which varied seasonally. The first instar nymph entered the leaf tissue, subsequently initiating formation of galls. The developing gall housed the developing nymph which completed additional four successive instars inside it. The fully matured fifth instar nymph came out by cutting a hole in the gall, moulted outside the galls and thus reached to adult stage. The average nymphal duration varied seasonally, maximum during summer (26.72±0.62 days) and minimum during rainy season (18.35±0.89 days). Adult longevity also varied seasonally, which have been recorded maximum during rainy season (17.56±0.32 days for males and 16.37±0.65 days for females) and minimum during summer (11.11±0.75 days for males and 10.01±0.85 days for females). Males were found to have been long-lived than females and possessed a longer life cycle. The life cycle of the psyllid was completed in almost 27-28 days. Prevailing temperature and relative humidity played a vital role in the growth and development of the egg, nymph and adult stages of the psyllid.

Keywords: biology, *Pauropsylla tuberculata* crawford, *Alstonia scholaris* (l.) r.br, leaf gall, nymph

1. Introduction
Alstonia scholaris (L.)R.Br. popularly known as Devil tree is a beautiful foliage tree which serves the purpose of the avenue plantation. It is grown widely in the landscapes, gardens as well as roadside plantations. One of the most important alkaloids present in the plant is called alstonine which was reported to have anti-cancerous property, apparently reflecting its medicinal value as reported by Datta and Dhiman, 2016 [3] and Pratap *et al*., 2013 [11]. *A. scholaris* is attacked by several insect pests like leaf skeletonizer, lactid borer and leaf gall former. Leaf gall former, *Pauropsylla tuberculata* Crawford (Psyllidae: Homoptera) is one of the major pests of *A. scholaris*. It induces gall formation on each part like stem, leaves, inflorescence, fruits etc of this highly prized tree (Dhiman *et al*., 2012 [5], Chander,2014 [2]), which adversely affects its looks and economic value.(Figure 1,2) The gall inducing psyllids are relatively specific in their selection of host plants. The insects are phytophagous both in nymphal as well as adult stages. Psyllid galls contain only one nymph per chamber, but some galls have been found to house more than one nymph. The galls may be found either as isolated or aggregated in distribution (Albert *et al*., 2011) [1]. Feeding by the psyllids during the nymphal phase is detrimental to the plant as they drain away the vital food and water or disseminate plant diseases (Jain and Dhiman, 2014) [7]. Effective management strategies have to be developed to reduce the losses caused by the insect. Understanding the biology of the pest in the crop will provide valuable information for strategizing the management options of the particular insect. Hence, the present investigation is carried out to study the biology of gall-making psyllid *Pauropsylla tuberculata* Crawf. In the devil tree.

2. Materials and Methods
An experiment was carried out during 2017-18 in the post graduate Research laboratory, Department of Entomology, College of Agriculture OUAT, Bhubaneswar and in the avenue plantation located adjacent to the OUAT, Bhubaneswar campus.

The gall-containing leaves, eggs, adults of psyllid *P. tuberculata* Crawf. for study of their biology were collected from unsprayed *Alstonia scholaris* trees. The field collected eggs along with the leaves were brought to the laboratory and placed in moist-blotting paper containing petridishes. The number of eggs on the leaves was recorded daily from 20 numbers of random leaves from five numbers of tagged the standing plants and the average of each fortnight (15 days) was calculated to assess the intensity of egg laying.

The leaves were tagged to observe the developing galls in the standing plants in the field which were then taken to laboratory and different sized-galls on the leaves were cut horizontally from the adaxial surface of the leaves to observe the nymphs inside the galls. The exuviae present inside the gall were considered as indication for change in instar. The duration from egg laying to emergence of first instar nymph was considered as the incubation period of eggs. The duration from entering of the first instar nymph inside the leaf up to the emergence of the matured fifth instar nymph from the large sized gall was recorded as total nymphal duration. To study the adults, leaves containing matured galls were kept in moist blotting paper containing petridishes and the adults emerged from the fifth instar nymphs were observed daily to assess their longevity and other characters.

The experiment was carried out under normal temperature prevailing during different seasons (summer: 32±2 ℃, rainy: 27±2 ℃, winter: 23±2 ℃) and normal photoperiod conditions (day: night 12:12 hrs). Light of the laboratory was switched off during night time. The eggs, nymphs in the cut galls, adults were observed under stereoscopic microscope (DGT 510CCD) and electron microscope (model S3400). Thus duration of different stages of growth was assessed.

3. Results and Discussion

Biology of *P. tuberculata* Crawf. was extensively studied on *Alstonia scholaris* host plant under both field and laboratory condition. The insects were phytophagous both in nymph as well as in adult stages. The results revealed that out of the three developmental stages of the psyllid like egg, nymph and adult, the nymph stage is the primary cause of gall formation in various parts of the host plant which is strongly favored by the findings of other workers like Albert *et al.*,(2011) [1]. Galls caused due to the psyllid infestation were observed on leaves, stems, fruits and inflorescence which matched with the observations of earlier workers like Krishnan *et al*., 2011 [10] who also have observed galls on different parts of the plant. The psyllid life cycle typically incorporates an egg stage, five nymphal instars and a sexually reproducing adult stage (Jain and Dhiman, 2014 [7], Percy *et al*., 2016) [10] with males and females usually showing only moderate deviation from a 1:1 sex ratio for a certain period of the year.

Adult female laid eggs on the newly opened tender leaves. (Fig. 3, A) The adult female of the psyllid lays eggs at the side of midribs and veins on the ventral surface of the leaves. The tender leaves of 7-8 cm size were completely covered with the tiny, slightly yellowish eggs scattered all over the surface within 4-5 days of opening of the leaves. A small hair like projection was observed at one end of the elongated egg. (Fig-3, D) The incubation period of eggs varied between 2-3 days and seasonal variation in incubation period was also observed which is given in the Table-1. Maximum no. of eggs is laid on the upper surface of a leaf than the lower surface. However, this finding is in partial agreement with the findings of Albert *et al*. (2011) [1] who opined that eggs are rather laid in both cracks and edges of leaves. Maximum numbers of eggs (192.2±1.30) were recorded during the month of October and minimum egg count (9.6±1.14) was recorded during the second fortnight of May. (Table-02)

Table 1: Incubation period of eggs of psyllid, *Pauropsylla tuberculata* Crawford during different seasons of study period

Parameters	Summer(May)	Rainy (August)	Winter(January)
Maximum	5.00	3.00	4.00
Minimum	3.00	2.00	3.00
Mean± SD	4.02±0.55	2.75±0.34	3.42±0.37

Each figure in the last row indicates Mean of 50 no. of samples ± SD

The immature stage of psyllid called as nymph undergoes five instars (Fig.3). This finding was in contradiction with the findings of Albert *et al*. (2011) [1]. Instead, views of Mathur (1975) [9] are in accordance with our findings. The first instar nymph came out of the eggs shell after hatching (Fig-3, B) and entered the leaf tissue and then the gall formation initiated on the leaf surface. Two distinct red spots became prominent inside the egg before emergence of the head of the 1st instar nymph. With the help of the mouth parts they made entry points on the leaf tissue, perhaps they secreted some chemicals which helped them to make the way into the leaf tissue. Subsequently 2nd 3rd and 4th instar nymphs grew inside the gall and thereby increasing the gall sizes. The fully matured 5th instar nymph came out of the gall by making hole at the tip of the gall and underwent moulting outside the gall on the leaf surface and reached to adult stage. (Figure 3, E, F, G, H, I)

The total nymphal period and the time taken for moulting varied according to different seasons. The total duration of the nymphal period and the time taken for last moulting by the psyllid nymph is given in the Table-03. The nymphal period was carefully observed in the standing plants in the tagged leaves till emergence of last instar nymphs from the cut gall which was found to be varied in different seasons as during summer 26.72±0.62 days, during rainy season 18.35±0.89 and during winter season 21.45±0.63 days and minimum nymphal development period (18.35 days) was recorded during Rainy season which confirmed the established fact that when temperature coupled with favourable relative humidity coincides with good food availability, the generation period is shortened as the rate of metabolism is high in this case.

The total time taken for moulting of the fifth instar nymph to reach the adult stage were recorded during as 18.33± 0.94 minutes, 13.1± 0.45 minutes and 14.86± 0.51 minutes during summer, rainy and winter season respectively. (Table-03)

Two sexes (male and female) were free living and sexual dimorphism was well distinct (Hodkinson, 2009) [6]. The males were smaller in body size than the females and are dark brownish or blackish in body colour. (Fig.3, O) The sex ratio observed in the present study in the field is 1:1 which was in concurrence with other workers like Hodkinson (2009) [6]. The longevity of adult males recorded were 15.75± 0.24 days, 17.56± 0.32 days and 11.11± 0.75 days during summer, rainy and winter seasons respectively while for female adults it was recorded as 10.01± 0.85 days, 16.37± 0.65 days and 14.75± 0.42 days during summer, rainy and winter seasons respectively. The longevity of adults was more (18.35 days) during the rainy days in the month of August and the males were long-lived than the females. (Table-04)

The study on the complete life cycle, including the incubation period of eggs till the death of adult male and female in three

different seasons were of varied duration. For males it was 41.85 ± 0.72 days, 40.62± 0.22 days and 38.66± 0.30 days during summer, rainy and winter seasons respectively while for females it was noted as 40.75± 0.83 days, 39.62± 0.43 days and 37.47± 0.62 days for summer, rainy and winter seasons respectively.(Table-05) Our study is in full agreement with the findings of Jain and Dhiman, (2014) [7] and Dhar, (2017) [4] who were of the views that the longevity of maximum insects increases with the increase in temperature up to a certain level and consequently declines with further increase in temperature. Rainy season being congenial for all the growth parameters, the biotic potential of the insect was high during that period.

Fig 1: A, B and C: Alstonia leaves infested with psyllid galls

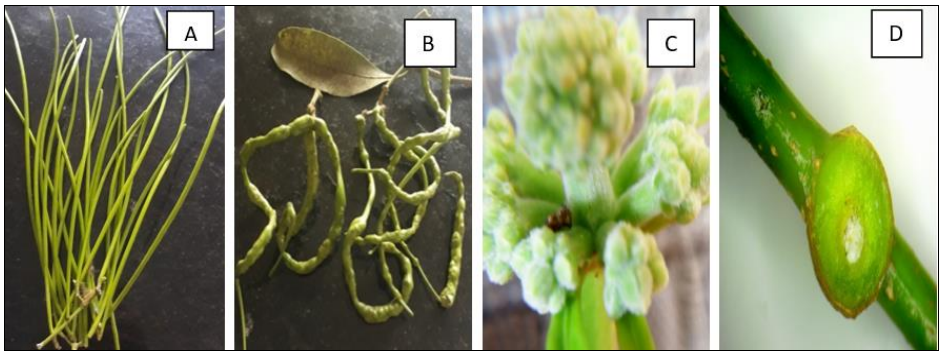

Fig 2: Psyllid infested different parts of the tree (A-uninfested fruits, B-infested fruits, C- infested inflorescence, D-infested stem)

Table 2: Mean No. of eggs laid/leaf by adult female of *P. tuberculata* in different months at Bhubaneswar

Month	Plant-1	Plant-2	Plant-3	Plant-4	Plant-5	*Mean± SD
OCT. I(2017)	190.82	192.52	194.55	192.22	190.83	192.2±1.30
OCT. II(2017)	188.45	184.66	182.41	184.71	185.77	185.2±1.92
NOV. I(2017)	109.54	111.76	113.77	111.12	108.81	111.0±1.58
NOV. II(2017)	108.22	110.34	107.23	108.66	104.55	107.8±1.92
DEC. I(2017)	88.69	85.22	84.17	85.58	83.34	85.4±2.30
DEC. II(2017)	85.69	83.12	83.44	81.33	79.42	82.6±2.30
JAN. I(2018)	55.06	53.98	58.49	60.77	54.70	56.6±2.41
JAN. II(2018)	45.38	48.59	54.66	41.32	39.05	45.8±2.77
FEB. I(2018)	31.65	30.87	36.12	35.55	33.81	33.6±2.07
FEB. II(2018)	31.30	28.62	25.01	25.78	28.29	27.8±2.39
MARCH I(2018)	27.55	23.78	26.73	29.03	21.91	25.8±2.68
MARCH II(2018)	24.81	22.49	20.47	24.88	23.35	23.2±1.64
APR. I(2018)	21.34	24.83	20.72	22.95	23.16	22.6±1.52
APR.II(2018)	19.37	18.28	17.67	15.32	16.36	17.4±2.07
MAY I(2018)	13.56	12.34	10.12	10.32	12.66	11.8±1.30
MAY II(2018)	10.53	11.39	9.28	10.25	6.55	9.6±1.14
JUNE I(2018)	21.81	18.74	17.14	20.83	19.48	19.6±1.67
JUNE II(2018)	18.42	21.71	25.34	18.52	21.01	21.0±2.74
JULY I(2018)	32.12	35.21	34.35	32.23	35.09	33.8±1.30
JULY II(2018)	32.49	35.31	38.11	34.51	37.58	35.6±2.51
AUG. I(2018)	45.36	43.74	45.92	47.31	45.67	45.6±1.95
AUG. II(2018)	69.23	65.81	64.38	67.53	65.05	66.4±2.07
SEPT. I(2018)	98.45	92.55	96.00	97.62	95.38	96.0±2.12
SEPT.II(2018)	128.34	127.48	129.56	130.49	131.13	129.4±2.07

I- First fortnight, II- Second fortnight.
Each figure under plant no.1, 2, 3, 4 and 5 is the mean of 20 leaves/plant
*Each figure is mean of observations of all the five plants ±SD

Table 3: Duration of the nymphal period and the time taken for last moulting by the psyllid, *Pauropsylla tuberculata* nymph at Bhubaneswar

Parameters	Summer(May)			Rainy(August)			Winter(January)		
	Min.	Max.	*Mean± SD	Min.	Max.	*Mean± SD	Min.	Max.	*Mean± SD
Nymphal development period (days)	26.50	28.00	26.72±0.62	17.00	19.5	18.35±0.89	20.5	22.00	21.45±0.63
Time taken for last moulting (in minutes)	17.00	20.00	18.33± 0.94	12.5	13.7	13.1± 0.45	13.9	15.00	14.86± 0.51

*Each figure is the mean of 20 samples ±SD

Table 4: Longevity of adults of psyllid *Pauropsylla tuberculata* Crawford during different seasons of the study period (in days) at Bhubaneswar

Parameters	Summer (May)			Rainy (August)			Winter (January)		
	Min.	Max.	*Mean± SD	Min.	Max.	*Mean± SD	Min.	Max.	*Mean± SD
MALE	10.00	12.00	11.11± 0.75	17.2	18.00	17.56± 0.32	15.30	16.00	15.75± 0.24
FEMALE	8.20	11.50	10.01± 0.85	15.5	17.00	16.37± 0.65	14.00	15.5	14.75± 0.42

*Each figure is the mean of 20 samples ±SD

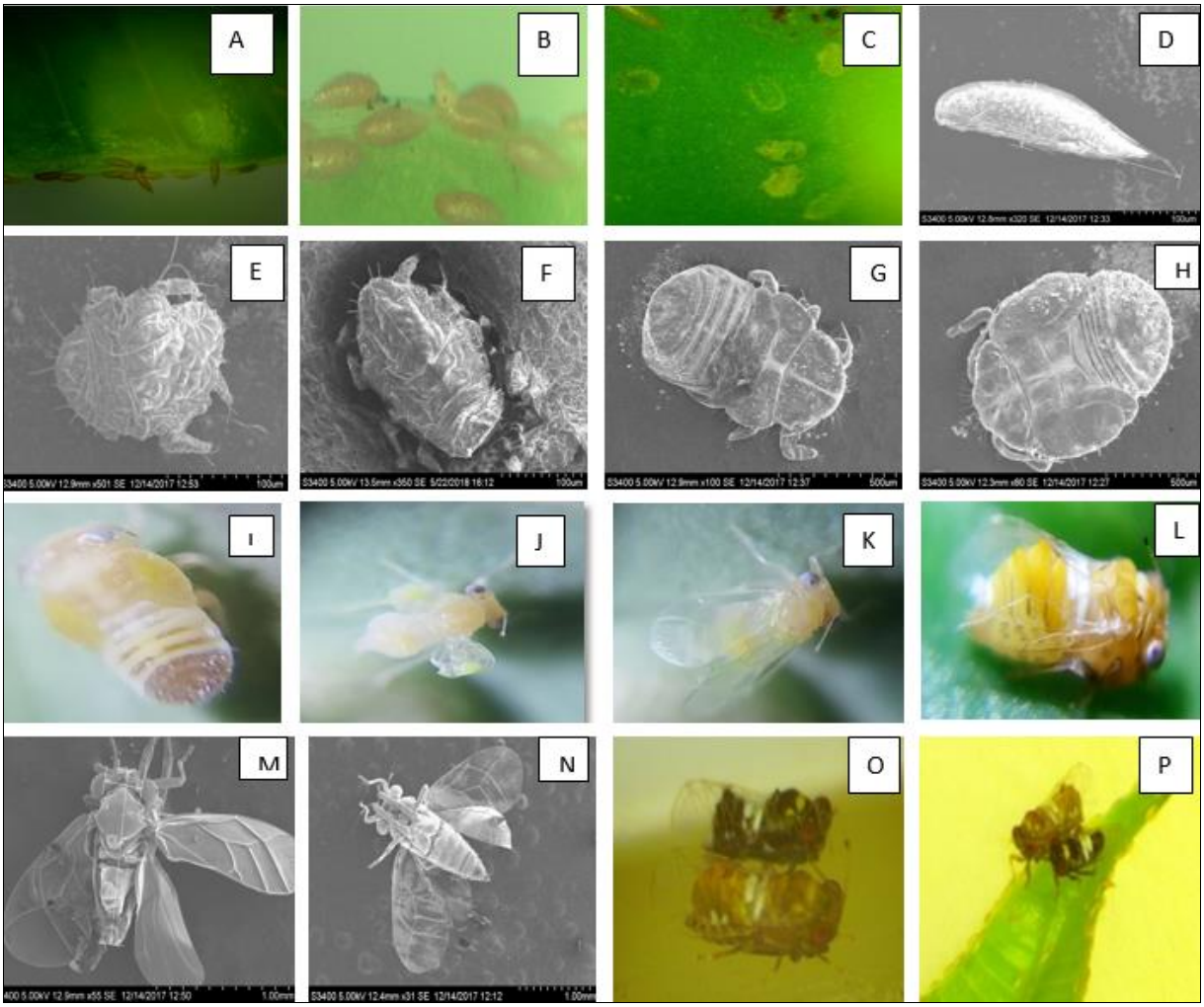

Fig 3: A: Eggs laid on leaves by the psyllid, **B:**1st instar nymph emerging out from the eggshell, **C:**1st instar nymphs before entering into the leaf tissue moving on the leaf **D:**Electron microscopic picture of egg, **E:**Electron microscopic picture of 1st instar nymph **F:**Electron microscopic picture of 2ndinstar nymph, **G:**Electron microscopic picture of 3rd instar nymph, **H:**Electron microscopic picture of 4th instar nymph, **I:** 5th instar nymph **J:** Newly emerged adult undergoing moulting, **K:** Newly emerged adult, **L:**Adult developing body coloration, **M:**Electron microscopic picture of adult male, **N:**Electron microscopic picture of adult female, **O:** Adult male and female (Upper- male, Lower-female), **P:** Adult male and female on Alstonia leaf

Table 5: Total life cycle of psyllid *Pauropsylla tuberculata* Crawford during different seasons of the study period (in days) at Bhubaneswar

Parameters	Summer(May)			Rainy(August)			Winter(January)		
	Min.	Max.	*Mean± SD	Min.	Max.	*Mean± SD	Min.	Max.	*Mean± SD
Male	39.50	45.00	41.85 ± 0.72	36.20	39.70	38.66± 0.30	38.80	42.00	40.62± 0.22
Female	37.70	44.50	40.75± 0.83	34.50	39.50	37.47± 0.62	37.50	41.50	39.62± 0.43

*Each figure is the mean of 20 samples ±SD

4. Conclusion

The biology study of the psyllid *Pauropsylla tuberculata* Crawf. infesting the host tree *Alstonia scholaris* (L.) R.Br. was conducted to examine various developmental stages of the psyllid and to measure their duration. The study indicates that the psyllids have three developmental stages (egg, nymph

and adult) and the nymphs are subject to five instars before turning into adults. Rainy season is found to be more favourable to both male and females of the psyllid for their development and survival and males are reported to have been long-lived than the females. For males the total life cycle duration was 41.85 ± 0.72 days, 40.62± 0.22 days and 38.66± 0.30 days during summer, rainy and winter seasons respectively while for females it was noted as 40.75± 0.83 days, 39.62± 0.43 days and 37.47± 0.62 days for summer, rainy and winter seasons respectively.

The psyllid, *Pauropsylla tuberculata* Crawf. Plays a leading role in deteriorating the ornamental value of the Devil tree, *Alstonia scholaris* R. Br. by forming galls in various plant parts, most importantly in the foliage, which tends to impart an ugly look to the tree. The study of biology of the psyllid informs us about the life stages and their durations, factors favoring their development and dispersal which can make an important tool in further studies regarding the psyllid in future. Again, the nymph and adult emergence time can play a crucial role while going for the management of the psyllid infestation as these two stages decide the fate of gall formation in the host plant. Further studies on the psyllid regarding all the aspects influencing its rate of survival are needed to be done which could further play an instrumental role in the psyllid management to render a conducive environmental condition for the human beings.

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6. References

1. Albert S, Padhiar A, Gandhi D, Nityanand P. Morphological, anatomical and biochemical studies on the foliar galls of *Alstonia scholaris* (Apocynaceae). Brazilian Journal of Botany. 2011; 34(3):343-358.
2. Chander J. Leaf gall insect, *Pauropsylla tuberculata* attacking fruit of *Alstonia scholaris*. Indian Forester. 2014; 140(7):721-723.
3. Datta O, Dhiman SC. Studies on the histomorphology of leaf galls on *Alstonia scholaris* L. (Apocynaceae) induced by *Pauropsylla tuberculata* Crawford. International Journal of Agricultural Invention. 2016; 1(1):65-70.
4. Dhar A. Role of abiotic Factors in the Distribution and abundance of gall aphids on Alstonia scholaris in Jammu region. Voyage. 2017; 8(2):146-153.
5. Dhiman SC, Kumar D, Malik V. Impact of global warming in relation to gall formation by *Pauropsylla tuberculata* (Homoptera: Psyllidae) on the leaves of *Alstonia scholaris* Linn. (Apocynaceae). Journal of Environmental Bio-Science. 2012; 26(1):147-149.
6. Hodkinson ID. Life cycle variation and adaptation in jumping plant lice (Insecta: Hemiptera: Psylloidea): a global synthesis. Journal of natural History. 2009; 43(2):65-179.
7. Jain S, Dhiman SC. Some ecological aspects of *Pauropsylla tuberculata* Crawford induced galls on *Alstonia scholaris* R.Br. Journal of Experimental Zoology. 2014; 17(2):431-436.
8. Krishnan V, Gopi M, Amerjothy S. Morphological diversity and some newly recorded plant galls in TamilNadu. India. Indian Journal of Science and Technology. 2011; 4(9):1067-1073.
9. Mathur RN. Psyllidae of the Indian subcontinent, US. Jain. Under Secretary for the Indian Council of Agricultural Research, New Delhi, 1975, 111-115.
10. Percy DM, Buttrill PT, Malenovsky I. Three new species of gall forming psyllids (Hemiptera: Psylloidea) from Papua New Guinea, with new records and notes on related species. Journal of Natural History. 2016; 50(18):1073-1101.
11. Pratap B, Chakraborthy GS, Mogha N. Complete aspects of *Alstonia scholaris*. International Journal of Pharmacological Research. 2013; 5(1):17-26.