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Study the Biology of Lace Bug, *Cochlochila Bullita* (Stal) (Hemiptera: Tingidae) Under Ambient Laboratory Conditions

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Abstract
Present study envisages the result of studies conducted on biology of lace bug, *Cochlochila bullita* (Stål) in the laboratory; experiments were conducted during 2015-16. Under laboratory conditions eggs were laid by the female bug mostly singly but sometimes in groups also on the under surface and margin of leaves and tender shoots within the air chamber. The incubation period varied from 3-7 (mean 5±1.24) days. The nymph passed through five instars to complete the nymphal period. Newly moulted nymphs were pale brown in colour. Later on, the cuticle colour changed to brown to black. The first instar lasted for 2 to 4 (mean 2.9±0.73) days. The second instar occupied 2 to 4 (Mean 2.8±0.78) days. The third instar larval duration was for 2 to 3 (mean 2.3±0.48) days. The Fourth instar occupied 1 to 3 (mean 2.0±0.81) days. The fifth instar took 1 to 2 (mean 1.2±0.42) days for its development. The total nymphal period varied from 8 to 16 (mean 19.8±3.58) days. The total life cycle of *C. bullita* from egg to adult emergence varied from 11.0 to 23.0 (mean 19.8±3.58) days. Females were significantly larger than male with respect to body length. The female can be differentiated from the male by the presence of an ovipositor whereas male has a distinct genital capsule with hidden structure (parameres). The adult individuals reared in the laboratory survived for 27 to 36 days with average of (mean 33.7±4.78) days. Total life duration was recorded as: 38-59 (mean 50±8.39) days.

Keywords: Biology, *C. bullita*, Laboratory condition, Total life cycle, Instars.

Introduction
'Indian basil', is an indigenous south Indian species (Bhasin, 2012). Among over 150 basil species belonging to the genus *Ocimum*, two most widely grown species for essential oil production are holy basil (*Ocimum sanctum* L.) and sweet basil (*Ocimum basilicum* L.). *Ocimum basilicum***,** an erect highly branched aromatic perennial herb of family Lamiaceae is well known for its sweet basil oil and is widely distributed throughout India. This species is believed to be originated in India and some neighbouring countries. In the plains of north India, south India and Assam it may; however be grown as both *Kharif* and *Rabi* crops. In actual practice, about 30-35 Kg/ha oil, corresponding to 12-13 Kg of flower oil and 18-22 Kg of whole herb oil is obtained from this species (Panda, 2005). Main components of basil essential oil are linalool, camphor, 1, 8 cineole and germacren-D (Arabaci, 2004 and Daneshian, 2013). The world production of different basil oil in 1986 stand at 12-14 tonnes. The world production of sweet basil was about 2 tonnes during 1992 in Egypt accounting for nearly half of the production. Other principle producers of sweet basil being Yugoslavia, Morocco, Bulgaria, USA, Italy and Spain. Sweet basil is used as a fragrance ingredient in perfumes, hair dressings, dental creams and mouth washes (Panda, 2005). According to Lawrence (1993), 43 tonnes of *O. basilicum* essential oil was produced worldwide in 1992, which was costing 2.8 million dollars.
Tulsi hybrid is now being cultivated in about 2000 hectares of land in India (Balyan and Pushpangadan, 1988) as ayurvedic and medicinal plant. Its leaves, stem, shoots, flowers, seeds and roots have tremendous economic importance in epidemiology and industry. Its leaves have anthelminthic and anti-tussive effects. Seeds yield various essential oils, monoterpenes, sesquiterpenes and phenols which provides pleasant odour and flavours to the crop. *Tulsi* extract has fungicidal, insecticidal antibacterial, antifeedant and larvicidal activities (Sathe *et al.* 2014).
In India, most requirements of basil oil are met by imports and the demand is on increase. Methyl chavicol and methyl cinnamate obtained from the essential oil of *O. basilicum* were found to be mainly responsible for the insecticidal activity of the oil against *Tribolium castaneum, Sitophilus oryzae, Stagobium paniceum* and *Bruchus chinensis* (Deshpande and Tipnis, 1977).

The essential oils of basil have antioxidant compounds. Leea *et al*. (2005) reported that the constituents of basil oil like eugenol, thymol, carvacrol and 4-allylphenol had stronger antioxidant activities than other volatile components. Basil plant is stomachic, stimulant, carminative, anti-pyretic, diaphoretic, expectorant, diuretic and also useful in heart, brain and blood diseases asthma, inflammations and enlarged spleen (Chopra *et al*. 1956). The infusion of seeds is given in gonorrhoea, diarrhoea and chronic dysentery. The oil is used in flavour and perfume industry (Khosla *et al*. 1999).

Basil plant is widely used for its therapeutic properties and culinary purposes. The essential oil may be used directly in food or as cosmetics industries for the production of shampoos, soaps, and perfumes. It is also used as folk medicine to relieve respiratory problems, as antiseptic, digestive and against intestinal parasites.

The essential oil possesses antimicrobial (Bozin *et al*. 2006; Elgayyar *et al*. 2001) and insecticidal (Bowers and Nishida, 1980) activities. In addition, basil extract and essential oil have been shown to possess antioxidant activity (Gulcin *et al*. 2007; Politeo *et al*. 2007 and Trevisan *et al*. 2006). Basil essential oil has been traditionally extracted from whole above ground herbage (stems, leaves, and flowers) using steam distillation (Trevisan *et al*. 2006).

However, *tulsi* crop is attacked by several sucking insect pests like lace bug *Cochlochila bullita* (Stal), whitefly *Aleurodicus dispersus* Russell, *Dialeurodes* sp. and aphid *Macrosiphum* sp. but *C. bullita* and *A. despersus* found throughout the year while aphid appeared occasionally in December-January (Sathe *et al.* 2014). Among these pests, *C. bullita* caused severe damage. Besides these pests, basil plant is also attacked by other pests insects like leaf roller, lace bug, etc. (Panda, 2005).

In Bihar, basil is grown in an area of about 32ha with an annual production rate of 3.20 tonnes/ha (Charan, 2013). The plant is attacked by various insect pests, among which lace bug, *Cochlochila bullita*, is a key pest limiting its production and productivity. It has been estimated that *C. bullita* causes approximately 27.8 per cent yield loss (Anonymous, 2012-13).

C. bullita is one of the tingid bugs which infests Lamiaceae (Labiatae) plant family and causes heavy loss to the leaves and inflorescence of *O. basilicum* causes drying and wilting of leaves resulting in ultimate death of the plants. Piercing and sucking mouthparts of *Cochlochila bullita* damage the host by removing nitrogen-rich plant fluids. This results in curling and drying of leaf tips, leaf dehiscence, and lowering the inflorescence production (Mohanasundaram and Rao, 1973; Palaniswami and Pillai, 1983). The adult lace bugs usually feed on tender shoots of the herb causing them to wilt and eventually die and in many instances, nymphs and adults feed, gregariously on the leaves, leaving tiny black spots of excrement on the upper surface of the leaves (Dhiman and Jain, 2010). *O. basilicum* plant is severely infested by the population of *C. bullita* at Saharanpur and causes drying and wilting of leaves resulting in ultimate death plants (Dhiman and Datta, 2013). According to Sajap and Peng (2010), adult *C. bullita* usually feed on tender shoots of the herbs causing them to wilt and eventually die. Nymphs are found on the under surface while the adults are on upper surface in colonies on the tender foliage and shoots. Leaves become discoloured and gradually dry up. Nymphs were observed on upper and lower leaf surfaces and reproductive structures, with foliar chlorosis evident on the upper surfaces and dark excrement on lower surfaces, severe feeding resulted in the death of plants.

The infestation of *C. bullita* was observed throughout the year. However, its incidence was highest during the months August to December, moderate from January to April and low from May to June. The pest hibernates in adult stage in scarcity of food and adverse (cold) conditions. Highest population 67.3 (range 60-72) was found in September (Sathe *et al*. 2014).

Dhiman and Dutta (2013) reported that at Saharanpur the population of *C. bullita* infest the host plants during July to November and from April to May. The population built up started on *O. basilicum* during first week of April and attained peak in September-November.

Materials and Methods

Studies on the biology of lace bug, *C. bullita* were conducted in the laboratory during 2015 at the Department of Entomology, Rajendra Agricultural University, Pusa, and Bihar. The temperature and relative humidity during the course of study of biology ranged between 22.47 ± 1.26 °C and 60.57±5.93 per cent, respectively.

Rearing of *C. bullita*: The rearing of bugs was done by feeding the bugs on *tulsi* tender leaves in glass cages. Adults of the bug were collected from the field and ten pairs adults were released along with soft twigs in glass cages. Observations pertaining to oviposition, incubation period, larval duration and adult duration were recorded.

Egg: Adult male and female were collected from fields and separated based on their ovipositor. The female possess an ovipositor whereas the male has a distinct genital capsule with hidden structures termed parameres (Ahmad and Peng, 2010). They were kept in pairs separately in small rearing cages. Pieces of healthy twigs of *tulsi* were provided in the cages for feeding. The eggs lay on the leaves and twigs were collected along with plant parts, from the cages and the eggs deposited on the leaves and twigs were isolated with fine camel hair brush and counted separately. The leaves were replaced with fresh ones every day. Eggs were examined every day for the emergence of nymphs.

Incubation period: For the study of the incubation period, ten freshly laid eggs were taken out along with leaves and tender twigs, and were kept on filter paper in three covered Petri dishes with sufficient moisture. To maintain sufficient moisture inside, water soaked cotton swab were used. At the time of hatching the hand lens was used to see the changes occurring in the eggs.

Nymphs: To assess the nymphal behaviour and the duration of different nymphal instars of *tulsi* lace bug, the newly hatched nymph were collected and transferred carefully using a wet camel hair brush on fresh leaves and tender twigs. The leaves were changed on alternate days and till formation of adults. While transferring on fresh leaves, the nymphs were examined for signs of moulting. The interval between two moults was taken as length of the each instar. Constant humidity of 100 per cent level was maintained by utilizing water soaked cotton balls. The rearing provided an opportunity to observe the behavior and development of the nymph and to assess the number of nymphal instars.

Adult: Adults were separated in pairs and reared in rearing cages on *tulsi* leaf. The longevity of both male and female bug along with prevailing temperatures was recorded.

Results and Discussion

Incubation period

Under laboratory conditions the adult female laid eggs singly in mostly cases however, some eggs were also laid in groups

at the under surface and margin of leaves and tender shoots within the air chamber. Freshly laid eggs were, dark brown in colour and oblong in shape with slightly tapered towards opercula. The incubation period was studied by taking these eggs along with leaves and was kept on filter paper in 5 covered Petri dishes with sufficient moisture. The incubation period ranged between 3-7 (mean 5±1.24) days (Table 1).
This finding is in partial agreement with the result of Kumar (2013) who reported that the mean Incubation period as 6.06 days. The present finding is also in conformity with the results of Sathe *et al*. (2014); Jain and Dhiman (2011). This variation in incubation period might be due to the variation in climatic conditions.

Nymphal period
The nymph stage passed through five instars to complete the nymphal period. Five newly hatched nymphs were collected and transferred carefully using a wet camel hair brush on fresh leaves in the Petri dishes. Ahmad and Peng (2010) also reported five nymphal instars in the life cycle of lace bug. Newly moulted nymphs were pale brown in colour. Later on, the cuticle colour changed to brown to brownish-black. The first instar lasted for 2 to 4 (mean 2.9±0.73) days. The second instar was dark brown, later becoming somewhat black, more rounded shape and margin bears spines which were especially prominent on the abdomen. Other characters were similar to first instar. The duration of second larval instar was 2 to 4 (mean 2.8±0.78) days. The third instar was similar in all respect with that of second instar it was little larger, more rounded and short cephalic spines present. It lasted for 2 to 3 (mean 2.3±0.48) days. The fourth instar increased in size, paranotum was larger and wider on the thorax compared to third instar, cephalic spines were longer and it lasted for 1 to 3 (mean 2.0±0.81) days. In fifth instar body shape was similar to fourth instar except more elongated and it lasted for 1 to 2 (Mean 1.2±0.42) days. The total nymphal period varied from 8 to 16 (mean 19.8±3.58) days (Table 1).
Kumar (2013) documented that the total nymphal period of *C. bullita* was 11.50 days. Sathe *et al*. (2014) observed there were five larval instars and nymphal stages lasted for about 12 days which is more or less similar to the present findings. Similar observations were also made by other workers (Ahmad and Peng, 2010; Neal and Douglass, 1988).

Total life cycle
The total life cycle of *C. bullita* from egg to adult emergence varied from 11.0 to 23.0 (mean 19.8±3.58) days (Table 1).
The present result is in close conformity with the report of Sathe *et al*. (2014) who documented the total life cycle of *C. bullita* from egg to adult emergence 18 days. Kumar (2013) observed total developmental period from egg to adult emergence was 17.8 days. More or less similar observations have been reported by several workers (Ahmad and Peng, 2010; Neal and Douglass, 1988 and Wheeler, 2010).

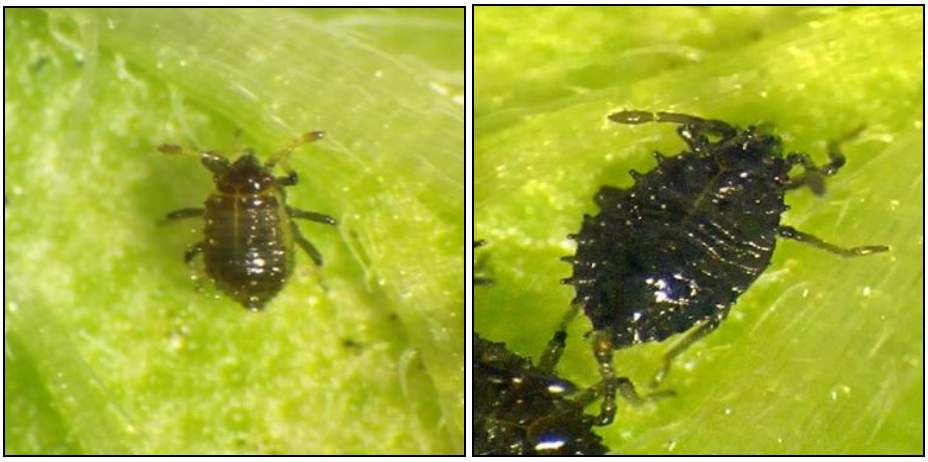
Adult stage
Adults were tiny bugs, about 2.5-3 mm long, black in colour with hyaline wings, because their wing were partially transparent and lace-like in architecture and a characteristic hollow, globular outgrowth on the dorso-lateral portion of thorax. The adult male and female were morphologically similar, except the female was significantly longer with respect to body length. The female can be differentiated from the male by the presence of an ovipositor whereas male has a distinct genital capsule with hidden structure (parameres).
Adults mostly remained on the leaves and tender shoots and suck the sap from plant tissues. The adults were weak fliers. The mouthparts were of piercing and sucking type. The adult individuals reared in the laboratory survived for 27 to 36 days with average mean of 33.7±4.78 days. Total life duration was 38-59 days (mean 50.5±8.39) days (Table 1).
The present findings corroborate earlier results of Ahmad and Peng (2010). They reported a clear case of sexual dimorphism in *tulsi* lace bug and mentioned that the black and smaller bugs are males, whereas the black and bigger ones are females. Female bugs possess ovipositor and male has a distinct genital capsule.
Sathe *et al*. (2014) reported the adult individuals reared in the laboratory survived for 34 days. These present results are more or less in agreement with the findings of Kumar (2013) and Neal and Douglass (1988).

Table 1: Life cycle of *Cochlochila bullita* (Stal) under ambient laboratory conditions

Sl. No.	Stage of Insect	Range (Days)	Mean ± SD
1.	Incubation period	3-7	5±1.24
2.	Nymphal period		
	1st instar	2-4	2.9±0.73
	2nd instar	2-4	2.8±0.78
	3rd instar	2-3	2.3±0.48
	4th instar	1-3	2.0±0.81
	5th instar	1-2	1.2±0.42
3.	Total nymphal period	8-16	12.6±2.98
4.	Total developmental period (egg to adult emergence)	11-23	19.8±3.58
5.	Adult longevity	27-36	33.7±4.78
6.	Total life duration	38-59	50.5±8.39

Life cycle of *Cochlochila bullita*

Egg **1st Nymphal instar**



2nd Nymphal instar **3rd Nymphal instar**

4th Nymphal instar **5th Nymphal instar**

Female **Male**

Conclusion

The incubation period varied from 3-7 (mean 5±1.24) days. The first instar lasted for 2 to 4 (mean 2.9±0.73) days. The second [instar] occupied 2 to 4 (mean 2.8±0.78) days. The third instar lasted for 2 to 3 (mean 2.3±0.48) days. The fourth instar lasted for 1 to 3 days (mean 2.0±0.81) while fifth instar lasted for 1 to 2 days (mean 1.2±0.42). The total nymphal period varied from 8 to 16 (mean 19.8±3.58) days. The total life cycle of *C. bullita* from egg to adult emergence varied from 11.0 to 23.0 (mean 19.8±3.58) days. Adults are tiny insects, black in colour with hyaline wings. The adult male and female are morphologically similar, except the female was significantly larger with respect to body length. The female can be differentiated from the male by the presence of an ovipositor. The adult individuals reared in the laboratory survived for 27 to 36 days (mean 33.7±4.78). Total life duration was 38-59 days (mean 50±8.39).

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