

Seasonal incidence and biology of conopid fly, *Physocephala tibialis* in bumble bee, *Bombus haemorrhoidalis* Smith in India

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ABSTRACT

Conopid flies are larval parasites of bumble bees which lay eggs inside the abdomen of forager bee. Present studies were conducted during 2011-2014 to know the role of conopid fly, *Physocephala tibialis* in bumble bee rearing. Bumble bee foragers were collected from the natural and artificially established bumble bee colonies in the field. Seasonal incidences revealed higher infestation in bumble bee population during June to August with 48% infestation in bumble bee foragers. Infested foragers (queen, worker and drone) died after 8-10 days of infestation. Thus, conopid infestation reduces the working force of the bumble bee colony hence the development of colony is affected negatively.

Key words: Conopid fly, Morphometric, Biology, Seasonal incidence

Introduction

Bumble bee in today's world is commercially reared for the pollination of different crops under protected conditions. Rearing methods have been developed in our country (Dayal and Rana, 2004; Thakur *et al.*, 2005) but its rearing success rate is affected by different pests and diseases. Very little efforts have been made earlier in our country to study these pests and diseases (Rana *et al.*, 2011). In view the importance of different pests and diseases, present studies were undertaken to know the role of conopid fly, *Physocephala tibialis* (Conopidae; Diptera) which is an important natural enemy of bumble bee in Himachal Pradesh as a limiting factor in the rearing. These flies are larval parasitoids of bumble bees and wasps. Smith and Peterson (1987) found the adults of conopid fly as pollen and nectar feeders.

Adults lay eggs in the abdomen of bumble bee workers while foraging on flowers or in flight. From Himachal Pradesh Rana *et al.* (2011) found that 45.2% collected queens did not laid eggs and out of these, 20% of the queens had larva or pupa of conopid fly. Hence, conopid flies infested large populations of bumble bee foragers and hampers their colony development to large extent. Keeping in view the higher infestation of these flies in bumble bees, present studies were conducted to know the biology and incidence of conopid flies so that per cent rearing success of bumble bee could be increased.

Materials and Methods

The studies were carried out during 2011-2014 in the laboratory and field area of the department of Entomology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

at an altitude (1250m amsl), longitude of 77° 11' 30" E and latitude 30° 52' 30" N subtropical areas.

Attacking behaviour of conopid fly

The studies are based upon the personal observations of the author with regard to the attacking behaviour of the conopid fly to infest the foraging bumble bees in the field.

Adult female conopid sits besides the bumble bee forager foraging on *Ocimum sanctum* and folded its abdomen. It then retracted its abdomen on the last segment of bumble bee abdomen and opened the sclerites/anal portion of the bumble bee and then inserted her egg into bumble bee abdomen. The infested bumble bee lost her senses for few minutes and showed back and forth movement of legs. After few minutes it started walking and then behaved normally. After 9 days, the infested forager died and on dissection pupa of conopid fly was found from the abdomen.

Seasonal incidence

Seasonal incidence of conopid fly was studied by collecting the foragers from the field during period under investigation (January, 2012–July, 2014) and dissected them under the stereomicroscope. Out of the total dissected bees, the per cent infestation in bumble bee foragers was calculated as:

Per cent infestation = (Total number of infested bees/Total number of bees collected) × 100

Developmental biology

Duration of egg stage and hatchability

Freshly parasitized bumble bee was collected from the field after the female conopid fly injected the egg in the abdomen of the forager worker of bumble bee. The foraging workers were also collected both from the natural and the field established nests. These workers were dissected and the different developmental stages of conopid fly were observed. The egg period was recorded/established by subtracting one day (24hrs) from the first instar larva.

Duration of larval period

The neonate larvae (12-24 hour old) were transferred to the petri plates containing the freshly dissected bumble bee workers with the help of camel's hair brush. The Petri plates were then kept inside incubator at 26.9±1°C. The dissected bees were changed daily. Observations on duration of different

instars were recorded daily. Experiment was replicated five times with 5 larvae/replication.

Duration of pupal period

The pupae formed in each replication were kept separately in the glass vials inside incubator at 26.9±1°C and also at room temperature. The number of days for which the insect remained in the pupal stage was counted with the emergence of adults.

Results

Morphology

Conopid flies are larval parasites of bumble bees which parasitize the foraging bumble bees (Fig a and Fig b). The larva was white in colour with swollen body measuring 30-60 mm x 25-40 mm. It had a pointed mouth which was protrusible. Development was completed within 10–12 days after oviposition when the host was killed and the parasite pupated in situ (Fig d). The size of pupa varied from 30-50 mm x 25-35 mm and was elongated in shape with brown colour. Adult fly had yellow head with large eyes and prominent head (Fig e). The ovipositor was modified for inserting egg into the bumble bee body. Development of the parasite made the bee unable to carry large loads of nectar, as the conopid larvae found where the honey crop was located. The bees died after 8-10 days of infestation with symptoms of open ovipositor due to conopid parasitization.

Seasonal incidence

Seasonal incidence of conopid fly has been presented in Table 1 which reveal that percent that percent infestation was 13.47, 22.87 and 16.74 during 2012, 2013 and 2014, respectively. It was minimum in October (4.54%) and maximum in July (34.37%) during 2012 whereas, in 2013, maximum infestation was during August (48.14%) and minimum during December (1.45%). In 2014, the infestation was found to be maximum during June (26.19%) and minimum in April (6.25%). The studies thus revealed that the infestation was high during June to September (rainy season) as the dead bees had maximum larval and pupal stages of the fly (Fig 1).

The developmental biology of conopid fly was studied under laboratory conditions by collecting and dissecting the infested bees. The incubation period varied from 1-2 days with mean duration of 1.82 days. The durations of the first, second and

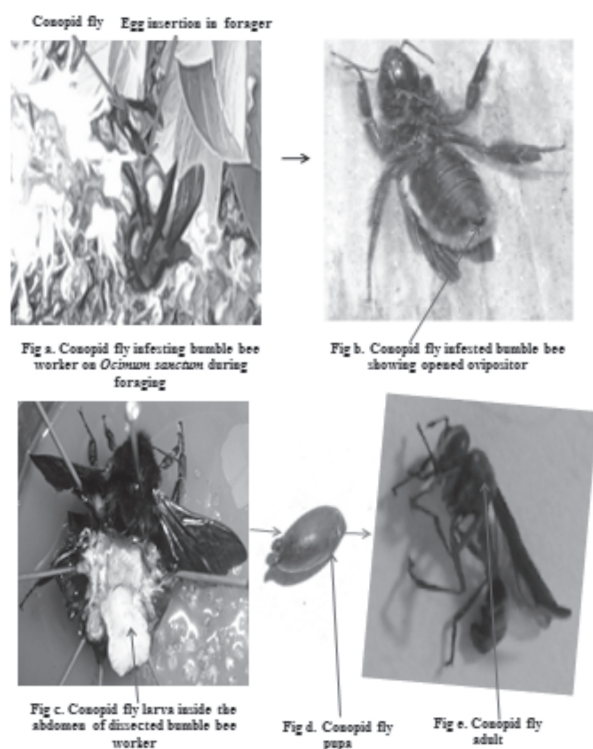


Fig. 1. Incidence of conopid fly, *Physocephala tibialis* in bumble bees and its developmental biology

third larval instars varied from 2-3, 2-3 and 4-5 days, with average durations of 2.51, 2.99 and 4.31 days, respectively. The total larval period varied from 9-13 days with an average duration of 9.81 days. The pu-

pal period was found to be very long which ranged from 154-190 days with average duration of 154.74 days. Total developmental period for conopid fly was 166.37 days with a range of 164-205 days, respectively.

Discussion

Present studies revealed that *Physocephala tibialis* are the larval parasites of bumble bees which parasitize the bumble bee foragers. Its larva is white in colour having swollen body and develops inside the abdomen of workers, queens and males into pupa. The size of pupa varied from 30-50 mm x 25-35 mm and was elongated in shape with brown colour. Adult fly had yellow head with large compound eyes and prominent head. The ovipositor was modified for inserting egg into the bumble bee body. The total average larval and pupal period was 9.81 and 154.74 days while the developmental period ranged between 164-205 days, respectively. Similar results were recorded by different workers (Howell, 1967; Askew, 1971; Hempel and Hempel, 1988). According to them, conopid flies attacked foraging bees. A single egg is either attached to or inserted into the abdomen, where it hatches into larva and feeds on haemolymph and internal organs (Cumber, 1949). Further, Pouvreau (1974) had also reported its three larval instars in 6-10 days after which it undergoes pupation inside the bee body. The adult emerges in the next summer (Postner, 1951). Similarly,

Table 1. Seasonal incidence (%) of *Physocephala tibialis* in bumble bees during February 2012 - July 2014

Number of bumble bees (queen/worker) infested with <i>Physocephala tibialis</i> in the indicated year						
Month	2012		2013		2014	
	Total number of bees collected	Per cent Infestation	Total number of bees collected	Per cent Infestation	Total number of bees collected	Per cent Infestation
January	Nil	Nil	Nil	Nil	3	33.33
February	19	10.52	25	12.00	19	10.52
March	21	9.52	32	15.62	26	15.38
April	32	12.50	54	12.96	48	6.25
May	36	19.44	66	19.69	39	17.94
June	39	23.07	74	28.37	42	26.19
July	32	34.37	72	22.22	38	21.05
August	39	10.25	54	48.14		
September	48	10.41	52	40.38		
October	44	4.54	39	12.82		
November	29	6.89	32	6.25		
December	32	6.25	29	1.45		
Mean		13.47	529	22.87		16.74

Table 2. Developmental biology of Conopid fly, *Physocephala tibialis*

Developmental Stages		Duration (days)	
		Mean± SE	Range
Incubation period		1.82±0.09	1-2
Larval instars	I	2.51± 0.04	2-3
	II	2.99 ± 0.12	2-3
	III	4.31 ± 0.02	4-5
Total larval period		9.81 ± 0.18	9-13
Pupal period		154.74 ± 10.11	154-190
Total developmental period		166.37±10.23	164-205

Chauhan *et al.*, (2013) have also found its larva, feeding inside the abdomen of *B. haemorrhoidalis* which caused mortality of infected queens and workers in 10 days.

The studies also showed that 13.47-22.87% *B. haemorrhoidalis* bees were infested by conopid parasitism during 2012-14. Chauhan *et al.* (2013) have recorded its infestation in 20.58% in bees of the same species at the same place. Similarly, Hempel and Hempel (1988); Shykoff and Hempel (1991) have also recorded 20.20-21.70% conopid parasitism in *B. terrestris*.

Conclusions

Conopid fly, *Physocephala tibialis* attacks foraging bumble bees (all castes) which affects the strength of the colony thus posing a threat to the developing brood due to insufficient incoming food supply which may lead to collapse of colony in the early seasons of development (August-September). These flies have short larval period which kills the foragers in 8-10 days of infestation. Incidences showed higher infestation during August- September which is a hinderance in bumble bee development. This study may help in development of bumble bee management practices for the control of this important pest of *B. haemorrhoidalis*.

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