

LIFE CYCLE OF HOLOTRICHIA KARSCHI BRENSKE (COLEOPTERA: SCARABAEIDAE: MELOLONTHINAE)

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ABSTRACT

The soil dwelling insect pests causing damage to crops are mainly the white grubs, termites, cutworms, wireworms etc. Among these white grub has recognized as the pest of national importance. Adults of *Holotrichia karschi* Br. were collected from Amba Reserve Forest of Kolhapur district which comes under the Western Ghats. Mated Female laid the eggs singly at a depth of 5- 10 cm in the soil. The incubation period of the eggs was ranged from 10 to 16 days. The first instar lasted 12 to 16 days. The subsequent second and third instars were lasted for 29 to 32 and 25 to 30 days respectively. The pupal period was recorded about 17 to 20 days. Adult longevity was observed in laboratory conditions. It took 14 to 25 days. Studies on the host range revealed that adult feed on the foliage of seven different plants according to their distribution and availability.

INTRODUCTION

The white grubs are complex set of polyphagous species responsible for heavy crop loss of many cultivators in the country. The white grubs damages almost of all types of agricultural crops and economical important trees in natural and artificial stands. The damage has also been reported to the roots of tea, coffee, areca nut, cashew nut, rubber and forest nursery plants. Several species have been observed to cause serious damage throughout the country right from Himalaya to Kerala and Gujarat to North eastern regions (Chandla *et al.*, 1988; Misra, 1992). The species of *Holotrichia* are well distributed in the Indian Subcontinent and found to be very destructive. Nearly 300 species of white grubs were recorded from India (Shivayogeshwara and Veeresh, 1983). The biology, ecology and behavior of white grubs have been worked out by many workers (Veeresh, 1977; Yadava *et al.*, 1977; Brar and Sandhu, 1980).

The duration of life cycle in different white grub species was found to be variable ranging from 1 to 5 years (Veeresh, 1980). As the species of *Holotrichia* are well scattered in India; the *Holotrichia consanguinea* Blanch. was predominantly noticed in Northern parts of India (Gupta and Avasthy, 1957). *Holotrichia serrata* Fab. was found in southern states viz. Tamil Nadu, Karnataka, (Veeresh, 1977). Another white grub *Holotrichia fissa* Br. recorded from Kerala, Karnataka, Haryana (Verma, 1975; Veeresh, 1975; Abraham and Rajendran, 1978). In many districts of Maharashtra *Holotrichia fissa* Br. turned out to be a serious problem especially in Ahemadnagar, Dhule, Nanded, Buldhana, Osmanabad, Sangli, and Satara.

In a Survey on host plants of white grubs from Konkan region the *Holotrichia fissa* Br. was noticed on 22 plants (Lolage and Patil, 1988). The information on the white grub menace in natural stands is sparse and very little published work is available on the ecological aspects of white grubs. Hence detailed studies were conducted on life cycle and adult host range of *Holotrichia karschi*.

MATERIALS AND METHODS

The biology of *Holotrichia karschi* was studied during May 2007 to June 2008. The host range of adults and occurrence was studied in Amba Reserve Forest, Kolhapur District, Maharashtra. Amba Reserve Forest is tropical Semi evergreen forest. It is situated 16°55'43.60" NL and 73°48' 27.09" EL about 500 m above MSL and covers an area of 318.16 ha. Temperature ranges of study region during summer is 30°C , in winter it is 10°C to 20°C and in rainy season temperature ranges from 25°C to 30°C .

The emergence of beetles was observed during the course of monsoon i.e. June to September. The adults of *H. karschi* were collected during the evening from 7.00 pm to 10.00 pm by using light traps because beetles easily attracted towards light at night time. Mostly the beetles were found on tall trees therefore for easy collection 7 to 8 feet bamboo sticks were also used to shake the tip of branches. The trapped beetles were brought in to the laboratory and maintained for the further study. The earthen pots with moist soil were used for rearing. 20 beetles with equally mixed sexes were released in earthen pots. The tender leaves of Arjun (*Terminalia arjuna*) were

provided as a food to the beetles. The pots were covered with another inverted earthen pot to stimulate the darkness.

After mating, female laid eggs singly in the soil at a depth of 5 to 10 cm. Eggs were collected, separated and kept in earthen pots containing moist soil (approximately 15% moisture) for incubation, at room temperature 25°C to 30°C with relative humidity varying from 70% to 90%. The pots were covered with another similar inverted earthen pot to stimulate darkness and to protect from predation. The hatched grubs were kept in different earthen pots containing moist soil (15 to 20 % moisture) with 10 larvae, each of first and second instar. Cut potatoes (*Solanum tuberosum*) and roots of grasses (*Panicum and Heteropogon*) were given as food to the growing larvae. Such pots were kept in plastic troughs containing moist sand which keeps the soil moistened for longer duration. The identification of the beetle was made by Dr. V.V. Ramamurthy, IARI, New Delhi up to generic level. Further it is identified up to species level by comparing the specimen with the specimen present in the collection of Department of Entomology, College of Agriculture Kolhapur under All India Co-ordinated research project on white grubs funded ICAR, New Delhi. The description of the species exactly matches with the description of *Holotrichia karschi* Br. (Brenske, 1892).

RESULTS AND DISCUSSION

Host range of *Holotrichia karschi* Br.

Adults of *H. karschi* are nocturnal in habit. The survey regarding the host range of *H. karschi* was made from evening onwards. During the study period adults were observed seven different plants viz. *Terminalia arjuna*, *Terminalia tomentosa*, *Guazuma ulmifolia*, *Syzygium cumini*, *Zizyphus jujuba*, *Dalbergia sp.* and *Acacia auriculiformis*. But the most preferred host plants were *Terminalia arjuna* and *Terminalia tomentosa* (Table 3).

Pest Status of Grub

The late second and the entire third instar feed voraciously on the roots of various agricultural crops like *Sorghum bicolor*, *Zea mays*, *Apios americana*, *Oryza sativa*.

Life cycle

Beetle emergence

Adult emerge from the soil after the first downpour of monsoon that is during the second week of June and continued to remain active up to the second week of August. Beetles feed on the tender succulent leaves and on the newly formed seeds. Beetles emerge from the soil at 7.00 pm to 8.00 pm. After emergence adults congregate on the trees for feeding.

Earlier workers observed the emergence of *Holotrichia fissa* soon after the onset of monsoon i.e. from second week of June (Kalra and Kulshreshtha, 1961; Rai *et al.*, 1969; Yadava and Misra, 1977; Sandhu *et al.*, 1980; Brar and Sandhu, 1982). Similarly, the activity of *Holotrichia serrata* Fab. start with onset of monsoon (Raodeo and Deshpande, 1987). The beetles feed on the plants at dusk and leave their host plants at dawn and go back to the soil. Later it was observed that the heavy rainfall during July and August affected the emergence of beetles. In *Holotrichia consanguinea* Blanch. activity of

emergence was decreased at the end of July in Konkan region. The results are confirmatory with the earlier reports (Kalra and Kulshreshtha, 1961; Lolage and Patil, 1988).

Mating and Oviposition

Soon after emergence from the soil at dusk females alight on tender braches of Arjuna and commenced feeding on the leaf margin. Males get attracted towards female possibly due to pheromonal action. Mating takes place by inserting adeagus in to the female genital chamber through female gonopore and spermatophores are released. During copulation initially male hold female just behind the head latter on male hangs freely downward in upside down position. Such mating pairs are observed in the field as well as in the laboratory condition. Mating last for 40 to 60 minutes, get separated and they feed on the leaves throughout the night and return back to the soil at dawn. Mating takes place once in adult life but the emergence of mated adult especially females continue for 8 to 10 days for feeding. It indicates for maturation of ovaries feeding is essential. The mated female under laboratory condition kept without food second day onwards deposit only 3 to 5 eggs and well nourished female that is the female allowed to feed for entire 8 to 10 days period deposit eggs in full capacity that is at the max 28 eggs. Females and males continued to feed on the leaves in the night and went in to the soil at dawn. The mated female laid eggs singly in the soil at a depth of 5 to 10 cm. Deposited eggs are protected by constructing earthen cell of fine soil particles around it. Female lays 2 to 6 eggs per day with a total of 23 to 30 eggs during the entire life span. The egg laying continued for 6 to 13 days.

Eggs

The freshly laid eggs were oval in shape and white in colour. Later on the eggs become yellow in colour and prior to hatching embryo is clearly visible (Plate1, Fig.1).. The incubation period was of 10 to 16 days (Table 1). It was 1.60 to 1.80 mm in length and 1.26 to 1.36 mm in breadth (Table 2). Incubation period for *H. serrata* noticed about 10 to 13 days (Raodeo and Deshpande, 1987). In *H. consanguinea* it was ranged for 7 to 10 days (Patel *et al.*, 1967; Rai *et al.*, 1969).

Larval development

Larvae are subterranean and feed on the developing root tips of the grasses and decaying organic matter. In all two moults were observed during the larval development which totally lasted for 66 to 78 days.

First instar

The newly hatched grub was dirty white in colour. Head is light brown in colour later on it becomes dark brown when larva start to feed on soil and organic matter. The first instar lasted 10 to 16 days under laboratory conditions (Plate1, Fig.2).

Table 1: Duration of different stages of *Holotrichia* sp. in days

Stage	Min.	Max.	Mean	S.D.	SEM
Egg Incubation Period	10	16	13.6	3.098	0.979
Larval 1 st Instar	12	16	14.4	2.066	0.653
Period 2 nd Instar	29	32	31.2	1.317	0.416
3 rd Instar	25	30	27	2.582	0.816
Pupa	17	20	19.4	1.265	0.400
Adult	14	25	20.3	3.199	1.012

Figures are mean of 10 samples, SD- Standard deviation, SEM- Standard Error of Mean

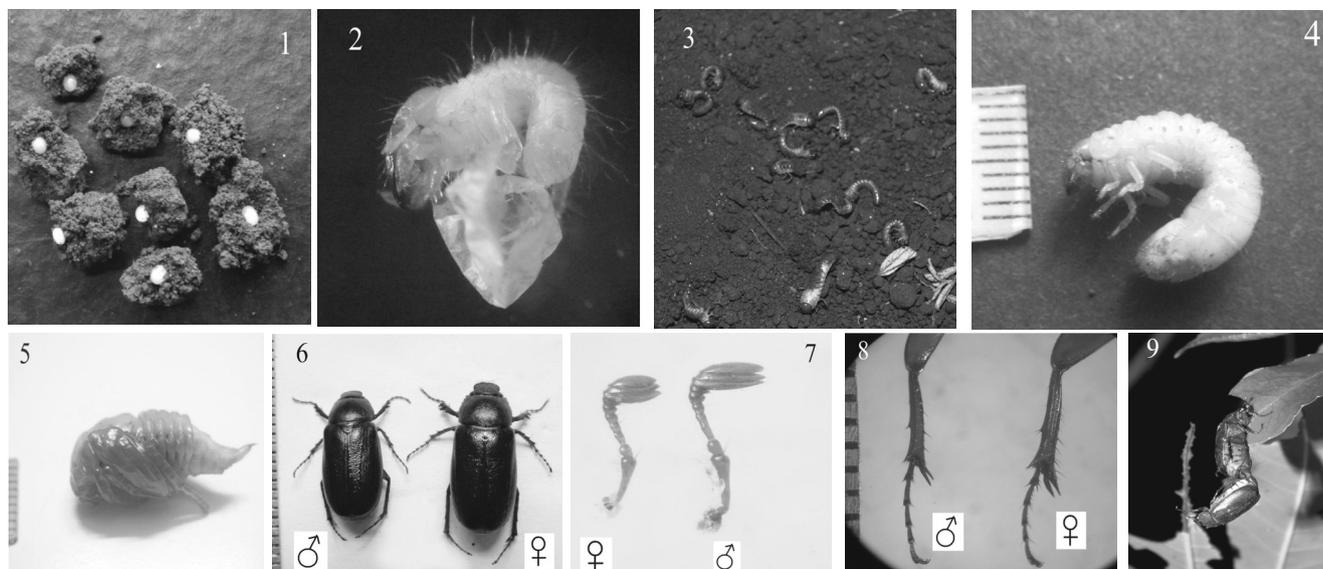


Plate 1: Life Cycle of *Holotrichia karschi* Br. (1) Deposited eggs are protected by constructing brood ball of fine soil particles. (2) First Instar - newly hatched grub. (3) Second instar. (4) Third instar. (5) Pupa (6) Adult - Male and Female. (7) Antennal club of terminal segments in male is larger than in the female. (8) In male tibial spurs of hind leg are narrower, slender with pointed apex while in female these are broad, flat and sufficiently strong blade like. (9) Mating-Male hangs freely downward in an upside down position.

It was measured 6 to 8 mm in length and 2 to 4 mm in breadth (Table 2). The first instar in *H. fissa* was completed in 18-23 days and in *H. consanguinea* it was lasted for 9 to 18 days (Lolage and Patil, 1988). The average duration of first instar was 32 days in *H. serrata* (Mujumdar and Teotia, 1965).

Second instar

Morphologically, it resembles to the first instar larva except that its last abdominal segment was enlarged. Larva was darker in colour than the first instar (Plate1, Fig.3). It was measured

Table 2: Morphometric data of *Holotrichia* sp. in mm

Stages		Min.	Max.	Mean	SD	SEM
Egg	Length	1.60	1.80	1.68	0.062	0.019
	Width	1.26	1.36	1.30	0.038	0.012
Larva	Length	6	8	7.4	0.966	0.305
	width	2	4	2.9	0.737	0.233
1 st Instar	Length	14	16	15.3	1.033	0.994
	Width	4	6	5.1	0.326	0.314
2 nd Instar	Length	30	35	32.5	2.635	0.833
	Width	5	9	7.4	2.066	0.653
3 rd Instar	Length	15	18	17.4	1.265	0.400
	Width	6	8	7.6	0.843	0.266
Pupa	Length	18	21	19.8	1.549	0.489
	Width	7	10	8.8	0.788	0.249

Figures are mean of 10 samples, SD- Standard deviation, SEM- Standard Error of mean

Table 3: Recorded host plants of *Holotrichia* sp. in Amba forest

S. No.	Scientific name	Common name
1	<i>Acacia auriculiformis</i> A. Cunn. ex Benth.	Australian Acacia
2	<i>Terminalia arjuna</i> (Roxb.ex DC.) Wight and Arn.	Arjun
3	<i>Terminalia tomentosa</i>	Ain.
4	<i>Syzygium cumini</i> (L) Skeels	Jamun
5	<i>Dalbergia</i> sp.	Sissu
6	<i>Guazuma ulmifolia</i> Lam.	Badraksh
7	<i>Zyziphus jujuba</i> Lam.	Ber

14 to 16 mm in length and 4 to 6 mm in breadth (Table 2). The second instar lasted 29 to 32 days (Table 1). The second instar in *H. fissa* lasts for 24 to 28 days. In *H. serrata* it ranged from 32 to 38 days (Mujumdar and Teotia, 1965; Lolage and Patil, 1988).

Third instar

The fully grown grub was dirty white in colour. Head is large with strong mandibles and are brown in colour; antennae long slender and four segmented; apical segment of the antenna is smaller; next segment provided with lateral projections; third segment larger than the others; fourth segment provided with seta (Plate1, Fig.4). Legs are well developed, similar in structure and provided with long setae. The thoracic region is provided with series of setae. There is one pair of spiracle located on the prothoracic region and eight in the abdominal region. It is 30 to 35 mm in length and 5 to 9 mm in breadth (Table 2). The third instar larva was lasted for 25 to 30 days. In the *H. fissa* third instar larvae lasted for 27 to 34 days (Table 1). It was noticed that third instar of *H. serrata* lasted for 81 days (Mujumdar and Teotia, 1965). The third instar of *H. consanguinea* was completed in six weeks (Yadava and Saxena, 1977).

Pupa

The full grown larva burrows deep in to the soil and stops feeding. It prepared a small earthen cell and pupated within earthen cell. The pupa is exerate. The newly formed pupa measured 15 to 18 mm in length and 6 to 8 mm in breadth (Plate1, Fig.5). The pupal period lasted for 17 to 20 days. In *H. fissa* pupal period ranged for 14 to 18 days (Lolage and Patil, 1988). The pupal period in *H. coriacea* Hope was ranged for 12 to 20 days (Chandla et al., 1988).

Adult

The adult is brownish black in colour. Head short with lamellate antennae (Plate1, Fig.6).

Antennal club of terminal segments in males is larger than in the females (Plate1, Fig. 7). Mandibles well developed. Maxillary palpi four segmented; labial palpi three segmented. Eyes are prominent. Pronotum is short; legs fuscous; hind leg longer than the others.

In this species sex dimorphic characters were recorded, usually females are larger than males. The hind leg of males shows three tibial spurs (Plate1, Fig. 8). All the three spurs are narrower, slender with pointed apex. Among them last spur is largest. The hind legs of female also have three tibial spurs. They are broad flat and sufficiently strong blade like. The terminal abdominal sternum of adult of either sex is narrower elongated plate just beneath the pygidium.

In female, sternum possesses 4 to 5 rows of large bristles and small bristles are intermixed in between the rows of large bristles, one behind the other present on the anterior margin of the 6th sternum. Remaining part of the 6th sternum has only small bristles. The size of adults was measured 18 to 21 mm in length and 7 to 9 mm in width. Adults survived for 14 to 25 days under the laboratory conditions.

The study is still continued to get more comprehensive picture regarding the larval host plants and biology on these different host plants.

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