# BIONOMICS OF *HYPOLIXUS TRUNCATULUS* (F.) (COLEOPTERA: CURCULIONIDAE: LIXINAE: LIXINI), A MAJOR PEST OF *AMARANTHUS CAUDATUS* L.

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ABSTRACT: *Hypolixus truncatulus* (F.) has been observed as a major pest of cultivated amaranthus viz., *Amaranthus caudatus* L. in the Jammu region whose leaves are used as greens and seeds for medicinal purposes. Maximum of 49 specimens at different stages of development were recorded (±SE) from a single plant. Weevils were found to breed from April to November and overwinter in soil or inside the debris of harvested plants. Adults defoliate the plants while larvae feed on internal tissues of the stem and branches to form irregular zigzag tunnels resulting in galls. Infestation varies from 34.96 to 82.3% with an average of 62.52% ±21.4. Mating normally lasts for one and half an hour. Female after 20-40 minutes of copulation commences laying eggs singly in the excavated hole in the stem, branches, petiole or midrib of the leaves. Incubation varies between 3-6 days with an average of 4.2±0.36 days. Larva when taken out of the stem or branch shows a typical C-shaped curvature. Larval period ranges from 42-45 days with an average of 43.6±0.45 days. Pupal period ranges from 12-15 days with an average of 13.5±0.43 days. Total life cycle takes 58-64 days with a mean of 61.10±0.71 days. At least three overlapping generations were observed from April to November.

KEY WORDS: *Hypolixus truncatulus*, bionomics, *Amaranthus caudatus*, infestation.

Curculionids have been found infesting a variety of host plants not only in the field but also in storage. Among these *Hypolixus truncatulus* (F.) was first noted by Lefroy (1909) as a pest and some life history notes were given by Fletcher (1914). Ayyar (1922) described the nature of damage caused by the larvae while Pruthi (1937) and Ahmad (1939) gave accounts of its biology and parasites. Gupta and Rawat (1954) gave an account of its life history while Agarwal (1985) added some information on its gall inducing habits. Kalia et al. (1994) reported its damage on *Acacia nilotica* and Phogat et al. (1994) recorded its seasonal incidence, and effects on growth and grain yield. Beeson (1938) and Kalia and Lal (1999) reported its damage on *Dalbergia sissoo*. Brief surveys conducted at Jammu on the four species of amaranthus namely *A. caudatus*, *A. spinosus*, *A. gangeticus* and *A. viridis* grown for green vegetables revealed its pest status. Hence detailed studies were made on this weevil on *A. caudatus* towards its biology and the results are presented herein.

## MATERIAL AND METHODS

Collections were made from five different sites viz., Bhainchh, Kanoyian, Poonch, Khanetar and Lassana from Poonch district of Jammu, and rearings were made through culture on potted caged plants. Adults though copulated did not oviposit in captivity and oviposition alone was studied in the fields through field cages. The incubation period was determined from freshly laid eggs. These eggs were placed in the niches and on the moist filter papers in petridishes to prevent their desiccation before studying them for hatching.

In order to determine the individual larval periods cellular rearing was done in the field plants. Freshly oviposited places on previously uninfested shoots were covered by thin wire mesh cages and examined regularly. From the collected data only the total larval period could be derived; to determine the larval instars, newly hatched larvae and the subsequent larvae of different age groups and size were utilized, and subjected to Dyar's law for analysis.

To determine the pupal period matured larvae collected from the infested plants were observed at intervals till the emergence of adults. For morphological studies, eggs, larvae, pupae and adults were preserved in 90 percent ethyl alcohol.

The mode and extent of damage caused by the adults and larvae were studied by visual observations of the symptoms and by counting the number of damaged plants during May to September when the attack on plants was easily discernible. Infestation was observed by taking into consideration five localities viz., Mandi, Draba-Bufliaz, Bhainchh, Khanetar and Jhullas; localities were selected on the basis of endemic nature and occurrence of pest. At each locality 5-7 plots were considered; minimum 55 to maximum 132 plants were observed in each plot. A total of 2596 plants were observed out of which 1717 were found to be damaged and percentage infestation was calculated.

## OBSERVATIONS AND DISCUSSION

**Distribution:** The results of the present study and the persual of the literature reveal the distribution of the weevil in Poonch and Rajouri; subtropical region of Sunderbani, Nowshera, Kalakote, Rajouri, Manjakote, Balakote, Mendhar and Haveli. Punjab in the West to Myanmar border in the East and Bihar in the North to Madras in the South, besides, Pusa, Coimbatore, Dehra Dun and Kolkata (Ahmed, 1939); New Delhi (Phogat et al., 1994; Butani and Jotwani, 1983); Jabalpur, Madhya Pradesh (Kalia et al., 1994); Mirzapur, Allahabad, Uttar Pradesh (Agarwal, 1985); Nagpur, Maharashtra (Gupta and Rawat, 1954); Chhatisgarh (Oudhia, 2005); Kanpur, Uttar Pradesh (Mall, 1981); Palampur, Himachal Pradesh (Ramesh, 1994); Assam (Deka and Dutta, 1998); Pant Nagar, Nanital, Uttaranchal ( Singh, 1970).

**Hosts:** It is a polyphagous pest and its grubs form galls on the stem of *Amaranthus* spp., while the adults observed to feed besides various species of *Amaranthus* to a large variety of other host plants.

**Pest status:** It is a major pest of the cultivated amaranthus, larvae tunnel the stems and adult feed on tender leaves. The maximum number of adults recorded from a single plant (2.6m height) is eight; however a maximum of 49 specimens at different stages of development recorded from a single plant, in the month of June-July. Sometimes as many as 33-35 larvae found attacking on a single plant. Percentage infestation was calculated at Mandi, Draba-Bufliaz, Bhainchh, Khanetar and Jhullas 34.96, 45.4, 82.3, 68.8 and 81.2 respectively showing infestation from 34.96-81.2% with average 62.53±21.40. Results reveal it as a

serious pest on cultivated amaranthus. It has also been found a major pest of cultivated amaranthus in Madhya Pradesh and 17-18 grubs were found attacking a single plant (Gupta and Rawat, 1954). Ahmad (1939) collected 155 individuals at different stages of development from a single large plant.

**Seasonal occurrence:** The weevil breeds from April to October and during other periods undergoes overwintering in cracks and crevices of the walls or sometimes it remains inside the dead remains of the harvested stems and in the stumps in the soil. Maximum oviposition had been observed from June to September. All stages found in the field from May to October with considerable overlapping.

**Nature and symptoms of damage:** The presence of adults in the field is noticed by the scratched stem branches and eaten up tender margins of leaves (Fig. 1) with careful search revealing adults hidden under the leaves. After about 6-8 days, the mature weevil starts ovipositing by notching out holes with the help of its snout in the tender and succulent branches or in the stem at the axil of the leaves or branches; after ovipositing the mouth of the holes were sealed with an yellowish secretion, which after 2-4 days turn dark-brown or black, which further confirms the attack. The presence of eaten leaves with irregular deeply incised margins visible from a distance is the indication of its severe damage. After 6-7 weeks of larval life, pupal chambers get formed at the basal part of the stem or at the axil of the side branches (Fig. 3), which grow in size and form galls. These galls increase in size considerably with the pupa developing inside. After about two months exit holes of the emergence (Fig. 5) of the adults could be observed and longitudinal splitting of the mature stem, presence of broken stems and plants breaking with even slight winds are symptoms at this stage.

Adults cause appreciable damage through feeding on the leaves, upon the epidermis of the tender stems by making irregular scratches, and sometimes eating up all the inner contents of stem leaving behind only the epidermis and hypodermal tissues. Larvae cause damage through tunneling within the stems in a zig-zag way (Fig. 4), thus reducing the vitality and vigour of the plants and chiefly impairing the standing capacity. Many such stems later rupture longitudinally thus exposing to the risk of desiccation; sometimes even 2-3 tunnels may be seen in transverse sections of the stem (Fig. 6). At the places where the larva prepares its pupal chamber, the stem walls become thickened so as to form galls. The adults emerge by biting holes through these galls. As a result, the stem becomes very weak and breaks down at such places during heavy winds; such plants often lie prostrate on the ground and dry up. Similar observations had earlier been recorded by Pruthi (1937), Ahmad (1939), Gupta and Rawat (1954), Butani and Jotwani (1983), Agarwal (1985), Phogat et al. (1994), Kalia et al. (1994), Kalia and Lal (1999) and Oudhia (2005) from various parts of India. The percentage of infestation is low in the temperate belt and high in the subtropical region, extending to 62.5 percent. In Madhya Pradesh, Kalia et al. (1994) observed that the adults feed on tender leaves and shoots of *Acacia nilotica* and damage of seedlings and saplings extend up to 25 percent.

## Life history

**Emergence:** The weevil has a slow and steady development with overlapping generations, fresh adults starting emergence from June to November without any interruption. Synchronized breeding with the growth of the host plant had been observed with adults seen from fourth week of March to second week of November.

**Mating behaviour:** After few minutes (5-10 min.) of courtship, the male succeeds in riding over the female, which was then held firmly by its legs and

antennae, with mating taking place a number of times. Adults are almost sexually matured upon emergence itself and therefore, premating and preoviposition periods are lacking. Mating lasted for about 60 to 90 min. sometimes upto 4-5 hours during night. Oviposition was observed immediately upon copulation. In Uttar Pradesh, adults remain in copulation for 2-5 hours; females copulate with more than one male and after resting for 20 min. to one hour, the impregnated female starts ovipositing which continued for 4-10 days (Agarwal, 1985). With slight disturbance the copulating pair falls to the ground intact in copulatory posture but sometimes they separate and feign death.

**Oviposition behaviour:** Immediately after copulation or sometimes 20-40 min. after copulation, the female makes a hole, 1-2 mm deep in the tender branches or in the petiole or in the midrib of the leaves, with its mouth parts and rostrum, afterwards turns around and deposits a single egg therein (Fig. 8). The hole is narrower near the opening and broader at the base and its mouth is plugged with a sticky secretion, spread into an oval flap. When fresh, this flap is dull green, thus making it difficult to make out the location of oviposition without careful examination of the twig. After 2-4 days, the flap becomes black, but by this time the egg hatches and the grub bores into the stem. Some similar observations had earlier been recorded by Ahmad (1939), Gupta and Rawat (1954) and Agarwal (1985). It has also been observed that the older branches of the plants, which are usually hard and somewhat dry, are avoided for oviposition and hence no egg recorded in October-November.

**Egg** (Fig. 7)**:** Freshly laid eggs oval with both ends rounded, surface smooth, shiny, soft, translucent and light yellow, measuring 1.25 ± 0.03 mm long ranging between 0.90-1.46 mm and 0.81 ± 0.02 mm broad, ranging from 0.67-1.05 mm. As development starts, its colour changes to dull yellow. If the egg was removed from the plant and kept on moist filter paper, it fails to hatch.

**Egg period:** Egg period varies from three to six days in June-July with a mean of 4.2 ± 0.36 days, with egg hatching into a small, apodous, creamish white grub. Variations had been observed in egg period recorded in different parts of the country; Uttar Pradesh, from 3-5 days (Agarwal, 1985), Madhya Pradesh, 2-4 days (Gupta and Rawat, 1954); did not hatch at all if removed from the niche, whereas at room temperature in March and November, egg period lasted for 10-12 days but if kept at constant temperature of $20^{O}$C and $27^{O}$C, lasted 10 and 4 days respectively (Ahmad, 1939).

**Larva and larval instars** (Fig. 9): Five larval instars were recorded in the study. Agarwal (1985) observed three larval instars and all looking more or less alike; in Egypt, 5 larval instars observed (Tawfik *et al.*, 1976). As there is little difference between the instars description of the first and the final instars and only the measurements of body and head capsule are given in detail.

**First instar:** Creamish white, body C-shaped, slightly curved at the posterior end, posteriorly narrower, segmentation not clearly demarcated. Head light brown with dark brown, prominent, triangular mandibles. Sparse hairs present on the head capsule and on the elongate posteriorly tapering body. When taken out of the niche, larva show ventral curvature and appear C-shaped. Body measures 1.01-1.98 mm long with a mean of 1.48 ± 0.13 mm and 0.45 -0.67 mm wide with a mean of 0.58 ± 0.03 mm. Head capsule measures 0.48 -0.60 mm long averaging 0.53 ± 0.02 mm and 0.41 -0.56 mm wide averaging 0.47 ± 0.02 mm.

**Second instar:** Similar to the first instar except for the body segmentation clearly demarcated; three thoracic segments with prominent pedal lobes and hairs, and nine abdominal segments; all segments nearly equal in size except the

last two being elongate and narrow. Body measures 2.81 ± 0.26 mm long ranging between 2.17 -3.50 mm and 0.78 ± 0.04 mm wide ranging between 0.63 –0.90 mm. Head capsule measures 0.61 ± 0.05 mm long ranging between 0.48 – 0.78 mm and 0.61 ± 0.01 in wide ranging between 0.56 – 0.63 mm.

**Third instar:** Similar to second instar except increase in size and presence of transverse rows of hairs dorsally in each segment. Head dark brown with sparse, long hairs. Body measures 5.33 ± 0.33 mm long ranging between 4.00 – 6.00 mm and 1.67 ± 0.16 mm wide ranging between 1.01 - 2.00 mm. Head capsule measures 1.00 ± 0.08 mm long ranging between 0.63-1.23mm and 1.05 ± 0.09 mm wide ranging between 0.63 -1.31 mm.

**Fourth instar:** Similar to the third instar except for body size and eight pairs of spherical spiracles clearly visible, one pair of spiracle present laterally in the inter-segmental area between pro and mesothorax, abdomen has seven pairs of small spherical spiracles with brown margin, laterally on 1-7 segments. Length varies between 7.00 -10.00 mm averaging 8.33 ± 0.53 mm and width between 2.00 – 3.00 mm averaging 2.44 ± 0.18 mm. Head capsule measures 1.25 ± 0.03 mm long ranging between 1.12-1.42 mm and 1.27 ± 0.05 mm wide ranging between 1.01-1.50 mm.

**Fifth instar:** Full grown larva measures on an average 14.70 ± 0.42 mm long ranging between 3.00 -16.00 mm and 4.05 ± 0.05 mm wide ranging between 4.00 -4.50 mm. Body stout, creamish white, apodous, elongate, cylindrical and when taken out of the gall show typical curvature, becomes C-shaped with posterior end slightly narrower. Head fairly well sclerotized, provided with mandibulate mouth parts. Head dark brown with sparse, long hairs and measures 1.86 ± 0.04 mm long ranging between 1.68 -2.06 mm and 1.98 ± 0.04 mm wide ranging between 1.68 -2.13 mm. Mandibles strong, black, triangular and bidentate. Thorax with three segments, each with a pair of cushion-like pedal lobes on the ventral side, and slightly broader than abdominal segments with transverse rows of hairs dorsally one each in every segment. Abdomen large, prominent, nine segmented slightly narrowing posteriorly. First seven segments similar in size, eighth and ninth narrow and rounded. Sparse hairs present all over the body. One row of long hairs in each segment dorsally. Laterally eight pairs of small spherical spiracles clearly visible. One pair in the segmental groove between pro and mesothoracic segment and seven pairs each in first seven abdominal segments.

**Larval period:** Total larval period on *Amaranthus caudatus* vary between 42-45 days with a mean of 43.6 ± 0.45 days in the month of June-July. In Madhya Pradesh, however the larva becomes fulfed in 20-24 days in October-November and in 12 days in May (Gupta and Rawat, 1954); grub period lasted for 20-65 days, being longer in winter (Butani and Jotwani, 1983); Ahmad (1939) observed that larvae that hatched between 26$^{th}$ March and 12$^{th}$ April pupated after 40-65 days, and those that hatched at the end of October or beginning of November overwintered in the larval stage.

**Feeding behaviour:** Immediately after emergence, the larva begins to feed on the internal tissues, making its way into the stem in the form of an irregular zig-zag tunnel, filling it with excreta as it bores down. Larva moves by wriggling movements along the tunnel. Nearly all the pith region gets completely eaten up and it goes on tunneling downwards until fully fed and gets ready for pupation. Galls get induced as a small spherical or oval swelling on the main stem and thick branches or at the places of bifurcations of branches. These galls are regular, subglobose, oval or fusiform, hollow, hard, unilocular, persistent, thick, wartly, having pale brown, short evaginations and longitudinal ridges on the surfaces formed by the withering of the epidermis (Fig. 3). It grows gradually till adult

emerges, appears ovoid, tapering gradually towards the distal ends; even after the insect emergence, the gall grows and increases in size so long as the branch bearing it grows in diameter. The size of a mature gall was usually 2.0 to 4.0 cm long with a mean of 3.50 ± 0.16 cm, and 1.0 to 2.5 cm wide with a mean of 1.87 ± 0.10 cm. Galls were concolorus with stem, young galls green but with the growth of the shoot they become pale yellow, old gall from which the adult has emerged shows a rounded or slightly oval exit hole, this passage was cut by the adult for its exit and measures 5.60 ± 0.31 mm long ranging between 4.0 to 8.0 mm, and 3.83 ± 0.19 mm wide, ranging between 3.0 to 5.0 mm.

**Pupation:** Full grown larva before pupation bores its way upto the stem surface, where a small round hole is made leaving the thin epidermis layer intact. A hole gets formed either at the level of the soil surface or at the axil of basal branch, the hole being intended for the emergence of the adult. At the same place, subsequently the larva encarves elongate oval pupal chamber which afterwards swells up and develops a large gall. Pupal chamber greyish brown, hard, compact, made out of frass and execreta, within which the mature larva pupates. At such places of pupation the stem was found to get swollen and galls get induced (Fig. 3). Pupal chamber measures 16.3 ± 0.04 mm, varying from 13.0 -20.0 mm long, and 4.70 ± 0.13 mm wide varying from 4.0-5.0 mm.

**Pupa** (Fig. 10): Exarate, naked, with all its appendages distinctly visible and freely projecting on the ventral surface. Creamish white in the beginning but gradually turning pale yellow. Head light brown with yellowish median line, and ventrally prolonged rostrum which was cylindrical and touches forecoxae. Eyes prominent, black, present at the base of the rostrum. A pair of geniculate antennae present on either side of the rostrum and segmentation not clearly demarcated. Sparse hairs present on the head. Thorax three segmented, creamish yellow with two wing pads, and three legs folded on the ventral side. Abdomen prominent, nine segmented, with posterior end narrower. All segments have dorsal transverse row of setae at the middle. Fine sparse hairs present all over the body. Setae in the eighth segment well developed and pupillated structures present. Last segment narrow, ventrally curved with two black curved anal setae on either side of the anal opening. Six spherical brown spiracles visible from segment 2-7. Pupa measures 12.88 ± 0.18 mm long, varying between 11.0 -15.0 mm and 3.84 ± 0.07 mm wide varying between 3.0 -4.00 mm. Total pupal period lasts 13.5 ± 0.43 days, varying between 12-15 days in June-July. Earlier studies recorded that pupal period lasted for 9-10 days at 27$^{O}$C in April and 20-24 days at 20$^{O}$C (Ahmad, 1939); 10 days in summer and 14-18 days in October-November (Gupta and Rawat, 1954); 9-24 days, usually during summer but even longer in winter (Butani and Jotwani, 1983) and 7-10 days during summer (Agarwal, 1985). Pupa ultimately transforms into adult (Fig. 2, 11) and emerges out from the pupal chamber through the emergence hole made by the mature larva. Immatures remain in the pupal chamber for 5-9 days averaging 6.9 ± 0.46 days and finally mature adult emerges out, which was pale brown to start with and gradually changes to dark reddish brown with a bloom in the form of faint ashy marks begins to appear over the elytra and prothorax afterwards.

**Adult description** (Fig. 12)**:** Adults dark brown, variegated with white hairs and several dark patches of dense pubescence. Body medium sized measuring 11.70 ± 0.27 mm varying from 9.0 - 14.0 mm long and 3.57 ± 0.08 mm wide varying from 3.0 -4.0 mm. Females slightly larger than males. Head prognathus, being broad at the base and extended greatly into a pronounced rostrum, anteriorly at the tip of rostrum. Chewing and biting type of mouth parts present; mandibles prominent,

black and bidentate. An oblique scrobe present on either side of the rostrum for the scape of the antennae. Eyes large, well developed, black located at the base of rostrum on either side. Antennae geniculate, fourteen segmented, present on either side of the snout arising from anterior one third of the snout; scape narrow, elongate and broader at the apex; first segment of funicle broader than second, but longer than first; club broad in the middle with pointed tip. Thorax highly sclerotized, fairly large, prothoracic sclerites fused to form an undivided annular band. Forewing modified into highly chitinized elytra, which cover completely the hindwing and extend upto the tip of abdomen dorsally. Dorsally on each elytron there are longitudinal rows of pits which are also clearly visible on pronotum. Laterally there are grooves longitudinally but covered with dense white hairs. Scattered pits on the thoracic region with shining spots. Legs almost similar in structure and size; coxae round, trochanter triangular; femur large, stout roughly cylindrical; tibia narrow at the base and broad at the apex with ventral spine; tarsi four in number, first three bear ventral hairy pads and fourth elongated with two ventrally curved, pointed claws. Abdomen dorsally completely covered by the elytra; from ventral side five segments clearly visible and uniformly dirty white. Though very sluggish and disinclined to fly, adult is quite alert in noticing an approaching hand. By a little but prompt movement it just turns around the stem away from the hand and gets concealed by falling on the ground and feigning death. On falling down it lies ventral surface upwards and legs stretched out. The ventral surface being uniformly dirty white, matches exactly with the ground colour and thus seems to offer a successful protection against enemies.

**Number of generations:** Total lifecycle takes 58-64 days with a mean of 61.10 ± 0.71 days, there are at least three generations from April to November. Similar observations were recorded earlier (Pruthi, 1937; Ahmad, 1939 and Butani and Jotwani, 1983). Grubs that hatched at the end of September, pupated after 45 days in the month of November at the basal part of the host plant and the collection of pre-mature adults from the pupal chambers in the basal parts of host plants confirm that this weevil passed the entire winter in the adult stage. Some of the earlier emerged adults overwinter in cracks and crevices also. Sometimes adult remains inside the dead remains of the harvested stems and in the stumps in the soil. However in other parts of India, some earlier workers has observed that the individuals of last generation overwinter in all stages (Pruthi, 1937; Ahmad, 1939; Butani and Jotwani, 1983).

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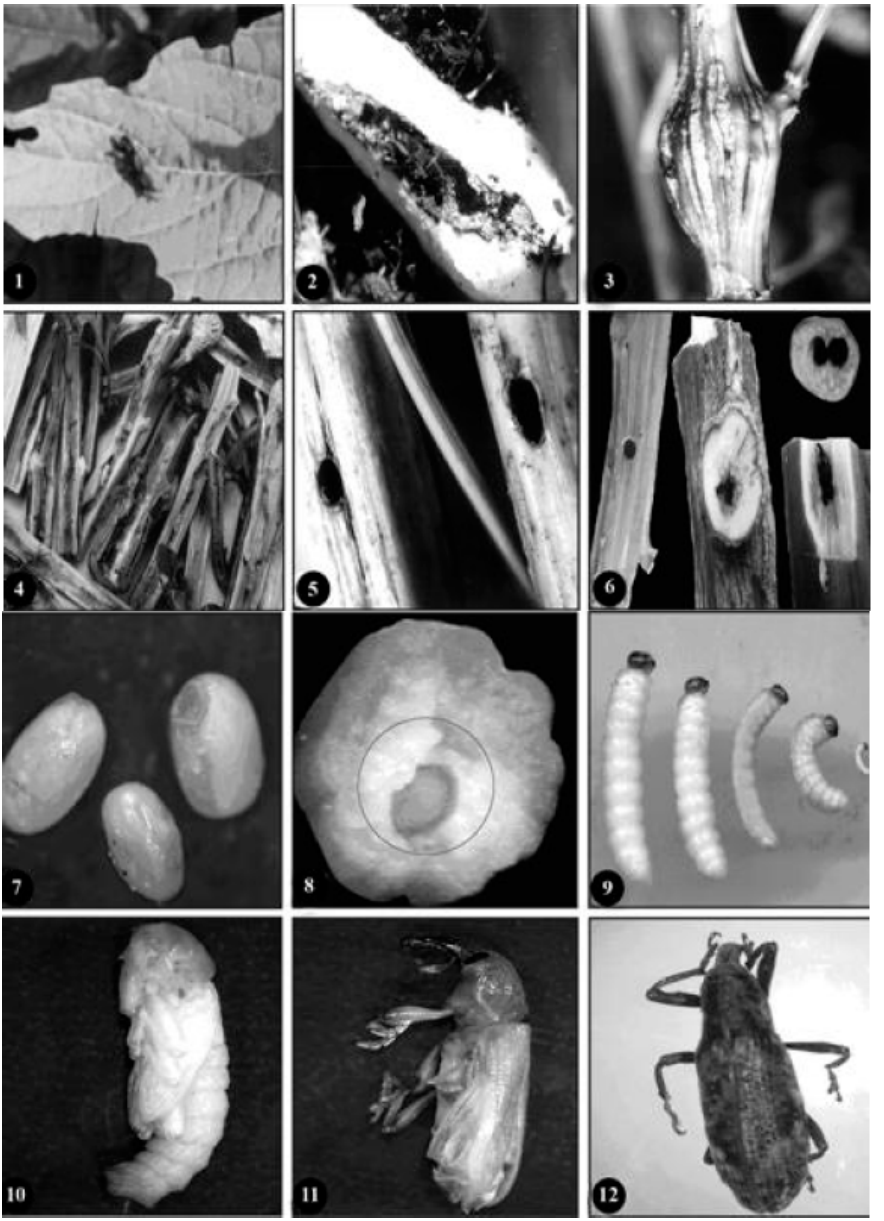


**Figs**: **1**. Adult damage, **2**. Imago in tunnel, **3**. Gall with larva inside, **4**. Internal galleries formed by larvae, **5**. Exit holes, **6**. Emergence holes and tunnels, **7**. Eggs, **8.** Egg in niche **9**. Larval instar stages, **10**. Pupa, **11**.Adult (young), **12**. Adult (matured).