



RESEARCH ARTICLE

First report of an invasive pest, *Sphenoptera lafertie* T. (Coleoptera: Buprestidae) on cherry plantation (Rosaceae), from the North-Western Himalayas, Kashmir

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Received: 07 September 2025; Accepted: 05 December 2025; Available online: Version 1.0: 20 April 2026

Cite this article: Mir OA, Swaranjit SP, Muneer J, Wasim Y, Khalid F, Shahjahan R. First report of an invasive pest, *Sphenoptera lafertie* T. (Coleoptera: Buprestidae) on cherry plantation (Rosaceae), from the North-Western Himalayas, Kashmir. Plant Science Today. 2025; 13(sp2): 1-8. <https://doi.org/10.14719/pst.11662>

Abstract

Cherries are a typical temperate fruit crop that can be consumed fresh, dried, pickled, canned, or processed. They are a rich source of anthocyanins and antioxidants, improve cognitive functioning and thrive in regions that don't experience extreme heat or cold. Nevertheless, the soft bark and gum-exuding properties make it vulnerable to severe insect pest damage, resulting in significant economic losses to the horticulture industry. The incidence and mortality of plants were observed in the North-Western Himalayan region of India by creating galleries inside the trunks. To identify and assess pest damage, a morphological characterisation was carried out in 2021 and 2022 at the Fruit Experimental Farm, Sher-e-Kashmir University of Agricultural Sciences and Technology Kashmir (SKUAST-K), Kashmir, India. During the investigation, it was confirmed that invasive pest is a trunk borer (*Sphenoptera lafertie* T.), a member of the family Buprestidae and order Coleoptera. A survey conducted across three orchards in North, Central and Southern Kashmir revealed the highest infestation levels on the cherry variety Bigarreau Noir Grossa (Mishri), with approximately 63 % of live holes recorded in North and South Kashmir. In Central Kashmir, the variety Guigne Pourpera Prece (Awal Number) exhibited a 67.8 % infestation at the SKUAST-K Farm.

Keywords: cherry; grub; Himalayan region; orchards

Introduction

In the Rosaceae family, which includes almond, apricot, plum, peach and nectarine, cherries are members of the genus *Prunus*. Primarily, the species originated in the region between the Black and the Caspian Seas and spread by natural dispersal and human cultivation, becoming widely domesticated in Europe, particularly in Greece around 300 BC. Sweet cherry (*Prunus avium* L.), one of them, is often pyramid-shaped and large, reaching heights of 30 to 40 feet. The branches grow upright and the flowers appear in clusters of two to five on short spurs (1). Presently, the leading world producers of cherry are the United States of America, Germany, Italy, France and Russia (2). Only a few species of cherry are cultivated commercially. The fruits are large with a pronounced stem cavity and vary in color from light yellow to dark red or even purplish black (3). The red or purple colour of cherries is due to abundant anthocyanin pigments. The fruit possesses remarkable antioxidant properties and is a rich source of dietary phenolics (4, 5). Its cultivation in India is mainly confined to the North-Western Himalayas, including the Kashmir valley and adjoining regions such as parts of Himachal Pradesh and Uttarakhand (6). The total acreage and annual production of cherry in Kashmir are about 2962 hectares and 21800 MT, respectively (7).

As with other stone fruits, cherry orchards worldwide, including in India, are affected by a range of insect pests. In the temperate region like Kashmir, the major pests which feed on the cherry plant are stem borer (*Aeolesthes sarta*), round head borer (*Macrotoma crenuata*), shot hole borer (*Scolytis nitidus*), hairy caterpillar (*Lymantria obfuscata*), cherry fruit fly (*Rhagoletis cingulata*), brown scale (*Lecanium corni*), etc. (8). The most recent infestation of dreadful pest, peach flat-headed borer (*Sphenoptera lafertie* T.), observed in Kashmir valley, had inflicted heavy damage on the cherry plants.

The pest infests cherry plantations and has led orchardists to cut trees due to its devastating feeding on bark. Farmers often avoid establishing cherry plantations because the borer pest remains hidden and camouflages with the tree bark, making it difficult to detect. As a result, the borer pest damages the tree's xylem and phloem tissues, ultimately leading to the death of the tree (9). The process of egg laying by females occurs under the bark or in deep bark crevices in areas exposed to sunlight (10). However, the peak egg-hatching period is in late spring and summer. The feeding of the larvae under the bark is consistent, intruding into the plant's transport system by mining throughout the trunk and branches, eventually girdling the tree and resulting in a compromised trunk

and plant stature, or tree death. After emergence, the pest larva is very distinctive, with an enlarged thorax that gives it a large, flattened head appearance. The wounds on the tree cause oozing or amber-coloured gummy sap to flow continuously at the site of injury on cherry plants. The larval damage, which is most evident in tree trunks during early spring, is revealed by peeling back the bark to show feeding channels packed with frass and cream-colored larvae of 2–4 cm (11). Due to persistent larval feeding, the bark splits open as the tissue beneath it dies, presumably from winter temperature fluctuations. Within 2 to 5 years, excessive tunnels form, leading to persistent oozing gums and the eventual death of the tree (12). The borer completes larval development within the tree and adults emerge in late spring and early summer of the following year. The body of the adult insect borer is usually bullet-shaped and the wings are metallic, dark olive-gray to brown, with distinct blue or green on the underside, usually 0.3–0.6 inches long. The adult stage of the borer is difficult to find in the field because of its rapid movement and its camouflage among the tree bark. The study was conducted in the North-Western Himalayas, in the Kashmir valley, focusing on recording the invasive pest's cryptic behavior on a cherry plant (*P. avium*) in Shalimar, Srinagar and on evaluating management tactics.

Materials and Methods

The study of cherry tree borer was conducted across three different locations in Central, Northern and Southern parts of Kashmir, India viz., Shalimar (34°8'32.48" N; 74°51'46.48" E and 1585 m above mean sea level (AMSL), Tangmarg (34°03'33" N; 74°25'28" E and 2156 m) and Shopian (33° 43' 2.03" N; 74° 50' 2.87" E and 2146 m AMSL) respectively. At the experimental site, the insect specimen was collected from the field of fruit science at the Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences and Technology Kashmir (SKUAST-K), in June 2021. Due to the camouflaged nature of adult borers, it remains difficult to detect and capture them from a distance. On keen observation, the adult borer insect was collected from the plant surface (10 per orchard) and the larvae were collected by excising the bark of the tree with a knife and preserved in 70 % alcohol for morphological examination. The Division of Entomology, FOH Shalimar Srinagar (34°8'42" N; 4°39'5" E; 1615 m AMSL), SKUAST Kashmir, was the site of all laboratory investigations conducted between 2021 and 2022, during which all standards were met and proper tools for insect handling were used. A 14:10 (light:dark) hr photoperiod, a temperature of 20±1 °C and a relative

humidity of 80±5 % were maintained in the laboratory in enclosed chambers using glass insect rearing cages.

At each location, cherry trees from each variety were randomly selected and thoroughly checked for *Sphenoptera* sp. trunk infestation and presence of dead/live holes (Fig. 1). The borer incidence based on trunk infestation and presence of dead/live/gummosis sites present on the varieties of different cherry trees was calculated (Fig. 2) as per the following formulae:

$$\% \text{ Trunk incidence} = \frac{\text{Total number of infested trunks} \times 100}{\text{Total number of trunks examined}} \quad (\text{Eqn. 1})$$

$$\% \text{ Pest incidence} = \frac{\text{Total number of live holes} \times 100}{\text{Total number of holes}} \quad (\text{Eqn. 2})$$

Number of plants per variety

Five trees from each variety were randomly selected and tagged for recording observations at weekly intervals throughout the plant growth season (Fig. 2). Borer holes, both live and dead, were counted on the main trunk and, if present, on scaffold branches.

Larval count

To record larval counts, live holes indicative of fresh sawdust or gummosis sites were excavated to collect different larval instars. The larvae so collected were counted and preserved in 70 % alcohol (Fig. 3). The number of larvae per live hole was counted and different instars were separated/recorded based on head capsule size using an ocular micrometer.

Collection of borer specimens

Extensive surveys were conducted fortnightly to record the trunk incidence of *S. laferte* across different ecological zones of Kashmir. Three orchards from every location and 10 untagged and randomly selected plants were thoroughly inspected to record the cherry borer trunk presence. The study employed a fortnightly survey, initiated in the 13th standard week (SW) (corresponding to the 2nd fortnight of March) and concluding in the 39th SW (the 2nd fortnight of September). Each sampling interval involved surveying five designated units within every orchard (Fig. 4).



Fig. 1. (a) Newly formed holes and (b) Holes on the old trunk due to the emergence of the borer.

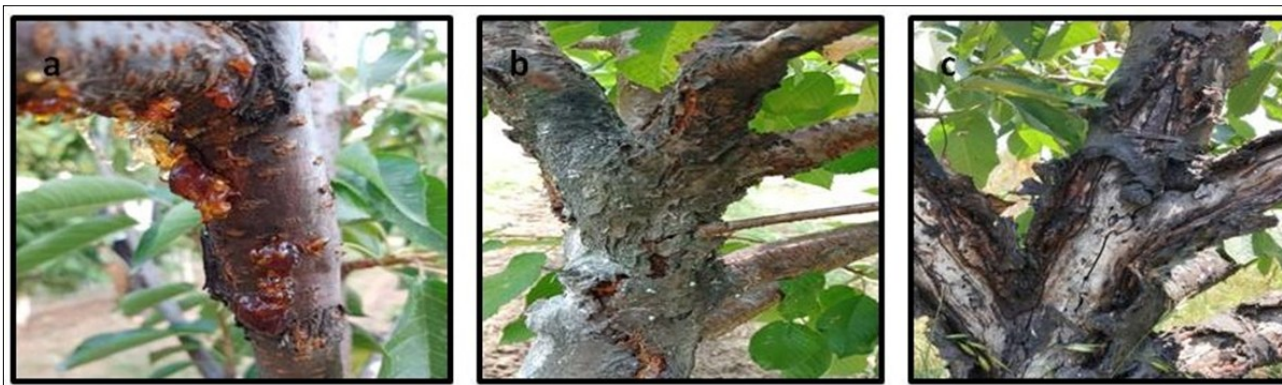


Fig. 2. (a) Gummosis on a new plantation, (b) Subsequent infestation of trunk borer and (c) Effect on old trees.

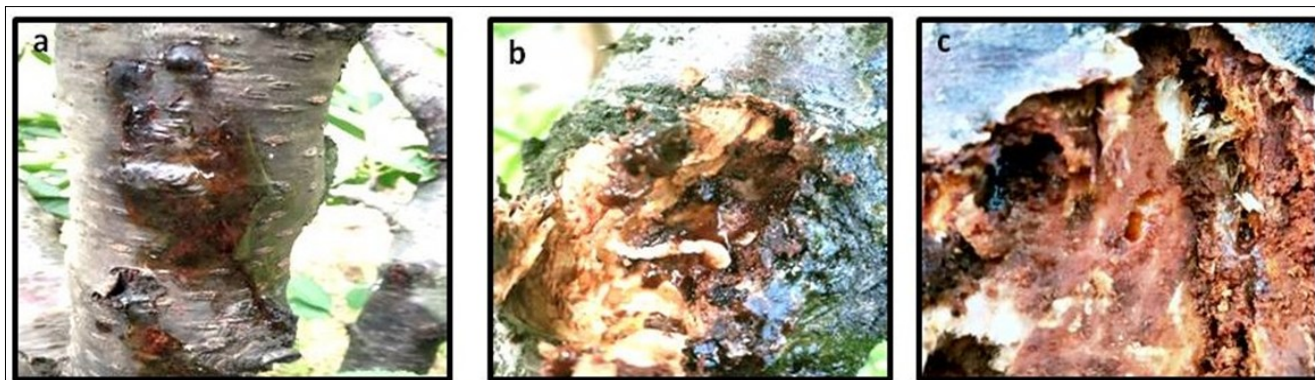


Fig. 3. (a) Oozing site for the collection of larvae, (b) Collection done by digging and (c) Scraping of bark of tree.

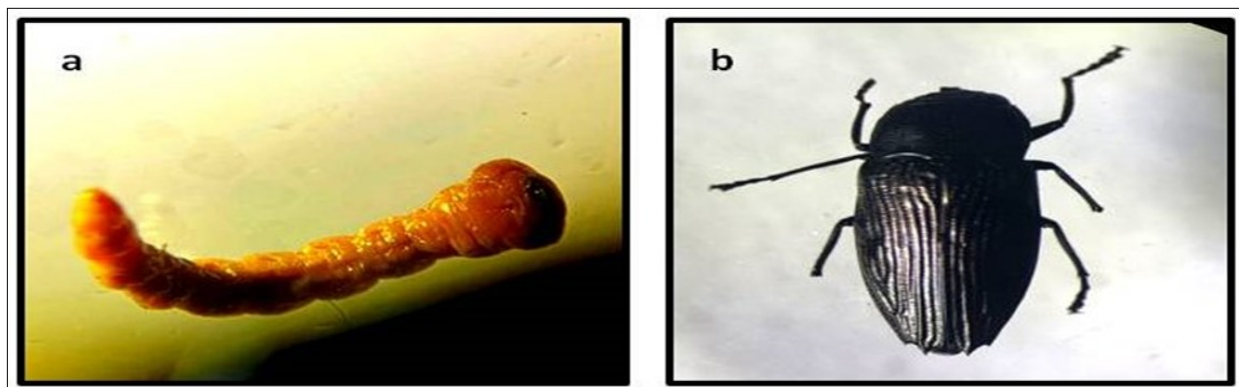


Fig. 4. (a) Collection of larvae and (b) Adult borer done from the infested cherry plantation.

To determine the percentage of infestation, 10 shoots were randomly selected from 10 trees per location and observed from the lower canopy (1.0 m adult exit holes). Larvae were collected from the infested trunks of cherry plants and daily observations of emerging adults were made. The collected larvae were brought to the Laboratory of the Division of Entomology, SKUAST-K and fed small pieces of cherry logs suitable for larval survival and pupation. For taxonomic identification, the larvae were kept at room temperature and checked regularly for adult emergence. A standardised technique with minor adjustments was adopted for clearing and preparing the genitalia for microscopy and 70 % ethanol was used to process the samples (13). A stereoscope binocular microscope (Olympus 598472, Japan) was used to view the genitalia. To properly identify the borer, the samples were sent to the Indian Agricultural Research Institute (IARI) in New Delhi.

Microscopy of the samples

Specimens of the trunk borer were obtained from experimental sites and raised in the laboratory and dissected (14, 15). The live borers were put in killing jars and given ethyl acetate to make them unconscious. First, the wings and legs were removed and then the

entire body was dissected with tiny razor blades, forceps and delicate needles. With the aid of delicate brushes, the male and female genitalia were meticulously removed from the abdomen. Genitalia of both sexes were dissected without abdominal tissue attached and the adult beetle's dissected body parts were then ready for microscopy (11, 14, 15). To relax the musculature, the dissected portions were left in a 10 % potassium hydroxide (KOH) solution overnight. The specimens were then thoroughly cleaned with distilled water two or three times before being submerged in 70 % ethanol for 1 hr. The specimens were then left overnight again in a clearing agent (a 3:1 mixture of xylene and phenol) using proper gear. Before being placed on dry, clean standard microscopic slides in Canada Balsam (used for permanent slides) and covered with a coverslip, genitalia and other body parts were cleaned, dried and flattened for microscopy. The same stereo zoom microscope, along with a digital camera for genuine pest identification, was used to take direct photos of every dissected component.

Identification of cherry trunk borer

The cherry trunk borer specimens collected from the Experimental Farm, SKUAST-K, Shalimar, were sent to IARI, New Delhi, for

identification. The identification of the adult beetle was done by Dr. Nithya Chandran, Professor, Division of Entomology, IARI, under the RRS. No. 413–16/2020.

Results

Feeding behavior

The larva is the destructive stage of this insect, entering the tree through the bark and creating tiny pathways inside the wood, occasionally penetrating the cambial part. Upon maturation, the fully developed larva completes its development and transforms into a pupa in 60–70 days. By creating tiny exit openings from the wood, covered with excreta and frass, the adult emerges.

Microscopy of the trunk borer

The thorax, abdomen, head, appendages, male and female genitalia are among the general body parts examined for microscopy (Fig. 5).

Life cycle assessment

In order to investigate the life cycle and annual number of generations carried out by the trunk borer, the bark of cherry trees from a single location of Shalimar, afflicted with the pest, was gathered from the experimental site (Shalimar) and transported to the Division of Entomology laboratory, Faculty of Horticulture, Shalimar, SKUAST-K. To establish the initial culture of the invasive fruit borer, the pupa and overwintering stages were also collected by removing bark sections and brought to the lab. The infested trunk

was placed in glass or plastic containers and muslin cloth was fastened with rubber bands over the open end of each container. The several stages of the pest's development were tracked in the lab every day. When the adults emerged from the pupae, they were fed a 10 % honey/sugar solution and moved to the rearing cages (Fig. 6). The adults survived for 7–12 days during which mating and oviposition occurred.

Incidence of cherry trunk borer based on dead and live holes in different ecological zones

Incidence of cherry trunk borer based on dead and live holes in north Kashmir (Tangmarg)

Perusal of the data presented in Table 1 revealed that, in the cherry variety Bigarreau Napoleon, the maximum number of dead holes per plant (3.7) was recorded during the second fortnight of March (13th SW). The live holes due to *S. lafertei* in all the varieties were recorded from the first fortnight of April onwards (15 SW). The number of fresh holes in the Bigarreau Napoleon cherry variety increased from 2.4 per plant in the 15th SW, eventually peaking at 8.7 per plant. This peak was also observed in the Bigarreau Noir Grossa variety. In contrast, the Guigne Noir Hative variety reached a lower maximum of 7.0 holes per plant by the second fortnight of September (the 39th SW). The data computed for the percentage of live and dead holes by *S. lafertei* revealed that the maximum proportion of dead holes, 45.9 %, was in variety Guigne Noir Hative, followed by 40.6 % in Bigarreau Napoleon; though, the minimum percentage of dead holes, 36.1 %, was in variety Bigarreau Noir

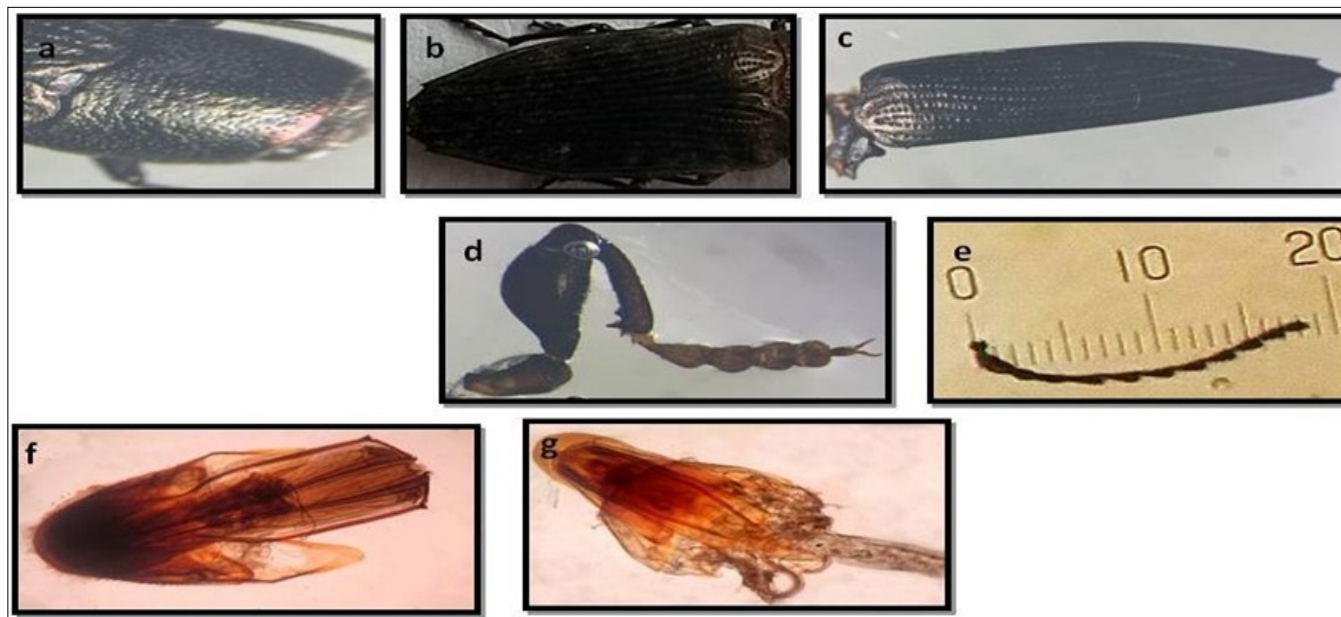


Fig. 5. Microscopy of (a) Thorax, (b) Abdomen, (c) Elytra, (d) Membranous hind wings, (e) Leg, (f) Antenna, (g) Female genitalia and (h) Aedeagus.



Fig. 6. Different stages of borer pest reared under lab conditions (a) Larvae, (b) Pupa and (c) Adult.

Table 1. Incidence of cherry trunk borer, *S. lafertie* in different cherry varieties based on dead and live/fresh holes in North Kashmir during 2019

North Kashmir Tangmarg		Standard meteorological week														Total holes (Dead + Live holes)	Mean±SD	Holes incidence (%)	
		13	15	17	19	21	23	25	27	29	31	33	35	37	39				
		(26/3)	(9/4)	(23/4)	(7/5)	(21/5)	(4/6)	(18/6)	(2/7)	(16/7)	(30/7)	(14/8)	(28/8)	(12/9)	(26/9)				
Sl. No.	Variety	Dead holes		Live holes												Dead Holes	Live/ Fresh		
1	Bigarreau Napoleon	3.7*	2.4*	2.7	3.4	3.7	4.4	4.7	5.4	5.7	6.4	7.0	7.7	8.4	8.7	5.4±2.1	9.1	40.6	59.4
2	Bigarreau Noir Grossa	3.0	2.0	2.4	3.4	3.7	3.7	4.0	4.7	4.7	5.4	6.0	7.4	8.0	8.7	4.9±2.0	8.3	36.1	63.9
3	Guigne Noir Hative	3.4	1.7	2.4	2.7	2.7	3.4	3.7	3.7	4.0	4.4	4.7	5.4	6.7	7.0	4.0±1.5	7.4	45.9	54.1
Mean		3.3	2.0	2.5	3.1	3.3	3.8	4.1	4.6	4.8	5.4	5.9	6.8	7.7	8.13	4.8 ± 1.9	8.2	40.8	59.2

*Each value is the mean of 3 replications

Grossa. Similarly, the maximum proportion of fresh holes, 63.9 %, was recorded in the variety Bigarreau Noir Grossa, followed by 59.4 % in Bigarreau Napoleon; however, the minimum percentage of fresh holes was in the variety Guigne Noir Hative, at 54.1 % (Table 1).

Incidence of cherry trunk borer at SKUAST-K, Central Kashmir, based on dead and live holes

Studies conducted at SKUAST-K Central Kashmir revealed that in the cherry variety Bigarreau Napoleon, the number of dead holes was 3.4 per plant during the second fortnight of March (13th SW). The live holes due to trunk borer in all the varieties were recorded from the first fortnight of April onwards (15th SW). In the cherry variety Bigarreau Napoleon, the number of fresh holes, recorded as 2.7 per plant during the 15th SW, gradually increased in subsequent weeks, peaking at 7.7 per plant during the second fortnight of September (39th SW). The data computed for the percentage of live and dead holes by *S. lafertie* revealed that the maximum proportion of dead holes, 42.0 %, was in the variety Lambert, while the minimum, 32.2 %, was in Guigne Pourpera Prece. Nevertheless, the maximum proportion of fresh holes, 67.8 %, was recorded in the variety Guigne Pourpera Prece and the minimum percentage of fresh holes was in the variety Lambert (58.0) (Table 2).

Incidence of cherry trunk borer at Shopian, South Kashmir, based on dead and live holes

The research conducted in South Kashmir (Shopian) presented in Table 3 revealed that in the cherry variety Bigarreau Napoleon, the maximum number of dead holes (3.4 per plant) was recorded during the second fortnight of March (13th SW). The live holes due to *S. lafertie* in all the varieties were recorded from the first fortnight of April onwards (15th SW). In the cherry variety Bigarreau Noir Grossa, the maximum number of fresh holes was 2.4 per plant during the first fortnight of April (15th SW), which gradually increased in successive observation levels from 17th SW (second fortnight of April) to 8.7 during the second fortnight of September (39th SW). Over the entire observation period from the second fortnight of March (13th SW) to the second fortnight of September (39th SW), the cherry variety Bigarreau Napoleon recorded the highest cumulative mean of 8.6 total holes per plant. In contrast, Guigne Noir Hative showed the lowest cumulative mean, with 7.0 holes per plant. The data computed for the percentage of live and dead holes by *S. lafertie* revealed that the highest percentage of live holes (63.0 %) was recorded in the variety Bigarreau Noir Grossa.

Discussion

The current study examined the microscopy of trunk borer body specimens. However, no previous literature was available on the characters, including the thorax, legs, head and its appendages. This kind of in-depth research appears to be among the first detailed microscopic studies of the trunk borer in *S. lafertie*. The adult borer is moderately elongated, strongly convex and black, with a dark greenish-bronze sheen. The head was slightly broad, narrower anteriorly than the pronotum. The eyes were projected forward beyond the contour of the head (16). The pronotal depressions featured rough, dense macropunctures, while the disc's medial portion had irregular, sparse punctures that were smaller. Laterally, the macropunctures were large and rather flat, appearing rasp-shaped in places, with dense, distinct and partly coalescent micropunctures near the posterior angles. The microscopy of the elytra revealed that the elytra were 1.76–1.94 cm long and

Table 2. Incidence of cherry trunk borer, *S. lafertie* in different cherry varieties based on dead and live/fresh holes in Central Kashmir (SKUAST-K Shalimar) during 2021

Central Kashmir Shalimar		Standard meteorological week															Total holes (Dead + Live holes)		Holes incidence (%)
		13 (26/3)	15 (9/4)	17 (23/4)	19 (7/5)	21 (21/5)	23 (4/6)	25 (18/6)	27 (2/7)	29 (16/7)	31 (30/7)	33 (14/8)	35 (28/8)	37 (12/9)	39 (26/9)				
		Sl. No.	Variety	Dead holes		Live holes											Dead Holes	Live/Fresh holes	
1	Bigarreau Napoleon	3.4*	2.7*	3.0	3.7	4.0	4.0	4.7	4.7	5.4	5.7	6.4	6.7	7.4	7.7	5.0±1.4	8.4	40.4	59.6
2	Bigarreau Noir Grossa	2.4	2.4	2.7	3.0	3.4	3.7	4.4	4.7	5.4	5.7	6.0	6.7	7.7	8.0	4.9±1.6	7.3	32.8	67.2
3	Guigne Noir Hative	2.7	1.4	2.0	2.4	2.4	3.4	3.7	4.4	4.4	4.7	5.0	5.0	6.7	7.0	4.0±1.5	6.7	40.2	59.8
4	Early Mishri	2.7	3.0	3.4	3.7	4.0	4.4	4.7	5.0	5.4	5.7	7.0	7.4	8.4	8.7	5.4±1.6	8.1	33.3	66.7
5	Stella	3.0	2.7	2.7	3.4	3.7	4.3	4.7	4.7	5.4	5.7	6.7	7.4	8.7	9.0	5.3±1.8	8.7	34.4	65.6
6	Lambert	3.7	2.0	2.7	3.4	3.7	4.0	4.4	4.7	4.7	6.0	6.7	7.4	8.4	8.7	5.1±1.9	8.8	42.0	58
7	Sweetheart	3.0	2.4	2.4	3.0	3.4	4.4	4.7	5.4	5.7	6.0	6.4	7.4	8.4	8.7	5.2±1.9	8.2	36.5	63.5
8	Guigne Pourpera Prece	3.0	3.4	3.7	4.4	4.7	5.4	5.7	6.4	6.7	7.3	7.7	8.4	9.0	9.3	6.3±1.8	9.3	32.2	67.8
9	Van	3.7	2.4	2.7	3.4	3.7	4.0	4.7	5.0	5.4	5.7	6.4	7.4	8.4	8.7	5.2±1.8	8.9	41.5	58.5
10	Bing	3.4	2.7	3.0	3.7	3.7	4.0	4.4	4.7	4.7	5.4	6.7	8.0	8.3	8.7	5.2±1.8	8.6	39.5	60.5
Mean		3.0	2.5	2.8	3.4	3.7	4.2	4.5	4.9	5.2	5.7	6.4	7.2	8.0	8.4	5.1±1.7	8.1	37.0	63.0

*Each value is the mean of 3 replications

Table 3. Incidence of cherry trunk borer, *S. lafertie* in different cherry varieties based on dead and live/fresh holes in South Kashmir (Shopian) during 2021

Sl. No.		Variety	Dead holes	Standard meteorological week														Total holes		Holes incidence (%)
				13 (26/3)	15 (9/4)	17 (23/4)	19 (7/5)	21 (21/5)	23 (4/6)	25 (18/6)	27 (2/7)	29 (16/7)	31 (30/7)	33 (14/8)	35 (28/8)	37 (12/9)	39 (26/9)	Mean±SD	(Dead + Live holes)	
Live holes		Dead Holes		Live/Fresh holes																
1.	Bigarreau Napoleon	3.4*	2.0*	2.7	3.4	3.7	4.0	4.4	4.7	5.0	5.7	6.4	7.7	8.7	9.3	5.2±2.3	8.6	39.5	62.5	
2.	Bigarreau Noir Grossa	3.0	2.4	2.7	3.4	3.7	4.0	4.4	5.0	5.4	6.0	6.4	7.0	8.4	8.7	5.1±2.0	8.1	37.0	63.0	
3.	Guigne Noir Hative	3.0	1.7	2.0	2.4	2.4	3.7	3.9	4.0	4.4	4.7	4.7	5.0	6.4	6.7	4.0±1.5	7.0	42.8	57.2	
Mean		3.1	2.0	2.4	3.0	3.2	3.9	4.2	4.5	4.9	5.4	5.8	6.5	7.8	8.1	4.7 ± 1.9	7.6	39.0	61.0	

*Each value is the mean of 3 replications

1.76–1.94 cm wide, near humeri slightly wider than pronotal base, their sides subparallel or very slightly convergent to posterior 2/5, then very slightly arcuate, distally nearly rectilinearly converging to apex. The feeding of the cherry trunk borer was consistent with a previous study that found the borer favors trees that are weak or damaged (17). Mortality of large limbs results from the feeding activity of larvae, which consume internal tissues and excavate a network of shallow, irregular tunnels. This damage disrupts sap flow, a condition exacerbated by the subsequent loosening of the bark. The larvae, which exude gum and feed on the cambium, can quickly girdle and kill young or recently grafted trees (18, 19). The eggs are laid on bark of a tree and after hatching, the larvae emerge. The extracted grubs were creamy white and found feeding under the bark. The larvae transform into a pupa and finally into an adult, which emerges in late May. Many overlapping generations were recorded from the emergence of adult borers and larval damage throughout the summer (20, 21). Therefore, it is evident that the pest responsible for massive damage to cherry orchards in Kashmir was a flat-headed borer, as it was previously restricted to parts of northern India. The flat-headed trunk borer, *S. lafertie* is a pest of almost all stone fruits, including plum (70.4 %), peach (53.3 %) and apricot (42.5 %), belonging to the family Buprestidae of the order Coleoptera (22). The borer pest inflicted immense damage across the valley's cherry plantations, with the highest infestation rates, as measured by live holes, observed in the Bigarreau Noir Grossa (Mishri) variety (63–68 % across North and South Kashmir) and the Guigne Pourpera Prece (Awal number) variety (67.8 %), as detailed in Table 2. These findings are consistent with the earlier reports, which documented comparable infestation levels in Ludhiana (63.1 %), Ambala, Haryana (57.4 %), Amritsar, Punjab (44.7 %), Shimla, Himachal Pradesh (42.9 %), Solan (35.9 %) and a minimum in Hisar (18.9 %) (10). The infestation across all orchards ranged from 54–68 %, consistent with findings from another study that documented infestation rates of 20–53 % (23). The highest damage in the varieties was due to the cryptic behaviour of pest and the natural gumming of stone fruits delayed detection, leading to significant tree loss. Upon surveys and surveillance across multiple cherry-growing areas, tree mortality was evident due to the trunk borer, with dead holes found throughout the trunks. Delayed detection of *S. lafertie* led to extensive tree mortality and orchard abandonment before management could be applied (17, 24). Consequently, the cherry cultivar 'Guigne Noir Hative' in North Kashmir (Tangmarg) showed the highest mortality-associated boreholes, affecting 45.9 % of trees.

Conclusion

According to microscopic analysis of the invasive cherry trunk borer in cherry orchards of Kashmir, the pest that causes early fruit drop and significant trunk flat-headed borer infestation, *S. lafertie*, belonging to the family Buprestidae of order Coleoptera, is reported for the first time in Kashmir valley. The pest incursion into the valley is attributed to the importation of plant material that violated proper quarantine protocols. These phytosanitary failures are the responsibility of both the state agriculture department and private companies. Furthermore, the life cycle analysis revealed that in the Kashmir climate, it completes 2.5 overwintering generations, with a single cycle lasting roughly 2 months under field conditions. To effectively manage this pest and avoid financial losses in cherry, a life cycle analysis is crucial for identifying its weak points and devising

management tactics, such as regular monitoring, trunk pasting with systemic insecticide, etc., to achieve effective control.

Acknowledgements

The authors acknowledge the Division of Entomology (Bio-Control) for providing the lab conditions for the smooth conduct of the research and Dr. Dibjayani Dey (Professor, Division of Entomology, IARI) for helping obtain the identification.

Authors' contributions

MOA conducted the complete research and authored the manuscript. SSP designed the study and facilitated species identification. MJ assisted in surveying various orchards to assess borer infestation levels. WY and KF contributed to the microscopy analysis of borer samples. SR developed the paper's structural framework and ensured originality. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflicts of interest to declare.

Ethical issues: None

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