Postprint: Study on the Newly Emerged Iridescent Agrilus Beetle and Its Damage in Xinjiang Wild Fruit Forests

Authors: Lin Qi, Zhang Yanlong, Cao Liangming, Wang Xiaoyi, Rozi Turap, Gao Guizhen

Date: 2025-07-14T11:39:24+00:00

Abstract

In recent years, the dangerous pest Agrilus viduus Kerremans has been discovered in Yili, Xinjiang. Currently, this insect has penetrated into the hinterland of wild fruit forests, causing damage to wild apples and wild apricots. Through field surveys, fixed-point observations, and indoor rearing, the distribution range, life history, damage characteristics, and host plant species of this insect in the wild fruit forest region have been preliminarily clarified. This insect is distributed in Xinyuan, Gongliu, Huocheng, and Tekes counties in Yili, and has already entered the wild fruit forests in these counties. The insect has one generation per year, begins activity in early to mid-May, starts emergence in early July, with late July being the peak emergence period; adults begin oviposition in mid-July, emergence gradually ends in early August, and overwintering begins in early November as second to third instar larvae. The damage primarily consists of larvae boring and feeding on the phloem, cambium, and xylem of host plants; high larval population densities can kill the host. In wild fruit forests, this insect can damage wild apricot (Armeniaca vulgaris), wild apple (Malus sieversii), and other wild fruit tree resources. The oviposition characteristics of this insect are rather distinctive: eggs are laid in clusters on the bark surface, then covered with secretions to form an egg sheath. The distribution of Agrilus viduus egg sheaths is correlated with tree height, being mainly distributed in the 120–240 cm range; egg sheath distribution is also correlated with branch thickness, being mostly distributed on branches with diameters of 2–3 cm. Through literature review and field investigation, it can be determined that this insect is a newly invasive pest in Xinjiang's wild fruit forests, posing significant danger and warranting attention from relevant authorities; emergency eradication should be implemented using integrated physical, biological, and chemical control methods based on its biological characteristics.

Full Text

Agrilus viduus Kerremans: An Emerging Pest in Xinjiang Wild Fruit Forest and Assessment of Associated Damage

LIN Qi[12], **ZHANG Yanlong**[2], **CAO Liangming**[2], **WANG Xiaoyi**[2], **Rouzi TUREPU**[1], **GAO Guizhen**[1]

[1]College of Forestry and Landscape Architecture, Xinjiang Agricultural University, Urumqi, Xinjiang, China
[2]Key Laboratory of Forest Protection, National Forestry and Grassland Administration, Institute of Forest Ecology and Nature Conservation, Chinese Academy of Forestry, Beijing, China

Abstract

The destructive pest *Agrilus viduus* Kerremans was recently discovered in Ili Prefecture, Xinjiang. This insect has penetrated the core area of the wild fruit forest, causing damage to wild apples (*Malus sieversii*) and wild apricots (*Armeniaca vulgaris*). Through field surveys, fixed-point observations, and laboratory rearing, we preliminarily clarified the pest's distribution range, life history, damage characteristics, and host plant species in the wild fruit forest region. The pest is distributed throughout Xinyuan County, Gongliu County, Huocheng County, and Tekes County in Ili, and has invaded the wild fruit forests within these counties. *A. viduus* completes one generation per year, with overwintering larvae becoming active in mid-May. Adults begin emerging in early July, with peak emergence occurring in late July. Egg laying commences in mid-July, and the emergence period concludes in early August. Second- and third-instar larvae begin overwintering in mid-November. Damage is primarily caused by larvae boring into the phloem, cambium, and xylem of host plants. High larval populations can kill the host. In wild fruit forests, the pest attacks wild apricots, wild apples, and other wild fruit tree resources. The oviposition behavior is distinctive: eggs are laid in clusters on the bark surface and covered with secretions to form egg cases. The distribution of egg cases is significantly correlated with tree height, occurring mainly at 120–240 cm above ground, and with branch thickness, occurring predominantly on branches 2–3 cm in diameter. Based on literature review and field investigation, we conclude that *A. viduus* is a newly invasive pest in Xinjiang's wild fruit forests that poses a serious threat. Relevant authorities should pay close attention and implement emergency eradication measures combining physical, biological, and chemical control methods based on the pest's biological characteristics.

Keywords: *Agrilus viduus*; distribution; Xinjiang wild fruit forest; new invasive pest; biological characteristics

Introduction

The Tianshan wild fruit forest in Xinjiang represents a remnant Tertiary plant community composed primarily of wild apple (*Malus sieversii*), wild apricot (*Armeniaca vulgaris*), wild walnut (*Juglans regia*), wild hawthorn (*Crataegus songarica*), wild cherry plum (*Prunus divaricata*), and other wild plant resources. These wild fruit trees are progenitors of most modern cultivated fruit varieties and possess rich genetic diversity, serving as an important gene pool for breeding and cultivar improvement. Due to its unique characteristics, the Xinjiang wild fruit forest has been included in China's priority conservation ecosystem list. These wild resources hold significant value for local ecological environments, forestry and fruit industries, and tourism development.

However, increasing human activities, such as extensive land reclamation and overgrazing around and within the Tianshan wild fruit forest, have drastically reduced its area, gradually disrupting the original ecological balance and deteriorating the environment. Consequently, the frequency of pest and disease outbreaks has continuously risen. In particular, wild apple and wild apricot communities have suffered severe damage from the apple tree borer *Agrilus mali* and the apricot scale *Sphaerolecanium prunastri*, which have caused large-scale infestations, severely affecting the growth of wild apples and apricots and even causing extensive mortality. This has profoundly impacted local ecological environments, forestry and fruit industries, and tourism.

During biodiversity surveys in the Ili River Valley, a wood-boring buprestid beetle was discovered. Dr. Eduard Jendek, a Czech specialist in *Agrilus* taxonomy, identified it as *Agrilus viduus* Kerremans. *A. viduus*, also known as the iridescent narrow jewel beetle in Taiwan, belongs to the family Buprestidae, order Coleoptera. Previous reports documented its distribution in multiple Chinese provinces, but Xinjiang was not among them, indicating that this species represents a new record for the region. The beetle was first discovered on cultivated apple seedlings in Qingshuihe, Huocheng County, where it caused mortality in 5–6-year-old apple trees. Subsequently, it was found on purple-leaf plum (*Prunus cerasifera*) in Gongliu and Xinyuan counties near the wild fruit forest. In recent years, it has also been detected on cultivated apricot trees near the wild fruit forest and on wild apple trees within the forest, establishing the wild fruit forest as a new habitat for this pest.

For the wild fruit forest, *A. viduus* may represent an invasive species posing significant security risks. However, current research on this beetle is extremely limited domestically and internationally, with only sparse literature documenting its distribution and hosts, which cannot provide necessary support for emergency prevention and control efforts. Therefore, in-depth research is needed to clarify fundamental data on its distribution range, host species, life history, and damage characteristics in the newly discovered area, providing support for emergency control measures.

Materials and Methods

1.1 Damage Investigation

Field surveys followed a route reconnaissance method combined with fixed-point detailed investigation. From May to August 2024, along the main roads of the Ili River Valley (county, provincial, and expressway roads), we surveyed roadside green belts, orchards (apple and apricot), and the edges and interior of wild fruit forests, looking for dead trees of Rosaceae or elm species. In areas with numerous dead trees, we employed fixed-point detailed surveys, randomly selecting 20 trees (or all trees if fewer than 20) to investigate and record location coordinates, host species, damage conditions, and pest developmental stages. Representative sample trees with typical damage were cut at the base, sectioned, and brought back to the laboratory for dissection and statistical analysis.

1.2 Morphological Characteristics Observation

Infested wood sections were collected from the field and cut into 50 cm segments, placed in insect-rearing cages under natural outdoor conditions until adult emergence. Both male and female adults were collected directly from the cages. Specimens of other developmental stages were obtained by dissecting infested branches. Live specimens were measured and observed under a microscope, with morphological characteristics described systematically. Morphological photographs and damage characteristics were taken using an Olympus CX31 microscope and composited using an "optical full-focus system."

1.3 Life History, Emergence Pattern, and Daily Activity Rhythm Observation

Observations combined indoor rearing with field investigation. Field surveys focused on damage assessment. For laboratory observations, infested wood sections were collected from the field, cut into 50 cm segments, placed horizontally in rearing cages with 10 cm of soil for moisture retention. Cages were checked daily at 11:00, 12:00, 13:00, 14:00, 15:00, and 16:00. After adult emergence, fresh apricot branches and leaves were provided daily. Larval development and pupation progress were recorded by dissecting infested branches. Adult emergence, mating, and oviposition were directly observed and recorded.

1.4 Vertical Distribution Pattern and Branch Diameter Selection of *A. viduus*

To clarify the vertical distribution pattern of *A. viduus* oviposition on hosts, five damaged apricot trees were felled, and the number of egg cases at different heights was surveyed and counted. Starting from the base, trees were cut into 40 cm sections. The diameter of each section's upper and lower cross-sections was measured, and the number of egg cases on each section was counted. The proportion of egg cases at different heights was calculated, and statistical comparisons were made of egg case distribution on branches of different diameters.

1.5 Data Processing

Wood sections collected from the field were cut into 50 cm segments, with both ends sealed with paraffin to prevent water loss. Infested wood sections were then placed in rearing cages. Egg cases were counted and recorded. Data were organized using Excel 2019. SPSS software was used to analyze the correlation between egg case distribution and apricot tree height and branch diameter. Normality and homogeneity tests revealed that egg case numbers at different heights and basal diameters did not follow a normal distribution, preventing one-way ANOVA. The Kruskal-Wallis H test was used instead to determine significant differences ($P < 0.05$).

Results

2.1 Morphological Characteristics

The life cycle of *A. viduus* includes four developmental stages: egg, larva, pupa, and adult.

Egg: Elongated oval, milky white, approximately 1.0–1.2 mm long and 0.2–0.26 mm wide. Eggs are covered with a protective coating that is yellowish-green when freshly laid, later turning dark gray-green. Each egg cluster contains 3–15 eggs covered by a single egg case (Fig. 1a).

Larva: Newly hatched larvae are milky white; mature larvae are yellowish-white, 3–15 mm long, slender, legless, with a small head retracted into the prothorax, exposing only the mouthparts. The prothorax is slightly enlarged with a distinct brown median groove on the dorsal surface. The abdomen is slender with nine segments, each clearly demarcated, with the first eight segments bearing a pair of nearly circular, yellowish-brown spiracles on the sides. The terminal segment bears two inwardly serrated, dark brown urogomphi (Fig. 1b).

Pupa: Exarate pupa, 5.5–8.5 mm long, initially milky white, turning dark brown with green metallic luster near eclosion (Fig. 1c).

Adult: Minimal sexual dimorphism. Small, slender body, 5.5–8.5 mm long, purplish-brown with green metallic luster. The forewing surface is slightly brownish-red. The emergence hole is D-shaped. The vertex is transversely concave with coarse longitudinal striations. The frons extends slightly forward, slightly beyond the top of the compound eyes, with fine longitudinal striations and punctures. Antennae are serrate from the third segment onward. The pronotum is 1–2 mm wide, with a doubly arched anterior margin, broad middle lobe, laterally curved margins, and a wavy posterior margin connecting to the elytra. The middle lobe is slightly arched and concave at the center, with the dorsal surface overall convex, bearing shallow depressions at the anterior and posterior midline. The scutellum has a transverse anterior half with an arched anterior margin and densely fine punctures; the posterior half is triangular. The elytra are approximately twice as long as wide, without color spots, with sides

arcing inward from behind the humeri, gradually narrowing toward the apex. The wing tip is arc-shaped but pointed at the center. The wing surface bears irregular short striations or granular protrusions, with gray hairy spots in the basal depressions. The middle of the abdomen is brown, with purple-brown sides, densely covered with irregular punctures and a few gray hairs (Fig. 1d).

2.2 Life History

A. viduus completes one generation per year in the Ili region, overwintering as larvae under the bark. Overwintering larvae become active in mid-to-late May of the following year, boring tunnels in the phloem. From late May to early June, larvae bore into the cambium, with feeding amount and tunnel length increasing. The tunnels are filled with reddish-brown frass, disrupting nutrient transport. In late June, mature larvae bore into the xylem, constructing pupal chambers. Adults emerge from pupal chambers in early July, biting through xylem and phloem to create a D-shaped emergence hole (Fig. 2a). After the elytra harden, adults emerge from the holes, moving along branches, feeding on host leaves for nutrition, showing strong flight capability and thanatosis. Adult feeding causes minimal damage. Adults prefer strong light and high temperatures, emerging when temperatures are high, mostly between 13:00–15:00. They do not emerge at night, on rainy days, or when temperatures are low. After emergence, adults typically remain motionless on branches and leaves. Oviposition preference is shown for weaker hosts, with eggs laid mainly on the sunny side of branches. After oviposition, a dark gray-green covering can be observed on the bark surface, protruding about 1–2 mm in height and 3–4 mm in width, with the lowest at 0–1 cm. The covering is the egg case (Fig. 2b).

2.3 Host Plant Species and Geographic Distribution in the Ili River Valley

According to surveys, *A. viduus* is distributed in Xinyuan County, Gongliu County, Huocheng County, and Tekes County in Ili, Xinjiang (Table 2). Hosts identified during surveys include wild apple, wild apricot, cultivated apple (*Malus domestica*), cultivated apricot (*Prunus armeniaca*), purple-leaf plum (*Prunus cerasifera*), crabapple (*Malus* spp.), and peach (*Prunus persica*). Wild apple and wild apricot are newly discovered hosts.

2.4 Damage Characteristics and Habits

A. viduus primarily damages host plants during the larval stage by boring into the phloem, cambium, and xylem. After egg hatching, larvae bite through the bark and bore into the epidermal layer, feeding and developing beneath the epidermis. The subepidermal tunnels are reddish-brown, winding and thread-like, relatively narrow (Fig. 2c). After overwintering larvae emerge in spring, boring activity increases, penetrating from the epidermis into the phloem. As larvae grow, tunnels lengthen and widen, forming curved galleries filled with reddish-brown frass. When tree nutrient transport tissues are severed, leaves

wither and yellow, branches dry and discolor, and all parts above the damaged area die. When infestation is severe and population density is high, bark separates from the trunk, exposing the phloem and affecting nutrient transport, ultimately causing whole-tree mortality.

2.5 Distribution Pattern of Egg Cases on Apricot Trees

Analysis using the Kruskal-Wallis H test for multiple samples revealed a statistically significant relationship between egg case distribution and apricot tree height ($H = 12.95$, $P < 0.05$) and between egg cases and basal diameter ($H = 15.32$, $P < 0.05$). Median values showed distinct distribution trends. The 120–240 cm height interval had the highest median, indicating more egg cases in this range. The 0–40 cm and 280–320 cm intervals had medians of 0, indicating few egg cases at the base and top. The 2–3 cm basal diameter interval had the highest median, showing egg cases were most abundant on branches of this thickness, followed by the 4–6 cm interval. The 0–1 cm interval had the lowest median, indicating fewer egg cases on thin branches.

Discussion

3.1 *A. viduus* as a New Invasive Pest in Wild Fruit Forests

A. viduus is a wood-boring pest that damages Rosaceae plants, primarily attacking host branches and trunks during the larval stage. It is currently distributed across 13 provinces and regions in China, first described by Kerremans in 1914 from specimens collected in Taiwan. Later, Obenberger (1924) modified the name to *Agrilus hoscheki*, *Agrilus chinganicus*, and *Agrilus cardaces*, while Kurosawa (1957) changed it to *Agrilus subviduus*, but these revisions were later corrected, and the original Kerremans (1914) name is now used. Previous comprehensive surveys of wild fruit forest pests by Lin Peijun et al. documented 105 pest species but did not include this insect. The *Agrilus* (Coleoptera, Buprestidae) of East Asia (Jendek 2011) did not list Xinjiang in its distribution, and neither *Colored Pictorial of Insects in Xinjiang* (Hu Hongying et al. 2012) nor *Insects of Forest in Xinjiang* (Ma Wenliang 2015) included this species. Therefore, we infer that *A. viduus* is a newly recorded species in Xinjiang and a new invasive pest in the wild fruit forest.

Analysis of egg case vertical distribution on apricot trees indicates that oviposition site selection is statistically related to both tree height and branch diameter. The median value for the 120–240 cm height interval was highest, showing adult preference for this range. The 0–40 cm and 280–320 cm intervals had median values of 0, indicating minimal oviposition at the base and top. This pattern may be related to environmental factors: the 120–240 cm height range may provide optimal light conditions and temperature/humidity for egg development and hatching. The base, being near ground level, has high humidity and numerous predators, while the top experiences abrupt temperature changes and thinner branches unsuitable for egg development. Analysis of egg case distribution rela-

tive to branch thickness showed the highest median in the 2–3 cm basal diameter interval, indicating oviposition preference for branches of this thickness. The 0–1 cm and 4–6 cm intervals had lower medians, with fewer egg cases. Thin branches have less phloem and xylem tissue, providing insufficient nutrients for larvae. Additionally, wood-boring pests like *Agrilus* need space to create galleries, and thin branches limit larval movement and growth. Overly thick branches have thicker bark and higher lignification, hindering newly hatched larvae.

3.2 Invasive *Agrilus* Species Pose High Risk in Xinjiang

Invasive *Agrilus* insects have strong tree-killing ability and rapid spread, primarily damaging under bark during the larval stage, making conventional control methods difficult. For example, *Agrilus mali* and *Agrilus planipennis* have caused extensive host mortality in Xinjiang. After *A. mali* was first discovered at Gaochao Ranch in Xinyuan County, it spread to apple orchards in Gongliu and Nileke counties and later invaded wild fruit forests. Between 1993 and 1995, wild apple forests suffered severe *A. mali* infestations, with affected areas expanding from 33 hm^2 to 4,886 hm^2, causing over half of the wild apple forest to wither and die, earning *A. mali* the title of "Public Enemy Number One" to wild fruit forest ecosystems. Although local forestry departments initiated special control projects in 1996, reducing pest density significantly, the spread trend has not been fundamentally curbed. By 2013, affected areas reached 3,866 hm^2, about 15.8% of the total wild fruit forest area.

Agrilus planipennis, as a devastating pest, spread extremely rapidly. First discovered in a winery in Ili in 2008, by 2010 it had invaded the ash protection area and urban street trees in Manas County and Bole City, severely affecting ecological construction and urban landscaping. By 2023, 2,941 affected trees were found in Bole City, covering 9.87 km^2. Both pests have been listed in Xinjiang's supplementary quarantine forestry pest 名录 due to their severe impact on Xinjiang's landscaping and ecological construction. *A. viduus* belongs to the same genus as *A. mali* and *A. planipennis*, with similar damage characteristics, making it a potential outbreak invasive species for Ili's wild fruit forests requiring strengthened monitoring and prevention.

3.3 Control Recommendations for *A. viduus*

Xinjiang has a well-developed fruit industry with large apple and apricot plantations. Wild apples and apricots are widely and continuously distributed in wild fruit forests. In recent years, human factors such as grazing and forest reclamation, combined with the overall decline and poor stress resistance of wild fruit forests, mean that if *A. viduus* spreads and outbreaks, it will reduce orchard yields, affecting farmers' income and causing devastating damage to wild fruit forests, significantly impacting Ili's fruit industry and tourism. Therefore, timely eradication measures should be implemented.

Quarantine measures can prevent *A. viduus* spread. Since damage symptoms are conspicuous and egg cases on bark are visible to the naked eye, relevant departments can strengthen quarantine to reduce invasion risk. Preventing transport of dead branches as firewood from infested areas and blocking entry of infested seedlings into new areas can contain spread at the source.

Physical control shows good effect. During oviposition periods, manual scraping of egg cases can precisely eliminate the pest. Infested branches can be pruned and promptly destroyed. Since *A. viduus* prefers weaker branches, artificially creating weakened trees before adult emergence can attract oviposition, with these trap trees destroyed after the oviposition period. Adults exhibit thanatosis and can be shaken from trees for collection.

Chemical control is prioritized for new invaders. Adults are the only exposed life stage, preferring light and high temperatures and requiring supplementary nutrition. Chemical sprays targeting adult activity can kill large numbers. Larvae are vulnerable when active in phloem in spring or before overwintering in autumn, before entering xylem. Trunk application of systemic insecticides with strong contact activity that can be absorbed and translocated through conductive tissues is recommended. Adjuvants can enhance penetration and efficacy.

Biological control can supplement eradication efforts. Natural enemies can be surveyed and screened from *A. viduus* distribution areas outside Xinjiang for classical biological control. Local natural enemies should be conserved to exert natural control. Woodpeckers effectively control *Agrilus* pests; artificial nests can be hung in forest areas to attract woodpeckers for predation.

Conclusion

This study investigated the biological and ecological characteristics of *A. viduus* through field observations and laboratory rearing, describing its morphological features, life history, hosts, distribution, and damage characteristics, and analyzing its distribution patterns on host branches. The main conclusions are:

1. *A. viduus* is a newly invasive species in Xinjiang's wild fruit forests.
2. In the Ili River Valley, *A. viduus* completes one generation annually. Adults emerge in early July, with peak emergence in late July. Egg laying occurs in mid-July, and the emergence period ends in early August. Larvae damage host branches until mid-November, when second- and third-instar larvae overwinter, becoming active again in mid-May of the following year. Adults prefer light and high temperatures, and egg cases are formed after oviposition.
3. The distribution of egg cases is significantly correlated with tree height and branch diameter, with most egg cases found at heights of 120–240 cm and on branches with basal diameters of 2–3 cm.

Acknowledgments

We thank Dr. Eduard Jendek, a Czech taxonomic expert on the genus *Agrilus*, for identifying the research specimens.

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