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RESEARCH ARTICLE

The Emerald ash borer *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae) invaded Belarus

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Abstract

The emerald ash borer, *Agrilus planipennis* Fairmaire, 1888 (Coleoptera: Buprestidae), is a harmful East Asian insect pest damaging ash trees *Fraxinus* spp. Over the past three decades, it has invaded European part of Russia and Ukraine, causing widespread mortality of ash trees in both urban and natural ecosystems. Here, we report first occurrence of this devastating pest in Belarus, specifically in the city of Gomel. During reconnaissance survey performed in the late June 2025, a total of 46 ash trees, including 39 *Fraxinus pennsylvanica* and 7 *F. excelsior* trees, displayed characteristic symptoms of infestation: canopy dieback, epicormic sprouting, and distinct D-shaped exit holes in the bark. A single larva of the IV instar was found within a typical gallery beneath the bark, and 13 adult beetles mating and feeding on the foliage of both ash species were recorded. Given the proximity of infested regions in neighboring countries – specifically Bryansk (243 km away from Gomel) and Smolensk (270 km) in Russia, as well as Kiev (220 km) in Ukraine – it is suspected that the buprestid was accidentally introduced from some of these localities rather than expanding its range by itself. Urgent research is required to delineate the extent of its spread within Belarus. Moreover, decisive actions must be taken promptly to suppress current infestation foci and prevent further distribution of this highly aggressive alien pest.

Keywords
EAB, buprestid, *Fraxinus pennsylvanica*, *F. excelsior*, invasion, East Europe

Introduction

The Emerald Ash Borer, *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae), is a highly destructive East Asian insect pest that continues extending its secondary range in Europe, causing severe decline of ash trees *Fraxinus* spp. (Oleaceae) (Musolin et al. 2017; Orlova-Bienkowskaja et al. 2020; Meshkova et al 2023; Sun et al. 2024). The loss of ash trees triggers a cascade of dramatic consequences leading to the decline of biodiversity in ash-related communities (Wagner and Todd 2015; Hultberg et al. 2020), exacerbating landscape degradation (Kolka et al. 2018), and compromising the aesthetic integrity of urban environments (Schrader et al. 2021).

Agrilus planipennis is officially listed as a quarantine pest for the Eurasian Economic Union (EEU), encompassing five post-Soviet nations (Armenia, Belarus, Kazakhstan, Kyrgyzstan, and Russia), and for the EPPO region, which includes 52 member countries, predominantly European. Given the ongoing invasion, rapid decline of ash plantings and associated ecological and economic consequences, *A. planipennis* is of an enormous concern for Europe (Musolin et al. 2017).

For the first time in Europe, *A. planipennis* was documented in Russia, specifically in urban plantations of Moscow in 2005 (Mozolevskaya and Izhevsky 2007; Baranchikov et al. 2008). Subsequent dendrochronological studies indicated that the species might have been present in Moscow as early as 1992 (Baranchikov et al. 2016). Over the past two decades, this buprestid has distributed within European Russia, occupying 23 administrative regions (Sun et al. 2024; Baranchikov and Ponomarev 2024; Baranchikov et al. 2024a). Several of these regions, including Rostov, Voronezh, Belgorod, Kursk, Bryansk, Smolensk, and Leningrad, share borders with Eastern European countries such as Ukraine, Belarus, Latvia, Estonia, and Finland. In 2019, the pest was first detected in Ukraine (Drogvalenko et al. 2019), reaching Kiev by 2023 (EPPO 2023; Meshkova et al., 2024), continuing expanding its secondary range westwards.

So far, this invasive pest has not been detected in Belarus, despite survey efforts (Orlova-Bienkowskaja et al. 2020). On the Russian side, *A. planipennis* was documented is Smolensk Region in 2018, just 70 km from the border with Belarus, suggesting that the pest may sooner or later enter the country (Baranchikov and Seraya 2018).

Here we provide data on the earliest occurrence of *A. planipennis* in Belarus, in Gomel region, where the pest was least expected. At the first time, the data of survey of ash plantings in four regions of Gomel city and the illustration of characteristic damage, larvae and adults are given, the suggestive donor regions and invasion vectors are mentioned. These data are highly important for developing urgent strategy to mitigate the impact and combat the further spread of this aggressive tree pest.

Materials and methods

The study was conducted in Belarus in four administrative regions: Vitebsk, Lyozna, and Orsha from June to July annually between 2018 and 2025 (Fig. 1A). These three regions, situated in northeastern Belarus, were selected for surveys bearing in mind their proximity to Russian territories invaded by *A. planipennis* (Baranchikov and Seraya 2018) and their connectivity via railway and motorway with Smolensk, Russia. In 2025, the reconnaissance survey was expended to Gomel, located in southeastern Belarus, bearing in mind that *A. planipennis* was detected in Ukraine in 2019, including in Kiev in 2023 (EPPO 2023).

In the mentioned above regions, plantings along intercity roads, mostly consisted of the North American ash *Fraxinus pennsylvanica*, were inspected. Significant attention was also paid to urban ash plantings of the main cities (Vitebsk, Lioznensky, Orsha, and Gomel). Where present, the European ash, *F. excelsior* was also examined. The trees of these ash species were visually inspected for the presence of characteristic symptoms: canopy dieback, epicormic sprouting, exit D-holes in bark in low or middle part of on the main trunk.

In Gomel, ash trees were examined in city parks and alleys in all four city districts (Fig. 1B). Additionally, ashes growing in the Park of the Gomel Palace and Park Ensemble (Centralniy District) were examined (Fig. 1B). The infested ash trees were assigned to a certain category according to their health conditions as per the classification proposed by Alekseev (1989), with the modification by Baranchikov et al. (2024b), summarized in Table 1.

Upon detecting D-shaped exit holes, sections of bark measuring 20×30 cm were carefully removed from the main trunk (up to 2 m above ground) to inspect for larval galleries. This procedure was applied selectively to ash trees representing varied levels of health condition within Gomel, specifically at Kosmonavtov Avenue and Vladimirova st. 10b. Opportunistically, ash foliage was also checked to find the beetle adults. The damaged trees, the beetle larva and adults were photographed using the digital camera incorporated in smartphone Xiaomi14T (China).

Identification of *A. planipennis* was carried out by morphological features of the imago (relatively big size; color features; distinctive spine-like projection on pygidium) and larvae (bell-shaped abdominal segments) (Volkovitsh et al. 2020; Baranchikov et al. 2024b). The larval instar was identified based on the size of urogomphi (Orlova-Bienkowskaja and Bienkowski 2016).

To determine how the buprestid could spread to Belarus, ash plantations along roads and in settlements on the routes leading to regional centers (Vetka, Dobrush, Rogachev) and to the nearest borders of Belarus (motorways M10, E95, P30, P35, P85, P125, H4382, H4384) were examined. The data on ash trees infested by *A. planipennis* in Gomel and possible spread routes were mapped using ESRI ArcGIS Pro 3.1 software (ESRI 2024).

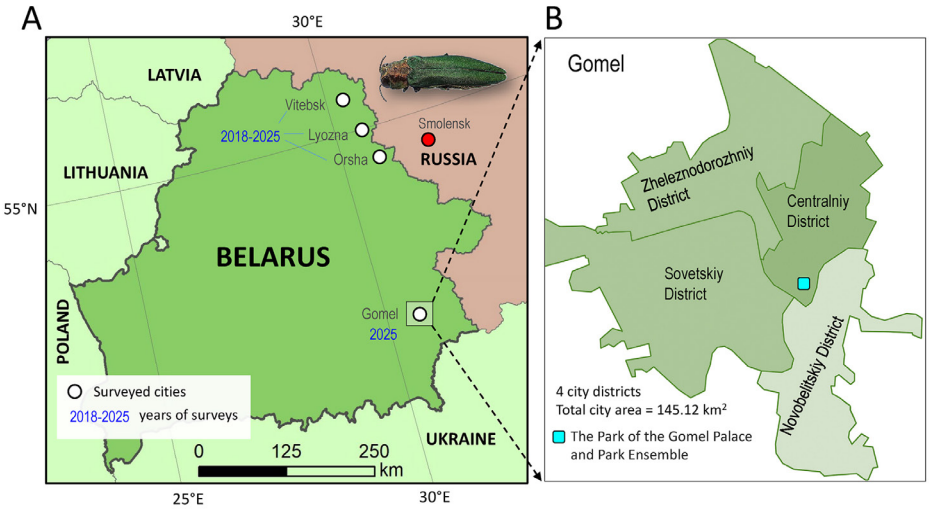

Figure 1. The study area in Belarus in 2018–2025. (**A**) The main cities of the surveyed regions (Vitebsk, Lyozna, Orsha, and Gomel) bordering with Russia where *Agrilus planipennis* is distributed, including in Smolensk, the most western point situated in about 70 km on direct line from the border with Belarus. (**B**) The districts of Gomel, where plantings of *Fraxinus pennsylvanica* and *F. excelsior* were inspected in 2025.

Table 1. Sanitary categories of ash trees affected by *Agrilus planipennis*

Sanitary category		Symptom description
I	Healthy tree	No external signs of crown and trunk damage.
II	Weakened tree	Reduction of crown density by 30%, no dry branches in tree crown or presence of very few dry branches (early canopy dieback).
III	Significantly weakened tree	The upper third of the crown with up to 60 % of dry branches (progressive canopy dieback).
IV	Dying tree	The upper part of the crown is dry, intense epicormic sprouting in the lower part of the tree crown, the beetle exit holes in the middle part of the tree crown or in the lower part of the main trunk.
V	Freshly dead tree	The main trunk is dry with beetle's exit holes (having yellowish or light brown inner walls), intense epicormic sprouting.
VI	Long-dead tree	Completely dry trunk, often with loose bark, old exit holes (with dark gray inner walls) on the trunk, insignificant epicormic sprouting.

Results

Survey in Northeastern Belarus

Extensive surveys conducted between June and July 2018–2025 encompassing over 1,000 trees of *Fraxinus pennsylvanica* and *F. excelsior* across three administrative regions (Vitebsk, Lyozna, and Orsha) failed to identify any presence of *A. planipennis*. No infestations were noted either in urban or periurban plantings within the primary cities of these regions nor along anticipated distribution pathways, namely the railways and motorways (M1, M8, P15, P21, P73, P96, P122, 66A-3) extending from infested zones in Russia, particularly the Smolensk Region.

Surveys in Southeastern Belarus

During reconnaissance survey conducted in Gomel on June 27–28, 2025, characteristic symptoms of *A. planipennis* infestation were observed on both *F. pennsylvanica* and *F. excelsior* trees. They included canopy dieback, epicormic sprouting, and distinct D-shaped exit holes in the bark (Fig. 2). Furthermore, examination of four *F. pennsylvanica* trees in distant localities within the city (Cosmonauts Av., Vladimirov st.) revealed the presence of larval galleries (Fig. 2B).

Within one gallery on *F. pennsylvanica*, a living larva of *A. planipennis* was found (Fig. 3A, B). The length of urogomphi (the paired structures located on the terminal abdominal segment) was 0.92 mm, corresponding to the IV instar larva (Orlova-Bienkowskaja and Bienkowski 2016).

On June 27, in few streets of Gomel (Cosmonauts Av., M.G. Efremov st., Dokutovich st.), at a day temperature of 23°C, 13 beetles of *A. planipennis* were recorded (Fig. 3). Of them, two beetles were mating (Fig. 2E), six were resting, and five were feeding on the leaves of *F. pennsylvanica* (2 feeding beetles documented) and *F. excelsior* (3 feeding beetles).

Altogether, 46 trees infested by *A. planipennis* were identified across three districts of Gomel: Zheleznodorozhniy (railway district), Sovetskiy, and Centralniy (Figure 4, Table 2). Of these, 39 belonged to *F. pennsylvanica* and seven to *F. excelsior*. Notably, the majority of infested trees were situated in areas proximate to railway tracks, particularly those leading to Bryansk in European Russia and Kiev in Ukraine (Fig. 4). No infested trees were observed in the Novobelitskiy district, located in the southeastern part of Gomel.

Six trees, all belonging to *F. pennsylvanica*, were assigned to the category V 'Freshly dead trees' (Fig. 4, red circles). Characteristics of these trees included dead crowns, exit holes with light-brown interior surfaces on the main trunk, and the presence of epicormic shoots. Majority of the infested trees, constituting 29 out of 46 (approximately 63%), fell into the category IV 'Dying trees' (Fig. 4, yellow circles); among these, 25 trees were *F. pennsylvanica* (54%) and four were *F. excelsior* (9%). Despite being classified as dying, these trees retained scattered live branches

with small or chlorotic foliage. Remaining nine infested trees, i.e., six *F. pennsylvanica* and three *F. excelsior*, belonged to the category III 'Significantly weakened trees' (Fig. 4, orange circles).

No larval parasitoids were observed within the larval galleries in *F. pennsylvanica* and *F. excelsior* trees in the surveyed districts of Gomel.

Figure 2. Characteristic symptoms of damage caused by *Agrilus planipennis* to *Fraxinus* spp. in Belarus (Gomel, Zheleznodorozhniy district). (**A**) Canopy dieback of *F. excelsior*; (**B**) larval gallery under the bark of *F. pennsylvanica*; (**C**, **D**) the D-shape exit holes on *F. pennsylvanica*; (**E**) mating adults on the leaves of *F. excelsior*. Photo: (**A**–**D**) V.B. Zviagintsev, (**E**) M.I. Chernik. Note that the lower parts of ash tree trunks (up to 1.5 m above ground level) are coated with white lime mortar for sanitary purpose.

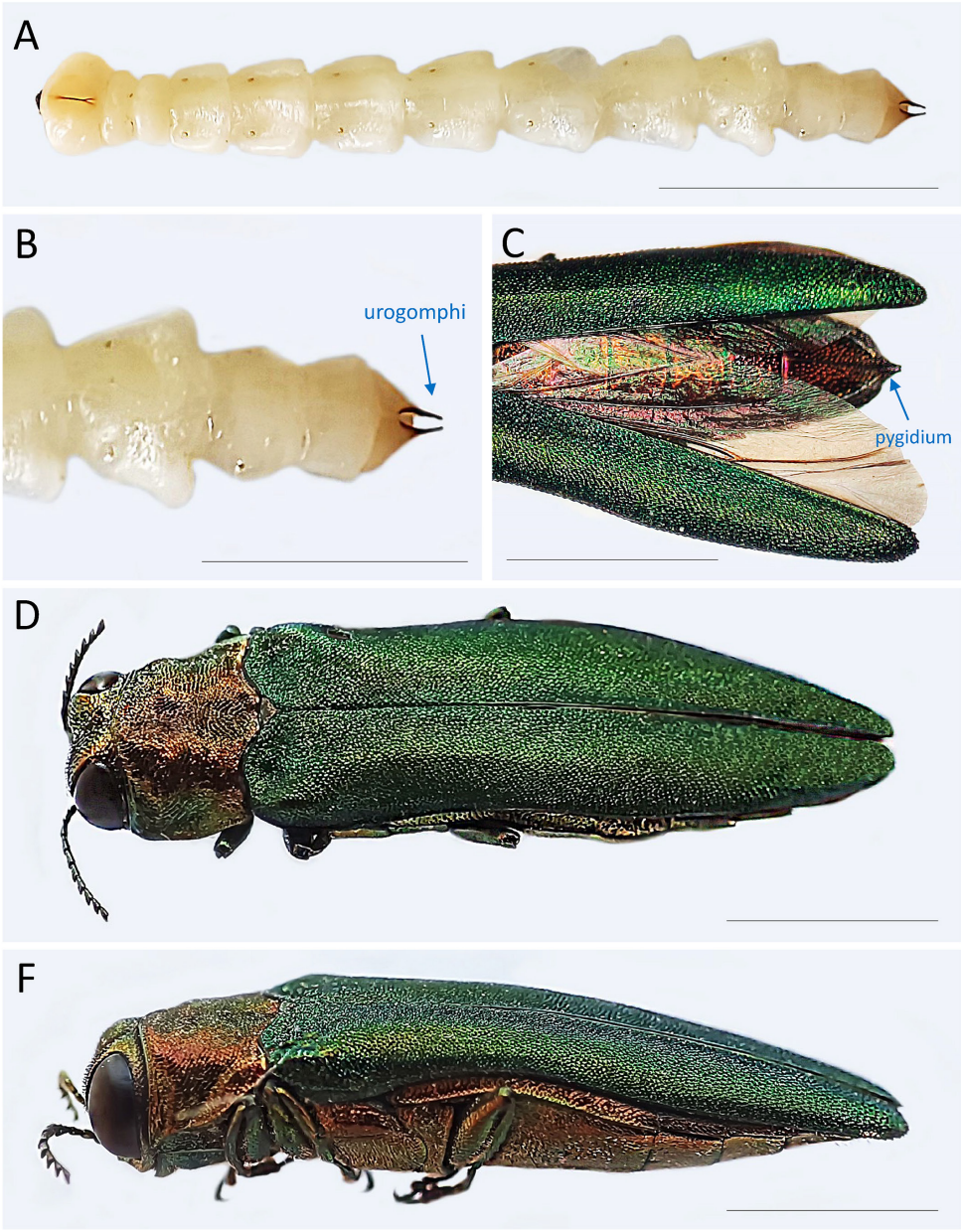

Figure 3. Larvae and adult of *Agrilus planipennis*. (**A**) Larva, dorsal view; (**B**) the last segments of the larval body with urogomphi; (**C**) the last tergite of the adult abdomen with spine-like projection on pygidium; (**D**) adult, dorsal view; (**F**) same adult, lateral view. Scale: (**A**) 10 mm, (**B**–**F**) 5 mm. Photo: N.I. Kirichenko.

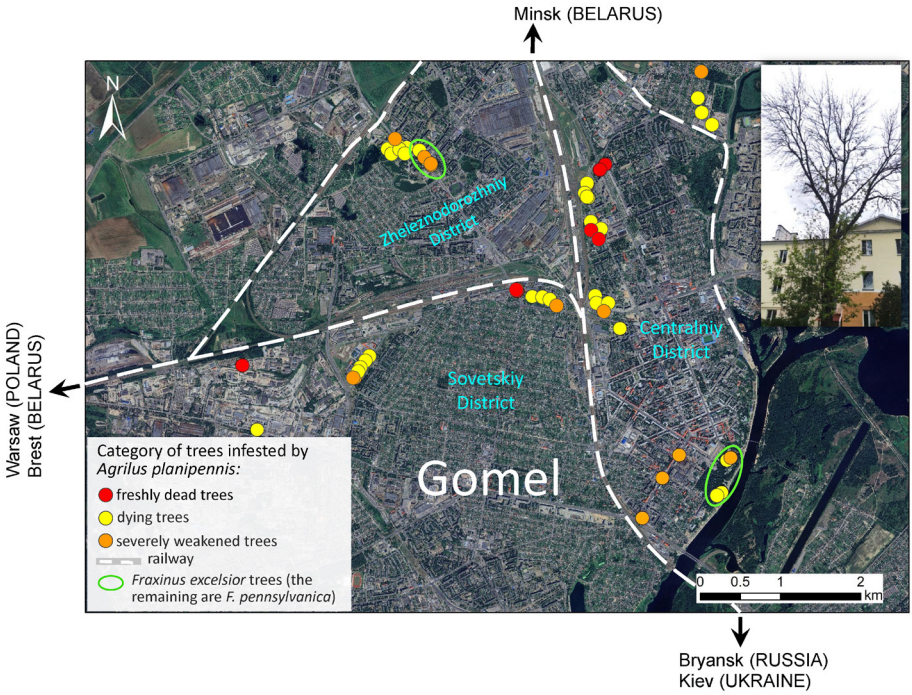

Figure 4. Location of ash trees (*Fraxinus pennsylvanica* and *F. excelsior*) infested by *Agrilus planipennis* in Gomel, Belarus in 2025, and the direction of railway tracks.

Table 2. The localities in the city of Gomel with ash trees damaged by *A. planipennis*

No	Street, park	*Fraxinus* sp.*	Tree situation	Category	Latitude	Longitude
		Zheleznodorozhniy district				
1	Cosmonauts Av., 94	F.p.	single	IV	52.457064	30.955361
2	Cosmonauts Av., 90	F.p.	single	IV	52.457224	30.955046
3	Cosmonauts Av., 90	F.p.	alley	IV	52.457201	30.956066
4	Cosmonauts Av., 61A	F.p.	alley	IV	52.455959	30.959546
5	Cosmonauts Av., 61A	F.p.	alley	IV	52.456133	30.959321
6	Cosmonauts Av., 61A	F.p.	alley	III	52.456276	30.959144
7	M.G. Efremov st., 1B	F.e.	group	IV	52.455423	30.960705
8	M.G. Efremov st., 1B	F.e.	group	III	52.455475	30.960625
9	M.G. Efremov st., 1B	F.e.	group	III	52.455279	30.960598
10	Dokutovich st., 57A	F.p.	group	IV	52.440568	30.991659
11	Dokutovich st., 57A	F.p.	group	IV	52.440548	30.991711
12	Dokutovich st., 57A	F.p.	group	IV	52.440525	30.991758

No	Street, park	*Fraxinus* sp.*	Tree situation	Category	Latitude	Longitude
13	Dokutovich st., 57A	F.p.	group	IV	52.440489	30.991821
14	Dokutovich st., 57A	F.p.	group	III	52.440312	30.991844
15	Starochernigovskaya st., 49	F.p.	single	IV	52.449247	30.990436
16	Starochernigovskaya st., 43	F.p.	group	IV	52.448517	30.991061
17	Starochernigovskaya st., 41	F.p.	group	V	52.448047	30.991830
18	Starochernigovskaya st., 41	F.p.	group	V	52.447972	30.991819
19	Starochernigovskaya st., 43	F.p.	group	IV	52.448256	30.991417
20	Starochernigovskaya st., 43	F.p.	group	IV	52.448338	30.991401
21	Starochernigovskaya st., 43	F.p.	alley	IV	52.448479	30.991321
			Centralniy district			
22	Kirov st., 135	F.p.	alley	IV	52.452154	30.989647
23	Kirov st., 148	F.p.	alley	IV	52.452261	30.989234
24	Kirov st., 148	F.p.	alley	IV	52.452520	30.989239
25	Kirov st., 149	F.p.	single	III	52.453657	30.989405
26	Soviet st., 97/4	F.p.	single	V	52.455910	30.992554
27	Soviet st., 156	F.p.	alley	V	52.455309	30.991602
28	Frunze st., 4	F.p.	single	III	52.416418	31.001186
29	Internationalnaya st., 23	F.p.	alley	III	52.420988	31.004622
30	Internationalnaya st., 10/2	F.p.	alley	III	52.423611	31.007601
31	Park of the Gomel Palace and Park Ensemble	F.e.	group	IV	52.423150	31.016383
32	Park of the Gomel Palace and Park Ensemble	F.e.	group	III	52.423458	31.017028
33	Park of the Gomel Palace and Park Ensemble	F.e.	group	IV	52.419557	31.015625
34	Park of the Gomel Palace and Park Ensemble	F.e.	group	IV	52.419526	31.015597
			Sovietskiy district			
35	Nikolskaya st., 22	F.p.	group	IV	52.440887	30.979865
36	Nikolskaya st., 30	F.p.	group	IV	52.441578	30.977033
37	Nikolskaya st., 30	F.p.	group	III	52.441710	30.977009
38	Nikolskaya st., 26A/2	F.p.	group	V	52.441455	30.977688
39	Industrialny proezd st., 3	F.p.	single	V	52.432278	30.927035
40	Polesskaya st., 22	F.p.	single	IV	52.437600	30.996083
41	Vladimirov st., 10b	F.p.	alley	III	52.431175	30.947700
42	Vladimirov st., 10b	F.p.	alley	IV	52.431235	30.947773
43	Vladimirov st., 10b	F.p.	alley	IV	52.431305	30.947844
44	Vladimirov st., 10b	F.p.	alley	IV	52.431366	30.947907

No	Street, park	*Fraxinus* sp.*	Tree situation	Category	Latitude	Longitude
45	Vladimirov st., 10b	F.p.	alley	IV	52.431420	30.947971
46	Barykin st., 293	F.p.	single	IV	52.425106	30.930107

Note: * F.p. – *Fraxinus pennsylvanica*, F.e. – *F. excelsior*.

Discussion

Since 2018, we have conducted visual inspections of ash trees planted alongside major motorways crossing Vitebsk, Lioznensky, and Orsha regions of Belarus, as well as in their principal urban centers. Given the proximity of these regions to Russia, specifically the neighboring Smolensk and Bryansk regions (Fig. 5), where the pest had already been reported in recent years (Baranchikov and Seraya 2018; Shelukho 2021), we hypothesized that *A. planipennis* could accidently enter Belarus. The plantings along motorways were considered as a potential corridor for the distribution of *A. planipennis*, as in Belarus, both ash species, *F. pennsylvanica* and *F. excelsior*, are widely used in such plantings, as well as commonly utilized in landscaping in Belorussian towns and cities (Zviagintsev et al. 2015). However, our suggestion that the pest could spread to northeast regions of Belarus failed: no evidence of *A. planipennis* infestation was observed in these regions between 2018 and 2025.

Surprisingly, in June 2025, we discovered the invasive buprestid during reconnaissance survey of ash trees in the southeastern part of Belarus, specifically within the city of Gomel. While our present paper was under the review in the journal, we came across a short note in a newspaper that other team detected *A. planipennis* in Gomel too, in June 2025 (Usenia and Pomaz 2025). In their note, the authors informed about the species detection in the city and its identification through DNA-barcoding.

In contrast, we provided data on the pest spread within Gomel and the state of impacted trees. Importantly, we noticed absence of the typical signs of ash tree damage attributed to *A. planipennis* in both near Gomel and along motorways leading toward the borders with Russia and Ukraine. This observation makes us thinking that the insect did not disperse naturally but was most likely inadvertently transported via railway lines linking Belarus with neighboring regions (Fig. 5). Indeed, according to our fieldwork, the majority of affected trees in Gomel are clustered in close proximity to railway tracks.

Railway transport (Short et al. 2020) and cars (Gninenko et al. 2016) are considered as primary vectors of *A. planipennis* distribution over long distances. Considering that cross-border train and vehicle communication between Belarus and Ukraine stopped in February 2022, it is most probable that the pest was accidently transported to Belarus, i.e., to Gomel, from Russia. Indeed, direct railway connections and roads link Gomel to Russia via Bryansk Region.

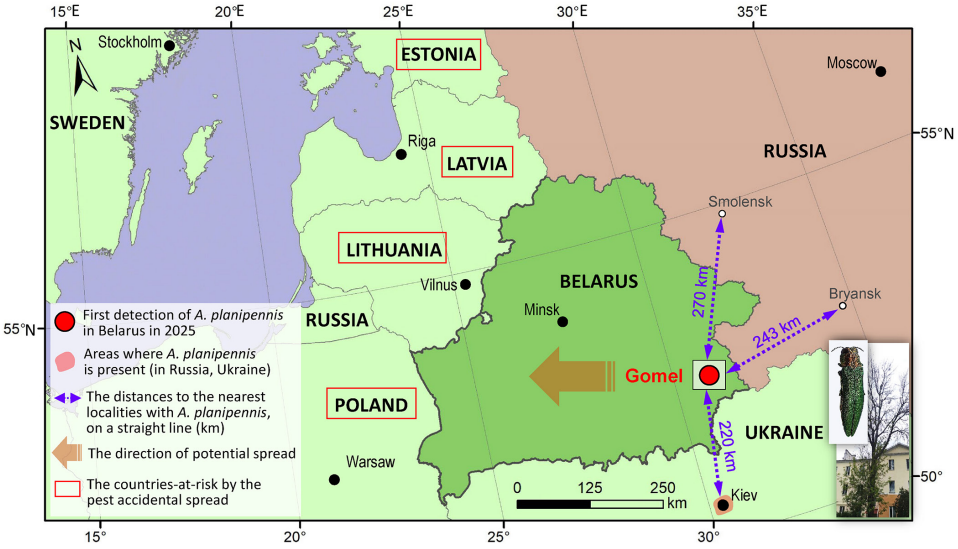

Figure 5. Possible directions of *Agrilus planipennis* invasion in Belarus and beyond. Smolensk and Bryansk (Russia) and Kiev (Ukraine), where *A. planipennis* was discovered in recent years (Baranchikov and Seraya 2018; Shelukho 2020; Meshkova et al. 2024), situating in about similar distance to Gomel, are considered as the potential donors of *A. planipennis* for Belarus.

Currently, in Bryansk and its environs, ash trees are declining intensively due to *A. planipennis*. The pest was discovered in Bryansk back in 2019 (Orlova-Bienkowskaja et al. 2020), and already next year, about 30% of infested trees of *F. pennsylvanica* died in nine localities, and the remaining trees experienced various stages of weakening due to *A. planipennis*, and only 5% of trees were unaffected (Shelukho 2021). By 2023, the quarantine zone was established in Bryansk Region (Rosselkhoznadzor 2023). Consequently, this heavily afflicted region could have served as a source for *A. planipennis* spread to Gomel, implying that such accidental introduction occurred relatively recently.

Indeed, the entomological studies carried out in Gomel in 2013–2023 did not reveal any sign of *A. planipennis* presence (Zhorov and Vorobyova 2024; Yarmosh and Zviagintsev 2024). A very recent occurrence of *A. planipennis* in Gomel arises from the conspicuous lack of parasitoid activity within larval galleries. The parasitoids "catch up" with the invader with a delay, as was observed in the European part of Russia (Gninenko et al. 2016). Thus, integrating these contextual insights, we suggest that the invasion of *A. planipennis* in Gomel is a very recent event spanning roughly four to six years.

The North American *F. pennsylvanica* and the European ash *F. excelsior* are the important ornamental elements of Gomel's green landscape architecture (Zhadko 2011). Notably, some of the oldest specimens of *F. excelsior*, estimated to be around

150 years old, grow in the Park of the Gomel Palace and Park Ensemble. Meanwhile, *F. pennsylvanica* has been intensively planted since the latter half of the twentieth century (Padutov et al. 2013). Based on our investigation conducted in Gomel, both North American and European ashes have been found to suffer attacks and mortality from *A. planipennis*. The presence of the IV instar larva beneath the bark of *F. pennsylvanica* in June suggests that *A. planipannis* has a biennial life cycle in Gomel. Nonetheless, further study is required to clarify seasonal pattern and voltinism of this alien pest in Belarus.

In Gomel, tree trunks, including those of ashes, undergo sanitization through application of white lime mortar up to 1.5 m height above ground (Fig. 2A). Our preliminary observations suggest that the treated parts of trunks remain free from colonization by *A. planipennis*. This method holds promise as a protective measure for safeguarding ash trees against the invasive pest. Nevertheless, additional research is needed to validate its efficacy.

If *A. planipennis* continue spreading across Belarus, it may threaten neighboring countries, such as Lithuania, Latvia, and Poland, whereas both Latvia and Estonia might receive the pest from adjoining Russian territories (Fig. 5). Considering the extensive ground traffic between neighboring countries, it is anticipated that further spread of this species will largely result not from natural dispersion mechanisms but rather from unintentional introductions associated with transportation by vehicles.

Conclusions

The dangerous quarantine species *A. planipennis* has been documented in Belarus, extending its presence more than 200 km beyond the previously recognized western limit of its secondary range in Russia and Ukraine. Our finding confirms the species potential for rapid long-distance dispersal facilitated by unintentional human-mediated transportation via railways and motorways. To date, *A. planipennis* has been detected exclusively within urban tree plantations in Gomel. However, given its ability to damage indigenous Europe ash, *F. excelsior*, there is a high risk that the invasive pest may continue distributing throughout Belarus, posing a threat to vulnerable ash forest ecosystems. Transport networks both within Belarus and between Belarus and adjacent European Union member states, namely Poland, Lithuania, and Latvia, increase the likelihood of further westward dispersal of this buprestid beetle. The comprehensive measures aimed at suppressing the pest foci are to be urgently implemented in order to prevent further spread and mitigate the cascade of negative impacts associated with the invasion of *A. planipennis*.

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