

Preparing for emerald ash borer in Great Britain



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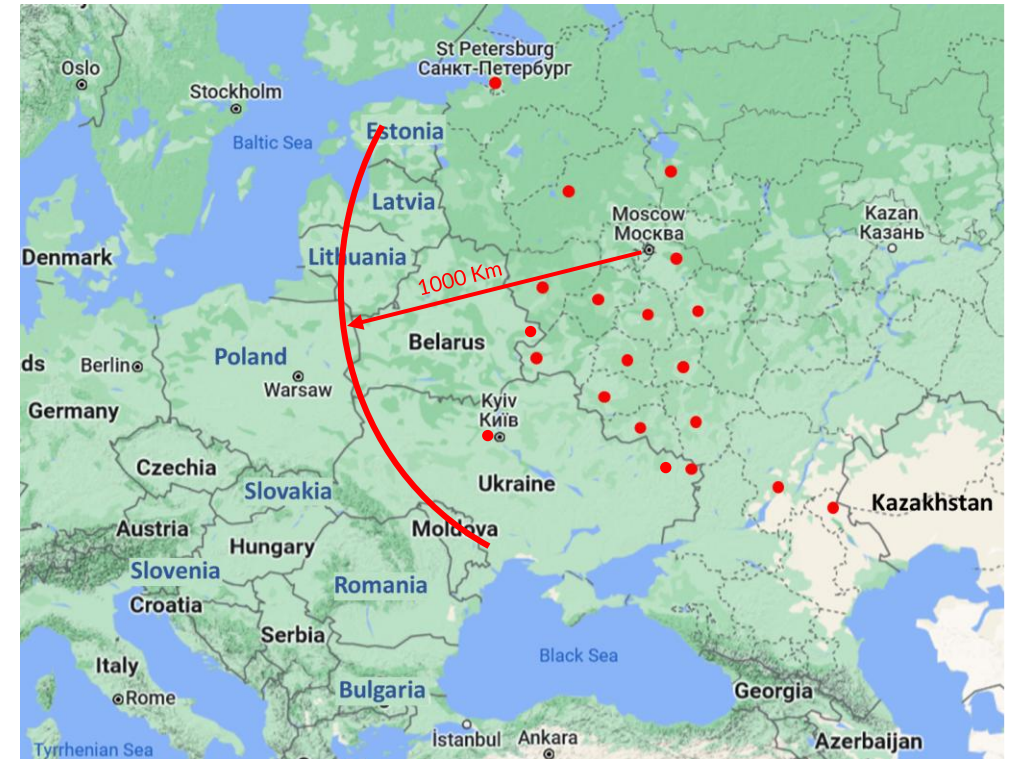
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The risk to Great Britain

- 2002 - first reported in Moscow
- 2019- found in Ukraine
- 2021 - reported in St Petersburg and in the Lower Volga Basin, approaching Kazakhstan
- 2025 – South-east Belarus
- Rate of spread c. 50 Km/year

- Natural spread a concern, UK c. 2500 Km from Moscow
- Accidental import of infested ash material a greater immediate risk
- European ash, *Fraxinus excelsior* is susceptible to EAB
- Trees that are stressed are readily attacked by EAB
 - Trees with ash dieback could be more vulnerable

Spread of EAB



GB climate

- establish in southern England
- semivoltine life cycle

Management options

North American experience

- Eradication of EAB is highly unlikely
- Manage the risk and slow EAB spread
- Integrated approach

Urban environment - chemical control



Trunk injections of plant protection products

Area-wide - classical biological control



Exotic parasitoids released in North America

- *Oobius agrili*, *Spathius agrili*, *etrastichus planipennisi* (2007); *Spathius galinae* (2015)
- have established and spread (*Spathius agrili* limited establishment)
- having some impact on EAB populations

Research to ensure capability of both approaches for GB

Trunk injections

Emamectin benzoate

- only effective chemical treatment against EAB
- provides up to 3-years protection.

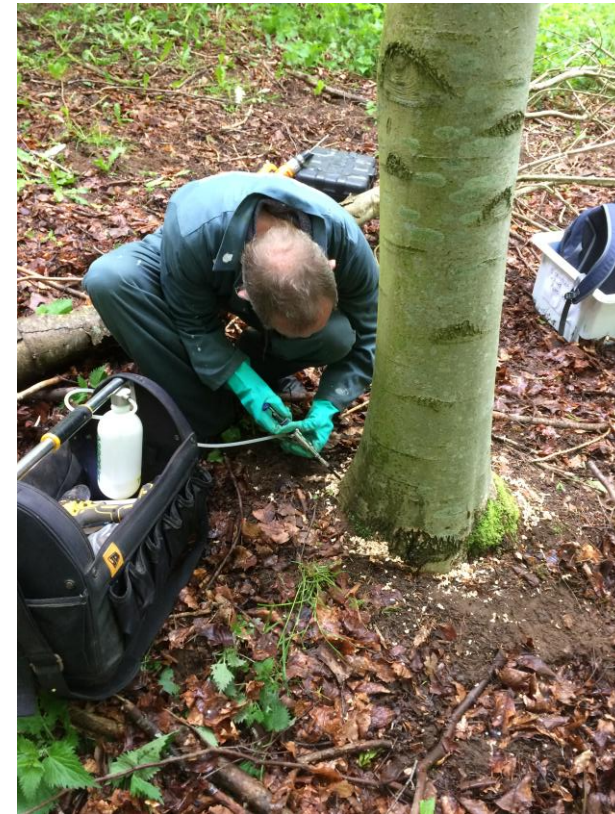
Challenges for use in GB

1. No plant protection product registered for use by trunk injection.

- Defra - Emergency approval for emamectin benzoate.

2. Knowledge gaps for European ash, *Fraxinus excelsior*

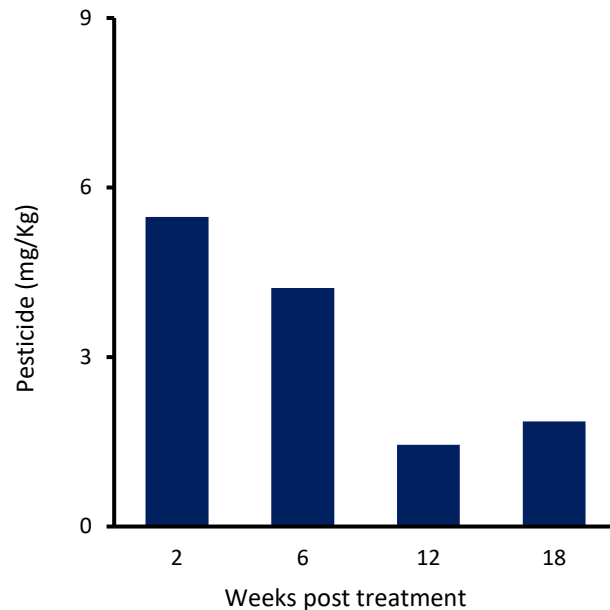
- Persistence in European ash
- Decomposition in leaf litter
- Levels in ash pollen.
- Impact on non-target organisms



- Ash trees injected with Revive II (emamectin benzoate)
 - <5m height
 - Injected early spring, post flowering, before bud burst
- Foliage samples collected from trees over a 2.5-year period
- Foliage extracted and analysed by HPLC-MS/MS

Trunk injection results

1. Emamectin benzoate in foliage



- Levels dropped dramatically 1 to 2½ years post injection
 - <0.1 mg/Kg
 - Would protect trees for at least 1 year

2. Emamectin benzoate in composted foliage (collected 6-months post treatment)

Time (months)		Pesticide (mg/Kg)
Year 1	0	0.5 ± 0.1
	12	0.2 ± 0.1
Year 2	0	0.01 ± 0.01
	12	0

3. Emamectin benzoate in male flowers

Time (months post injection)	Pesticide (mg/Kg)
12	0.013 ± 0.006
24	0.002 ± 0.002

< acute LD₅₀ for honeybees

No pesticide in control samples

Classical biological control

The intentional introduction of an exotic biological control agent (BCA)

- Subject to regulatory measures, licence to release, including rigorous risk assessment and review process
- May take years before approval is granted allowing the pest population to build and spread
- Post-release evaluations are also needed to evaluate the establishment, spread and impact of the BCA release

Pre-emptive biological control

- Approval for release of exotic BCA in advance of its arrival
- Start much earlier in the management programme
- Euphresco project – developed guidelines
 - Led by Fera Science Ltd (Neil Audsley) and The New Zealand Institute for Plant & Food Research Limited (Gonzalo Avila)



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Guidelines and framework to assess the feasibility of starting pre-emptive risk assessment of classical biological control agents

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Pre-emptive biological control for EAB

Non-native parasitoids selected

- Most promising from USA evidence
 - Egg parasitoid
 - *Oobius agrili*
 - Larval parasitoids
 - *Tetrastichus planipennis*
 - *Spathius galinae*



Tetrastichus planipennis

- European parasitoid
 - Larval parasitoid *Spathius polonicus*
 - parasitising EAB in Russia
 - Not established in the UK
 - Broad host-range
 - Buprestids and scolytids

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**Discovery of the first European parasitoid of the emerald ash borer
Agrilus planipennis (Coleoptera: Buprestidae)**

MARINA J. ORLOVA-BIENKOWSKAJA¹ and SERGEY A. BELOKOBLYSKIY²

Risk assessments have been drafted for all 4 selected BCAs to support licence applications for release

Addressing uncertainties

1. Establishment and spread

- Climate matching (MaxEnt and MADIFA analyses)
 - Low bioclimatic suitability (Limited to SE England)
 - *Spathiopsis galinae* most likely to establish in GB
 - Predictions limited by data

2. Identified gaps in knowledge and uncertainties where further research is required

- Host specificity (especially native *Agrilus* species)
- Potential to hybridise with native parasitoid species of same genus (No *Oobius* species in the UK)

3. Preparing for post-release monitoring

- Developing molecular diagnostic techniques
 - To monitor establishment, spread and non-target impacts
 - To distinguish between different life-stages of introduced and native parasitoids

Host specificity

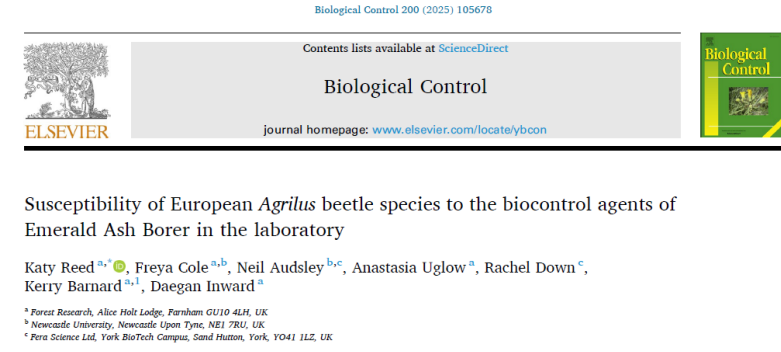
- Risk - Coleopteran species belonging to the Buprestidae and Cerambycidae
- Identified based on:
 - phylogenetic relationship to the target host
 - shared host plant
 - shared larval niche
 - endangered species.
- 20 species of Buprestidae present in GB
 - 10 *Agrilus* spp, restricted to Southern England, *A. biguttatus* most common
 - non feed on ash, but potential non-target hosts
 - recent incursions of *A. convexicollis*; feeds on dead and dying ash.
- 62 species of Cerambycidae native or naturalised in GB
 - most are associated with living or dead wood of trees and shrubs
 - 2 species (*Tetrops starkii* and *Saperda populnea*) associated with *F. excelsior*



Host specificity

USA studies

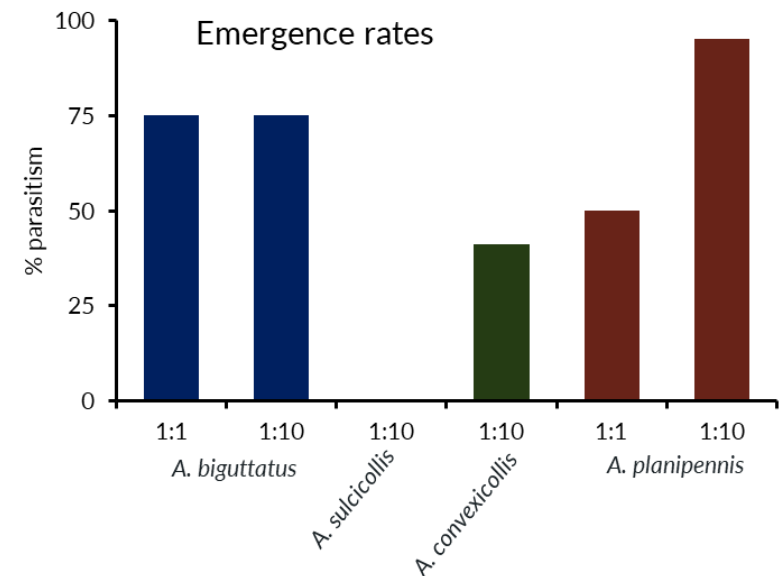
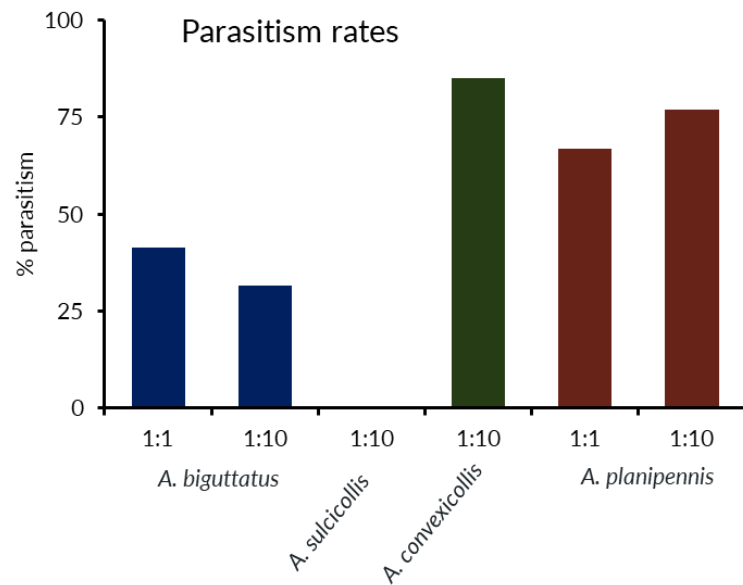
- *Spathius galinae*
 - Attacks only *Agrilus auroguttatus* under laboratory conditions
 - Not present in Europe
- *Tetrastichus planipennis*
 - Reported to be highly specific to EAB
- *Oobius agrili*
 - Parasitised eggs of 3 *Agrilus* species (*A. anxius*, *A. bilineatus*, *A. ruficollis*)
 - Eggs of similar in size to EAB
 - None present in GB
- All three are specific to *Agrilus* species



- Abundant species of ecological similarities selected
- *A. biguttatus*, *A. sulcicollis* (oak); *A. convexicollis* (ash)
 - Field collected and reared in the lab.
- EAB and EAB parasitoids were provided by
 - USDA APHIS EAB Biocontrol Facility
 - Canadian Forest Service

Host specificity - *Oobius agrili*

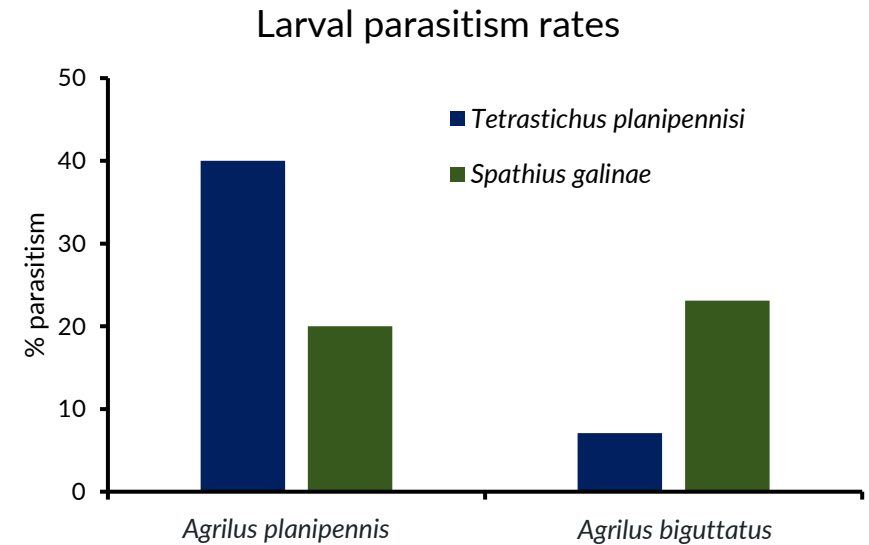
- No-choice testing of *Agrilus* eggs
 - *O. agrili* : *A. biguttatus*, *A. sulcicollis* or *A. convexicollis* eggs = 1:1 or 1:10 for 1 week
 - Parasitised eggs left to develop for 6-weeks - adult emergence
 - Unparasitised eggs left for 10 days to determine viability
- EAB used as positive control
- *O. agrili* parasitises *A. biguttatus* and *A. convexicollis* eggs
- *A. sulcicollis* eggs are not parasitised by *O. agrili*



Host specificity – larval parasitoids

- No-choice testing of *Agrilus biguttatus* larvae
 - One larva-colonised bolt and 1-2 ♀ + 1 ♂ parasitoid for 1 week
 - Monitored for emergence, destructively sampled after 6-weeks
 - EAB larvae used as positive controls

- *A. biguttatus* larvae are parasitised by both *T. planipennis* and *S. galinae*



Potential to hybridise with native species

- Mate recognition experiments
 - Capture live native species
- Genetic distance between two species
 - More similar (98%) more likely to hybridise
 - Comparison between cytochrome C oxidase subunit I (COI) gene region (obtained from BOLD and GenBank)
- Compare native species to *T. planipennisi*, *S. galinae*
 - No data for *S. polonicus*
 - No indigenous *Oobius* species in GB, so hybridisation with native species is highly unlikely
- Ecological similarities
 - Inform which species most at risk and potential need for laboratory testing
- There are no reports of hybridisation of *O. agrili*, *S. galinae* or *T. planipennisi* with other related species

Potential to hybridise

Spathius galinae

Native species	Pairwise similarity to <i>Spathius galinae</i>
<i>Spathius rubidus</i>	95.9%
<i>Spathius exarator</i>	94.6%
<i>Spathius brevicaudis</i>	93.1%
<i>Spathius phymatodis</i>	No data
<i>Spathius pedestris</i>	No data
<i>Spathius umbrata</i>	No data

Red = ecological similarities (parasitise bruprestids)

- Relatively low pairwise similarities - less likely, but not impossible, for hybridisation with related native species
- Species with ecological similarities may warrant further investigation

Tetrastichus planipennisi

- 33 *Tetrastichus* species in GB
- 7 species have ecological similarities
- Pairwise similarities < 94%
 - No data for 6 species (but no ecological similarities)

Summary

Chemical control

- Capability to treat (urban) trees using trunk injections of emamectin benzoate
 - Persistence in *F. excelcior* < North American species
 - Protection not as great?

Pre-emptive biological control

- Risk assessments identified gaps in knowledge and uncertainties (research on-going)
 - Bioclimatic matching highlights uncertainties
 - Host specificity
 - Exotic parasitoids parasitise and *A. convexicollis* eggs and *A. biguttatus* eggs and larvae
 - Potential to hybridise with native species
 - Genetic distance suggests highly unlikely (data missing for some species)
 - Work on-going via PhD (Freya Cole) at Forest research

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**FUTURE PROOFING
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