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Spatial distribution of ambrosia-beetle catches: A possibly useful knowledge to improve mass-trapping

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Abstract

Several species of ambrosia beetles (Coleoptera: Scolytidae) have recently started attacking standing, living beeches (*Fagus sylvatica*) in southern Belgium. In 2001, 1.3 million m^3 of apparently healthy trees were struck. So far the outbreak has been limited to the Ardenne, and partly the Gaume, areas, and Brussels has been untouched. The city of Brussels is surrounded by a vast 4300 ha forest, mainly planted with beech, the Forêt de Soignes, of invaluable ecological and recreational value, of which 1600 ha belong to the regional authorities. In the spring 2001, these latter commissionned a study to assess the new threat to the forest. A 500 m × 500 m grid of small traps, baited with ethanol and lineatin, was deployed over the regional part of the forest. The main species caught were *Trypodendron domesticum*, *Anisandrus dispar* and, in high numbers, *Xylosandrus germanus*, an exotic species of Asian origin found for the first time in Belgium in 1994. Whilst there was a consistent homogeneity between catches within the same sites (2 traps/site, distant by 2–6 m), there were no spatial relationships between catches at larger distances for *T. domesticum* and *A. dispar*. For *X. germanus*, spatial autocorrelations were observed within distances of 2000 m, suggesting that this species has sufficient mobility to cover this range. The planning of the 2002 trapping campaign will take this information into account: the traps will be deployed within a smaller grid.

Introduction

Since the late nineties, for still poorly understood reasons, ambrosia beetles (Coleoptera: Scolytidae) have started attacking standing, living beeches (*Fagus sylvatica* L.) in southern Belgium. In 2001, *Trypodendron domesticum* (L.), *T. signatum* (F.) and *Anisandrus dispar* (F.) attacked 1.3 million m^3 of apparently healthy trees (see Huart *et al.*, this volume). The fate of these trees is still unknown; if they survive, the timber value will be considerably reduced; if they die, huge silvicultural and ecological problems will be added to the economic losses. So far the outbreak has been limited to the Ardenne and, partly the Gaume areas, and Brussels has been untouched.

The city of Brussels is surrounded by a vast 4300 ha forest, the Forêt de Soignes, of invaluable ecological and recreational value, of which 1600 ha belong to the Regional Authorities and are mostly (78%) covered with beech (Figure 1). The conditions for beech are far from optimal in the Forêt de Soignes, with an unbalanced age structure, poor soils and poor natural regeneration. As these conditions could predispose the trees to ambrosia-beetle attacks, the Region commissionned in the spring 2001 a study to assess the new threat to the forest.

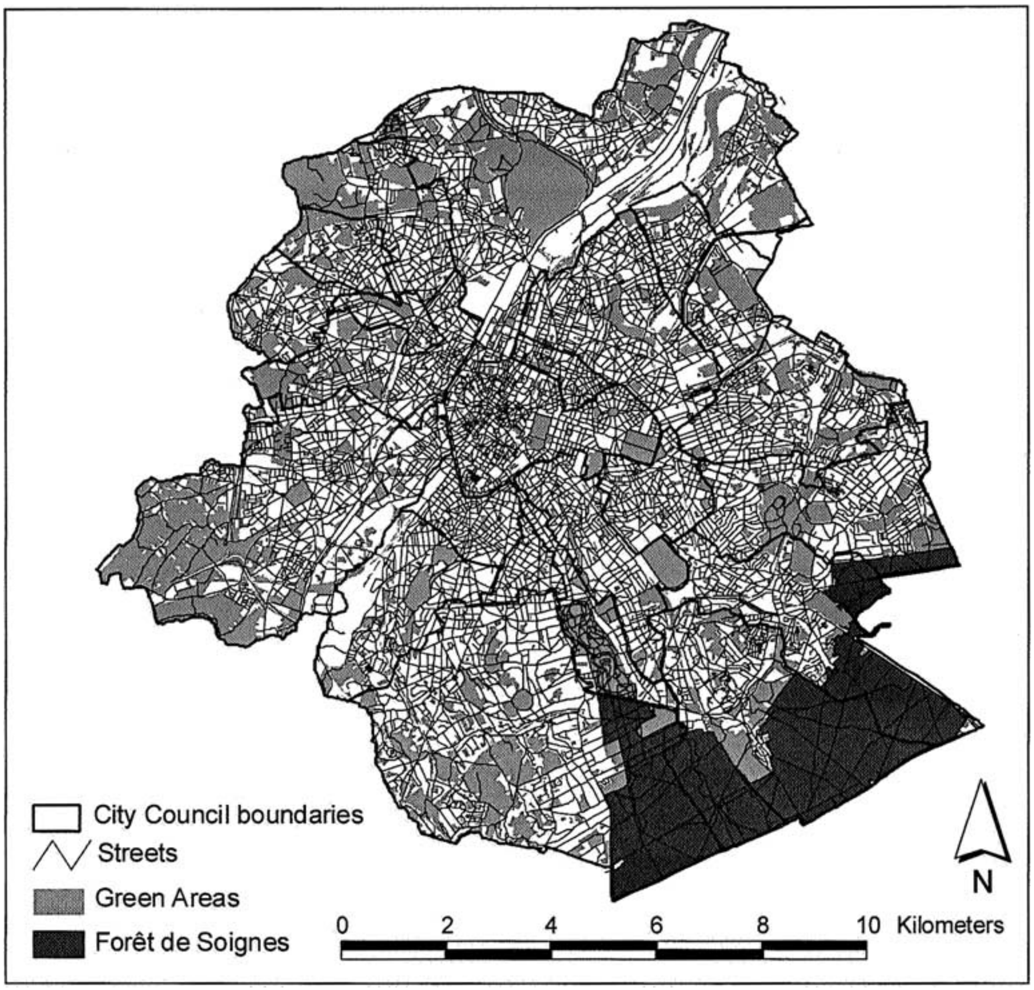

Figure 1. Map of Brussels showing the part of the Forêt de Soignes managed by the Brussels Regional Authorities.

The entomological problems affecting beech in southern Belgium raised serious concern for the Forêt de Soignes, leading the Regional authorities to fund a limited research programme on the ambrosia-beetle threats to the forest.

Material and Methods

A first, small-scale study (31 May–11 July 2001), consisted in a network of 9 sites established over the forest (Figure 3), with two 30m × 15 cm 'bottle-traps' (Figure 2) per site. A bottle-trap is a barrier-trap, 25 cm high and 14 cm wide, made out of a PET mineral water bottle, placed bottleneck down and which has had its bottom cut out, as well as half the cylindrical part, leaving a flat surface connected to a funnel (the ex-bottleneck), to which a collecting bottle has been fixed. Each trap was stapled to a post 1.5 m above ground and baited with half a lineatin lure (Phero Tech Inc., Canada) and with 50 ml of pure ethanol in the collecting bottle.

In a second campaign (11 July–30 August 2001), the network was extended to 50 sites, roughly distant by 500 m from each other. Each site was equipped with two bottle-traps. The traps were baited as in the first campaign, except that the ethanol was denaturated with 3% ether.

During both campaigns, the traps were surveyed roughly every 2 weeks; insects caught were individually counted. The spatial structure of trap catches was analysed using exploratory variography.

Results

Catches

The 18 traps set up in June–July caught a total 12131 beetles, among which 9655 (79.6%) *Xylosandrus germanus*. There was a high heterogeneity of catches between sites (Figures 3 and 4A). Catches of *T. domesticum* correlated well with catches of *X. germanus* ($R^2 = 0.830$; $p = 0.002$: Figure 5A) but *A. dispar* catches did not. Within-site catches were very tightly correlated for *X. germanus* ($R^2 = 0.924$; $p = 0.000\,04$: Figure 6A), and a significant, although weaker, correlation between trap catches within each site was also observed for *T. domesticum* ($R^2 = 0.746$; $p = 0.002\,7$: Figure 6B).

The 100 traps set-up in July–August caught less beetles as the season was already too advanced. Out of the 4718 beetles caught, 3963 (84%) were *X. germanus*. Again, there was a high heterogeneity of catches between sites (Figures 3 and 4B), and catches of *T. domesticum* correlated well with catches of *X. germanus* ($R^2 = 0.284$; $p < 0.001$: Figure 5B) but there was no link between *A. dispar* and *X. germanus* catches. As in the first campaign, within-site catches were very highly correlated for *X. germanus* ($R^2 = 0.540$; $p < 0.001$: Figure 7A), and again a weaker but significant correlation was also observed for *T. domesticum* ($R^2 = 0.160$; $p < 0.01$: Figure 7B).

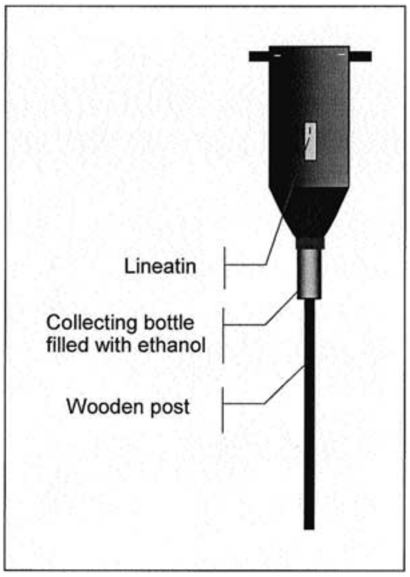

Figure 2. A ‘bottle-trap’ on its post.

Spatial analyses

Inverted correlograms of *T. domesticum* and *A. dispar* catches showed no evidence of spatial dependence at the scale of this study, indicating that most of the

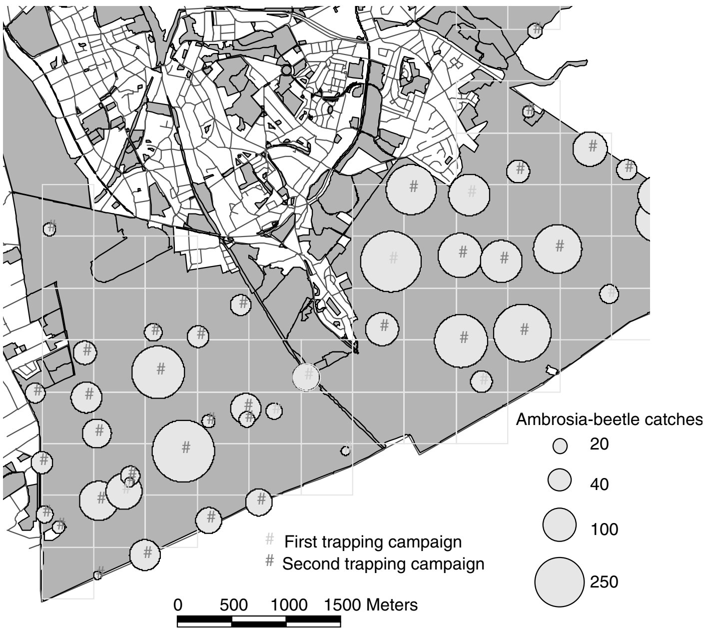

Figure 3. Spatial distribution of total catches in the Forêt de Soignes. Size of circles around trap locations is proportionnal to total trap catches during the season.

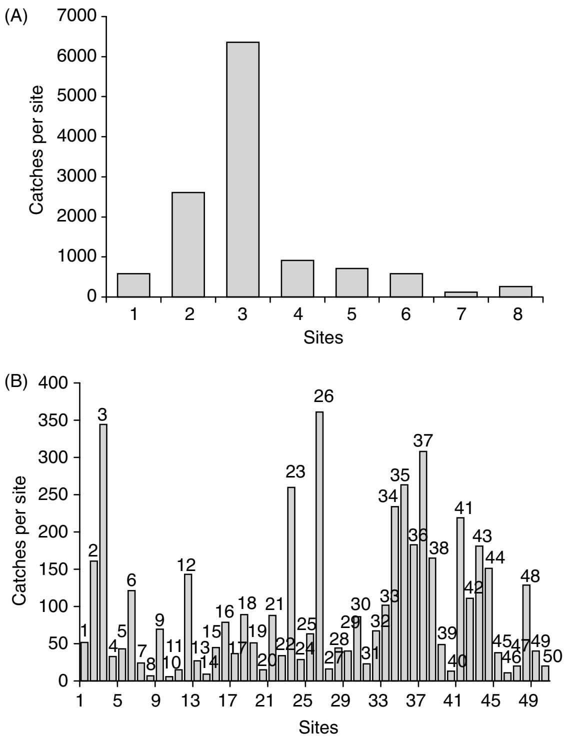

Figure 4. (A) Total catches (all species), June–July 2001; (B) Total catches, July–August 2001.

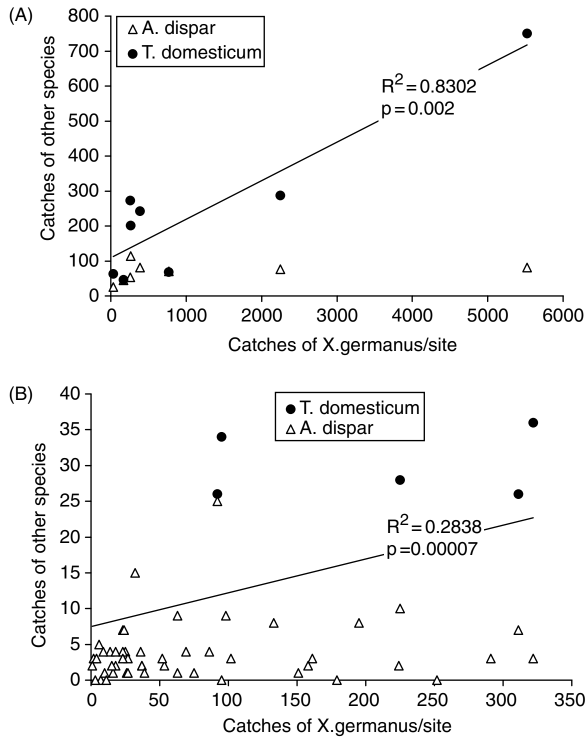

Figure 5. (A) June–July 2001, catches of *T. domesticum* and *A. dispar* as a function of *X. germanus* catches; (B) July–August 2001, catches of *T. domesticum* and *A. dispar* as a function of *X. germanus* catches.

variability in catches is explained by local conditions occuring at a smaller scale than the inter-trap average distance (Figure 8).

In comparison, the inverted correlogram of *X. germanus* catches showed significant spatial dependence at distances inferior to 2000 m (Figure 8).

Discussion

A first result of this study is to reveal the importance of *X. germanus* in the Forêt de Soignes. This Japanese invasive species that had been found recently (1994) in Belgium (Bruge 1995) has been constantly increasing its distribution area during the last century, being described in 1932 in the US and in 1952 in Germany (Bruge 1995). So far, only a few individuals have been caught in southern Belgium (M. De Proft, unpublished), which could mean, either that the insect has not yet spread southward, or that the colder climatic conditions in the south restrict its establishment. This beetle can cause important mechanical damage (e.g. Graf & Manser (2000) mention spruce and fir degrade amounting to 1 million CHF in Switzerland in 1995), and it is also known to vector pathogenic fungi (e.g. Frigimelica *et al.* 1999). Therefore, its future movements and population changes should be watched carefully.

The two campaigns showed a high level of heterogeneity in the catches at the different sites. The good within-site homogeneity observed in catches (see Figures 6 and 7) suggests that the differences between sites were probably determined by local site conditions, and not by random effects due to individual trap characteristics.

This between-site heterogeneity of catches could either indicate the presence of unevenly distributed local population reservoirs (due e.g. to the local presence of stumps, timber or windfalls), or reveal a degree of local variability in trapping conditions (due, e.g. to stand density and composition, slope, light). The fact that no spatial dependence was observed for *T. domesticum* catches suggests either that this species is not very mobile (there would be local reservoirs of insects that would fly to the nearest traps), or that it is mobile but favours particular trapping sites that are

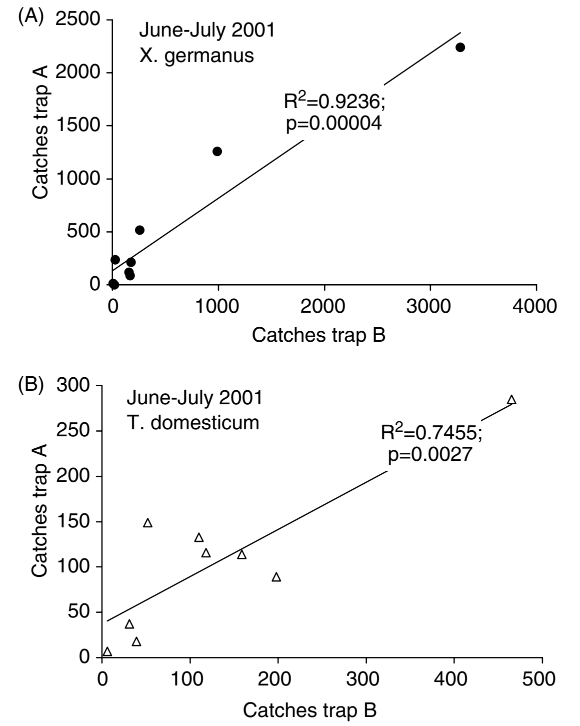

Figure 6. June–July 2001, within-site catches of *X. germanus* (A) and *T. domesticum* (B).

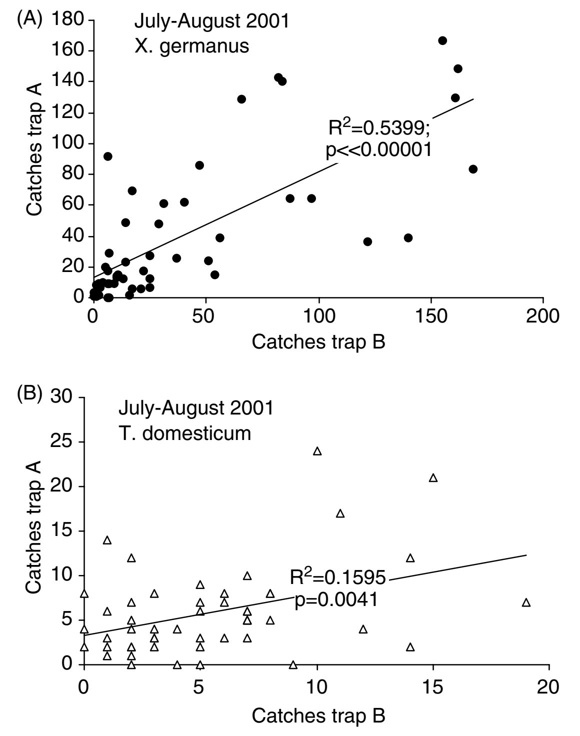

Figure 7. July–August 2001, within-site catches of *X. germanus* (A) and *T. domesticum* (B).

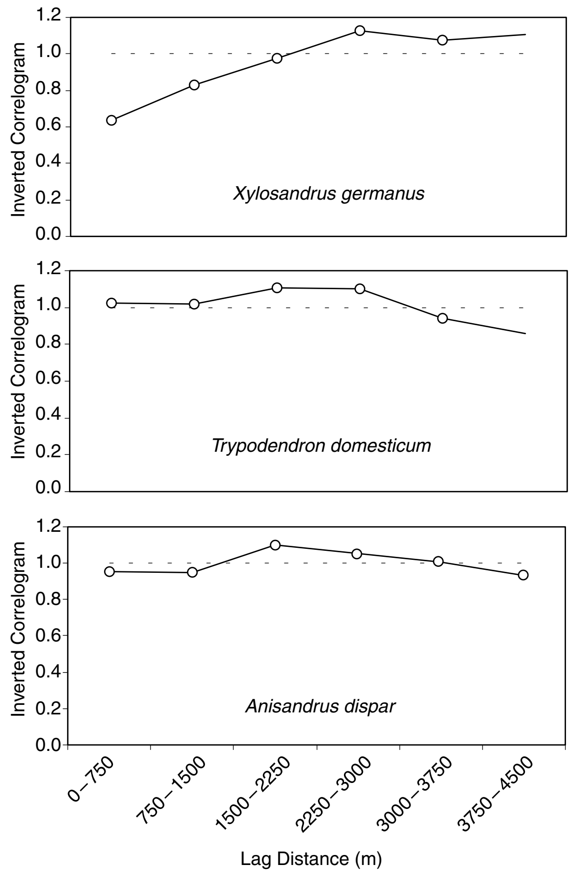

Figure 8. Inverted correlograms of catches during the July–August 2001 period. Catches of *X. germanus* show spatial dependance within a 2000 m radius.

not spatially autocorrelated. *X. germanus* might follow a different pattern: the spatial dependance that was observed for this species means either that it can move within a larger radius or that it responds to environmental variables autocorrelated to a similar degree. However, catches of both species were closely correlated (Figure 5), suggesting that, like *T. domesticum*, *X. germanus* is trapped in non-spatially dependent sites. They would thus both stem from local reservoirs thriving on the same local resources, and these resources would drive the local catches. If this hypothesis holds true, the spatial dependence observed in *X. germanus* is likely to be caused by a higher mobility. Conversely, the lack of spatial dependence for *T. domesticum* would indicate a reduced mobility.

If this is the case, the absence of spatial dependance for catches of *T. domesticum* within the 500m × 500 m grid suggests that the beetles do not fly over

500 m. This would suggest that mass-trapping must be organized within a smaller grid. *X. germanus*, which displays spatial dependance over 2000 m, should be less responsive to this increase of trap density.

Acknowledgements

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References

Bruge, H. (1995) *Xylosandrus germanus* (Blandford, 1894) [Belg. sp. nov.] (Coleoptera Scolytidae). *Bulletin et Annales de la Société Royale Belge d'Entomologie* **131**, 249–64.

Frigimelica, G., Stergulc, F., Zandigiacomo, P., Faccoli, M. and Battisti, A. (1999) *Xylosandrus germanus* and walnut disease: an association new to Europe. In B. Forster, M. Knízek and W. Grodzki (eds) *Proceedings of the second workshop of the IUFRO working party 7.03.10: Methodology in Forest Insect and Disease Survey in Central Europe*, pp. 98–101. Sion-Châteauneuf, Switzerland. April 20–23, 1999.

Graf, E. and Manser, P. (2000) Beitrag zum eingeschleppten Schwarzen Nutzholzborkenkäfer *Xylosandrus germanus*. Biologie und Schadenpotential an im Wald gelagertem Rundholz im Vergleich zu *Xyloterus lineatus* und *Hylecoetus dermestoides*. *Swiss Forestry Journal* **8**, 271–81.