PREVENTING INVASIONS OF ASIAN LONGHORN BEETLE AND CITRUS LONGHORN BEETLE IN EUROPE

HOLISTIC MANAGEMENT OF EMERGING FOREST PESTS AND DISEASES

Photo credit:
Anoplophora chinensis | KKPCW | commons.wikimedia.org

Summary

This policy brief is based on a study published in the *Journal of Pest Science* and conducted within HOMED's framework by Sofia Branco, Massimo Faccoli, Eckehard G. Brockerhoff, Géraldine Roux, Hervé Jactel, Nicolas Desneux, Emmanuel Gachet, Raphaelle Mouttet, Jean-Claude Streito, and Manuela Branco.

With the increase in international trade and globalisation, the introduction of non-native species into new environments has exacerbated the problems of biological invasions worldwide (Brockerhoff and Liebhold, 2017; Liebhold and Kean, 2019; Lesieur et al., 2019; Zhao et al., 2020). Two particularly worrying invasive pest species are the Asian longhorn beetle (ALB) *Anoplophora glabripennis* (Motschulsky) and the citrus longhorn beetle (CLB) *Anoplophora chinensis*. Both of them have unintentionally arrived in North America and Europe and due to their potential impact on forest ecosystems and many tree species, major efforts have been put into preventing further entry and establishment and promoting their successful eradication.

To get a better understanding of the successes and failures of such efforts, scientists analysed historical data regarding the interceptions, establishments and eradications of the two Asian longhorn beetles. They found that the combined international efforts, including legislative changes, have proven to have an impact, with more than 45% of eradication programmes being successful. And although the costs of such eradication programmes can be high, their benefits outweigh inaction. Furthermore, the researchers concluded that prevention and management of Asian longhorn beetles can be challenging but not impossible and new research avenues could be pursued to improve the current state of affairs.

Keywords

biological invasions, eradication, management strategies, pest detection, surveillance

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Relevance to legislation

International conventions

- Convention on Biological Diversity
- International Plant Protection Convention (IPPC)
- Agreement on the Application of Sanitary and Phytosanitary Measures (SPS agreement)
- Regulation of wood packaging material in international trade (ISPM15)
- Methodologies for Sampling of Consignments (ISPM 31)
- Guidelines for Inspection

EU legislation

- EU Biodiversity Strategy for 2030
- EU Regulation 1143/2014 on Invasive Alien Species
- EU Regulation 2016/2031 on protective measures against pests of plants
- Commission Implementing Decision (EU) 2015/893
- Commission Implementing Decisions 2012/138/EU

Relevance to actual environmental problems

Forest threats and vitality, Biodiversity loss, Climate change, Alien species invasion, Forest pest management

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Description of the problem

Forests worldwide are affected by non-native species invasions, the number of which has increased with the rise in international trade and globalisation (Brockerhoff and Liebhold, 2017; Liebhold and Kean, 2019; Lesieur et al., 2019; Zhao et al., 2020). Specifically, two Asian longhorn beetles – Anoplophora glabripennis (ALB) and Anoplophora chinensis (CLB) – are among the most threatening for trees in North America and Europe. Due to their potential impact on ecosystems, major efforts have been put into preventing their further entry and establishment and in turn promoting their successful eradication.

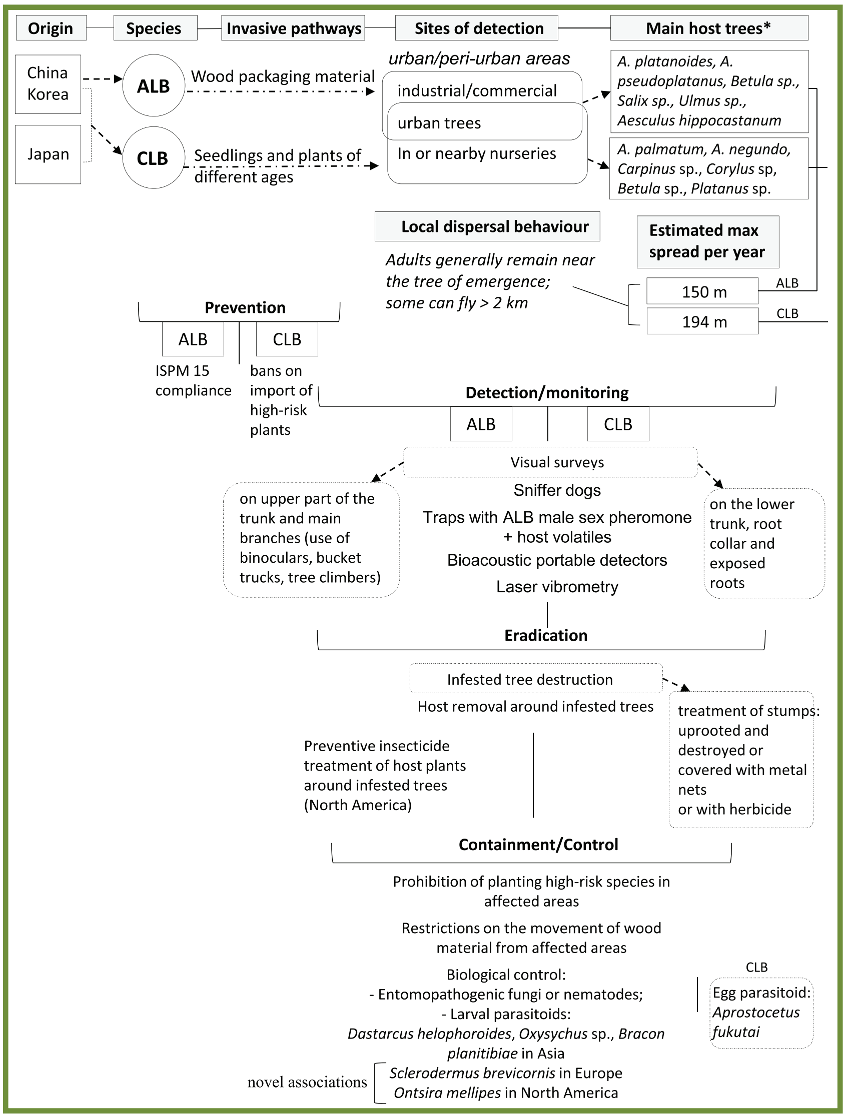
Combined international efforts have proven to have a positive impact, with more than 45% of eradication programmes being successful in the last twelve years. However, these efforts are often hampered by the ongoing arrival of new beetles from their native regions or from other invaded areas via bridgehead effects. To better understand the successes and failures of such efforts, data from 2008 to 2020 was analysed, regarding interceptions, establishments and eradications of the two beetles. Furthermore, these figures were compared to the data available from prior to 2008 (Haack et al., 2010).

The two Asian longhorn beetles differ regarding the plant part on which they develop – CLB develops in the lower trunk and roots of trees, whereas ALB develops mostly in the upper part of the trunk and branches. This leads to the two species having different introduction pathways. ALB introductions are usually associated with the use of solid wood packing material (WPM) in international trade – 96% of ALB interceptions were associated with WPM – whereas CLB is mainly related to imports of live plants, such as bonsais. Live plants are subject to stronger inspections, which explains why 87% of ALB detections occurred after establishment.

Despite the adoption of the International Standard for Phytosanitary Measures (ISPM) 15, which sets strict standards for the use of WPM in international trade (IPPC, 2009), the number of reported interceptions related to wood packaging in Europe has increased. Most failures of phytosanitary measures could be attributed to fraudulent use of the ISPM 15 mark and unintentional non-compliance (not achieving minimum required doses of fumigant or heat). Therefore, further improvements may be needed to ensure prescribed ISPM 15 treatments are carried out and WPM is thoroughly checked (Haack et al., 2014).

Furthermore, a study on the connection between interceptions and establishments of longhorn beetles (including ALB and CLB) concluded that there is a beneficial correlation between the two parameters (Brockerhoff et al., 2014), which points to the potential usefulness of recording interception data from inspections of relevant imports.

With respect to the current steps of invasion and management strategies, you can find a graphic summary in the Figure below:



Summary of the steps of invasion and management strategies of Anoplophora spp. in invaded range. Source: Branco, S., Faccoli, M., Brockerhoff, E.G. et al. (2022).*

The available scientific knowledge on the beetles' dispersal ability (e.g. Adachi, 1990; Bancroft and Smith, 2005; Cavagna et al., 2013; Li et al., 2010; Sawyer et al., 2011; Turgeon et al., 2015) suggests that boundaries of delimiting survey areas have to be adjusted. Furthermore, current information on ALB and CLB dispersion patterns shows that human-mediated dispersal related to commerce and transport of infested plants, wood and other materials is a major component in the spread of both species. Thus, it needs to be further considered as a cause of satellite infestations (e.g. Turgeon et al., 2015; Tsykun et al., 2019).

As for detection methods, visual surveys are still the standard monitoring procedure for ALB and CLB (EFSA et al., 2019a,b). They are based on the examination of potential host trees by looking for signs of infestation. Most infested trees were detected within the first 2 min of the survey and it was observed that using a team of inspectors for each tree is potentially more effective than using a single inspector per tree (Turgeon et al., 2010).

A potential improvement in detection methods relates to the use of acoustic signals. In such cases, portable detectors are attached to trees to record the sounds and vibrations produced by larvae (Mankin et al., 2008; Sutin et al., 2019). Their usefulness has been acknowledged by the international European and Mediterranean Plant Protection Organization standards, but their use in the field is difficult and their accuracy can be influenced by the nature of the sensor-substrate interface. However, a recent improvement in this area has been the development of laser vibrometry, in which a laser beam is used to detect the vibrations produced by larvae. Although only lab tests have been conducted to date, this method showed high sensitivity and a high signal to noise ratio (Zorović and Čokl, 2015; Hérard and Maspero, 2019).

Recommendations

Taking into consideration the aforementioned research findings, we have established the following recommendations, aimed at improving the prevention of Asian longhorn beetle and citrus longhorn beetle invasions:

- Although eradication campaigns through host tree removal are costly and time-consuming, we recommend that those continue to be employed and further improved. They have proven to have a positive impact and their benefits outweigh inaction in most cases – estimates of potential economic loss caused by invasions suggest eradication campaigns are well worth their price. For example, during the first year of an eradication program for a small ALB outbreak in Cornuda, Italy, the ornamental value of the saved trees was six times higher than the eradication costs (Faccoli and Gatto, 2016).

- Evidence shows that the ISPM 15 does not guarantee that wood packing material is entirely pest-free since it can be fraudulently used or unintentionally non-complied with. Therefore, we advise that further improvements be made to ensure prescribed ISPM 15 treatments are carried out and WPM is thoroughly checked.

- We suggest a harmonisation of the inspection procedures amongst all Member States based on the most effective methodology. Additionally, it is advised that a record be kept of the interception data from inspections of relevant imports since such data is connected to the establishments of ALB and CLB.

- Finally, we believe that a number of improvements in current efforts could lead to enhanced detection and responses. First, we suggest that the boundaries applied to define the delimiting survey areas mandatory by law be revised based on available knowledge on the beetles' dispersal ability. Also, more attention should be paid to the human-mediated dispersal related to commerce and transport of infested plants as a cause of satellite infestations. Second, we advise that when conducting visual surveys, a team of two inspectors is used for each tree instead of a single inspector. Third, detection methods using acoustic signals could benefit from the use of the recently developed laser vibrometry, which allows to carry out the recording directly from the vibrating surface without the need to mount detectors on the tested materials.

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Sources

Main source

Branco, S., Faccoli, M., Brockerhoff, E.G. et al. (2022). Preventing invasions of Asian longhorn beetle and citrus longhorn beetle: are we on the right track?. J Pest Sci., 95: 41–66. doi:10.1007/s10340-021-01431-x

Additional sources

Adachi, I. (1990). Population studies of Anoplophora malasiaca adults (Coleoptera: Cerambycidae) in a citrus grove. Res Popul Ecol., 32(1): 15–32. doi:10.1007/BF02512587

Bancroft, J.S., & Smith, M.T. (2005). Dispersal and influences on movement for Anoplophora glabripennis calculated from individual mark-recapture. Entomol Exp Appl., 116(2): 83–92. doi:10.1111/ j.1570-7458.2005.00320.x

Brockerhoff, E.G., & Liebhold, A.M. (2017). Ecology of forest insect invasions. Biol Invasions, 19(11): 3141–3159. doi:10.1007/ s10530-017-1514-1

Brockerhoff, E.G., Kimberley, M., Liebhold, A.M. et al. (2014). Predicting how altering propagule pressure changes establishment rates of biological invaders across species pools. Ecology, 95(3): 594–601. doi:10.1890/13-0465.1

Cavagna, B., Ciampitti, M., Bianchi, A. et al. (2013). Lombardy Region experience to support the prediction and detection strategies. J Entomol Acarol Res, 45(1s): 1–6

EFSA (European Food Safety Authority), Hoppe, B., Schrader, G. et al. (2019a). Pest survey card on Anoplophora chinensis. EFSA Supporting Publications, 16(12): 22. doi:10.2903/sp.efsa.2019.EN-1749

EFSA (European Food Safety Authority), Hoppe, B., Schrader, G. et al. (2019b). Pest survey card on Anoplophora glabripennis. EFSA Supporting Publications, 16(12): 30. doi:10.2903/sp.efsa.2019.EN-1750

EU (European Commission). (2012). Commission Implementing Decision 2012/138/EU of 1 March 2012 as regards emergency measures to prevent the introduction into and the spread within the Union of Anoplophora chinensis (Forster). Off J EU, 64: 38–47

EU (European Commission). (2015). Commission implementing decision 2015/893 of 9 June 2015 as regards measures to prevent the introduction into and the spread within the Union of Anoplophora glabripennis (Motschulsky). Off J EU, 146: 16–28

Faccoli, M., & Gatto, P. (2016). Analysis of costs and benefits of Asian longhorned beetle eradication in Italy. Forestry, 89(3): 301–309. doi:10.1093/forestry/cpv041

Haack, R.A., Hérard, F., Sun, J., & Turgeon, J.J. (2010). Managing invasive populations of Asian longhorned beetle and citrus longhorned beetle: a worldwide perspective. Ann Rev Entomol, 55: 521–546. doi:10.1146/annurev-ento-112408-085427

Haack, R.A., Britton, K.O., Brockerhoff, E.G. et al. (2014). Effectiveness of the International Phytosanitary Standard ISPM No. 15 on reducing wood borer infestation rates in wood packaging material entering the United States. PLoS ONE, 9(5): e96611. doi:10.1371/ journal. pone.0096611

Hérard, F., & Maspero, M. (2019). History of discoveries and management of the citrus longhorned beetle, Anoplophora chinensis, in Europe. J Pest Sci, 92(1): 117–130. doi:10.1007/s10340- 018-1014-9

IPPC (International Plant Protection Convention). (2009). International Standards for Phytosanitary Measures: revision of ISPM No. 15, Regulation of wood packaging material in international trade. Food and Agriculture Organization of the United Nations, Rome

Lesieur, V., Lombaert, E., Guillemaud, T. et al. (2019). The rapid spread of Leptoglossus occidentalis in Europe: a bridgehead invasion. J Pest Sci, 92: 189–200. doi:10.1007/s10340-018- 0993-x

Liebhold, A.M., & Kean, J.M. (2019). Eradication and containment of non-native forest insects: successes and failures. J Pest Sci, 92: 83–91. doi:10.1007/s10340-018-1056-z

Li, G., Gao, R., Smith, M.T., & Kong, L. (2010). Study on dispersal of Anoplophora glabripennis (Motsch.) (Coleoptera: Cerambycidae) population. For Res, Beijing, 23(5): 678–684. doi:10.1603/0046-225X-30.6.1036

Mankin, R.W., Smith, M.T., Tropp, J.M. et al. (2008). Detection of Anoplophora glabripennis (Coleoptera: Cerambycidae) larvae in different host trees and tissues by automated analyses of sound-impulse frequency and temporal patterns. J Econ Entomol, 101(3): 838–849. doi:10.1093/jee/101.3.838

Sawyer, A.J., Panagakos, W.S., Horner, A.E. et al. (2011). Asian longhorned beetle, over the river and through the woods: habitat-dependent population spread. In: McManus, Katherine A, Gottschalk KW (eds) Proceedings, 21st US Department of Agriculture interagency research forum on invasive species 2010; 2010 January 12–15; United States Department of Agriculture, Annapolis, MD, pp. 52–54

Tsykun, T., Javal, M., Hölling, D. et al. (2019). Fine-scale invasion genetics of the quarantine pest, Anoplophora glabripennis, reconstructed in single outbreaks. Sci Rep, 9: 19436. doi:10.1038/s41598- 019-55698-3

Turgeon, J.J., Pedlar, J., De Groot, P. et al. (2010). Density and location of simulated signs of injury affect efficacy of ground surveys for Asian longhorned beetle. Can Entomol, 142(1): 80–96. doi:10.4039/n09-049

Turgeon, J.J., Orr, M., Grant, C. et al. (2015). Decade-old satellite infestation of Anoplophora glabripennis Motschulsky (Coleoptera: Cerambycidae) found in Ontario, Canada outside regulated area of founder population. Coleopt Bull 69(4): 674–678. doi:10.1649/0010-065X-69.4.674

Zhao, Z., Reddy, G.V.P., Chen, L. et al. (2020). The synergy between climate change and transportation activities drives the propagation of an invasive fruit fly. J Pest Sci, 93: 615–625. doi:10.1007/ s10340-019-01183-9

Zorović, M., & Čokl, A. (2015). Laser vibrometry as a diagnostic tool for detecting wood-boring beetle larvae. J Pest Sci, 88: 107–112. doi:10.1007/s10340-014-0567-5