When a threatened species becomes a threat: a key to reading the Habitats Directive based on occurrence and distribution of Cerambyx cerdo L. in Mediterranean urban and peri-urban areas

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Abstract. 1. Cerambyx cerdo is a large saproxylic species included in the Annex IV of the European Habitats Directive as a ‘priority species’.

2. Although C. cerdo populations have shown a significant decline in size and distribution in central and northern European forests, in the Mediterranean basin it is often considered as a pest in urban and peri-urban areas.

3. Based on European legislations currently in use, we propose a simplified decision-making flowchart that should be followed regarding the adoption of different control measures against severe C. cerdo infestations.

Key words. Conservation biology, EU Habitats Directive, Great Capricorn beetle, IPM.

Introduction

Cerambyx cerdo L. (Coleoptera Cerambycidae), commonly known as the great capricorn beetle (GCB), is a large and emblematic saproxylic longhorn species, generally associated, but not exclusively, with decaying oaks and other forest trees (Torres-Vila, 2017; De Zan et al., 2017). GCB larvae need living and fresh wood to feed on and properly develop. Mated females wander over the host tree probing the bark with the ovipositor and lay up to more than 300 eggs individually into suitable bark crevices and pruning wounds. After hatching, larvae initiate feeding under the bark and then move towards the inner wood from about the second year. Larvae growth during 2–3 (4) years and when complete their development, mature larvae tunnel outwards, build a pupal cell closed by a calcareous plug and pupate inside. About 1 month after pupation, in late summer or early autumn, adults emerge, but they remain inside the pupal cells throughout the winter in a reproductive stage until the following season. Adults leave the host tree from May to August depending on local climatic conditions, altitude and latitude. Adults emerge from the host trees through 15–20 mm ellipsoid-shaped exit holes on the bark, often producing abundant frass (Neumann, 1985; Bense, 1995; Horák et al., 2010; Torres-Vila, 2017; De Zan et al., 2017).

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Control of *Cerambyx cerdo* in urban areas

The situation described so far is the cause of a number of conflicts between people and public administrations and very often between different administrations (Table 1), as there is an underlying legislative and ethical dilemma: to protect the tree or to protect the beetle. Therefore, public administrations often wonder whether certain control and management measures against GCB can be applied in compliance with the principles of both the Habitats Directive and the indications of the IUCN Red List of Threatened Species. In order to respond readily to this question, we propose a simplified decision-making flowchart (Fig. 1) representing a key to reading the European legislation and other indications that should be followed regarding the adoption of different control measures against severe GCB infestations.

**Decision-making approach to manage GCB infestations in urban and peri-urban areas**

Activities made by a public administration must always consider whether the area to be controlled covers the Natura 2000 network or not (Fig. 1). Based on the Habitats Directive, if an area or site is included in the Natura 2000 network, intervention measures negatively affecting conservation and biodiversity cannot be adopted. Differently, if an area or site is not included in this network, the adoption of intervention measures can be considered, depending on the presence of threatened and endangered species and the risk to public safety. Therefore, outside the Natura 2000 network, after a preliminary assessment of the species present, no intervention measures can be applied in case of occurrence of organisms included in both the Habitats Directive and the IUCN Red List as threatened or endangered species with limited distribution areas and decreasing populations. To date, the IUCN Red List of Threatened species represents the most effective conservation proposal listing and ranking system throughout European countries, especially because species are listed considering quantitative criteria rather than qualitative ones. This issue is of primary interest because GCB can have a different conservation status, depending on the geographical area, being considered as ‘Near threatened’ species in central-northern Europe and ‘Least concern’ species in Mediterranean areas (Horák *et al.*, 2010). However, whatever the conservation status, GCB damages could be controlled with methods based on integrated pest management (IPM) when a high risk for human safety occurs (article 6 of the Habitats Directive). The latter statement allows public administrations to consider control measures against GCB infestations occurring in urban and peri-urban areas, where colonised trees might represent a significant threat to citizens. Recognition of GCB colonised trees is relatively simple by detecting the presence of the typical oval exit holes on the trunk and main branches. These holes can persist over many years or even decades, but typical signs of GCB recent activity are wood frass and fresh holes with red-colored interior sides (*Buse et al.*, 2007; *Torres-Vila et al.*, 2017). However, if the occurrence of another large wood-boring beetle is suspected, GCB identity must be confirmed because exit holes are not species specific (*Torres-Vila et al.*, 2017). This scenario is usual, for instance, in those

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| Year | Site | Municipality | Province | Country | Host species | Tree number | Species | Source |
|------|------|--------------|----------|---------|--------------|-------------|---------|--------|
| 2008 | San Martín (Cajigal del Carmen) | Santurtz (Cajigal del Carmen) | Santander | Spain | *Quercus faginea* | Several | Cc | https://www.eldiariomontanes.es/20081014/region/santurtztoranzo/gobierno-saneara-roble/20081014.html |
| 2010 | Santa María | Civitanova | Macerata | Italy | *Quercus Ilex* | Several | [Cc] | https://m.cronachemaceratesi.it/2010/08/23/albero-crollatosopra-ora-a-civitanovasi-iniziano-ad-abbattere-piante-malate/40613/ |
| 2011 | La Herguijuela de doña Blanca (Alcornocales El Abuelo) | Toril | Cáceres | Spain | *Quercus suber* | Single | Cw Cc | https://www.elperiodicoextremadura.com/noticias/extremadura/el-abuelo-muere-quemientos-anos_625188.html |
| 2012 | Ca n’Oriol (Roure de Ca n’Oriol) | Rubí | Barcelona | Spain | *Quercus pubescens* | Single | Cc | https://www.rubi.cat/es/ayuntamiento/comunicacion/al-a-depresa/notas/el-ayuntamiento-de-rubi-y-la-generalitat |
| 2012 | Valsorcheno | Plasencia | Cáceres | Spain | *Quercus suber* | Several | Cc Cw | https://www.hoy.es/v/20121029/plasencia/seca-avanzaamenaza-alcornocal-20121029.html |
| 2014 | A Carballeira | Caldas de Reis | Pontevedra | Spain | *Quercus robur* | Several | Cc | https://www.diariodopontevedra.es/articulo/noticias/priorizaran-la-carballeira-ante-la-plaga-de-insectos-de-una-espabio-protegida/201401124500240132.html |
| 2014 | Villa Fondo | Piano di Sorrento | Napoles | Italy | *Quercus Ilex* | Several | Cc | http://www.comune.pianodiSORrento.un.it/news/alberi-del-villafondi-e-negoziazione-degli-spazi-verde |
| 2014 | Viale Colombo, Viale Marconi | Quartu Sant’Elena | Cagliari | (Sardinia) | *Quercus Ilex, Quercus sp.* | Several | [Cc] | https://www.castedduonline.it/il-coleottero-che-uccide-gli-alberidiquartu-striscia-la-notizia-ce/ |
| 2015 | San Mariña de Augas Santas (Carballo de Santa Marína) | Maside | Ourense | Spain | *Quercus robur?* | Single | Cw [Cc] | https://www.laregion.es/articulo/d/provincia/protector-carballo-santa-maria/2015022712412527127.html |
| 2015 | Somogil | Molinaseca | Murcia | Spain | *Quercus faginea* | Single | Cc | https://arbolesmonumentalesudinitia.blogspot.com/2015/11/roble-de-somogil-molinaseca.html?m=1 |
| 2016 | Mourente (Carballo de Santa Margarida) | Mourente | Pontevedra | Spain | *Quercus robur* | Single | Cc | https://www.lavozdelacca.es/noticia/20160715/carballo-santa-margarita-pasando-bien/0003_20160715P15C4991.htm |
| 2015 | Serra de tramuntana | Mallorca (Illes Balears) | Mallorca | Spain | *Quercus Ilex* | Several | Cc | https://www.mallorcadiario.com/lucha-contra-escarabajo-banyarriquer-mallorca |
| 2016 | San Pietro in Cerro (Quercia de San Pietro in Cerro) | San Pietro in Cerro | Piacenza | Italy | *Quercus robur* | Single | Cc | http://www.baronierampanis.it/intervento-quercia-pietro/ |
| 2016 | Marais de Bruges | Bruges | Gironde | France | *Quercus robur* | Several | Cc | https://www.google.com/url?q=http://www.gironde.gouv.fr/content/download/29724/213455/file/RNN-Marais-Bruges_Gd-Capricorne.pdf&usg=AFQjCNFjIPb-YdhupPif-6VdO3CKdLyGwg (continued) |
Table 1. (continued)

| Year | Site | Municipality | Province | Country | Tree species* | Source | Tree number | Species | Site | Host species | Source |
|------|------|--------------|----------|---------|--------------|--------|-------------|---------|------|--------------|--------|
| 2018 | Parco La Mandria | Venaria Reale | Torino | Italy | Quercus robur | http://www.alcedonatura.it/il-cerambice-della-quercia/ | Several | Cc | Reale | Quercus ilex | https://amp.romatoday.it/green/villa-borghese-lecci-malati-tronchi-scavati-.html |
| 2020 | Villa Borghese | Roma | Roma | Italy | Quercus petraea | https://www.ouest-france.fr/bretagne/plechatel-35470/pres-de-rennes-un-chene-vieux-de-400-ans-perd-une-ramure-de-23-metres-6092918 | Single | Cc | Pléchâtel Ille-et-Vilaine | France | https://www.ouest-france.fr/bretagne/plechatel-35470/pres-de-rennes-un-chene-vieux-de-400-ans-perd-une-ramure-de-23-metres-6092918 |
| 2020 | Via Mameli | Pistoia | Pistoia | Italy | Quercus robur | http://www.valdinievoleoggi.it/a87197-via-mameli-inizia-la-riqualificazione-con-nuove-alberature-prevista-anche-un-area-gambotta-can.html | Several | Cc | Pistoia | Quercus robur | http://www.valdinievoleoggi.it/a87197-via-mameli-inizia-la-riqualificazione-con-nuove-alberature-prevista-anche-un-area-gambotta-can.html |

Reported cases are listed following chronological occurrence.

*Cc: Cerambyx cerdo, Cw: Cerambyx welensii. Species membership suspected or inferred, but not specified in the source, is given in brackets.

ecosystems where C. cerdo coexists sympatrically with its congeneric Cerambyx welensii Küster (Torres-Vila & Bonal, 2019).

After having ascertained the presence of the target insect and the possibility of adopting control measures, a visual tree assessment (VTA) procedure or other risk assessment methods (i.e. sonic tomography) should be implemented to evaluate the risk for public safety due to tree infestation. Following Mattheck and Breloer (1994) and Carpaneto et al. (2010), risk assessment might lead to the classification of different levels of falling risk category (FRC), indicating a status of an infested tree that ranges from ‘no risk’ to ‘high risk’. No maintenance procedures are needed when a low or absent risk to public health is revealed, and interventions should be done exclusively when the risk exceeds the preset threshold. Measures to be performed must firstly consider low-impact control actions such as pruning and removing part of the trees highly attacked by GCB. Management of natural enemies such as the egg parasitoid Oobius rudnevi (Nowicki) could also be potentially effective in some situations (Torres-Vila & Fusu, 2020; Torres-Vila et al., 2021). These interventions normally lead to a significant decrease in GCB infestations and reduce drastically the risk of potential damage to citizens by falling branches. The use of traps baited with a mixture of vinegar, wine, beer and/or fruit during the GCB flight period is often recommended for monitoring purposes (De Zan et al., 2017) and can be taken into account to collect adults alive in order to transfer them onto other areas as well. This approach, although difficult to be implemented in some urban areas, could allow to estimate GCB population density and reduce at the same time the adult population size (Torres-Vila et al., 2012). The use of food-baited traps, which is the only effective method for trapping GCB adults due to the lack of species-specific long-range sex pheromones, could be considered mainly in some restricted areas (e.g. private parks and gardens) for some general, as well as technical, limitations. In fact, non-lethal trapping of GCB involves a daily check to avoid any injury or death of the individuals collected (De Zan et al., 2017), being particularly time and cost consuming for public administrations. Moreover, in roadways and other public areas commonly frequented by citizens, traps placed on trunks and branches are easily visible and approachable by visitors, causing potential interferences even when they are located as hidden as possible within the canopy. Basically, all these potential control/management methods could be insufficient at high densities of GCB and, in the most critical situations, the use of low-impact insecticides might be necessary. On the basis of GCB biology and larval development, insecticide application could be carried out by endotherapeutic treatments, which should be applied in an IPM approach together with appropriate cultural techniques (e.g., optimal tree growing conditions, smart pruning, and insecticide application immediately after GCB egg laying) to maximise benefits. Endotherapeutic treatments (i.e., injection of systemic insecticides into the trunks) have been suggested as an effective, environment-friendly and environmentally safe method against pests, with a significant reduction in pesticide losses to the environment. Although no species-specific data are
available, endotherapy might be useful to control GCB larvae feeding under the bark, as already reported for other longhorn beetles infesting trees in urban areas (Maspero et al., 2006; Sarto i Monteys & Torras i Tutusaus, 2018).

Conclusions

Our key to reading the European Habitats Directive and, possibly, other European legislations must not neglect that conservation of vulnerable and endangered species must be of primary interest in all areas, including urban and peri-urban ones, where limited populations are recognised. However, attention to species like GCB must always consider its potential role as a pest in Mediterranean ecosystems. In areas where a risk for conservation of a threatened species does not occur, selected measures against GCB could be considered to manage damaging populations, preserving the trees and reducing the potential risk for citizens. Additionally, our indications evidence the urgent necessity to revise and update the regulations currently in use, mainly because they do not take into account the different needs for species conservation in geographically and ecologically different European regions and countries.

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Conflict of interest

The authors declare no conflict of interest.

Data availability statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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