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# Monitoring Great Capricorn Beetle (*Cerambyx cerdo*) populations in the Natura 2000 network

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**Abstract:** The Great Capricorn Beetle, *Cerambyx cerdo* L., is a saproxylic insect highly dependent on oak trees. Presence of this species was reported in the Natura 2000 site "Gravine di Matera" (code IT9220135), a 7000-hectares protected area in southern Italy. From June to early July 2019, we conducted the first monitoring study of this species, assessing the population size and habitat preference. Baited traps were positioned on trees of different oak species present in the area in order to assess the population size of the Great Capricorn beetle across the study area. Overall, 78 beetles (37 females, 41 males) were caught during 16 days of sampling. Highest densities of *C. cerdo* were encountered on downy oak trees (*Quercus pubescens* Willd.) and tree size appeared to be positively correlated with the number of *C. cerdo* individuals captured on the tree. This demonstrates the importance of the presence of large veteran trees for the conservation of this species.

**Key words:** xylophagous, habitat preference, Cerambycidae, Natural park, *Quercus*

## Introduction

Saproxylic insects are among the most threatened groups of invertebrates in Europe and they are experiencing a severe decline in abundance, principally due to the rapid change in forestry practices over the last two centuries (Davies et al., 2008).

The Great Capricorn Beetle *Cerambyx cerdo* L. (Coleoptera, Cerambycidae) is a saproxylic insect found throughout most of Europe, Northern Africa and the Caucasus, with the largest populations located in the Mediterranean area (Casula, 2017). This species depends on the presence of oak trees (*Quercus* spp.) to complete its life cycle: females lay eggs on oak tree bark and larvae develop in galleries under the bark for a period of up to 5 years. The Great Capricorn Beetle is a veteran tree specialist, with old and isolated trees constituting its preferred habitat for reproduction (Buse et al., 2007). A recent study from Platek et al. (2019) has shown, however, tree choice in *C. cerdo* to be site-dependent, showing that this insect is able to occupy a diversity of niches depending on broad environmental conditions such as soil type and climate.

*Cerambyx cerdo* is currently listed as Vulnerable in Europe by the IUCN, and its decline is attributed mainly to the loss of oak forests, the reduction in numbers of large veteran trees and erroneous woodland management practices (Casula, 2017). *Cerambyx cerdo* is considered an ecosystem engineer and umbrella species (Buse et al., 2007): the galleries excavated by its larvae have been found to be occupied by other saproxylic insects (Buse et al., 2008), reptiles (Gottfried et al., 2019 a) and bats (Gottfried et al., 2019 b).

Understanding its ability to colonize different microhabitats is therefore very important to ensure that forestry practices consider this species' needs. Although its habitat preference has been studied for several central European populations (chiefly in Poland, Germany and Czechia), relatively little is known about its ecology in Mediterranean oak forests, which differ significantly from their northern counterparts in abiotic and biotic factors (Platek et al., 2019).

The Natura 2000 site 'Gravine di Matera' is a protected area of 6968 hectares located in the Basilicata region, Italy, and adjacent to the city of Matera. The presence of *C. cerdo* in the area has been confirmed, along with the presence of four oak species that constitute potential reproduction sites: the downy oak (*Quercus pubescens* Willd.), the holm oak (*Quercus ilex* L.), the Macedonian oak (*Quercus trojana* Webb) and the Virgilian oak (*Quercus virgiliana* Ten.) (Joint Nature Conservation Committee, 2013).

In this study, we aim to assess the habitat preferences of the Great Capricorn Beetle in a diverse forest assemblage. With a mark-recapture approach, we investigated how tree species, tree size and tree density affect the abundance of *C. cerdo*. We hypothesize that large, isolated veteran trees are going to be its preferred kind of habitat. It is not possible to speculate the effect of tree species on habitat choice as there is no available literature on the colonisation of the oak species that will be investigated in this study except for the holm oak.

## Material and methods

### *Timespan and location*

The study took place between the 5$^{th}$ of June and the 5$^{th}$ of July 2019, as this is the peak time for the emergence of the adults of *C. cerdo*. The study was carried out in two locations of the Murgia Materana Regional park, which were named "Bosco del Comune" and "Lucignano". The necessity of splitting the sampling area in two sub-areas arose due to the logistical difficulties that carrying out sampling activities across the full park area would have implied.

### *Trap design and mark-recapture protocol*

To determine the abundance of *C. cerdo* for each tree species, we utilised a mark-recapture approach with the emerging adults. Adults of this species are easily sampled by the utilisation of funnel traps, baited with a mixture of wine and sugar, that have been proven to be the most effective survey technique (Redolfi De Zan et al., 2017). We developed a novel trap design based on the model described by Redolfi De Zan et al. (2017) with the intent of simplifying the construction procedure (Figure 1).

Traps were realized using polyvinyl-chloride (PVC) tubes commonly employed in the construction industry. A metal mesh was glued in the tube to stop the captured insects from falling in the attractant. On every sampling day, traps were active from dusk to the following afternoon as *C. cerdo* is a predominantly nocturnal species. We checked the traps daily and marked each captured individual on the elytra with common nail polish, which has proven to be an effective way to mark coleopters (Hagler and Jackson, 2001). Following the marking, each individual was released on the trunk of the tree where it was trapped. In order to identify which habitat characteristic is best predictive of *Cerambyx* presence in an ecosystem, we utilized a negative-binomial generalized linear model. The final model includes the total number of beetles per sampling session as a response variable and tree species, diameter at breast height (DBH) and sampling site as explanatory variables.

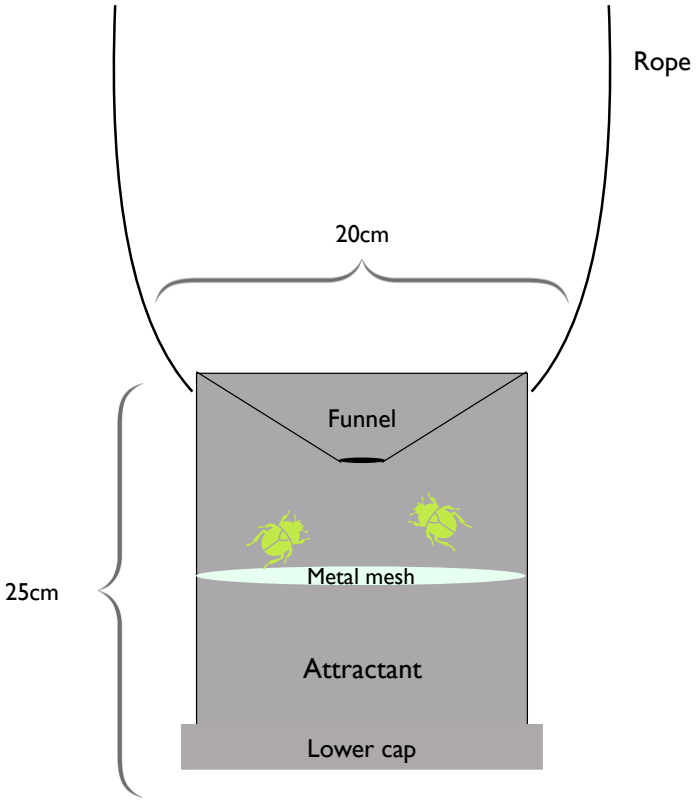


Figure 1. Cross-section of the baited funnel trap for the sampling of adult beetles.

## Results and discussion

Across both sampling sites, a total of 78 beetles (37 females and 41 males) were caught during the 16 days of sampling. Of these, 11 were recaptured at some point: recapture rate was higher for females than for males with a total of 9 females and 2 males recaptured.

Tree preference appear to diverge across sampling sites: in the "Bosco del Comune" area the vast majority of insects was sampled on *Q. pubescens* and no insects were sampled from *Q. trojana*; in the "Lucignano" area, however, the majority of insects was sampled on *Q. ilex* (Figure 2).

Overall numbers of insects sampled varied greatly across sites, with 57 individuals sampled at Lucignano and 21 sampled in the Bosco del Comune area. We hypothesize that this difference is mostly linked to the difference in times of sampling: Lucignano was sampled earlier than Bosco del Comune and this might mean that the peak emergence in adults occurred when sampling was carried out at the Bosco del Comune area. The model showed that the most influential predictor of *Cerambyx* presence is the diameter at breast height of the host tree ($p < 0.05$).

Our data demonstrates that *C. cerdo* is able to colonize all three major oak tree species present in the Natura 2000 site "Gravine di Matera". Interestingly, beetles seem to differ in their habitat preference across two sites in the same protected area. However, in order to effectively assess habitat preference in a species, it is necessary to employ an experimental approach that accounts for resource availability and samples different sites at the same time as time of emergence is critical when estimating population sizes in insect species.

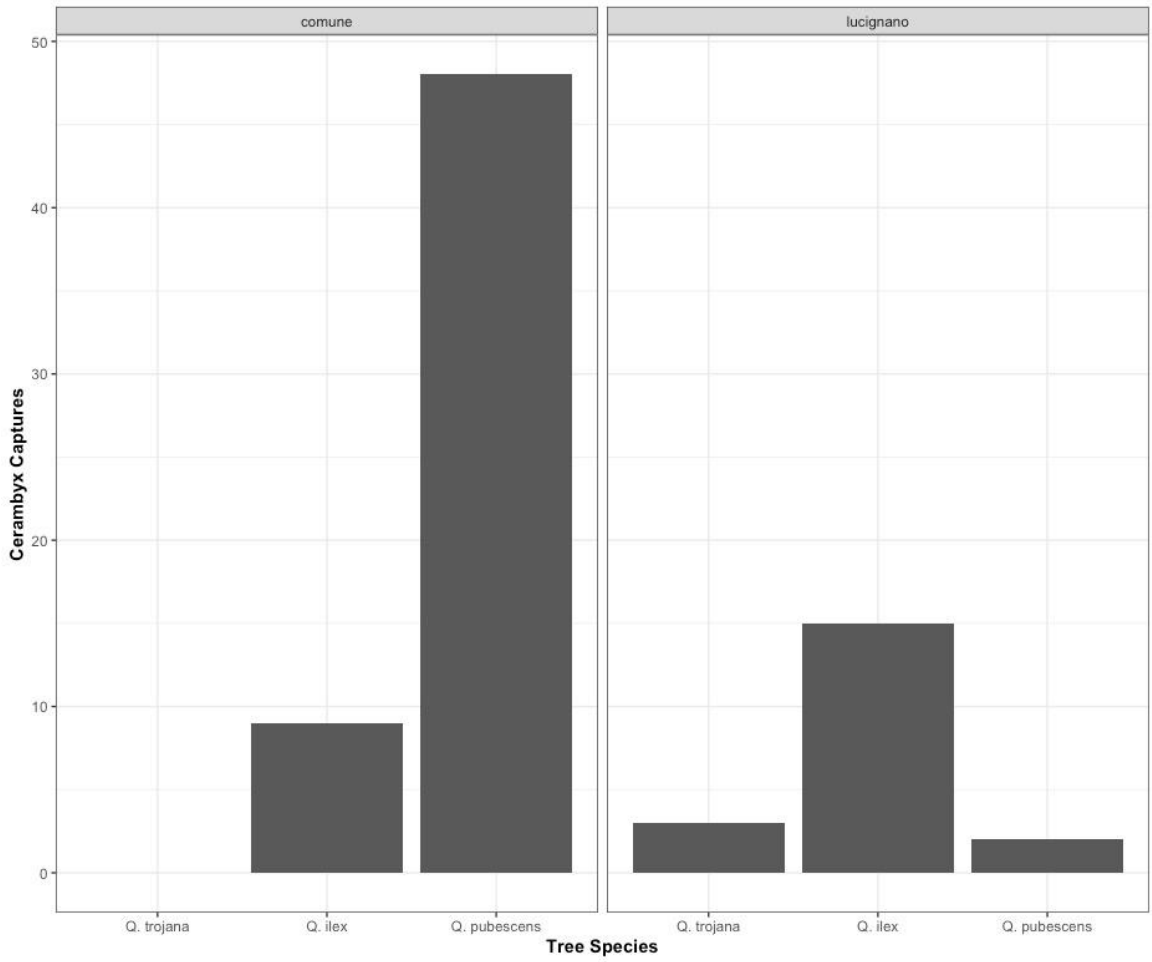


Figure 2. *Cerambyx cerdo* captures on different oak species.

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