

Updating new invasions: The Australian tortoise beetle *Trachymela sloanei* (Blackburn, 1897) (Coleoptera: Chrysomelidae) in the Iberian Peninsula

Álvaro Pérez-Gómez^{1,2,3}  | Jairo Robla⁴  | José Manuel Barreda²  |
Ginés Rodríguez⁵  | José Manuel Amarillo³ 

¹Department of Biology, University of Cadiz, Cádiz, Spain

²Sociedad Andaluza de Entomología, Sevilla, Spain

³Sociedad Gaditana de Historia Natural, Cádiz, Spain

⁴Department of Conservation Biology, Doñana Biological Station (EBD) - CSIC, Sevilla, Spain

⁵Department of Botany, Ecology and Plant Physiology, University of Córdoba, Córdoba, Spain

Correspondence

Jairo Robla, Department of Conservation Biology, Doñana Biological Station, (EBD), CSIC, C/Américo Vesputio, 26, 41092, Sevilla, Spain.

Emails: jairo.robla@ebd.csic.es; jairobblasuarez@gmail.com

Abstract

Trachymela sloanei (Blackburn, 1897) is a non-indigenous beetle of the Iberian Peninsula herbivorous of several species of *Eucalyptus* trees. Since its first detection in Europe in 2014, little information is available about the populations of this beetle in this distribution range. Therefore, a complete chorological update of the Australian tortoise beetle in the Iberian Peninsula is carried out. The ecology, phenology and potential distribution are discussed. Certain features of its morphology are fully illustrated to increase knowledge of this species. Finally, other remarks of interest that could be useful for the future management perspectives of this plague of *Eucalyptus* in the European continent are commented on briefly.

KEYWORDS

Alien species, bioinvasions, *Eucalyptus*, pest species, Portugal, Spain

1 | INTRODUCTION

Eucalyptus L'Hér is a genus of woody plants belonging to the family Myrtaceae that includes more than 700 species native to Australia, Indonesia, the Philippines and New Guinea (Chippendale, 1988). Many *Eucalyptus* species have been introduced and planted throughout the world. Therefore, eucalyptus trees can easily be found in large parts of America, Africa, the entire European Mediterranean region and Asia, as plantations or isolated trees (Doughty, 2000; Paine et al., 2011). Uses include wood and paper production, providing shade and windbreak or for ornamental purposes (Paine et al., 2015; Ruiz & López, 2010). For example, *Eucalyptus* cultivation has a considerable economic importance in the Iberian Peninsula since a good part of wood production comes from species of this genus (CELPA, 2019; MAPA, 2019) and more than one million hectares are covered with *Eucalyptus* plantations (Fernández-Darriba &

Silvia-Pando, 2016; Ruiz & López, 2010; Tomé et al., 2021). However, the expansion of these trees has also led to the establishment of several specialized insect pests of *Eucalyptus* and their parasitoids, outside their native range (Csóka et al., 2017; Inghilesi et al., 2013; Paine et al., 2011; Ramanagouda et al., 2010; Rassati et al., 2016; Schröder et al., 2020; Suma et al., 2018). Some of the most common distributed species in the Iberian Peninsula are psyllids, gall wasps, hemipterans and beetles (Barreda, 2021; Bercedo & Bahillo, 1998; Cadahía & Rupérez, 1980; Hurtado & Reina, 2008; Mansilla, 1992; Mansilla et al., 2004; Prieto-Lillo et al., 2009; Rupérez & Cadahía, 1973; Sánchez-García et al., 2009; Sánchez et al., 2015; Tomàs et al., 2021). Among the beetles, *Trachymela* is a Coleoptera genus belonging to the Chrysomelidae family that includes about 120 species (Reid, 2006). Native to Australia and New Guinea, most of them feed on eucalyptus trees (Reid, 2006). The Australian tortoise beetle *Trachymela sloanei* (Blackburn, 1897) is one of the best known and most widely

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distributed. Recently, this beetle has spread due to the transport of eucalyptus trees and has been accidentally introduced into New Zealand (Steven & Mulvey, 1977), North America (Garrison, 1998), South America (Villablanca & Villablanca-Miranda, 2022), Europe (Sánchez et al., 2015) and Asia (Zhang et al., 2020). However, the available information about European populations of *T. sloanei* is still scarce due to the recentness of the introduction. So, the main goals of this work were: (a) to update the chorological, ecological and phenological information of *Trachymela sloanei* populations in the Iberian Peninsula, (b) to illustrate the morphology of *T. sloanei* to assure its correct identification and to facilitate further comparisons between populations in future studies and (c) to comment on new areas in the Iberian Peninsula that are suitable for potential invasion, in addition to several new remarks on this recent plague.

2 | MATERIAL AND METHODS

The examined specimens correspond to several samplings in *Eucalyptus* trees and plantations carried out in the southern part of the Iberian Peninsula. The specimens were hand collected, fixed in ethanol 70% and kept in the authors' collections. Several specimens were transferred to the 'Museo Nacional de Ciencias Naturales' (MNCN) in Madrid (Spain). For the morphological study, the genital preparations were processed using 10% KOH for 12 h. Detailed photographs of *T. sloanei* were taken with a Nikon D3300 digital camera attached to a Leica MZ9.5 stereomicroscope. 'Zerene Stacker software' was used for focus stacking images. Additionally, photographs from the image database 'Biodiversidad Virtual' (<https://www.biodiversidadvirtual.org/>) were reviewed in order to find new records. Only specimens with clear habitus and diagnostic characters were included. For the selection of characters, works on the morphology and taxonomy of *Trachymela sloanei* (Blackburn, 1897; Garrison, 1998; Reid, 2006; Sánchez et al., 2015; Zhang et al., 2020) were consulted. The following morphological criteria were selected: hemispherical shape, pronotum broadest at middle or at the base, pronotal disc punctate, flattened underneath, dark brownish body with irregular black spots, usually covered with a white wax layer, elytra non-striate, usually acervate or verrucose. Maps were generated with ArcGis Desktop 10.8.1. Data on *Eucalyptus* plantations were obtained from 'Forest Map of Spain' (MFE50) at 1:50,000 scale for Spain and from 'Carta de Uso e Ocupação do Solo - 2018' from the Direção-Geral do Território of Portugal.

3 | RESULTS

3.1 | Material examined

We contributed with 59 new records of *T. sloanei* in the Iberian Peninsula: 24 from citizen science platforms and citizen observations (40.7%) and 35 from our own samplings (59.3%). For a more detailed summary of all the new records, see the Supplementary Material S1.

3.2 | Morphology

Trachymela sloanei is a quite unmistakable Chrysomelid species (Blackburn, 1897; Garrison, 1998; Reid, 2006; Sánchez et al., 2015; Zhang et al., 2020). This species has a characteristic hemispherical brown body covered with black spots, a white wax layer that can be absent (Figure 1a,b) and red wings. Although it could not be confused with other Iberian beetles, the row of fine hairs on the outer margin in the distal half of the mid and hind tibia is the most important diagnostic character of this species (Figure 1c). All the examined specimens fit former descriptions with hardly any variability. Pupa tend to be pale and, become brownish orange and darker with time (Figure 1d,e). The pupal cell is built under the bark of eucalyptus trees and consists of sawdust. It is cemented, probably as with other Paropsini, with exudations from its anus (Jolivet & Petitpierre, 1981). The larvae are brown or yellowish brown with a small black head and a prominent prothoracic shield, usually with several sclerotized black tubercles along the body (Figure 1f). Several features of the anatomy of *T. sloanei* are not well known due to the inexistence of accurate descriptions. In order to improve the morphological knowledge of this species and to facilitate future comparisons, male and female genitalia are illustrated and briefly commented on in Supplementary Material S2.

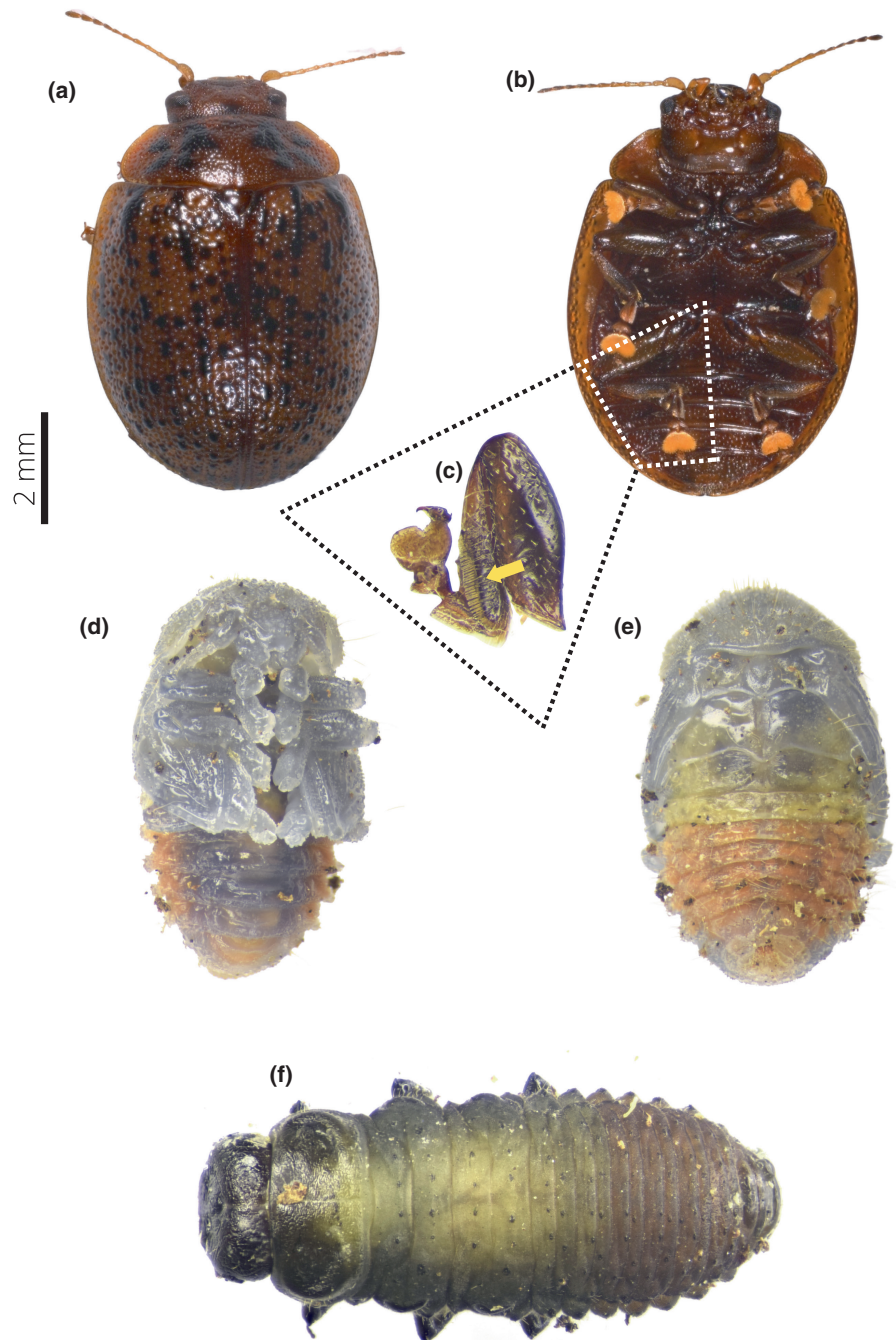
3.3 | Distribution

In Europe, until as recently as 2015, the presence of *T. sloanei* was limited to the southwestern Spanish province of Cádiz (Sánchez et al., 2015). However, the distribution of this *Eucalyptus* pest species has extended to most southwestern parts of Spain, as well as Cáceres, and Madrid in the central Iberian Peninsula (Figure 2). In addition, this species is reported for the first time in Portugal, where large areas of *Eucalyptus* plantations are exposed to possible infestations (Figure 2). In southwestern Spain and Cáceres, the distribution of *T. sloanei* is limited to *Eucalyptus* plantations or isolated trees (Figure 2). However, in Madrid (central Iberian Peninsula), which has no large eucalyptus plantations, *T. sloanei* has been detected in an urban park planted with ornamental *Eucalyptus* trees. There are suitable areas with large *Eucalyptus* plantations in the temperate Cantabric region (northern Iberian Peninsula) but until now without records of *T. sloanei*. In the rest of the Iberian Peninsula, eucalyptus plantations are rather scarce and there are only remanent trees in urban parks, on roadsides and in botanical and private gardens.

3.4 | Ecology and phenology

Most records of *Trachymela sloanei* are linked to one of its nutritious plants, *Eucalyptus camaldulensis* Denhn. However, *Eucalyptus globulus* Labill., as a host plant for *T. sloanei*, is registered for the first time in the Iberian Peninsula. Furthermore, several specimens

FIGURE 1 Different stages of *Trachymela sloanei*. (a) Dorsal view and (b) ventral view of imago. (c) Hind tibiae with the characteristic row of hair on the outer margin of the tibia (yellow arrow). (d) Ventral view and (e) dorsal view of a pupa. (f) Larvae



have been located far from *Eucalyptus* trees (e.g. *Quercus* forest, grassland or marshes) but also in completely isolated *Eucalyptus* trees. *Trachymela sloanei* has been found in shrublands, mountainous areas, crop lands, grasslands and marshes, but is also quite common in synanthropic environments such as gardens, urban parks, roadsides and other green areas with *Eucalyptus* trees. The Australian tortoise beetle has been found from sea level up to 900 metres above sea level in 'El Gastor' (Cádiz). Adults have been found all year round. However, there are not enough data to establish their life cycle. Larvae are difficult to detect due to their cryptic coloration, but they can be found in summer and autumn. For more detailed ecological data see the Supplementary Material S1.

3.5 | *Eucalyptus* signs of infestation

The most common sign of *T. sloanei* infestation is the apparition of damaged leaves (Figure 3a), starting with irregular notches (Figure 3b) and ending with semicircular holes along edges (Figure 3c). Loss of leaf mass can be considerable in high-density populations of *T. sloanei* (Figure 3a).

4 | DISCUSSION

Among all *Eucalyptus* plagues, one of the most recent introductions in the Iberian Peninsula is the Australian tortoise beetle

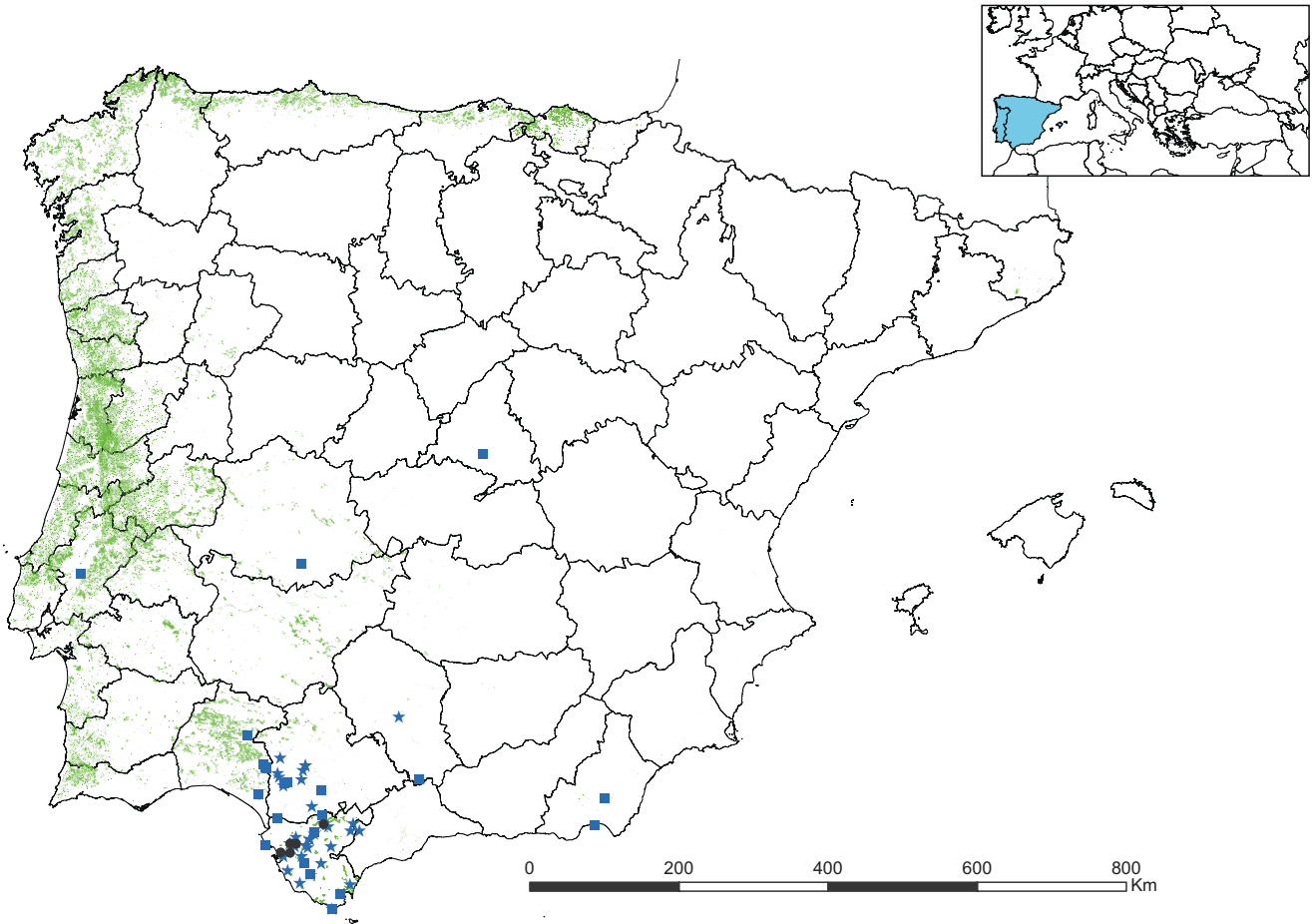


FIGURE 2 Distribution of *Trachymela sloanei* in the Iberian Peninsula. New records based on our own samplings (★), records from citizen science platforms and citizen observations (■) and bibliographic records (●). *Eucalyptus* plantations are represented in green. The position of the study area (blue) in Europe is shown

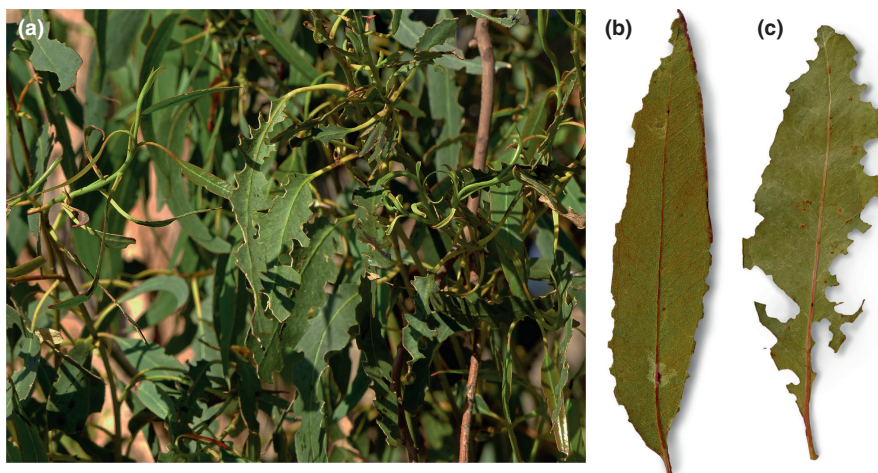


FIGURE 3 (a) Signs of a severe infestation of *Trachymela sloanei* in a *Eucalyptus* tree. (b) Slightly damaged leaf of *Eucalyptus camaldulensis*. (c) Heavily damaged leaf

Trachymela sloanei (Sánchez et al., 2015). As this beetle can cause significant damage to eucalyptus plantations (Garrison, 1998; Millar et al., 2009; Selman, 1994), its impact should be taken into account. In the few years since its detection, *T. sloanei* has widely spread throughout small and large *Eucalyptus* plantations in the southern

part of the Iberian Peninsula. Furthermore, it has been found in agricultural areas, urban parks, gardens and near roads with isolated *Eucalyptus* trees, but also in areas without its nutritious plant. All the available data suggest a good dispersive capacity, like other beetles of the same family (Carne, 1966; Tribe & Cillie, 1997), that

could be facilitated by humans. *T. sloanei* attacks several species of *Eucalyptus* (Millar et al., 2009; Sánchez et al., 2015; Selman, 1985; Zhang et al., 2020). The red river gum, *E. camaldulensis*, is the most common species planted in the southern Iberian Peninsula, but large plantations of blue gum, *E. globulus* are common in the north. Both species were reported as nutritious plants for *T. sloanei*, so these impacts should not be overlooked. Furthermore, there are other *Eucalyptus* trees that could be affected by *T. sloanei* in the Iberian Peninsula. In fact, it is likely that this species is more widely distributed in Portugal and other parts of Spain. In addition, *Eucalyptus* cultivation is widespread in the entire European Mediterranean region (Doughty, 2000; Paine et al., 2011; Silva-Pando & Pino-Pérez, 2016), so this tortoise beetle could quite probably be introduced into other countries becoming a problematic invasive species in future years. Adults are defoliating beetles (Garrison, 1998) and have been found throughout the year. This highlights the importance of the species as a persistent pest in eucalyptus, as it has several generations per year (Millar et al., 2009). The ways to fight this new plague are still uncertain. One specimen of *T. sloanei* was seen infected by an entomopathogenic fungus in Sierra del Arca (Cádiz) that could act as a potential biological control agent, quite similar to the situation discovered in one population from Asia (Zhang et al., 2020). However, much work needs to be done. It is imperative to highlight the importance of early monitoring programmes for newly introduced populations. Almost half of the records have been obtained from citizen science platforms, which have become a very useful tool for monitoring the expansion of alien populations (Howard et al., 2022). To facilitate future identifications and studies, we also provide illustrations of the larvae, pupae and adults found in the Iberian Peninsula as well as the signs that allow us to detect a *Trachymela* infestation. Although this species was described by Blackburn (1897), there are no complete morphological or anatomical illustrations that allow species comparison in future studies. We hope that this will facilitate future work on this species, as well as its identification by the scientific community, technical staff, and the non-specialist public.

5 | CONCLUSIONS

Trachymela sloanei is one of the many eucalyptus pests present in the Iberian Peninsula and Europe. Its rapid spread suggests that it could become a major pest in eucalyptus plantations in future years. In addition, *T. sloanei* can be found in several habitats, even in absence of *Eucalyptus* trees, proving its high dispersal capacity. However, the future management perspectives of this plague species are still uncertain. Thus, it is important to continue monitoring the range of *T. sloanei* populations to assess the real extent of the impact on eucalyptus plantations in the Iberian Peninsula and Europe where citizen science platforms can become a very useful tool for future studies.

AUTHOR CONTRIBUTIONS

APG and JR conceived the research. All authors conducted the samplings. APG and JR analysed the data. All authors wrote the manuscript. All authors read and approved the manuscript.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are all included in the 'Supplementary Material S1' of this study and in Sánchez et al. (2015).

ORCID

Álvaro Pérez-Gómez  <https://orcid.org/0000-0002-6752-0348>

Jairo Robla  <https://orcid.org/0000-0001-8866-1740>

José Manuel Barreda  <https://orcid.org/0000-0002-0782-9853>

Ginés Rodríguez  <https://orcid.org/0000-0002-7053-1865>

José Manuel Amarillo  <https://orcid.org/0000-0001-7605-9306>

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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