SAPIENZA
UNIVERSITÀ EDITRICE

E-ISSN 2284-4880
ISSN 0429-288X

Fragmenta entomologica, 56 (2): 181–186 (2024)

Research article
Submitted: April 4th, 2024 – *Accepted*: July 30th, 2024 – *Published*: December 10th, 2024
DOI: 10.13133/2284-4880/1595

Joining forces between scientists and citizens: new records and updated distribution of *Oryctes nasicornis grypus* (Illiger, 1803) in the north-western Iberian Peninsula (Coleoptera: Scarabaeidae, Dynastinae)

Francisco Alejandro LÓPEZ-NÚÑEZ[1, 2,*], Sergio ROJO[3]

[1] *Centre for Functional Ecology, Associate Laboratory TERRA, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra, Portugal* – lnfran85@gmail.com
[2] *Polytechnic Institute of Coimbra, Coimbra Agriculture School, Bencanta, 3045-601 Coimbra, Portugal*
[3] *Department of Vegetal Biology and Soil Sciences, Faculty of Sciences, University of Vigo, 32004 Ourense, Spain* – sergio.rojo.martinez@gmail.com
*Corresponding author

Abstract
The lack of detailed geographical distribution knowledge prevents defining reliable distribution ranges for many insects. Combining data from entomological collections, literature, citizen science and social media can frequently address this problem, but analysing the contribution of each information source is rarely applied. *Oryctes nasicornis grypus* is widely distributed across the Iberian Peninsula, but records from the Atlantic Arch, especially Galicia, are scarce. By reviewing literature, entomological collections, citizen science projects and social media, we delineated a more accurate distribution range for this species in Galicia, gathering 103 records and identifying 17 new grid cells. Additionally, we analysed the relative contribution of each information source for mapping this species. Social media contributed the most new grid cells (41.18%), followed by citizen science (29.41%) and entomological collections (23.53%). Furthermore, this work highlights the importance of public involvement in improving insect distribution knowledge and establishes a baseline for filling distribution gaps of *O. nasicornis grypus* in the northwestern Iberia.

Key words: Coleoptera, Scarabaeidae, Dynastinae, Citizen science, natural history, Galicia, geographic distribution, new records.

Introduction

Fully understanding insect biodiversity requires formal description and cataloguing of all species worldwide and precise mapping of their geographic distribution (Hortal et al. 2015; Lomolino & Heaney 2004). Unfortunately, achieving this goal remains utopian, due to deficiencies in taxonomic knowledge (i.e. the Linnean shortfall) and gaps in distribution data (i.e. the Wallacean shortfall) across many taxa, including insects (Marshall et al. 2024). Addressing the Wallacean shortfall involves compiling data from different information sources, such as entomological collections, entomological journals, checklists, citizen science projects or social media (Chowdhury et al. 2022; Méndez & Cortés-Fossati 2021). Unfortunately, despite the frequent combined use of these sources to map species distribution, analysing the contribution of each information source is not a common practice (Feldman et al. 2021), particularly for insects. Only a few works have addressed a similar attempt. For example, Méndez & Cortés-Fossati (2021) highlighted citizen science's role in mapping *Lucanus cervus* Linnaeus, 1758 (Coleoptera: Lucanidae) in Spain, and proposed guidelines for integrating citizen science projects, museum data and entomological publications.

Entomological collections are among the oldest biodiversity repositories, providing invaluable natural history information, but are often constrained by biased sampling influenced by funding and regional priorities (Pyke & Ehrlich 2010; Suarez & Tsutsui 2004). Citizen science projects have become invaluable for biodiversity research, involving the general public in data collection across large areas, demystifying science, and enhancing public knowledge about biodiversity and conservation (Pocock et al. 2018; Silvertown et al. 2013). Social media platforms, like Facebook, can also contribute to biodiversity research by

facilitating discussion and knowledge sharing; however, they are less efficient in systematically storing biodiversity observations, and retrieving metadata like names, locations and dates (Pocock et al. 2018).

The genus *Oryctes* Illiger, 1798 (Coleoptera: Scarabaeidae, Dynastinae), includes two species in the European part of the Palearctic region: *O. nasicornis* (Linnaeus, 1758), and the Canary Islands endemic *O. prolixus* Wollaston, 1864 (López-Colón 2003, 1996). *Oryctes nasicornis* is widely distributed throughout Europe with *O. nasicornis grypus* (Illiger, 1803) restricted to the Iberian Peninsula (including the Balearic Islands), France, Italy and Sicily (López-Colón 2003). In the Iberian Peninsula, *O. nasicornis grypus* is widely distributed in central and southern regions but sparsely distributed in the Atlantic Arch, especially in Galicia, where comprehensive data are lacking (Chapman & Champion 1907; López-Colón 2003; Novoa et al. 2014; Pino Pérez & Pino Pérez 2016; Valcárcel 2010).

In this context, the geographical range of *O. nasicornis grypus* needs to be improved by combining data from citizen science, social media, and entomological collections, filling in the gaps for future chorological studies and showing a more reliable species distribution. Therefore, the objectives of this paper are twofold: (1) to assess the relative contribution of each different sources of information, such as citizen science, social media, entomological collections and literature to delineate the distribution of *O. nasicornis grypus* in Galicia; and (2) to update the distribution of this species in the north-western corner of the Iberian Peninsula.

Material and Methods

Data compilation and curation

To update the distribution information of *O. nasicornis grypus* in Galicia, we conducted a systematic search, compiling scarce and fragmented records from the published literature (hereafter "literature") in Chapman & Champion (1907), López-Colón (2003), Novoa et al. (2014), Pino Pérez & Pino Pérez (2016) and Valcárcel (2010). Recognizing that these bibliographic records were not fully representative of the real species distribution in this region, we expanded our search to include unpublished records from the entomological collection of Arthropods of Centro de Investigación Forestal de Lourizán (CIF) (LOU-Arth) and, records from authors (hereafter "entomological collections"). Simultaneously, we incorporated data from various citizen science projects (hereafter "citizen science projects"), such as Biodiversidade.eu (https://biodiversidade.eu/), Biodiversidad Virtual (http://www.biodiversidadvirtual.org/), Observation.es (https://spain.observation.org/), iNaturalist (https://www.inaturalist.org/), as well as a specific social media group, "Fauna e Flora Salvaxe de Galicia" on Facebook (https://www.facebook.com/groups/1072317522807135) (hereafter "social media").

Despite criticisms about the reliability of citizen data identification from photographs (Gardiner et al. 2012), the distinctive morphology of *O. nasicornis grypus* instils confident identification based on images. However, due to the difficulty in identifying the larval stages from photographs, larval records were excluded from this study. Moreover, records without location were also excluded, and 10x10km Universal Transverse Mercator (UTM) coordinates were interpreted from decimal geographic coordinates or with Military Grid Reference System (MGRS) data. Geographical coordinates were interpreted from the locations cited on published data or in the original posts on social media and converted to 10x10km UTM grid. Only records from 1907 to 2023 were included in this work.

Data analysis

The compiled records of *O. nasicornis grypus* from the various sources were included in 10x10 km UTM grid distribution maps produced using QGIS programming. Two maps were created: one showing the distribution and unique/shared grid cells contributed by each information source, and another displaying the accumulated number of records by each grid cell. The first map provides information about the distribution, and the uniqueness or redundancy of each information source's contribution, while the second provides the relative sampling effort in each grid cell. Additionally, two plots were created to describe the yearly and monthly distribution of *O. nasicornis grypus* in Galicia, sorted by year and month, using the ggplot2 package (Wickham, 2016) in R v.4.3.1. (R Development Core Team, 2023).

Results

Overall, the following 103 records of *O. nasicornis grypus* from 1907 to 2023 are included in this work (literature: 33, citizen science projects: 13, social media: 15, and entomological collections: 42) (Supplementary Material S1).

These records are distributed across 29 UTM grid cells, each measuring 10x10 km. Additionally, more than half of the records included in this work are unpublished (67.96%), contributing 17 new grid cells where *O. nasicornis grypus* had not been previously recorded. A significant proportion of records (96.12%) and grid cells (86.21%) are predominantly scattered across the southern region of Galicia (Fig. 1). Specifically, Ourense and Pontevedra contain the highest number of records (53.40% and 42.72% respectively) and grid cells (41.38% and 48.27%, respectively). Although *O. nasicornis grypus* is widely distributed throughout southern Galicia, the number of records per grid cell is generally low (<5 occurrences). notably, only four grid cells showed a higher quantity of records, ranging from 5 to 26 individuals (Fig. 1 b).

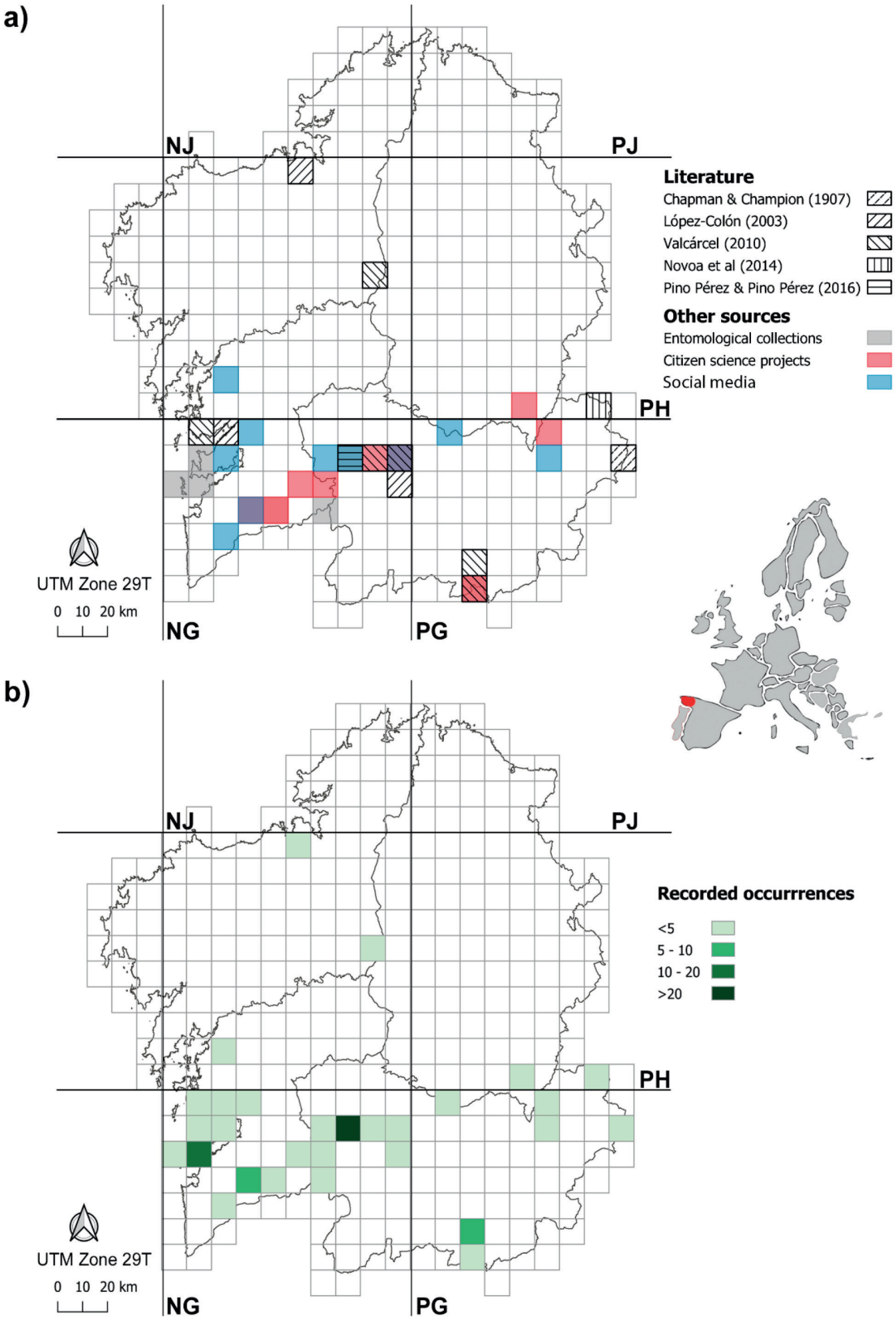

Fig. 1 – UTM map (10 x 10 km grid) with **(a)** the known distribution of *Oryctes nasicornis grypus* in Galicia (northwest of the Iberian Peninsula), and **(b)** the number of records *per* cell. Literature-derived records are marked with black stripes, while records from citizen science projects, social media, and entomological collections are represented by red, blue, and grey cells, respectively. Cells in violet indicate co-occurrences from citizen science projects and social media, while overlaid black striped cells indicate co-occurrences of literature sources with other sources.

Moreover, regarding the contribution weight of each information source, entomological collections and literature were the information sources with the highest contribution (40.78% and 32.03% respectively); while social media and citizen science projects contributed less (14.56% and 12.62% respectively). However, when considering only the 17 novel grid cells, the importance of each information source varied from the general pattern. While social media were the most contributing source with 41.18%, followed by citizen science projects (29.41%) and entomological collections (23.53%), only a 5.88% of the novel grids were derived from multiple sources (Fig. 1 a).

On the other hand, our data revealed the relevant roles of entomological collections and literature as sources of information in the late 20th century, with a substantial portion of the total records registered in 1997 (25.24%) (Fig. 2 a). It was only since the beginning of the 21st century that social media and citizen science projects have begun con-

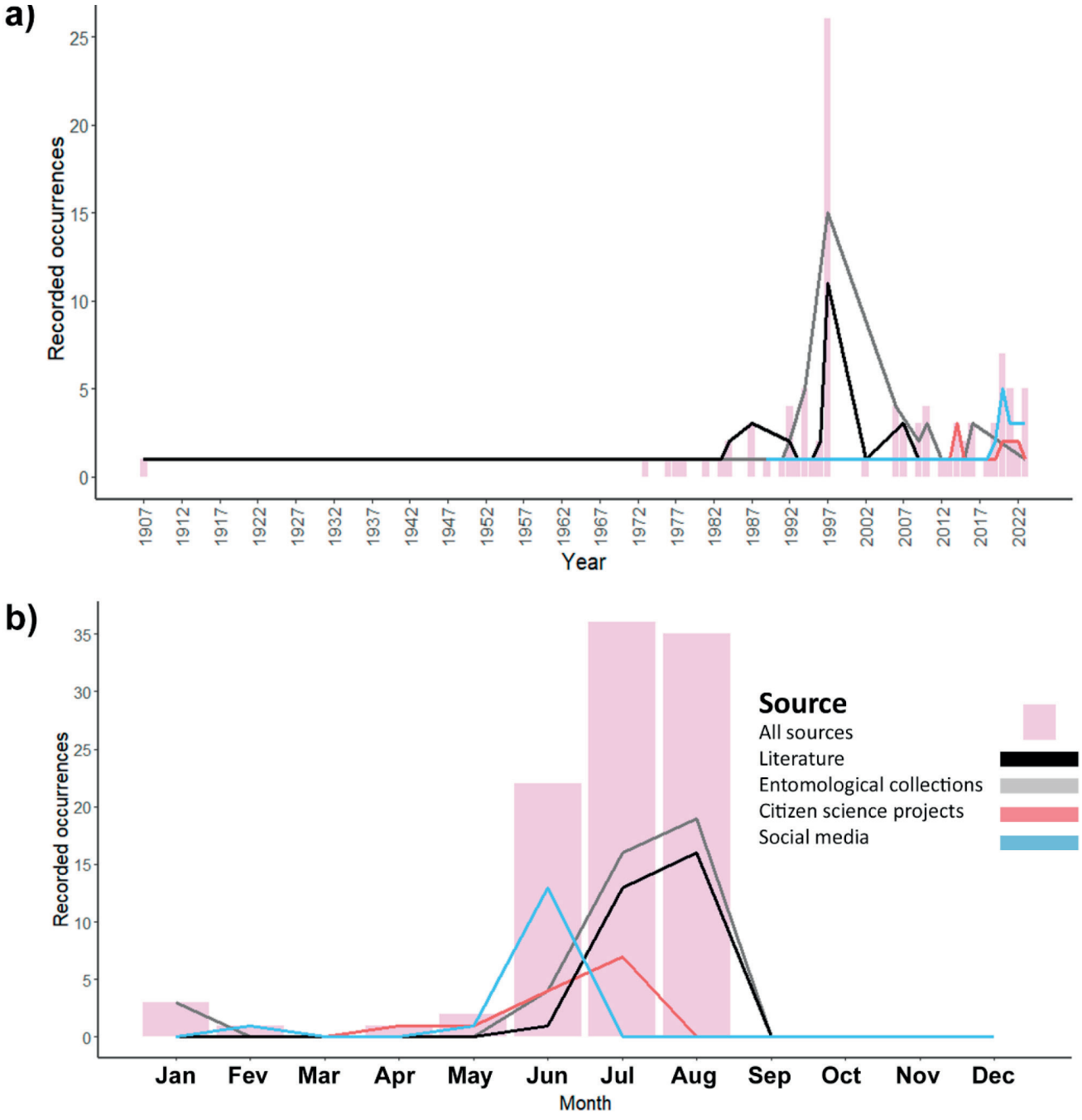

Fig. 2 – Yearly (**a**) and monthly (**b**) distribution of *Oryctes nasicornis grypus* records in Galicia (northwest of the Iberian Peninsula) gathered from different information sources.

tributing to an increase in records of *O. nasicornis grypus*. Furthermore, although records were sparse throughout the first half of the year, 93% of them were gathered during summer, from June to August (Fig. 2 b). Additionally, citizen science projects and social media contributed the majority of records during early summer in June and July, whereas literature and entomological collections showed higher abundance in late summer (i.e. August).

Finally, regardless of the information source, records of males outnumbered records of females (66.02%) from the total records, with an average of 2.19 males per female. This ratio reflects a higher number of males than females *per* grid cell on average (mean±sd) (2.34±4.38 for males and 1.07±2.40 for females respectively).

Discussion

We highlighted the importance of integrating data from traditional information sources such as entomological collections and scientific literature, with citizens derived data, including social media and citizen science projects, for mapping insects. Moreover, we increased the records of *O. nasicornis grypus*, and filled gaps in its known geographical distribution across the southern part of Galicia from inland areas to the Atlantic coast.

Several factors may explain how each information source contributes to mapping *O. nasicornis grypus* (i.e. abundance and distribution). One key factor is the sampling effort. Citizen scientists with lower sampling effort, can gather data over wider areas and longer periods than entomologists, improving the accuracy of mapping *O. nasicornis grypus* distribution (Dickinson et al. 2012; Pocock et al. 2018). Nevertheless, this temporal limitation of data from entomologists can be compensated by citizens data derived records, thereby enhancing the accuracy and precision of species phenology (Fitzpatrick et al. 2021).

The charisma and size of *O. nasicornis grypus* play a crucial role in mapping its distribution (Steger et al. 2017). Citizen science can greatly enhance this mapping process (Méndez and Cortés-Fossati, 2021). This species is one of the largest beetles in Europe which could occasionally be confused with *Copris* spp. (Scarabaeidae) by non-expert naturalists; however, its size, the absence of well-marked elytra striae, and its distinctive robust clypeal horn of males makes it unmistakable from any other beetle species. This distinctiveness makes it easily spotted and more appealing for citizens to report sightings of this species.

Many records of *O. nasicornis grypus*, mainly gathered from entomological collections, were from habitats dominated by *Quercus* spp., consistent with trophic preferences previously described (López-Colón 2003). Additionally, the majority of records from citizen derived data and entomological collections came from in peri-urban and agricultural areas, often near forest patches (Martínez García 2012). This can be explained by the synanthropic behaviour of *O. nasicornis grypus* and its high adaptability to other habitats. For example, Pino Pérez & Pino Pérez (2016) recorded this species in habitats highly disturbed and degraded by vineyards and urbanization. This high adaptability is probably due to the ability of the saproxylophagous larvae to complete their life cycle using diverse substrates such as decomposed organic matter and compost (Martínez García 2012). Additionally, the nocturnal and photophilic behavior of *O. nasicornis grypus* may explain the urban and peri-urban records, as adults are attracted to artificial lights from the surrounding of forest patches or other natural habitats (Martínez García 2012). Furthermore, although the phenological patterns described in this work are based on a limited number of observations, the phenology of *O. nasicornis grypus* in Galicia appears to align with the summer occurrence previously reported for this species (López-Colón 2003; Martínez García 2012).

Conclusions

This work goes beyond a mere study case by establishing a comprehensive baseline review of the distribution of *O. nasicornis grypus* in the north-western Iberian Peninsula. It fills gaps in the known distribution of this species by compiling data from various sources, providing novel and significant records. Notably, this update expands the known geographical range of the species to the west Atlantic coast, including, for the first time, the islands of the Atlantic Islands of Galicia Maritime-Terrestrial National Park, as well as the eastern hinterland of Galicia. Thus, the distribution of *O. nasicornis grypus* depicted in this work should be considered as a proxy to a distribution closer to reality than a real distribution. However, it is important to note that the absence of records in northern Galicia reflects a lack of surveying rather than a true absence of this species.

Acknowledgements – We thank J. Rabadán González and R. Laorga for providing data from Observation.org and Biodiversidad Virtual. We also thank R. Faria Juncal, M. Pazo, F. J. González, J. Rodríguez Paz, and F. Blanco for sharing their observations from social media. Special thanks to J. Pino and R. Pino for sharing their own data to this work, and Centro de Investigación Forestal de Lourizán (CIF) where the vouchers were deposited; to J. López Colón for providing references and additional data; to M. Tesouro Fernández, D. Costa and L.N. Duarte for their comments and suggestions during the review of this manuscript. This work was supported by FCT - Fundação para a Ciência e Tecnologia, I.P. by project reference UIDB/04004/2020 and DOI identifier 10.54499/UIDB/04004/2020 (https://doi.org/10.54499/UIDB/04004/2020) and by the Centre for Functional Ecology, Associate Laboratory TERRA, Department of Life Sciences, University of Coimbra by the project reference LA/P/0092/2020 and DOI identifier 10.54499/LA/P/0092/2020 (https://doi.org/10.54499/LA/P/0092/2020) .

Author contributions – SR and FALN conceived the study. SR collected the field data. FALN reviewed literature and databases, cured and analysed the data. Both co-authors wrote the first draft paper, reviewed and equally contributed to the definitive version of the manuscript.

References

Chapman T.A., Champion G.C. 1907. Entomology in NW Spain (Galicia and León). Transactions of the Royal Entomological Society of London, 1907: 147–171.

Chowdhury S., Aich U., Rokonuzzaman M., Alam S., Das P., Siddika A., Ahmed S., Labi M., Di Marco M., Fuller R., Callaghan C., 2022. A social media fix to the Wallacean shortfall. PREPRINT (Version 1) available at Research Square [https://doi.org/10.21203/rs.3.rs-1991321/v1]. Doi: https://doi.org/10.21203/rs.3.rs-1991321/v1

Dickinson J.L., Shirk J., Bonter D., Bonney R., Crain R.L., Martin J., Phillips T., Purcell K. 2012. The current state of citizen science as a tool for ecological research and public engagement. Frontiers in Ecology and the Environment, 10: 291–297. Doi: https://doi.org/10.1890/110236

Feldman M.J., Imbeau L., Marchand P., Mazerolle M.J., Darveau M., Fenton N.J. 2021. Trends and gaps in the use of citizen science derived data as input for species distribution models: A quantitative review. PLoS One, 16. Doi: https://doi.org/10.1371/journal.pone.0234587

Fitzpatrick L., Giambuzzi P.J., Spreitzer A., Reidy B., Still S.M., Rollinson C.R. 2021. Improving phenology predictions for sparsely observed species through fusion of botanical collections and citizen-science. Climate Change Ecology, 2: 100032. Doi: https://doi.org/10.1016/j.ecochg.2021.100032

Gardiner M.M., Allee L.L., Brown P.M.J., Losey J.E., Roy H.E., Smyth R.R. 2012. Lessons from lady beetles: Accuracy of monitoring data from US and UK citizen science programs. Frontiers in Ecology and the Environment, 10: 471–476. Doi: https://doi.org/10.1890/110185

Hortal J., De Bello F., Diniz-Filho J.A.F., Lewinsohn T.M., Lobo J.M., Ladle R.J. 2015. Seven shortfalls that beset large-scale knowledge of biodiversity. Annual Review of Ecology Evolution and Systematics, 46: 523–549. Doi: https://doi.org/10.1146/annurev-ecolsys-112414-054400

Lomolino M.V, Heaney L.R. 2004. Frontiers of biogeography: new directions in the geography of nature. Sinauer Associates.

López-Colón J.I. 2003. Datos sobre la alimentación y distribución ibérica de *Oryctes nasicornis grypus* Illiger, 1803 (Coleoptera, Scarabaeidae, Dynastinae). Boletín Sociedad Entomológica Aragonesa, 33: 183–188.

López-Colón J.I. 1996. Estudio del estatus taxonómico de *Oryctes prolixus* Wollaston, 1864: Rehabilitación de su validez específica (Coleoptera, Scarabaeidae, Dynastinae). Lambillionea, 96: 149–154.

Marshall L., Leclercq N., Carvalheiro L.G., Dathe H.H., Jacobi B., Kuhlmann M., Potts S.G., Rasmont P., Roberts S.P.M., Vereecken N.J. 2024. Understanding and addressing shortfalls in European wild bee data. Biological Conservation, 290: 110455. Doi: https://doi.org/10.1016/j.biocon.2024.110455

Martínez García À. 2012. *Oryctes (Oryctes) nasicornis* (Linnaeus, 1758) (Coleoptera, Dynastidae) en la provincia de Málaga (sur de España). Boletín de la Sociedad Andaluza de Entomología, 20: 34–49.

Méndez M., Cortés-Fossati F. 2021. Relative contribution of citizen science, museum data and publications in delineating the distribution of the stag beetle in Spain. Insects, 12: 202. Doi: https://doi.org/10.3390/insects12030202

Novoa F., Gañán I., Campos A., Fernández A.B., Santiago M., González J., Baselga A. 2014. Coleópteros (Coleoptera) del Parque Natural Serra da Enciña da Lastra (Galicia, noroeste de la Península Ibérica). Boletín Asociación Española de Entomología, 38: 91–130.

Pino Pérez J.J., Pino Pérez R. 2016. Primera cita de *Megascolia* (*Regiscolia*) *maculata flavifrons* (Fabricius 1775) (Hymenoptera: Scoliidae) para Galicia (España). Boletín de la Sociedad Entomológica Aragonesa, 58: 229–230.

Pocock M.J.O., Chandler M., Bonney R., Thornhill I., Albin A., August T., Bachman S., Brown P.M.J., Cunha D.G.F., Grez A., Jackson C., Peters M., Rabarijaon N.R., Roy H.E., Zaviezo T., Danielsen F. 2018. A vision for global biodiversity monitoring with citizen science. Advances in Ecological Research, 59: 169–223. Doi: https://doi.org/10.1016/BS.AECR.2018.06.003

Pyke G.H., Ehrlich P.R., 2010. Biological collections and ecological/environmental research: A review, some observations and a look to the future. Biological Reviews, 85: 247–266. Doi: https://doi.org/10.1111/j.1469-185X.2009.00098.x

R Development Core Team, 2023. R: A language and environment for statistical computing. The R Foundation for Statistical Computing.

Silvertown J., Buesching C.D., Jacobson S.K., Rebelo T. 2013. Citizen science and nature conservation, in: Macdonald D.W., Willis K.J. (Eds), Key Topics in Conservation Biology 2 (Wiley): pp. 127–142. Doi: https://doi.org/10.1002/9781118520178.ch8

Steger C., Butt B., Hooten M.B. 2017. Safari Science: assessing the reliability of citizen science data for wildlife surveys. Journal of Applied Ecology, 54: 2053–2062. Doi: https://doi.org/10.1111/1365-2664.12921

Suarez A.V, Tsutsui N.D. 2004. The value of museum collections for research and society. Bioscience, 54: 66–74. Doi: https://doi.org/10.1641/0006-3568(2004)054[0066:TVOMCF]2.0.CO;2

Valcárcel J.P. 2010. Coleoptera, Familia Dynastidae. Datos inéditos de dinástidos de la Península Ibérica, Islas Baleares e Islas Canarias. Arquivos Entomolóxicos, 4: 81–82.

Wickham H. 2016. ggplot2: Elegant graphics for data analysis. Springer-Verlag New York.