



Conference Abstract

# Phylogenomic insights into the evolution of subterranean Coleoptera

Pau Balart-Garcia<sup>‡</sup>, Slavko Polak<sup>§</sup>, Perry G. Beasley-Hall<sup>|</sup>, Tessa M. Bradford<sup>|,¶</sup>, Ignacio Ribera<sup>†, #</sup>, Steven J. B. Cooper<sup>|,¶</sup>, Rosa Fernández<sup>‡</sup>

<sup>‡</sup> Institute of Evolutionary Biology (CSIC - Universitat Pompeu Fabra), Passeig Marítim de la Barceloneta 37-49. 08003 Barcelona, Spain

<sup>§</sup> Notranjski muzej Postojna, Kolodvorska c. 3, 6230 Postojna, Slovenia

<sup>|</sup> Australian Center for Evolutionary Biology and Biodiversity, School of Biological Sciences, The University of Adelaide, Adelaide, South Australia 5005, Australia

<sup>¶</sup> South Australian Museum, Adelaide, South Australia 5000, Australia

<sup>#</sup> Institute of Evolutionary Biology (CSIC - Universitat Pompeu Fabra), Passeig Marítim de la Barceloneta 37-49. 08003, Barcelona, Spain

<sup>†</sup> Deceased author

Corresponding author: Pau Balart-Garcia ([pau.balart@ibe.upf-csic.es](mailto:pau.balart@ibe.upf-csic.es))

Received: 31 May 2022 | Published: 14 Jul 2022

Citation: Balart-Garcia P, Polak S, Beasley-Hall PG, Bradford TM, Ribera I, Cooper SJB, Fernández R (2022) Phylogenomic insights into the evolution of subterranean Coleoptera. ARPHA Conference Abstracts 5: e87194. <https://doi.org/10.3897/aca.5.e87194>

## Abstract

Subterranean specialization is often accompanied by dramatic phenotypic changes epitomized by regressive evolution (e.g. loss or reduction of eyes and pigmentation). Nevertheless, the genetic underpinnings underlying these changes have been largely unexplored. The beetle tribes Leptodirini (Leiodidae), Hydroporini and Bidessini (Dytiscidae) represent ideal systems for exploring the genomic basis of adaptation to life in subterranean habitats, as both are represented by epigeal and hypogean species including numerous lineages that independently colonized terrestrial and freshwater underground habitats respectively (Cooper et al. 2002, Ribera et al. 2010). We investigated gene repertoire evolutionary dynamics in both surface-dwelling and subterranean Coleoptera in lineages that underwent six independent underground colonization events. We generated highly complete transcriptomes for eight aquatic and fourteen terrestrial beetles including epigeal and hypogean species and explored the evolution of their gene repertoire through a phylogenomic approach. Our results indicated that gene loss was a major force facilitating adaptation to an underground lifestyle. In contrast, we also observed

that gene gain and duplication were also remarkable drivers for subterranean adaptation. Gene families experiencing contractions were involved in carbohydrate metabolism, response to starvation, wing disk development, rhodopsin and ommochrome biosynthetic processes and response to hypoxia, among many other examples. Conversely, gene families significantly expanded in subterranean lineages including those related to the regulation of apoptosis, alcohol metabolism, cell redox homeostasis, chitin-based cuticle development, larval instar development, oogenesis, and negative regulation of TORC1 signaling. Moreover we found that some gene families had experienced a more complex evolutionary dynamic encompassed by both expansion and contraction events, such as those involved in regulation of transcription, nervous system development, lipid metabolism, eye development, DNA repair and chemosensation, indicating that these gene families underwent an in-depth reshaping throughout the evolutionary time. At a lineage-specific level, we did not observe many differences between the gene repertoire of the hypogean and epigeal Leptodirini species in terms of gene gain and loss. Nonetheless, Hydroporini and Bidessini stygobitic species showed more disparity in their gene repertoire compared to their surface-dwelling relatives. Our results thus indicate that genomic exaptation may have facilitated underground colonization in Leptodirini prior to the diversification of the tribe, while in Hydroporini and Bidessini recent gene family turnover (dominated by gene loss) may have been guiding the surface-to-groundwater transition. These findings shed light towards understanding how the genomic toolkit has been reshaped in hypogean fauna from a macroevolutionary perspective.

## Keywords

phylogenomics, gene repertoire evolution, Coleoptera, troglitic and stygobitic fauna

## Presenting author

Pau Balart-García

## Presented at

25th International Conference on Subterranean Biology in Cluj-Napoca, Romania.

## Acknowledgements

This research was supported by the PID2019-108824GA-I00 and CGL2016-76705-P projects funded by the Ministerio de Ciencia e Innovación (MCIN) and the Agencia Estatal de Investigación (AEI) /10.13039/501100011033/ to Rosa Fernández and to Ignacio Ribera respectively, the FPI grant BES-2017-081050 and the Ramon y Cajal fellowship RyC2017-22492 funded by the MCIN/ AEI /10.13039/501100011033/ and by the European Social Fund (ESF) “Investing in your future” to Pau Balart-García and to Rosa Fernández

respectively, the Systematics Research Fund 2020 awarded by the Linnean Society of London and the Systematics Association to Pau Balart-García, the Australian Research Council grant DP180103851 to Steven J. B. Cooper, and the Centro de Supercomputación de Galicia (CESGA) that provided computational resources.

## Hosting institution

International Society for Subterranean Biology

Emil Racovitza Institute of Speleology, Cluj-Napoca, Romania

Romanian Institute of Science and Technology

## Author contributions

PBG conceived the study, generated and processed data, analyzed data, interpreted the results and prepared the presentation. SP collected some key species and provided knowledge about their ecological and taxonomic features. PBH analyzed data. TB generated and processed data. IR conceived the study, generated data and provided resources. SC conceived the study, generated data and provided resources. RF conceived the study, provided resources, generated data, assisted in the data analyses and interpretation and supervised the project. All the authors approved the abstract and accepted the contents of the presentation, with the exception of IR who unfortunately passed away at the beginning of this project.

## Conflicts of interest

No conflicts of interest

## References

- Cooper SJB, Hinze S, Leys R, Watts CHS, Humphreys WF (2002) Islands under the desert: molecular systematics and evolutionary origins of stygobitic water beetles (Coleoptera : Dytiscidae) from central Western Australia. *Invertebrate Systematics* 16 (4): 589-590. <https://doi.org/10.1071/IT01039>
- Ribera I, Fresneda J, Bucur R, Izquierdo A, Vogler AP, Salgado JM, Cieslak A (2010) Ancient origin of a Western Mediterranean radiation of subterranean beetles. *BMC Evol Biol* 10: 29. <https://doi.org/10.1186/1471-2148-10-29>