



A revised name and new insights into the Middle Jurassic sauropod trackways from Portugal. A correction of Santos et al. 2009

VANDA F. SANTOS, JOSÉ J. MORATALLA, RAFAEL ROYO-TORRES, MATTEO BELVEDERE, DIEGO CASTANERA, LUIS M.P. CERÍACO, PEDRO MOCHO, MARC MERINO, CHRISTIAN A. MEYER, and LARA SCISCIO

The Galinha dinosaur tracksite (Portugal) was declared a Natural Monument in 1996 and is currently designated as Ourém/Torres Novas Dinosaur Footprints Natural Monument. This tracksite yields a completely new and unique morphology of sauropod tracks from the Middle Jurassic (Bajocian–Bathonian). This new morphotype was named *Polyonyx* by Santos et al. (2009). However, recently it has been brought to our attention that this ichnotaxon name “*Polyonyx*” is preoccupied by the porcellanid decapod *Polyonyx* Stimpson, 1858 (Crustacea: Decapoda: Anomura: Porcellanidae). The priority is given to the latter and to avoid homonymy, the former is issued the new replacement name *Galinhapodus* igen. nov., creating the new replacement combination name *Galinhapodus gomesi*.

Introduction

Middle Jurassic (Bajocian–Bathonian) sauropod trackways were described by Santos et al. (1994, 2009) at the Galinha tracksite, located in a limestone quarry in the municipal area of Bairro, 10 km from Fátima, within the Maciço Calcário Estremenho (Portugal). The Galinha tracksite is one of the rare locations globally where long Middle Jurassic sauropod dinosaur trackways can be found and yield a completely new and unique track morphology. This morphology was assigned to a new sauropod ichnotaxon, *Polyonyx gomesi*, established and diagnosed by Santos et al. (2009: 409–422). The authors considered non-neosauropod eusauropods, likely from the Turiasauria clade, as possible trackmakers, suggesting that wide-gauge sauropod trackways were not exclusively produced by Titanosauriformes (Santos et al. 2009; Castanera et al. 2016; Meyer et al. 2018). Subsequently, various authors have compared the *Polyonyx gomesi* morphotype to sauropod tracks of the Middle Jurassic to Early Cretaceous age (e.g., Royo-Torres 2009; Alcalá et al. 2014; Castanera et al. 2014; Xing et al. 2014, 2016; Torcida et al. 2015, 2021; Moreau et al. 2020; Propat et al. 2021; Tomaselli et al. 2021). However, thus far, only sauropod tracks from the Middle–?Upper Jurassic of Morocco have been tentatively referred to this ichnogenus (Oukassou et al. 2019; Klein et al. 2023). This uniqueness underscores the significance

of this ichnotaxon, making the type locality (Galinha) a reference tracksite for the study of sauropod ichnology.

Recently, it has been brought to our attention that the name *Polyonyx* used by Santos et al. (2009) for this sauropod ichnotaxon is preoccupied by the decapod *Polyonyx* Stimpson, 1858 (Crustacea: Decapoda: Anomura: Porcellanidae). According to the Principle of Homonymy, Article 52.1, of the International Code of Zoological Nomenclature, therein the Code, “when two or more taxa are distinguished from each other they must not be denoted by the same name” (ICZN 1999). It is important to remember that the Code provisions apply to both living animals, fossils, and ichnotaxa, as noted in Article 1.2.1.

Article 52.3 of the Code, also known as the Principle of Priority, states that when two or more names are homonyms only the senior one can be considered valid. Therefore, and according to both Article 52.3 and Article 53.2, *Polyonyx* Stimpson, 1858, is the senior homonym, and *Polyonyx* Santos et al., 2009, is the junior homonym. Because the name *Polyonyx* has been consistently used since 1899 as a genus of decapod porcelain crab, with a new species being described as recently as 2022 (Osawa and Sato 2022), it has priority over *Polyonyx* Santos et al., 2009. According to Article 60 (Replacement of junior homonyms), specifically Article 60.1, “a junior homonym [Art. 53] must be rejected and replaced either by an available potentially valid synonym [Art. 23.3.5] or, for lack of such name, by a new substitute name [Art. 60.3]”. Because there are no synonyms available for this sauropod ichnotaxa, a new substitute name must be provided in accordance with Article 60.3, which states: “if the rejected junior homonym has no known available and potentially valid synonym it must be replaced by a new substitute name, with its own author and date; this name will then compete for priority with any synonym recognized later”.

Similar situations have occurred where the names of vertebrate ichnogenera coincided with previously established names and had to be renamed to avoid homonymy. For example, Harris (1997) changed the name of the dinosaur track *Exallopus* to *Saurexallopus* because *Exallopus* was preoccupied by the polychaete *Exallopus* Jumars, 1974 (Fauchald 1977). Lockley (2010) reported that *Walteria jeffersonensis*, proposed by Mehl (1931) and attributed to a crocodylian trackway, was renamed

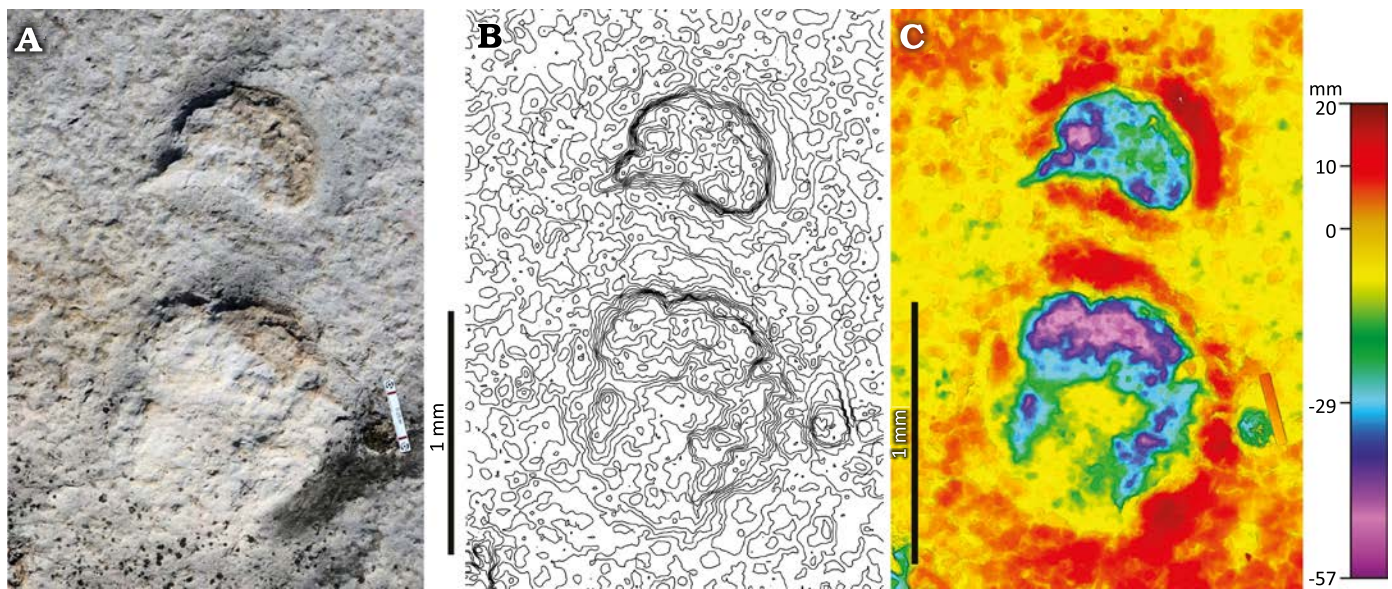


Fig. 1. Manus-pes pair from the *Galinhapodus* igen. nov. trackway G5. Photograph (A), contour-line outline (5 mm spacing) (B), and false-colour depth map (C) of a right manus-pes set from trackway 5 (G5) at Galinha tracksite (Bairro, Serra de Aire, west-central Portugal, Bajocian–Bathonian boundary, Middle Jurassic).

Mehliella jeffersonensis by Strand (1932) because the name *Walteria* was preoccupied by a sponge (*Walteria* Schulze, 1886). Therefore, we hereby propose a new ichnogenic name for sauropod tracks previously referred to as *Polyonyx*.

Nomenclatural acts.—This published work and the nomenclatural acts it contains have been registered in ZooBank: urn:lsid:zoobank.org:pub:D8F4A564-D0F1-4A4C-AA8F-89342C595512.

Systematic ichnology

Ichnogenus *Galinhapodus* nom. nov.

pro *Polyonyx* Santos et al., 2009 nec Stimpson, 1858

Zoobank LSID: urn:lsid:zoobank.org:act:0D13D0B0-3AC7-4DF1-91A0-09B74402AD7C.

Type ichnospecies: *Polyonyx gomesi* Santos et al., 2009.

Etymology: Combination of *Galinha*, to honour the name of the tracksite where this morphotype was identified. Furthermore, it is also to acknowledge the former quarry owner, Rui Galinha; and Greek *podus*, foot.

Diagnosis.—As for the type and only known ichnospecies; see Fig. 1 and SOM 1 (Supplementary Online Material available at http://app.pan.pl/SOM/app69-Santos_etal_SOM.pdf) and Morphosource (<https://doi.org/10.17602/M2/M634167>, <https://doi.org/10.17602/M2/M623555>, and <https://doi.org/10.17602/M2/M623561>), Santos et al. 2009: figs. 3–5.

Galinhapodus gomesi (Santos et al., 2009) comb. nov.

Holotype: An in situ sauropod trackway (trackway G5), 142 m long with 94 consecutive manus-pes print sets.

Type horizon: Serra de Aire Formation, close to the Bajocian–Bathonian boundary, Middle Jurassic (Azerêdo 1993, 2007; Azerêdo et al. 1995).

Type locality: Galinha tracksite, Municipal area of Bairro, Serra de Aire, Máciço Calcário Estremenho, west-central Portugal. This locality

is the first geological site to be declared a natural monument: Monumento Natural das Pegadas de Dinossáurio da Serra de Aire (Serra de Aire Dinosaur Tracks Natural Monument) by law in Portugal (Law Decree no. 12/96 of 22nd October) and it is under the management of the Instituto da Conservação da Natureza e das Florestas.

Diagnosis.—Wide gauge sauropod trackway revealing low heteropody (manus–pes area ratio 1:2) and two autapomorphies: (1) asymmetric manus prints with large digit I marks oriented in a medial direction with a large, posteriorly oriented, triangular claw mark, and impressions of digits II–V; (2) pes prints with four claw marks: claws I–II with an anterior orientation, and III–IV laterally oriented. Manus digits II–V show a slightly bent arrangement (Santos et al. 2009).

Description.—The same as described in Santos et al. (2009: 411–413).

Remarks.—Trackway G1 from the same locality was assigned to *Polyonyx* isp. Both the similarities and differences between the holotype trackway G5 and G1 have already been noted (see Santos et al. 2009; Castanera et al. 2016), especially in the manus impressions. G1 shows the characteristic speech-bubble-shaped manus of *Galinhapodus*, but they are more symmetrical, slightly longer, and no individual digits can be clearly identified with the exception of digit I, which projects posteriomedially (instead of medially). Santos et al. (2009) concluded that “it is still uncertain which features are diagnostic at the ichnospecies level”. Thus, trackway G1 is now classified as *Galinhapodus* isp.

Concluding remarks

A new replacement name, *Galinhapodus* igen. nov., is erected for sauropod tracks previously identified as *Polyonyx gomesi* by Santos et al. (2009), resulting in the new combination *Galinhapodus gomesi* comb. nov. This new name was needed

because a genus of porcelain crab (Crustacea: Decapoda) already bears the same name, something that was overlooked by Santos et al. (2009). The genus *Polyonyx*, established by Stimpson (1858), was therefore a senior homonym of that established by Santos et al. (2009). In compliance with Articles 23, 53, and 60 of the Code, the previously established name takes precedence in nomenclature, hence the proposal of the new replacement name *Galinhapodus* igen. nov.

The integration of trace fossils into the Code has made a separate code for trace fossil nomenclature unnecessary (Bertling 2007), solidifying the Code as the primary system for addressing such matters. In ichnology, names assigned to traces (ichnotaxa) are typically based on trace morphology and are often considered independently from the biological taxonomy of the organisms that created them (e.g., Bertling et al. 2006). This implies that despite the general independence, conflicts may arise between biological taxonomy and ichnotaxonomy, leading to the need for clarification. Thus, the renaming of the track to *Galinhapodus gomesi* aligns with the principles of the ICZN, ensuring compliance with established nomenclatural guidelines and addressing conflicts arising from homonymy issues.

The new replacement name *Galinhapodus* igen. nov. for these sauropod tracks pays tribute to the unique site where they were discovered and described, and in gratitude to Rui Galinha, the former limestone quarry owner, for his contribution to the preservation of this palaeontological heritage.

As a final conclusion, this work represents an example of good practices in science where a problem is identified, rectified and analysed following the guidelines of the Code.

Acknowledgements.—We would like to express our sincere gratitude to all individuals whose contributions have been invaluable in this correction, particularly Jerry D. Harris (Utah Tech University, St. George, USA) for his insightful guidance and expertise, and Carlos Marques da Silva (Faculdade de Ciências, Universidade de Lisboa, Portugal) for discussion on zoological nomenclature. Finally, we are grateful for the constructive feedback provided by the anonymous reviewer. Their thoughtful reviews greatly contributed to improving the clarity of this correction. Financial support was provided by Foundation for Science and Technology (Lisboa, Portugal), through the project UID/GEO/50019/2020 (<https://doi.org/10.54499/UIDB/50019/2020>) of Instituto Dom Luiz (IDL) and CEECIND/00726/2017/CP1387/CT0034 individual contract (<https://doi.org/10.54499/CEECIND/00726/2017/CP1387/CT0034> to PM); and the Swiss National Science Foundation (grant SNF 200021_192036, to LS). RRT is supported by Instituto Universitario de Investigación de Ciencias Ambientales (IUCA) and Beagle Research Group (S27_23R) financed by Gobierno de Aragón. DC is supported by Unidad de Paleontología de Teruel financed by Ministerio de Ciencia e Innovación (Gobierno de España) and E04_23R FOCON-TUR Research Group (Gobierno de Aragón).

References

- Alcalá, L., Pérez-Lorente, F., Luque, L., Cobos, A., Royo-Torres, R., and Mampel, L. 2014. Dinosaur footprints in shallowing intertidal deposits of the Jurassic–Cretaceous transition in the Iberian Range (Teruel, Spain). *Ichnos* 21: 19–31.
- Azerêdo, A.C. 1993. *Jurássico médio do Maciço Calcário Estremenho (Bacia Lusitânica): análise de fácies, micropaleontologia, paleogeografia*. 403 pp. Unpublished Ph.D. Thesis, Universidade de Lisboa, Lisboa.
- Azerêdo, A.C. 2007. Formalização da litostratigrafia do Jurássico Inferior e Médio do Maciço Calcário Estremenho (Bacia Lusitânica). *Comunicações Geológicas* 94: 29–51.
- Azerêdo, A.C., Ramalho, M.M., Santos, V.F., and Galopim de Carvalho, A.M. 1995. Calcários com pegadas de dinossáurios da Serra de Aire: microfácies e paleoambientes. *Gaia* 11: 1–6.
- Bertling, M. 2007. What's in a name? Nomenclature, systematics, ichnotaxonomy. In: W. Miller (ed.), *Trace Fossils: Concepts, Problems, Prospects*, 81–91. Elsevier, Amsterdam.
- Bertling, M., Braddy, S.J., Bromley, R.G., Demathieu, G.D., Genise, J., Mikuláš, R., Nielsen, J.K., Nielsen, K.S.S., Rindsberg, A.K., Schirf, M., and Uchman, A. 2006. Names for trace fossils: a uniform approach. *Lethaia* 39: 265–286.
- Castanera, D., Santos, V.F., Piñuela, L., Pascual, C., Vila, B., Canudo, J.I., and Moratalla, J.J. 2016. Iberian sauropod tracks through time: variations in sauropod manus and pes track morphologies. In: P.L. Falkingham, D. Marty, and A. Richter (eds.), *Dinosaur Tracks: The Next Steps*, 120–137. Indiana University Press, Bloomington.
- Castanera, D., Vila, B., Razzolini, N.L., Santos, V.F., Pascual, C., and Canudo, J.I. 2014. Sauropod trackways of the Iberian Peninsula: palaeontological and palaeoenvironmental implications. *Journal of Iberian Geology* 40: 49–59.
- Fauchald, K. 1977. The polychaete worms. Definitions and keys to orders, families, and genera. *Natural History Museum of Los Angeles County, Science Series* 28: 1–188.
- Gomes, J.P. 1915–1916. Descoberta de restos de saúrios gigantesco no Jurássico do Cabo Mondego. *Comunicações dos Serviços Geológicos de Portugal* 11: 132–134.
- Harris, J.D. 1997. Four-toed theropod footprints and a paleomagnetic age from the Whetstone Falls Member of the Harebell Formation (Upper Cretaceous: Maastrichtian), northwestern Wyoming: a correction. *Cretaceous Research* 19: 139.
- ICZN [International Commission on Zoological Nomenclature] 1999. *International Code of Zoological Nomenclature. Fourth edition*, 1–xxix + 1–306 pp. International Trust for Zoological Nomenclature, London.
- Jumars, P.A. 1974. A generic revision of the Dorvilleidae (Polychaeta), with six new species from the deep Pacific. *Zoological Journal of the Linnean Society* 54: 101–135.
- Klein, H., Gierliński, G.D., Oukassou, M., Saber, H., Lallensack, J.N., Lagnaoui, A., Hminna, A., and Charrière, A. 2023. Theropod and ornithischian dinosaur track assemblages from Middle to ?Late Jurassic deposits of the Central High Atlas, Morocco. *Historical Biology* 35: 320–346.
- Lockley, M.G. 2010. A solution to the *Mehliella* mystery: tracking, naming, identifying and measuring the first crocodylian trackway reported from the Cretaceous (Dakota Group, Colorado). *New Mexico Museum of Natural History and Science Bulletin* 51: 157–164.
- Mehl, M.G. 1931. Additions to the vertebrate record of the Dakota Sandstone. *The American Journal of Science, Fifth Series* 21: 441–452.
- Meyer, C.A., Marty, D., and Belvedere, M. 2018. Titanosaur trackways from the Late Cretaceous El Molino Formation of Bolivia (Cal Orck'o, Sucre). *Annales Societatis Geologorum Poloniae* 88: 223–241.
- Moreau, J.-D., Trincal, V., Fara, E., Baret, L., Jacquet, A., Barbini, C., Flament, R., Wienin, M., Bourel, B., and Jean, A. 2020. Middle Jurassic tracks of sauropod dinosaurs in a deep karst cave in France. *Journal of Vertebrate Paleontology* 39 (6): e1728286.
- Oukassou, M., Klein, H., Lagnaoui, A., Charrière, A., Saber, H., Gierliński, G.D., Lallensack, J.N., Hminna, A., Boumaalif, A., Oussou, A., and Ouarhache, D. 2019. *Polyonyx*-like tracks from Middle–?Upper Jurassic red beds of Morocco: implications for sauropod communities on southern margins of Tethys. *Palaeogeography, Palaeoclimatology, Palaeoecology* 536: 109394.
- Osawa, M. and Sato, T. 2022. A distinctive new species of the genus *Poly-*

- onyx Stimpson, 1858 (Crustacea: Decapoda: Anomura: Porcellanidae) from Okinawa, southwestern Japan. *Zootaxa* 5091: 587–597.
- Poropat, S.F., White, M.A., Ziegler, T., Pentland, A.H., Rigby, S.L., Duncan, R.J., Sloan, T., and Elliott, D.A. 2021. A diverse Late Cretaceous vertebrate tracksite from the Winton Formation of Queensland, Australia. *PeerJ* 9: e11544.
- Royo-Torres, R. 2009. Los dinosaurios saurópodos en la Península Ibérica. In: P. Huerta Hurtado and F.T. Fernández-Baldor (eds.), *Actas de las IV Jornadas Internacionales sobre Paleontología de Dinosaurios y su Entorno Salas de los Infantes, Burgos*, 139–166. Colectivo Arqueológico y Paleontológico de Salas, Salas de los Infantes.
- Santos, V.F., Lockley, M.G., Meyer, C.A., Carvalho, J., Galopim de Carvalho, A.M., and Moratalla, J.J. 1994. A new sauropod tracksite from the Middle Jurassic of Portugal. In: M.G. Lockley, V.F. dos Santos, C.A. Meyer, and A.P. Hunt (eds.), *Aspects of Sauropod Paleobiology*. *Gaia* 10: 5–13.
- Santos, V.F., Moratalla, J.J., and Royo-Torres, R. 2009. New sauropod trackways from the Middle Jurassic of Portugal. *Acta Palaeontologica Polonica* 54: 409–422.
- Schulze, F.E. 1886. Über den Bau und das System der Hexactinelliden. *Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin (Physikalisch-Mathematische Classe)*: 1–97.
- Stimpson, W. 1858. Prodromus descriptionis animalium evertibratorum, quae in Expeditione ad Oceanum Pacificum Septentrionalem, a Republica Federata missa, Cadwaladaro Ringgold et Johanne Rodgers Ducibus, observavit et descripsit W. Stimpson. Pars. V. Crustacea Ocy-podoidea. *Proceedings of the Academy of Natural Sciences of Philadelphia* 10: 93–110.
- Strand, E. 1932. Miscellanea nomenclatorica zoologica et palaeontologica, III, IV. *Folia Zoologica et Hydrobiologica* 4: 133–147, 193–196.
- Tomaselli, M.B., Ortiz David, L.D., González Riga, B.J., Coria, J.P., Mercado, C.R., Guerra, M., and Sánchez Tiviroli, G. 2021. New titanosaurian sauropod tracks with exceptionally well-preserved claw impressions from the Upper Cretaceous of Argentina. *Cretaceous Research* 129: 104990.
- Torcida, F., Díaz-Martínez, I., Contreras, R., Huerta, P., Montero, D., and Urién, V. 2015. Unusual sauropod tracks in the Jurassic–Cretaceous interval of the Cameros Basin (Burgos, Spain). *Journal of Iberian Geology* 41: 141–154.
- Torcida Fernández-Baldor, F., Díaz-Martínez, I., Huerta, P., Huerta, D.M., and Castanera, D. 2021. Enigmatic tracks of solitary sauropods roaming an extensive lacustrine megatracksite in Iberia. *Scientific Reports* 11: 16939.
- Xing, L., Lockley, M.G., Miyashita, T., Klein, H., Wang, T., Scott Persons, W., Pan, S., Zhang, J., and Dong, Z. 2014. Large sauropod and theropod tracks from the Middle Jurassic Chuanjie Formation of Lufeng County, Yunnan Province and palaeobiogeography of the Middle Jurassic sauropod tracks from southwestern China. *Palaeoworld* 23: 294–303.
- Xing, L., Lockley, M.G., Zhang, J., Klein, H., Li, D., Miyashita, T., Li, Z., and Kümmell, S.B. 2016. A new sauropodomorph ichnogenus from the Lower Jurassic of Sichuan, China fills a gap in the track record. *Historical Biology* 28: 881–895.
- Vanda F. Santos [vafsantos@fc.ul.pt; ORCID: <https://orcid.org/0000-0001-5842-7857>], Departamento de Geologia, Faculdade de Ciências da Universidade de Lisboa, Portugal; Instituto Dom Luiz (FCUL), Campo Grande, 1749-016, Lisboa, Portugal; Departamento de Geologia, Geografía y Medio Ambiente (Grupo de Investigación Paleolítica), Universidad de Alcalá, Spain.
- José J. Moratalla [j.moratalla@igme.es; ORCID: <https://orcid.org/0000-0002-4949-7666>], Instituto Geológico y Minero de España (IGME-CSIC). Departamento de Geología y Subsuelo. Ríos Rosas, 23. 28003 Madrid, Spain.
- Rafael Royo-Torres [royotorres@unizar.es; ORCID: <https://orcid.org/0000-0001-5116-3000>], Grupo Beagle-IUCA, Departamento Didácticas Específicas, Facultad de Ciencias Sociales y Humanas, Universidad de Zaragoza, C/Atarazanas 4, 44003, Teruel, Spain.
- Matteo Belvedere [matteo.belvedere@unifi.it; ORCID: <https://orcid.org/0000-0002-0135-4455>], Dipartimento di Scienze della Terra, Università degli Studi di Firenze, via G. la Pira 4, 50121, Firenze, Italy.
- Diego Castanera [castanera@fundaciondinopolis.org; ORCID: <https://orcid.org/0000-0003-3950-1630>], Fundación Conjunto Paleontológico de Teruel-Dinópolis/Museo Aragónés de Paleontología, Teruel, Spain.
- Luis M.P. Ceriaco [luis.ceriaco@cibio.up.pt; ORCID: <https://orcid.org/0000-0002-0591-9978>], CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, InBIO Laboratório Associado, Campus de Vairão, Universidade do Porto, 4485-661 Vairão, Portugal; BIOPOLIS Program in Geonomics, Biodiversity and Land Planning, CIBIO, Campus de Vairão, 4485-661, Vairão, Portugal.
- Pedro Mocho [p.mochopaleo@gmail.com; ORCID: <https://orcid.org/0000-0002-3348-5572>], Instituto Dom Luiz, Faculdade de Ciências, Universidade de Lisboa, Edifício C6, Campo Grande, 1749-016 Lisboa, Portugal; Departamento de Geologia, Faculdade de Ciências, Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal; Grupo de Biología Evolutiva, Facultad de Ciencias, Universidad Nacional de Educación a Distancia (UNED). Avda. Esparta s/n, 28232 Las Rozas de Madrid, Spain.
- Marc Merino [marc.merig@gmail.com; ORCID: <https://orcid.org/0000-0002-5482-4078>], C/ Nou 7, Cubelles, Barcelona, Spain.
- Christian A. Meyer [chris.meyer@unibas.ch; ORCID: <https://orcid.org/0000-0002-5069-8924>], Department of Environmental Sciences, University of Basel, Bernoullistrasse 32, CH-4056 Basel, Switzerland; Museo de Historia Natural Alcide d'Orbigny, Avenida Potosi N-1458 Cochabamba, Bolivia.
- Lara Sciscio [lara.sciscio@jurassica.ch; ORCID: <https://orcid.org/0000-0003-4178-2881>], Jurassica Museum, Porrentruy, Switzerland; Department of Geosciences, University Fribourg, Fribourg, Switzerland.

Received 24 April 2024, accepted 10 June 2024, published online 2 December 2024.

Copyright © 2024 V.F. Santos et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License (for details please see <http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.