Mujal, E., Fortuny, J., Pérez-Cano, J., Dinarès-Turell, J., Ibáñez-Insa, J., Oms, O., Vila, I., Bolet, A., & Anadón, P. (2019). Reply to the comment on "Integrated multi-stratigraphic study of the Coll de Terrers late Permian–Early Triassic continental succession from the Catalan Pyrenees (NE Iberian Peninsula): A geologic reference record for equatorial Pangaea" by Eudald Mujal, Josep Fortuny, Jordi Pérez-Cano, Jaume Dinarès-Turell, Jordi Ibáñez-Insa, Oriol Oms, Isabel Vila, Arnau Bolet, Pere Anadón [Global and Planetary Change 159 (2017) 46–60]. *Global and Planetary Change*, *174*, 180-183. [174]. https://doi.org/10.1016/j.gloplacha.2018.12.005

Peer reviewed version

License (if available):
CC BY-NC-ND

Link to published version (if available):
10.1016/j.gloplacha.2018.12.005

Link to publication record in Explore Bristol Research

PDF-document

This is the author accepted manuscript (AAM). The final published version (version of record) is available online via Elsevier at https://www.sciencedirect.com/science/article/pii/S092181811830537X . Please refer to any applicable terms of use of the publisher.

University of Bristol - Explore Bristol Research

General rights

This document is made available in accordance with publisher policies. Please cite only the published version using the reference above. Full terms of use are available: http://www.bristol.ac.uk/red/research-policy/pure/user-guides/ebr-terms/

Global and Planetary Change 174 (2019) 180–183

Contents lists available at ScienceDirect

Global and Planetary Change

journal homepage: www.elsevier.com/locate/gloplacha

Discussion

Reply to the comment on "Integrated multi-stratigraphic study of the Coll de Terrers late Permian–Early Triassic continental succession from the Catalan Pyrenees (NE Iberian Peninsula): A geologic reference record for equatorial Pangaea" by Eudald Mujal, Josep Fortuny, Jordi Pérez-Cano, Jaume Dinarès-Turell, Jordi Ibáñez-Insa, Oriol Oms, Isabel Vila, Arnau Bolet, Pere Anadón [*Global and Planetary Change 159* (2017) 46–60]

Eudald Mujal[a,b,*], Josep Fortuny[b], Jordi Pérez-Cano[c], Jaume Dinarès-Turell[d], Jordi Ibáñez-Insa[e], Oriol Oms[f], Isabel Vila[c], Arnau Bolet[g,b], Pere Anadón[e]

[a] *Staatliches Museum für Naturkunde, Rosenstein 1, D-70191 Stuttgart, Germany*
[b] *Institut Català de Paleontologia Miquel Crusafont, ICTA-ICP building, c/de les columnes, s/n, campus UAB, E-08193 Cerdanyola del Vallès, Catalonia, Spain*
[c] *Departament de Dinàmica de la Terra i de l'Oceà (Facultat de Geologia) i Institut de Recerca de la Biodiversitat (IRBio), Facultat de Ciències de la Terra, Universitat de Barcelona, c/Martí i Franquès s/n, E-08028 Barcelona, Catalonia, Spain*
[d] *Istituto Nazionale di Geofisica e Vulcanologia, Via di Vigna Murata 605, I-00143 Roma, Italy*
[e] *Institut de Ciències de la Terra Jaume Almera, ICTJA-CSIC, c/Lluís Solé i Sabarís s/n, E-08028 Barcelona, Catalonia, Spain*
[f] *Departament de Geologia, Universitat Autònoma de Barcelona, E-08193 Bellaterra, Catalonia, Spain*
[g] *School of Earth Sciences, University of Bristol, Life Sciences Building, 24 Tyndall Avenue, Bristol BS8 1TQ, United Kingdom*

ARTICLE INFO

Keywords:
Permian–Triassic transition
Stratigraphy
Pyrenean Basin
Western Tethys

ABSTRACT

Ronchi et al. (in press) comment on the stratigraphic, sedimentological, mineralogical and palaeontological analyses performed in the recently described Coll de Terrers Permian–Triassic terrestrial succession from the Catalan Pyrenees by Mujal et al. (2017a). The comment debates our interpretation of a succession of red-beds as Permian (Upper Red Unit, URU). Instead, the comment infers that the analysed succession is part of the regional upper Buntsandstein facies unit (Triassic), debating the proposed stratigraphic scheme by using the tectonic evolution as the main argument. Here, we clarify and present more details on the interpretation published in Mujal et al. (2017a). Based on this clarification and taking into account the comment, we arrive to the conclusion that the interpretation and inferences presented in Mujal et al. (2017a) are sound and justified.

1. Stratigraphic and sedimentological framework of Coll de Terrers

The uppermost Permian and lowermost Triassic terrestrial successions of the Catalan Pyrenees (NE Iberian Peninsula) are grouped in two major depositional units primarily defined by Gisbert (1981): the Upper Red Unit (URU; middle–late Permian) and the Buntsandstein facies unit (Early–Middle Triassic). Mujal et al. (2017a) analysed a newly discovered section, Coll de Terrers, where a potential sedimentary continuity throughout the Permian–Triassic boundary was suggested. The comment by Ronchi et al. (in press) questions the stratigraphic interpretation of the analysed strata from the Coll de Terrers section by Mujal et al. (2017a).

The URU can be split in the lower and upper sub-units (henceforth, lower URU and upper URU), as it has also been well-characterised in different Pyrenean areas by Gisbert (1981), Speksnijder (1985), Robles and Llompart (1987), Gretter et al. (2015) and Mujal et al. (2016a). The only work that studied the relatively inaccessible Coll de Terrers area is that by Mujal et al. (2017a). On this regard, it is worth to note that Mujal et al. (2017a) did not "present their geological maps of the Coll de Terrers section (Figs. 1C, 2A) as taken from Hartevelt (1970) and Gisbert (1981) with modifications" as stated by Ronchi et al. (in press): 1) the regional map (Mujal et al., 2017a, Fig. 1C) was updated by providing new field data and photointerpretation; 2) the Coll de Terrers

* Corresponding author at: Staatliches Museum für Naturkunde, Rosenstein 1, D-70191 Stuttgart, Germany.
E-mail addresses: eudald.mujalgrane@smns-bw.de (E. Mujal), josep.fortuny@icp.cat (J. Fortuny), jordi_perez-cano@ub.edu (J. Pérez-Cano), jaume.dinares@ingv.it (J. Dinarès-Turell), jibanez@ictja.csic.es (J. Ibáñez-Insa), joseporiol.oms@uab.cat (O. Oms), arnau.bolet@icp.cat (A. Bolet).

https://doi.org/10.1016/j.gloplacha.2018.12.005
Received 1 October 2018; Received in revised form 15 December 2018; Accepted 15 December 2018
Available online 01 February 2019
0921-8181/ © 2018 Elsevier B.V. All rights reserved.

detailed map (Mujal et al., 2017a, Fig. 2A) is entirely based in our field cartography and photointerpretation. In contrast, Ronchi et al. (in press) base their (re)interpretations of Coll de Terrers on the maps by Hartevelt (1970) and Gisbert (1981).

Ronchi et al. (in press) contest the assignment of a sandy-clayey red-bed succession to the Permian upper URU, by interpreting that such succession corresponds to the upper part of the Triassic Buntsandstein facies unit. However, such an interpretation is in contrast with their section 2.1 when the authors state that "these facies do not correspond to the "upper URU" as interpreted by Mujal et al. (2017a) but eventually they represent the "lower URU"". Therefore, the comment is unclear by ascribing the same portion of the succession (upper URU of Mujal et al., 2017a) to two different units. In fact, the stacking pattern of the fine-grained facies succession described as upper URU at Coll de Terrers by Mujal et al. (2017a) was never identified to be part of a lower URU succession (nor within the upper Buntsandstein facies unit) in any studied areas of the Pyrenees. Thus, it is unlikely that such fine-grained succession corresponds to any other unit than the upper URU (cf. Gisbert, 1981, 1986; Speksnijder, 1985; Gretter et al., 2015; Mujal, 2017).

The basic descriptions of the lower URU, upper URU and Buntsandstein facies unit of Ronchi et al. (in press) coincide with those of Mujal et al. (2017a). However, Ronchi et al. (in press) (their section 3) suggest that the boundary between the lower and upper URU as described by Mujal et al. (2017a) is actually a fault between the Permian strata and the Triassic Buntsandstein facies. Nevertheless, Ronchi et al. (in press) do not refer to the description of the lower/upper URU transition and to the supplementary Fig. S2 of Mujal et al. (2017a), which show a long-term palaeosol formation and no evidence of faulting between the lower and upper URU, i.e., being a stratigraphic contact (Mujal et al., 2017a, p. 50 and Fig. 8). It is worth to note that this interval is traceable at kilometre scale, as mapped in the Fig. 1C (white line within Permian red units) of Mujal et al. (2017a), and was previously described as facies 4A2 by Gisbert (1981, pp. 65-67).

Furthermore, the facies and stacking pattern described in the upper URU at Coll de Terrers by Mujal et al. (2017a) correlate with those described in other areas in the same stratigraphic framework: facies 4A1 of Gisbert (1981), Basinfill Sequence F of Speksnijder (1985), lacustrine architectural elements of Gretter et al. (2015). Interestingly, Speksnijder (1985, p. 194) documented a lateral composition change of the thin-bedded layers, from carbonate to sandstone, explaining why these layers are of carbonate or siliciclastic composition.

The position and correlation of each unit with the stratigraphic section at Coll de Terrers can be tested by the GPS coordinates provided in page 49 of Mujal et al. (2017a). Undoubtedly, the direct inspection and study of the section provide an unmistakable correlation.

2. Mineralogical data

The XRD analyses by Mujal et al. (2017a) were basically aimed at identifying and semi-quantifying the whole-rock mineralogy of Coll de Terrers. Such analyses, however, were not intended to support any sedimentary continuity, as Ronchi et al. (in press) suggest in their comment. Instead, Mujal et al. (2017a) inferred the stratigraphic continuity between the upper URU and Buntsandstein by means of (1) the monotonous strata dipping, (2) the persistence of the sedimentary setting (cyclic ephemeral lacustrine/playa-lake deposits), and (3) preliminary cyclostratigraphic analyses. Ronchi et al. (in press) indicate that no XRD analyses were conducted on oriented aggregates, pointing out that Xu et al. (2017) did employ such methodology. While it is true that oriented aggregates allow one to correctly identify clay minerals and their interstratifications, they cannot provide any information about whole-rock mineralogy. In this respect, the semi-quantitative analyses of the whole-rock mineralogy performed by Xu et al. (2017), not mentioned by Ronchi et al. (in press), are very similar to those presented by Mujal et al. (2017a).

Ronchi et al. (in press) point out the difficulties to discriminate chlorite and kaolinite, as done by Mujal et al. (2017a). However, since the early work by Biscaye (1964), it is known that the differentiation between kaolinite and chlorite by XRD on untreated slides is possible by using high-resolution diffractometer conditions and slow scan speeds. Today, employing state-of-the art diffractometers equipped with position sensitive detectors, the observation in powdered samples of separate features for the (001) reflection of kaolinite and the (002) reflection of chlorite around 7 Å is usually straightforward. In addition, the measurement of the corresponding peak areas for semi-quantitative purposes is possible with standard full-pattern matching procedures. Although it is true that this method may provide unreliable data in some cases (for instance, when the peak intensities are similar for both phases, or in samples with very poor crystallinity), it still allows one to obtain relevant semi-quantitative information about the mineralogy of large numbers of samples, as it was fairly done in Mujal et al. (2017a).

3. Palaeontological content and age constraints

The comment also challenges the interpretation of the tetrapod ichnotaxa analysed by Mujal et al. (2017a). While we concur that the Coll de Terrers ichnological record is fragmentary, we are confident that the integration of such data with all the other performed analyses in Mujal et al. (2017a) and data from previous works (Robles and Llompart, 1987; Gretter et al., 2015; Mujal et al., 2016a, 2016b, 2016c) provides a reliable biostratigraphic framework.

In essence, Mujal et al. (2017a, p. 56) suggest that "the tetrapod footprint morphotypes I and II … were potentially produced by similar (or the same) trackmakers as those corresponding to *Dicynodontipus* and *Pachypes*" on the basis of the similitudes between the Pyrenean footprints and these Permian ichnotaxa. In this sense, the Coll de Terrers footprint morphotypes I and II could correspond either to (1) *Dicynodontipus* and *Pachypes* (respectively) or to (2) equivalent ichnotaxa, most possibly coeval to the aforementioned ichnogenera, which are known from late Permian successions (de Klerk, 2002; Kustatscher et al., 2017). As the available data is fragmentary, we preferred to keep an open attribution, despite such footprints are not similar to any other Permian (nor Triassic) ichnotaxa.

Ronchi et al. (in press) further point to the presence of *Dicynodontipus* in the Early Triassic based on Retallack (1996) and Haubold (1971), but the morphological traits of footprints reported by these authors do not fit with those of the Coll de Terrers Morphotype I. Thus, no correlation is possible between these ichnological records. Instead, footprints of Morphotype I display features similar to those of the late Permian *Dicynodontipus* tracks studied by de Klerk (2002).

Ronchi et al. (in press) state that "the Coll de Terrers ichnoassociation lacks typical Late Permian ichnogenera like *Paradoxichnium*, *Hyloidichnus* and *Erpetopus*". However, in late Permian successions, according to Marchetti et al. (2017), *Paradoxichnium* is so far only known from Germany and Italy, and *Hyloidichnus*, from Morocco and Niger. Similarly, according to Marchetti (2016) and Voigt and Lucas (2018), *Erpetopus* is an index ichnotaxon of the early and middle Permian. All in all, the lack of typical late Permian ichnogenera does not mean that a succession is not of this age, and in this regard, Coll de Terrers does not preserve index ichnotaxa from any other time interval.

4. Regional context and palaeogeography

Ronchi et al. (in press) do not concur with Mujal et al. (2017a) in assigning a late Permian age to the upper URU, stating that this age is unlikely due to the foreseen regional context. Nevertheless, Ronchi et al. (in press) (their section 6) suggest that, according to Linol et al. (2009) and Bourquin et al. (2011), successions from the Catalan Coastal Ranges, Iberian Chain, Balearic Islands, Southern Italy, the French Central Massif, and even the Catalan Pyrenees (see Bourquin et al., 2011) could be also of late Permian age. Then, if there is a possible candidate among Pyrenean units to be of late Permian age, it must be the upper URU, which, according to Gisbert (1981), is the uppermost (i.e., youngest) Permian unit of the Pyrenees.

The late Palaeozoic–early Mesozoic Pyrenean rift system consists of a complex framework of depocentres of high lateral variation in both facies and thickness of the infilling deposits. In this regard, Mujal et al. (2017b) documented several Triassic Buntsandstein facies successions from the Catalan Pyrenees displaying a relatively high lateral thickness variation, ranging from ca. 150 m to 350 m (for similar observations, see also Saura, 2004 and Lloret et al., 2018). Thus, the lateral thickness variation shown in Fig. 7 by Mujal et al. (2017a) is in agreement with those variations observed by Mujal et al. (2017b), as well as with those reported by Lloret et al. (2018). We want to stress that the purpose of Fig. 7 by Mujal et al. (2017a) was to show in a simple way the thickening of the Buntsandstein facies out from Coll de Terrers, avoiding the representation of the complex tectonic frame between the different areas.

Ronchi et al. (in press) (their section 3) tackle part of the following conclusions by Mujal et al. (2017a, section 4.5): A) Mujal et al. (2017a) stated that the Coll de Terrers area acted like a topographic high; thus, in this area the Buntsandstein succession may be condensed, which does not mean non-deposition; B) Mujal et al. (2017a) did not suggest Coll de Terrers as a sediment source area, but as an area protected from the common erosion during the Early Triassic; C) Mujal et al. (2017a) never stated that Coll de Terrers is a by-pass area, instead, it is suggested that “the basal thick braided successions preserved out of Coll de Terrers represent by-pass deposits” (Mujal et al., 2017a, p. 55), and therefore that there was no sediment reworking at Coll de Terrers.

Ronchi et al. (in press) (their section 6) state that Mujal et al. (2017a) “propose that the upper Olenekian sediments were deposited under monsoon conditions with meandering fluvial systems development and a generally humid climate”. Such statement is not performed in our work. Instead, Mujal et al. (2017a, pp. 57-58) explained that monsoonal sequences are present in the lowermost Buntsandstein facies (equal to those of the upper URU), which so far have not been found elsewhere in the Catalan Pyrenees, and we interpret them as the earliest Triassic (i.e., Induan) as shown in Fig. 8 of Mujal et al. (2017a).

5. Concluding remarks

The main concern of Ronchi et al. (in press) is that the stratigraphic interpretation of Mujal et al. (2017a) does not fit with the Pyrenean depositional units described by Gisbert (1981). On this basis, Ronchi et al. (in press) challenge most of the derived interpretations. However, we conclude that the comment interpretation is not in agreement with the field data of the Coll de Terrers section analysed by Mujal et al. (2017a).

As stated by Mujal et al. (2017a), we concur that the Permian-–Triassic transition in the Western Tethys is often characterised by a temporal hiatus, expressed as an angular unconformity between the Triassic and the Palaeozoic units (cf. Gretter et al., 2015; Mujal, 2017; Mujal et al., 2016a, 2017b, 2018; Lloret et al., 2018). Notwithstanding, as exposed by Mujal et al. (2017a), some regions among the Western Tethys (not only Coll de Terrers nor the Catalan Pyrenees) may potentially show a more continuous sedimentation, though further documentation and analyses are required. The purpose of Mujal et al. (2017a) when describing the newly discovered Coll de Terrers area was to contribute to the understanding of the Permian–Triassic transition in the Pyrenees and, globally, in the Western Tethys. In this regard, a single section was described, as pointed out by Ronchi et al. (in press) (their section 6), but this does not imply that Coll de Terrers is the unique section with the potential record of the Permian–Triassic boundary. Instead, Mujal et al. (2017a) encourage the prospection and study of other equivalent Pyrenean successions in order to further constrain this exciting time interval.

Finally, we would like to note that modern science is based upon a collaborative scheme in which researchers within a discipline build together a body of knowledge, benefiting from feedback from colleagues. In particular, post-publication comments are essential in order to clarify published articles, and therefore we thank Ronchi et al. (in press) for their interest in our work and for their large review of Mujal et al. (2017a). Unfortunately, we cannot agree with the interpretation presented in Ronchi et al. (in press), as thoroughly exposed herein, while acknowledging the opportunity to clarify and further discuss our work.

References

Biscaye, P.E., 1964. Distinction between kaolinite and chlorite in recent sediments by *x*-ray diffraction. Am. Mineral. 49, 1281–1289.

Bourquin, S., Bercovici, A., López-Gómez, J., Diez, J.B., Broutin, J., Ronchi, A., Durand, M., Arche, A., Linol, B., Amour, F., 2011. The Permian-Triassic transition and the onset of Mesozoic sedimentation at the northwestern peri-Tethyan domain scale: palaeogeographic maps and geodynamic implications. Palaeogeogr. Palaeoclimatol. Palaeoecol. 299 (1–2), 265–280. https://doi.org/10.1016/j.palaeo.2010.11.007.

de Klerk, W.J., 2002. A dicynodont trackway from the *Cistecephalus* assemblage zone in the Karoo, east of Graaff-Reinet, South Africa. Palaeontol. Afr. 91 (38), 73–91.

Gisbert, J., 1981. Estudio geológico-petrológico del Estefaniense-Pérmico de la Sierra del Cadí (Pirineo de Lérida): Diagénesis y sedimentología. Ph.D. Thesis. University of Zaragoza, Spain.

Gisbert, J., 1986. Els Temps Tardihercinians. In: Santanach, P. (Ed.), Història Natural dels Països Catalans, Geologia I. Editorial Enciclopèdia Catalana, pp. 197–242.

Gretter, N., Ronchi, A., López-Gómez, J., Arche, A., De la Horra, R., Barrenechea, J.F., Lago, M., 2015. The late palaeozoic-early mesozoic from the Catalan Pyrenees (Spain): 60 Myr of environmental evolution in the frame of the western peri-Tethyan palaeogeography. Earth Sci. Rev. 150, 679–708. https://doi.org/10.1016/j.earscirev.2015.09.001.

Hartevelt, J.J.A., 1970. Geology of the upper Segre and Valira valleys, Central Pyrenees, Andorra/Spain. Leidse. Geol. Meded. 45, 349–354.

Haubold, H., 1971. Die Tetrapodenfährten des Buntsandsteins in der Deutschen Demokratischen Republik und in Westdeutschland und ihre Äquivalente in der gesamten Trias. Paläntologische Abhandlungen, Abteilung A Paläozoologie. pp. 395–548.

Kustatscher, E., Bernardi, M., Petti, F.M., Franz, M., van Konijnenburg-Van Cittert, J.H.A., Kerp, H., 2017. Sea-level changes in the Lopingian (late Permian) of the northwestern Tethys and their effects on the terrestrial palaeoenvironments, biota and fossil preservation. Glob. Planet. Chang. 148, 166–180. https://doi.org/10.1016/j.gloplacha.2016.12.006.

Linol, B., Bercovici, A., Bourquin, S., Diez, J.B., López-Gómez, J., Broutin, J., Durand, M., Villanueva-Amadoz, U., 2009. Late Permian to Middle Triassic correlations and palaeogeographical reconstructions in south-western European basins: new sedimentological data from Minorca (Balearic Islands, Spain). Sediment. Geol. 220, 77–94. https://doi.org/10.1016/j.sedgeo.2009.06.003.

Lloret, J., Ronchi, A., López-Gómez, J., Gretter, N., De la Horra, R., Barrenechea, J.F., Arche, A., 2018. Syn-tectonic sedimentary evolution of the continental late Palaeozoic-early Mesozoic Erill Castell-Estac Basin and its significance in the development of the Central Pyrenees Basin. Sediment. Geol. 134–157. https://doi.org/10.1016/j.sedgeo.2018.07.014.

Marchetti, L., 2016. New occurrences of tetrapod ichnotaxa from the Permian Orobic Basin (Northern Italy) and critical discussion of the age of the ichnoassociation. Pap. Palaeontol. 2 (3), 363–386. https://doi.org/10.1002/spp2.1045.

Marchetti, L., Voigt, S., Klein, H., 2017. Revision of late Permian tetrapod tracks from the Dolomites (Trentino-Alto Adige, Italy). Hist. Biol. 1–36.

Mujal, E., 2017. Registre sedimentari i icnològic del fini-Carbonífer, Permià i Triàsic continentals dels Pirineus Catalans: Evolució i crisis paleoambientals a l'equador de Pangea (Ph.D. Thesis). Universitat Autònoma de Barcelona, Spain.

Mujal, E., Gretter, N., Ronchi, A., López-Gómez, J., Falconnet, J., Diez, J.B., De la Horra, R., Bolet, A., Oms, O., Arche, A., Barrenechea, J.F., Steyer, J.-S., Fortuny, J., 2016a. Constraining the Permian/Triassic transition in continental environments: stratigraphic and paleontological record from the Catalan Pyrenees (NE Iberian Peninsula). Palaeogeogr. Palaeoclimatol. Palaeoecol. 445, 18–37. https://doi.org/10.1016/j.palaeo.2015.12.008.

Mujal, E., Gretter, N., Ronchi, A., López-Gómez, J., Falconnet, J., Diez, J.B., De la Horra, R., Bolet, A., Oms, O., Arche, A., Barrenechea, J.F., Steyer, J.S., Fortuny, J., 2016b. Insights on the Permian/Triassic transition in Western Tethys: new stratigraphic and paleontological data from the Catalan Pyrenees (NE Iberian Peninsula). Permophiles 63, 21–27.

Mujal, E., Fortuny, J., Oms, O., Bolet, A., Galobart, À., Anadón, P., 2016c. Palaeoenvironmental reconstruction and early Permian ichnoassemblage from the NE Iberian Peninsula (Pyrenean Basin). Geol. Mag. 153 (4), 578–600. https://doi.org/10.1017/S0016756815000576.

Mujal, E., Fortuny, J., Pérez-Cano, J., Dinarès-Turell, J., Ibáñez-Insa, J., Oms, O., Vila, I., Bolet, A., Anadón, P., 2017a. Integrated multi-stratigraphic study of the Coll de Terrers late Permian–early Triassic continental succession from the Catalan Pyrenees (NE Iberian Penisula): a geologic reference record for equatorial Pangaea. Glob. Planet. Chang. 159, 46–60. https://doi.org/10.1016/j.gloplacha.2017.10.004.

Mujal, E., Fortuny, J., Bolet, A., Oms, O., López, J.Á., 2017b. An archosauromorph dominated ichnoassemblage in fluvial settings from the late early Triassic of the

Catalan Pyrenees (NE Iberian Peninsula). PLoS ONE 12 (4), e0174693. https://doi.org/10.1371/journal.pone.0174693.
Mujal, E., Fortuny, J., Marmi, J., Dinarès-Turell, J., Bolet, A., Oms, O., 2018. Aridification across the Carboniferous–Permian transition in central equatorial Pangea: the Catalan Pyrenean succession (NE Iberian Peninsula). Sediment. Geol. 363, 48–68. https://doi.org/10.1016/j.sedgeo.2017.11.005.
Retallack, G.J., 1996. Early Triassic therapsid footprints from the Sydney Basin, Australia. Alcheringa 20, 301–314.
Robles, S., Llompart, C., 1987. Análisis paleogeográfico y consideraciones paleoicnológicas del Pérmico superior y Triásico inferior en la transversal del río Segre (Alt Urgell, Pirineo de Lérido). In: Cuadernos de Geología Ibérica. Vol. 11. pp. 115–130.
Ronchi, A., Lloret, J., Gretter, N., López-Gómez, J., De la Horra, R., Barrenechea, J.F., Arche, A., Diez, J.B., in press. Comment on “Integrated multi-stratigraphic study of the Coll de Terrers late Permian–early Triassic continental succession from the Catalan Pyrenees (NE Iberian Peninsula): a geologic reference record for equatorial Pangaea” by Eudald Mujal, Josep Fortuny, Jordi Pérez-Cano, Jaume Dinarès-Turell, Jordi Ibáñez-Insa, Oriol Oms, Isabel Vila, Arnau Bolet, Pere Anadón. Global and Planetary Change 159 (2017) 46–60. (Global and Planetary Change (2018)).
Saura, E., 2004. Anàlisi estructural de la zona de les Nogueres Pirineus Centrals. Ph.D. Thesis. Universitat Autònoma de Barcelona, Spain.
Speksnijder, A., 1985. Anatomy of a strike-slip fault controlled sedimentary basin, Permian of the Southern Pyrenees, Spain. Sediment. Geol. 44, 179–223.
Voigt, S., Lucas, S.G., 2018. Outline of a Permian tetrapod footprint ichnostratigraphy. In: Lucas, S.G., Shen, S.Z. (Eds.), The Permian Timescale. Vol. 450. Geological Society of London Special Publication, London, pp. 387–404. https://doi.org/10.1144/SP450.10.
Xu, G., Deconinck, J.-F., Feng, Q., Baudin, F., Pellenard, P., Shen, J., Bruneau, L., 2017. Clay mineralogical characteristics at the Permian–Triassic Shangsi section and their paleoenvironmental and/or paleoclimatic significance. Palaeogeogr. Palaeoclimatol. Palaeoecol. 474, 152–163. https://doi.org/10.1016/j.palaeo.2016.07.036.