Supplementary material for:

Palaeoecology of Middle Triassic tetrapod ichnoassociations (middle Muschelkalk, NE Iberian Peninsula) and their implications for palaeobiogeography in the western Tethys region

Chabier De Jaime-Soguero[a,1], Eudald Mujal[b,a,1,*], Jaume Dinarès-Turell[c], Oriol Oms[d], Arnau Bolet[a,e], Guillem Orlandi-Oliveras[a], Josep Fortuny[a,*]

(a) Institut Català de Paleontologia Miquel Crusafont, Universitat Autònoma de Barcelona, Edifici ICTA-ICP, c/de les columnes s/n, Campus de la UAB, E-08193 Cerdanyola del Vallès, Catalonia, Spain

(b) Staatliches Museum für Naturkunde Stuttgart, Rosenstein 1, D-70191 Stuttgart, Germany

(c) Istituto Nazionale di Geofisica e Vulcanologia, Via di Vigna Murata 605, I-00143 Roma, Italy

(d) Departament de Geologia, Universitat Autònoma de Barcelona, E-08193 Bellaterra, Catalonia, Spain

(e) School of Earth Sciences, University of Bristol, Wills Memorial Building, Queens Road, Bristol BS8 1RJ, United Kingdom.

(1) These authors contributed equally to this work

*Corresponding authors: eudald.mujalgrane@smns-bw.de (E. Mujal), josep.fortuny@icp.cat (J. Fortuny)

Text S1. Detailed stratigraphic and sedimentological descriptions of newly reported tetrapod localities from the middle Muschelkalk of the Catalan Basin (NE Iberian Peninsula)

Text S2. Systematic palaeontology

Text S3. Discussion on the distribution of tetrapod ichnotaxa within the middle Muschelkalk palaeoenvironments of the Catalan Basin (NE Iberian Peninsula)

References from Texts S1, S2, S3

Figures S1–S12

Tables S1 *(XLSX file)***, S2, S3**

Text S1. Detailed stratigraphic and sedimentological descriptions of newly reported tetrapod localities from the middle Muschelkalk of the Catalan Basin (NE Iberian Peninsula)

1. The Penya Rubí locality (Fig. 3 of the main text)

The stratigraphic succession analysed in this locality is up to ~27 m thick and encompass the Lower Unit (Paüls Gypsum) and part of the Middle Unit (Arbolí Gypsum and Guanta Sandstone) of the middle Muschelkalk facies (for nomenclature of the units, see Ortí et al., 2018). It is composed of distinct intervals that are as follows, from base to top:

- White gypsum ~2 m thick overlying the lower Musckelkalk limestones. These evaporites correspond to the Paüls Gypsum unit. They are followed by a covered interval of 20 m.
- The first outcrops above the covered interval correspond to a 0.7 m thick red-bed succession of fine- to very fine-grained sandstones alternated with mudstones. Sandstones are cross-laminated and display abundant water escape and load structures. The first tetrapod tracks, identified as *Rhynchosauroides*, appear in the uppermost surface of one of these sandstone levels the first tetrapod tracks. This interval corresponds to the Arbolí Gypsum. The base of this unit is probably situated somewhere within the previous covered interval.
- The red-beds described above are overlaid by a 0.5 m thick succession of finely laminated and mostly greyish dolostones. The succession displays a cyclic pattern, with laminae being thicker at the bottom and thinner at the top of each cycle. The uppermost part of each cycle is also more fine-grained, and often presents reddish-purplish (occasionally greenish) coloration. Thus, cycles are thinning- and finning-upwards, being interpreted as tidal flat deposits. Some surfaces of these dolostones display a voluptuous texture corresponding to shrink structures (elephant skin-like), which are considered microbially induced sedimentary structures (MISS; see also Ortí et al., 2018), and may in indicate periods of desiccation or drier conditions. Also, very thin (millimetric to submillimetric) mudstone laminae often cover the dolostone layers, which indicate a mud-draping during periods of stagnant waters between high and low tide phases. Such structures are characteristic of peritidal areas. Nearly all the small-sized (20–30 mm long) footprints (mostly *Rhynchosauroides*, with *Rotodactylus* and *Procolophonichnium* tracks present in a much lesser degree) from Penya Rubí

come from this dolostone interval with parallel lamination. Laterally, this interval becomes coarser (sandier component) and the parallel lamination turns to cross lamination, mostly consisting of wave and unidirectional ripples; load and water escape structures are also present. This lateral change indicates a patchy tidal flat system, with regions under a more energetic water flow, may corresponding to deposits infilling tidal creeks.

- The greyish interval is overlain by a 0.7 m thick red-bed succession composed of fine- to very fine-grained cross-laminated sandstones alternated with mudstones. Commonly, each cross-laminated sandstone layer displays a palaeoflow direction in the lower half and the opposite direction in the upper half, most probably indicating a tidal (bidirectional current) influence; this is further suggested by some *ex situ* blocks (most likely from these red beds) with interference ripples on the surfaces. The succession displays a cyclic pattern like that of the previous dolostone interval. Each cycle is thinning- and finning-upwards, changing from cross-laminated sandstone to laminated mudstone. This succession corresponds to the top of the Arbolí Gypsum unit (see below).
- A medium-grained red sandstone up to 1 m thick sharply overlies the previous succession, though a strongly erosive base is not observed. The sandstone displays cross stratification in the lower part, evolving to cross lamination to the top. The sandstone layer is of tabular geometry, and it can be laterally tracked in the whole extension of the outcrop, which is of dozens of metres. In the basal surface, preserved as casts, desiccation cracks are identified, as well as a *Chirotherium* manus-pes set (pes length of ~12 cm, though track is not complete). All these features suggest a more inland environment than that of the previous intervals. Therefore, this sandstone probably resulted from the development of a distal alluvial plain that underwent desiccation periods. Considering the stratigraphic position within the framework published in Ortí et al. (2018), it probably corresponds to the onset of the Guanta Sandstone unit (Fig. 2 of the main text).

To sum up, the middle Muschelkalk from Penya Rubí broadly shows a terrestrialization trend within the succession. In this case, the deposits of the Arbolí Gypsum unit are characteristic of a tidal flat setting. The lack of desiccation features in almost the entire succession, with the exception of wrinkle structures in the microbial mat layers, together with the presence of water escape and load structures, suggest that the setting was mostly under subaquatic conditions and/or that the substrate was mostly water saturated (high moisture). Therefore, these deposits most probably correspond to subtidal and intertidal areas. These features, together with the interpretation of equivalent successions as sabkha (or sabkha-like) deposits by Calvet and Marzo (1994), Mujal et al. (2018) and Ortí et al. (2018), suggest that during this regression period the Catalan Basin was a vast tidal flat, with a low relief that included a mosaic of environments ranging from subtidal to supratidal areas (Ortí et al., 2017). The sedimentological features of Penya Rubí show similarities with those of the Pedrera de Can Sallent tracksite (Mujal et al., 2018), though some differences are evident. The sedimentary succession of the Pedrera de Can Sallent displays a higher siliciclastic composition (e.g., major presence of micaceous minerals and absence of dolomites) than that of the Penya Rubí tracksite (see also sections 4.1 and 5.1 of the main text). However, in both cases the tracksites are dominated by small-sized footprints of *Rhynchosauroides* (more specifically, *R. tirolicus*; see Text S2). As further discussed in the main text, this indicates that the environmental setting was suitable for such track producers and/or the preservation of their ichnites. The onset of the Guanta Sandstone unit denotes that the tidal flat evolved to a distal alluvial plain, where subaerial conditions, and even desiccation periods, were more frequent.

2. The Puigventós locality (Fig. 4A of the main text)

A measurable stratigraphic succession is not available at Puigventós due to its tectonized setting. Nevertheless, the characteristics of the outcropping deposits allow to broadly infer the overall sedimentary evolution in this area. Most of the lithological and sedimentological features of the layers, including also most of the track-bearing ones, show more similarities to the medium-grained sandstone at the top of the succession of Penya Rubí (Guanta Sandstone) than to the underlying fine-grained intervals (Arbolí Gypsum). They are also similar to the succession of the Collcardús locality (see Mujal et al., 2015), which is just ~5 km to the E of the Puigventós locality. In fact, the track-bearing layers of Puigventós mostly consist of fine- to medium-grained sandstones, most of which with cross lamination (and occasionally cross stratification). Wave ripples with straight crests are present in some samples, indicating bidirectional flows. The different wave lengths (ranging from ~5 mm to 40 mm) in different layers suggest changing conditions, i.e., fluctuations in the water table, with common bidirectional flows, throughout the succession. In some cases, ripple crests are flat, suggesting subaerial exposure (capped ripples). Such exposure is further indicated by some mud-cracked surfaces, also denoting desiccation. Moulds of large salt crystals with depressed stepped faces (i.e., hoppers) are observed in some surfaces, even overprinting a 15.7 cm long *Chirotherium* pes track (see section 5.1 from the main text). All these features denote an environment with frequent desiccation periods and with highly salty waters. Such environmental conditions did not preclude biotic activity, as indicated by the relatively abundant bioturbation structures (mostly burrows, both vertical and horizontal respect to the stratification) in the sandstone layers. In the same way, tetrapod footprints are also abundant considering the limited exposure of the outcrops. Otherwise, the presence of tetrapod swimming tracks points to a flooding of the setting at least periodically. A few track-bearing layers are composed of finely laminated sandstones to dolostones, being similar to the microbial mats identified within the Penya Rubí succession.

A short interval with greyish laminated dolostones is present in the lowermost portion of the succession at Puigventós, close to the lower Muschelkalk limestones. This level could be equivalent to the greyish dolostones of Penya Rubí. Similar dolostone levels have been identified at the base of the succession of other middle Muschelkalk localities (Ortí et al., 2018). Given all the above described features and the position of the Puigventós locality within the Catalan Basin (Fig. 2 of the main text), most part of the succession might correspond to the Guanta Sandstone, although a short interval in the lowermost part could correspond to the Arbolí Gypsum. However, all the tetrapod footprints so far recovered from Puigventós are found in the Guanta Sandstone.

In summary, the middle Muschelkalk at the locality of Puigventós can be interpreted as a proximal sabkha plain (i.e., a supratidal flat) or a mixed-flat (denoted by a major presence of siliciclastic deposits), except for the basalmost part, which it was probably more similar to the tidal flats of the Penya Rubí locality. The sabkha was often affected by desiccation periods, but also by episodic floods (possibly during very high tide periods). An occasional coastal influence, stronger than the terrestrial one, can be inferred by the presence of sparse microbial mat layers. The Puigventós locality presents similarities with the nearby Collcardús tracksite (Mujal et al., 2015), which suggests that the setting was a distal alluvial plain that underwent periodic desiccation. This is in agreement with a terrestrialization trend as the described in the Penya Rubí locality, as well as with the palaeogeographic reconstructions and diagrams by Ortí et al. (2018). That is, towards the NE of the Catalan Basin the Guanta Sandstone was developed in earlier stages of the Middle Unit than in the rest of the basin.

3. The Montmany locality (Fig. 4B–J of the main text)

The outcrops of Montmany are a reminiscent of those of Puigventós. The entire succession is around 70 m thick (see Figaró section of Ortí et al., 2018, geographically close to the Montmany succession). The succession is composed of red bed deposits consisting of alternated mudstones and very fine-grained sandstones with tabular fine- to medium-grained sandstones. In the study area, the lower half of the succession is partially covered, and outcrops are better exposed towards the top of the unit, where footprints become more abundant.

The fine- to medium-grained sandstone beds are around 15–20 cm thick in average. They are often laminated, displaying climbing, wave and unidirectional ripples; occasionally low angle cross stratification is also observed, together with small soft pebbles (corresponding to mud fragments eroded from the underlying substrate and incorporated into the sandy bed). A fining-upwards trend is generally observed within each sandstone bed, though coarsening-upwards beds are also present. Sometimes sequences of successive multiple sandstone strata occur, with wave ripples present on top of each bed. Footprints are often preserved on the basal surface of sandstones, thus they are most commonly in convex hyporelief. Tracks are usually deeply impressed, suggesting that the original substrate was muddy and with high water content. The only tracks in concave epirelief within sandstones are a tiny manus-pes set (each track ~1 cm long) of *Rhynchosauroides*. The finer grained intervals, correspond to mudstones, which are usually finely laminated. They are interbedded with thin layers (2–3 cm thick) of very fine-grained sandstones with relatively abundant micaceous minerals and very finely laminated.

Additional structures of the sandstone strata are: invertebrate bioturbation consisting of horizontal sinuous burrows with meniscate infilling together with vertical burrows, all with circular transverse section, they together indicate sudden flooding after periods of low energy; surfaces covered by bulbous structures potentially corresponding to MISS are seldom present (occurring in fine- to very fine-grained sandstones), being also indicative of low energy deposition and drought periods; desiccation cracks and moulds of gypsum crystals or nodules, indicative of desiccation periods, as well as moulds of hopper crystals, indicative of salty waters; load and water escape structures, indicative of rapid flooding and sedimentation.

Noteworthy, a distinct interval has been identified within the red bed succession: it consists of a 25 cm thick massive carbonate layer with abundant *Rhynchosauroides tirolicus* footprints on the top surface. This stratum is bounded by very fine-grained sandstones with unidirectional ripples at the base and by very fine-grained sandstones with wave ripples at the top, subsequently followed by alternating micaceous very fine-grained sandstones and mudstones.

The transition with the upper Muschelkalk facies is characterised by a thinning of the strata and a change from reddish to whitish-yellowish-ochre coloration, eventually appearing the thick carbonate layers.

As a whole, most of the sedimentary features of the Montmany succession correspond to the Guanta Sandstone, with a palaeoenvironmental setting resembling an alluvial plain with salty waters, i.e., most likely being a proximal sabkha plain as the Puigventós succession. The very fine-grained interval encompassing the distinct carbonate layer could correspond to a seam of the Arbolí Gypsum, as noted by Ortí et al. (2018) in their section named Figaró; in fact, the stratigraphic position of this interval fits well with our field observations.

A final remark regarding the track-bearing slab MGSB-26310 must be taken into account. This specimen has a label indicating that it was found between Montmany and Puiggraciós; according to the geographic position of these place names, we suspect that this historical finding comes from the same outcrops as the material that we discovered in the new track locality of Montmany. However, we cannot completely rule out that this slab comes from a different (nearby) area.

Text S2. Systematic palaeontology

Ichnogenus *Procolophonichnium* Nopcsa, 1923

Ichnospecies *Procolophonichnium haarmuehlensis* (Holst et al., 1970)

Material. From Penya Rubí, an incomplete trackway composed of three footprints (left manus and the consecutive right manus-pes set, in part-counterpart slabs, IPS106616a, b) (Fig. S1A–C) and one isolated footprint in convex hyporelief (IPS106601b) (Figs. 5A, S1D).

Description. The most complete ichnite (IPS106601b) is pentadactyl and semiplantigrade, slightly wider than long (Figs. 5A, S1D). The right manus-pes set of IPS106616 is unguligrade to digitigrade, mostly preserving the claw impressions of digits I to IV, and shows no impression of digit V (Fig. S1A, B). The left manus of IPS106616 is semiplantigrade to plantigrade, preserving impressions of digits II to V (Fig. S1A, C). Footprints are characterised by elongated, moderately robust and straight to slightly distally bent laterally digit impressions with deep claw impressions that are laterally elongated into drag traces, giving the digit tips a T-shape. Digit impressions increase in length from I to III, being digit I imprint much shorter than digit II. The digit IV impression is subequal in length to digit III. The digit V impression is slightly longer than digit I. Digit V is separated from the other digits, being slightly proximally positioned and rotated outwards. The proximal imprint of the palm/sole, as preserved in IPS106601b, is markedly convex, being longer behind digits IV and V (Figs. 5A, S1D). Scale imprints are also preserved. Squamation of the digits is represented by 3–4 rows of rounded scales, disposed in parallel to the main axis of each digit. At the edges of the digits, the scales show an elongated and flattened shape on IPS106601b. The squamation in the palm or sole is ornamented with slightly laterally elongated scales organised in rows perpendicular to the footprint longitudinal axis. These scales are slightly larger than those of the digits. Scales in the partially impressed limb (Figs. 5A, S1D) are as those of the palm or sole impression.

Remarks. All track features, including being pentadactyl, with straight to distally bent laterally digit imprints and deep claw impressions that are characteristically bent outwards, are diagnostic of *Procolophonichnium haarmuehlensis*. This ichnospecies is known from several Lower and Middle Triassic localities from the Buntsandstein and Muschelkalk facies of the Germanic Basin in Germany and the Netherlands (Klein et al., 2015). The ichnogenus is also known from the Middle Triassic of France and northern Italy, the Moenkopi Group of Arizona and Utah (USA) and the Timezgadiouine Formation (T4) of the Argana Basin (Morocco) (see Klein et al., 2015 for a review; Table S1). It is especially well-represented and abundant in the Muschelkalk deposits of Winterswijk, the Netherlands, and Germany (Demathieu and Oosterink, 1983, 1988; Diedrich, 2002, 2008; Klein et al., 2015). The skin impressions identified in the Penya Rubí tracks display the same pattern as those reported by Demathieu and Oosterink (1988) and Klein et al. (2015). The potential trackmakers could correspond either to procolophonid parareptiles or therapsid synapsids (Klein et al., 2015; Marchetti et al., 2019). A review of this ichnotaxon, including analysis of footprint relative depth patterns (e.g., Mujal et al., 2020) may help to identify the most probable trackmakers.

Ichnospecies *Procolophonichnium* isp.

Material. From Montmany, one isolated right track in convex hyporelief (IPS120440) (Fig. 5B), and two isolated tracks in convex hyporelief (MGSB-26310) (Fig. S2).

Description. Small ichnites, slightly wider (7.5–13 mm) than long (6.9–10 mm) plantigrade and pentadactyl, corresponding to right (Figs. 5B, S2B) and left (Fig. S2C) footprints. The digit III impression is the longest, followed by digit IV, digit II and digit I. The digit V impression is subequal to digit I in length. All digit impressions are straight, notably divergent and clawed. In digits I to IV the tip imprints are the deepest parts. The impression of digit V is proximally positioned and has a higher angle of divarication respect the other digit impressions, being rotated outwards. The palm or sole behind the digit traces II, III and IV is represented by a relatively deep, oval-shaped and slightly wider than long impression. The proximal part of the digit I impression is connected to the medial side of the palm/sole. The proximal part of the digit V impression is connected to the postero-lateral side of the palm/sole.

Remarks. The general proportions of the footprints are comparable to those of *Procolophonichnium*, being most similar to *P. haarmuehlensis* (see Klein et al., 2015). Because this material is isolated and incompletely-preserved, an open nomenclature is preferred. Two main differences are found with the tracks from Penya Rubí: the Montmany ones are much smaller than the former, with a much more distinct impression of the palm/sole, and the digit imprints are proportionally stouter than in *P. haarmuehlensis*. Of note, these tracks are also reminiscent of the manus imprints of *Coelurosaurichnus ratumensis*, known from Winterswijk (Demathieu and Oosterink, 1988), though this ichnotaxon is much larger and has thicker manus digit imprints than the tracks from Montmany. However, as recently noted by Marchetti et al. (2019), the ichnites from that locality could indeed correspond to *P. haarmuehlensis*, thus in agreement with our interpretation. The relatively deeply impressed lateral portion of the footprints, with digits IV and V well defined, also supports therapsid synapsid trackmakers (Klein et al., 2015; Marchetti et al., 2019), in agreement with the functional prevalence groups proposed by Mujal et al. (2020).

Ichnogenus *Chelonipus* Rühle von Lilienstern, 1939

Ichnospecies *Chelonipus* isp.

Material. From Puigventós, trackway in convex hyporelief (IPS110268) (Figs. 5C, S3). From Montmany, a manus-pes set in convex hyporelief and isolated scratch traces (MGSB-26310) (Fig. S2A, D).

Description. Semidigitigrade tracks, associated with semiplantigrade to plantigrade tracks, with a trailing/dragging component of the digit tips. Some tracks are pentadactyl, others tetradactyl and the shallowest ones are tridactyl. The pentadactyl and tetradactyl tracks are composed of roundish impressions, corresponding to the digit tips, outlining a proximally concave arch. A digit tip drag trace is present in each of the three central digits. These are the most impressed parts (Fig. S3A'). Scratches are parallel to subparallel. The interdigital area is also impressed (Fig. S3C), denoting relatively short digits of the trackmaker. An expulsion rim is located in the proximal part of the digit tip impressions. The pentadactyl pes footprint on MGSB-26310 (Fig. S2D) displays an oval, wider than long impression of the sole that is not connected to the digit impressions. The tridactyl footprints correspond to impressions of the digit tips dragged on the surface, showing the same pattern as those of IPS110268 (Figs. 5C, S3). The anterior part of each scratch is pointed, whereas the posterior part is roundish, giving it the shape of an elongated raindrop. Within each tridactyl track, the two inner scratches are connected by a shallow impression to the proximal part (Fig. S3B). From the inner to the outer side, the scratches reach a more distal position. The identified (partial) trackway (IPS110268) (Fig. S3A) shows an irregular pattern, with no clearly recognised manus and pes tracks nor sets. Nevertheless, a wide gauge, with very low pace angulations can be inferred.

Remarks. The relatively wide tracks with roundish digital impressions and common digit scratches, the impression of the interdigital area between digits II, III and IV and the relatively wide trackway pattern are diagnostic features of *Chelonipus*. This ichnogenus is known from the Lower–Upper Triassic of the Germanic Basin (Germany) and the Moenkopi Formation (USA) (Haubold, 1971a; Lovelace and Lovelace, 2012; see Lichtig et al., 2018 for a review); it could also be present in Middle Triassic deposits of France, with tracks assigned to the ichnogenera *Chelonichnum* and *Chelichnus*, which may be junior synonyms of *Chelonipus* (see Gand et al., 2007). The small sample precludes any ichnospecific determination, as potential (extra-) morphological and gait variation within tracks and trackways would elucidate the actual morphological features (cf. Lichtig et al., 2018). Tracks of this ichnogenus have been traditionally correlated to turtles as potential producers. However, considering the skeletal record of the group and its evolution (e.g., Schoch and Sues, 2015), other potential trackmakers of *Chelonipus* cannot be discarded, especially for the Lower and Middle Triassic specimens. In this way, potential candidates could be small- to medium-sized temnospondyl amphibians (e.g., Mujal and Schoch, 2020), although other unknown producers cannot be ruled out. Considering the relative depth of the footprints herein reported, with digits II, III and IV as the most deeply impressed, the potential trackmakers would point to diapsid reptiles (see Mujal et al., 2020), but considering the small track sample, any identification of the trackmaker for the Catalan footprints should be taken with caution.

Ichnogenus *Rhynchosauroides* Maidwell, 1911

Ichnospecies *Rhynchosauroides tirolicus* Abel, 1926

Material. From Penya Rubí, multiple tracks and manus-pes sets (but no trackways), often including both parts and counterparts of specimens from IPS106601 to IPS106605, from IPS106607 to IPS106618, from IPS107033 to IPS107040 and from IPS110273 to IPS110290 (Figs. 3G, H, 5D, E, S4). From Puigventós, multiple tracks on specimens IPS110265 (including manus-pes sets; Fig. S5), IPS110269 and both part and counterpart of an isolated track on IPS110267. From Montmany, multiple tracks left *in situ*, including also manus-pes sets, in concave epirelief on a carbonate layer, one manus-pes set including both part and counterpart slab (IPS120442), and two small manus-pes sets in concave epirelief (IPS120439) (Fig. 5F).

Description. Tracks of highly asymmetrical, ectaxonic and lacertoid shape, pentadactyl and longer than wide, with manus imprints (ca. 20–30 mm long) being smaller than pes tracks (ca. 30–40 mm long). All digit impressions show claw traces with oval to circular shape, commonly slightly separated from the digit impressions. Manus tracks are mostly semiplantigrade (occasionally semidigitigrade), whereas pes tracks are mostly semidigitigrade (occasionally semiplantigrade); both manus and pes tracks are occasionally unguligrade (i.e., only preserving digit tip impressions). The manus digit impressions are proportionally shorter and wider than those of pes tracks. Digit impressions are curved inwards and increase in length from I to IV in both manus and pes imprints. In manus tracks, the digit I impression is slightly proximally positioned respect to digits II, III and IV; the digit V impression is similar to digit I in length, rotated outwards and in some cases posteriorly oriented; the digit V impression is markedly proximally positioned respect to digits I to IV. Differing from manus tracks, in pes tracks, the digit IV is markedly longer than the digit III. In both manus and pes tracks digits II to IV are the most deeply impressed. In fact, some pes tracks only preserve impressions of digits II to IV (Figs. 3G, H, 5E, F, S4H, J).

Phalangeal pad impressions are preserved in some specimens, both including manus and pes impressions, but only in the manus tracks the phalangeal pad formula can be confidently assessed as 2-3-4-5-3, though pes tracks may have a similar phalangeal pad formula (Fig. S4A, E, H). Some manus footprints, especially those more deeply impressed, display digits I and V rotated and curved backwards (Fig. S4E, H, J). All these features are well-visible in the track sample from the Penya Rubí locality and in the tracks on the carbonate layer from the Montmany locality. Instead, tracks from the Puigventós locality are mostly digitigrade to semidigitigrade. The tracks on IPS110265 from Puigventós (Fig. S5) are larger than all those from the Penya Rubí locality and have a greater divarication between digits, thus potentially corresponding to a different morphotype (see discussion below). The other tracks recovered in Puigventós (IPS110267 and IPS110269) are similar, both in shape and size, to those of Penya Rubí locality. The tracks from the red laminated fine- to very fine-grained sandstones from the Montmany locality are also different in shape to those of Penya Rubí. The tracks from the manus-pes set on IPS120439 (Fig. 5F) are <10 mm long, preserving only three subparallel thin digit impressions, and the pes track is posterolaterally positioned respect to the manus track. The semidigitigrade manus-pes set on IPS120442 is partially preserved, digit impressions from both manus and pes tracks are relatively more robust than those of Penya Rubí, and their tips display small pointed claw traces; the pes track is at lateral side of the manus track.

Skin impressions are preserved in several tracks from Penya Rubí locality (IPS106601, IPS106602, IPS106604, IPS106605, IPS106606, IPS106616). Scale prints are mainly represented in manus traces (Fig. S4A–D, F, H–K), but they are also present in some pes tracks (Fig. S4G, I, J, K). Both sole and palm impressions (though shallowly impressed) display granular to polygonal squamation. The scale pattern of the impressions of digits I to IV consists of granular scales arranged in rows of 2–3 scales perpendicular to the digit axis. Scale impressions of manus digit V consist in overlapped, laterally elongated scales with pointed extremes (of triangular shape), which gives a laterally elongated hexagonal shape perpendicular to digit axis (Fig. S4B). Scales of digit V are relatively thicker than those from the other digits. In more deeply impressed footprints (e.g., Figs. 5D, S4D), scales are apparently rectangular, organized in rows with the long side perpendicular to the digit axis (Fig. S4G, I, J, K). Pedal digit V scales are rectangular to quadrangular, with a shallow ridge perpendicular to the digit axis in the middle part (Fig. S4G, I).

Trackways or complete step cycles have not been identified. In most manus-pes couples, pes tracks anterolaterally overstep manus tracks, although in a few cases pes tracks are in a posterolateral position respect to manus tracks.

Remarks. The lacertoid, ectaxonic shape of the tracks, with slender digit impressions increasing in length from I to IV and being curved inwards and with the digit V impression proximally positioned and outwardly rotated, are diagnostic features of *Rhynchosauroides*. This is a common tetrapod ichnogenus in Triassic tetrapod track assemblages and encompasses a wide diversity of ichnospecies, although it is in need of a comprehensive revision (Haubold, 1971a; Hunt and Lucas, 2007; Klein and Niedźwiedzki, 2012; Mujal et al.,

2018) (cf. Table S1). The morphologic features of most of the specimens herein described match those from the nearby Pedrera de Can Sallent tracksite (Mujal et al., 2018). From the Collcardús tracksite, Mujal et al. (2015) described an isolated *Rhynchosauroides* footprint, but its poor preservation (with not all the digits well-impressed and some broken –and weathered– parts) precludes any further inference and comparison with the tracks herein reported. Avanzini and Renesto (2002) described two patterns of skin impressions for Middle Triassic *Rhynchosauroides*: *R. tirolicus* displays elongated scales disposed perpendicular to the main axis of the digit; *R. peabodyi* is composed of small quadrangular scales (Avanzini and Renesto, 2002:fig. 5; but see also Diedrich, 2008, who considered these two morphotypes as belonging to a single ichnospecies). The scale prints herein described are similar to those of *R. tirolicus* (Fig. S4). Furthermore, the general shape, size and digit proportions of the Catalan tracks (including those from Penya Rubí, Pedrera de Can Sallent, those from the carbonate layer of Montmany and Puigventós – potentially with the exception of those on IPS110265, IPS120439 and IPS120442) fit those of *R. tirolicus* (see Avanzini and Renesto, 2002; Valdiserri and Avanzini, 2007). As discussed in section 5 of the main text, *Rhynchosauroides* usually dominates coastal palaeoenvironments, though it is found in a wide range of settings (Diedrich, 2002, 2008; Mujal et al., 2018) (Table S1). More specifically, *R. tirolicus* is a remarkably common morphotype of the carbonate coastal (commonly tidal) deposits of Italy (Avanzini and Renesto, 2002; Mietto et al., 2020). The trackmakers of *Rhynchosauroides* may correspond to a relatively wide range of taxa, most likely being small neodiapsids (as indicated by the tridactyl functional prevalence, see Mujal et al., 2020), including lepidosauromorphs and/or archosauromorphs (e.g., Avanzini and Renesto, 2002; Diedrich, 2002, 2008; Mujal et al., 2018).

Ichnogenus *Rotodactylus* Peabody, 1948

Ichnospecies *Rotodactylus* isp.

Material. From Penya Rubí, two isolated footprints on two slabs preserving both parts and counterparts (IPS106606, IPS107033) (Figs. 3G, S6A, B). From Puigventós, two isolated footprints in convex hyporelief in IPS110270 (Fig. S6C) and several footprints in convex hyporelief on slab IPS110269 (Fig. S8).

Description. Footprints are digitigrade and pentadactyl. Impressions of digits II, III and IV present an increasing length and are straight to slightly curved inwards. The digit tips display rounded claw impressions markedly bent inwards. These three digit impressions are parallel to subparallel and form a compact group with a relatively indistinct boundary between each impression; the metatarso-phalangeal area is closely bunched, forming a straight line sometimes oblique to the digit long axis (oblique cross-axis). Digit I is mostly represented by a shallow rounded impression corresponding to the tip, and it is much shorter than the other digits. The digit V is solely represented by the digit tip, which is far proximally positioned respect to the other digits.

Remarks. The general shape, with digits I to IV in increasing length and being parallel and straight to slightly curved inwards, and with digit V trace positioned far posteriorly from digit group I–IV, are diagnostic features of *Rotodactylus* (e.g., Peabody, 1948; Haubold, 1971a; Niedźwiedzki et al., 2013). Most of these tracks could correspond either to pes or manus impressions, as they are isolated, but the left track in Fig. 5C corresponds to a pes impression given its large length. An ichnospecific assignation is precluded due to the isolated nature of the material. *Rotodactylus* tracks are usually attributed to dinosauromorphs. With the introduction of the ichnogenus (tracks from Olenekian–Anisian of the Moenkopi Formation, Arizona, USA), Peabody (1948) recognised similarities of *Rotodactylus* tracks with dinosaur-like archosaurs. Haubold (1967, 1999) considered lagosuchid dinosauromorphs as trackmakers of *Rotodactylus* by correlating trackways with skeletons, noting the importance of trackways that show a continuous lateral overstep of the manus by the pes and long strides. This attribution was further supported by Haubold and Klein (2002). More recently, Brusatte et al. (2011) and Niedźwiedzki et al. (2013) (and references therein) proposed dinosauromorphs as potential trackmakers, correlating *Prorotodactylus* and *Rotodactylus* tracks with the pes of *Lagerpeton,* as previously done by Haubold (1999) and Haubold and Klein (2002). Contrary to this interpretation, Padian (2013) suggested that the most probable trackmakers of *Rotodactylus* (and *Prorotodactylus*) correspond to non-dinosauromorph archosauromorphs, arguing that tracks of these ichnogenera do not match with the pes of the dinosauromorph *Lagerpeton*, because it would have produced digit impressions with different relative lengths than those of *Rotodactylus*, and the pedal digit I of *Lagerpeton* would only have been impressed with a plantigrade posture, a feature not observed in the ichnogenus. Thus, at this point, further track-trackmaker correlations may be necessary to confirm or reject the hypothesis of dinosauromorphs as trackmakers of *Rotodactylus*.

Ichnogenus *Chirotherium* Kaup, 1835

Ichnospecies *Chirotherium sickleri* Kaup, 1835

Chirotherium cf. *sickleri*

Material. From Montmany, two manus-pes sets in convex hyporelief (MGSB-26310) (Figs. 6A, S2A, D).

Description. Pes tracks are markedly longer (ca. 39–45 mm long) than manus (ca. 17–20 mm long) tracks; both manus and pes impressions are much longer than wide. Pes impressions are semiplantigrade and pentadactyl. The digit III impression is the longest, followed by digit IV, while the digit II impression is much shorter. These three digits impressions form a compact group. The digit I impression is the shortest, being in a slightly proximal position respect to digits II to IV. Digits I to IV impressions are straight and anteriorly directed. The digit V impression is similar in length to digit I; it is proximally positioned, separated from the anterior group I to IV and rotated outwards. Manus tracks are semidigitigrade and pentadactyl. The relative digits length is analogue to the pes tracks. The relative position of the digit impressions is also similar, with digit V proximally positioned and rotated outwards. Within couples, manus and pes impressions are in line, with manus tracks much anteriorly positioned respect to pes tracks.

Remarks. The shape of the footprints, with the characteristic compact group of digits I–IV, being straight and nearly parallel, and the proximally positioned and turned outwards digit V, the relative digits length, with digit III as the longest and digit I much shorter than digits II and III, are diagnostic features of *Chirotherium* (e.g., Haubold, 1971a, 2006). The relatively small size of these footprints and the relatively elongated tracks, with pedal digit I only slightly separated from the digit II–IV group and pedal digit IV longer than digit II are characteristic of *C. sickleri* (e.g., Haubold and Klein, 2002; Klein and Lucas, 2010a), an ichnospecies first described by Kaup (1835) from the Buntsandstein ("Thüringischer Chirotheriensandstein", Anisian) of Hildburghausen, Germany, co-occurring with *C. barthii* (see also Haubold, 1971b). Another feature of *C. sickleri* is that the pes imprint seems to be more outward rotated relative to the manus imprint, being the opposite in *C. barthii* (e.g., Klein and Lucas, 2010a; Klein et al., 2016); in the Montmany specimens, the pes tracks are slightly outward rotated relative to the manus tracks. However, due to the poor preservation of morphologic details, this ichnospecific assignment should be taken with caution, as the footprints are smoothed (possibly due to water currents soon after their impression). The potential trackmakers are possibly "rauisuchian" (pseudosuchian) archosauriforms (Klein and Lucas, 2010a).

Ichnospecies *Chirotherium barthii* Kaup, 1835

Material. From Puigventós, one left pes track in convex hyporelief (IPS85803) (Figs. 6B, S7A–F) and one left manus-pes set in convex hyporelief, not recovered (Fig. S7G). From Penya Rubí, one left manus-pes set in convex hyporelief, not recovered (Fig. S7H).

Description. Three tracks have been identified from the new localities. The description is based on the only one that is complete (IPS85803), with additional remarks from the other two specimens (which are coupled with partially preserved manus tracks). The Puigventós track IPS85803 (Figs. S6B, 7A–F) is a longer (15.7 cm) than wide (9.1 cm), pentadactyl and semiplantigrade left pes imprint. Digits I to IV impressions are robust and straight, distally tapering with elongated triangular, sharp claw traces (Fig. S7B, C). Digit III impression (8.5 cm) is the longest, followed by digits II (8.2 cm) and IV (7.8 cm); digit I (5.9 cm) is the shortest, and digit V (6.5 cm) is slightly longer than digit I. Digits I to IV impressions form a compact group, but digit I is more proximally positioned than digits II to IV. Digits II, III and IV impressions are characterised by three phalangeal pads, whereas digits I presents two phalangeal pads. The proximal metatarso-phalangeal impression of digits II to IV draws a straight to slightly proximally concave line (perpendicular to the digits axis). The digit V impression is in a more proximal position than and separated from the digit I–IV group, and it is slightly curved and rotated outwards. The digit V impression displays a relatively wide and deep, oval-shaped, proximal basal pad impression, followed by a thinner phalangeal impression of the middle-distal portion. In IPS85803, the digit I impression is the deepest, followed by digit II and the proximal pad of digit V; digit IV is the shallowest digit impression, and the sole impression is the shallowest part of the footprint (Fig. S7A’). The distal phalangeal pads of digits I to IV are the most deeply impressed parts of each digit. IPS85803 also preserves skin impressions. The scale impressions tend to be granular, non-overlapping and square- to hexagonal-shaped. There are two different patterns of scale arrangement in the footprint: in the digit impressions, scales (0.8–1 mm in diameter) are arranged in rows parallel to the digit long axis (Fig. S7D); in the sole, scales (~1.5 mm in diameter) show no particular arrangement, though each scale is surrounded by six other scales of the same size, giving them a hexagonal appearance (Fig. S7E). The size of the scales gradually changes from the proximal phalangeal pad to the sole. On the left border of digit IV, scale impressions are elongated, with a perpendicular orientation to the horizontal axis of the footprint (Fig. S7F), indicative of a foot dragging through the substrate during the impression and take-off phases (see discussion in Díaz-Martínez and Pérez-García, 2012). The other two additional footprints (not recovered) are incomplete and show no skin impressions. However, the left pes track (~15 cm long, ~9 cm wide) from Puigventós locality, with well-defined claw marks and a faint outline of the pad impressions (Fig. S7G), and the partially preserved left pes track (~12 cm long, ~8 cm wide) from Penya Rubí locality (Fig. S7H) display the main features of IPS85803. In addition, both tracks are associated with much smaller impressions immediately in front of them, corresponding to manus tracks (of the same manus-pes sets). The Puigventós manus track is only represented by three faint impressions with elongated shape (most probably corresponding to digits II, III and IV). The Penya Rubí manus track preserves digits I, II, III and IV, being digits II and III subequal in length and more deeply impressed.

Remarks. The shape and size of the pes tracks, with the characteristic compact group of digits I–IV and digit V separated from the others and in a more proximally positioned and curved outwards, the relative length of the digits, with digit III the longest, followed by digits II and IV, and digit I much shorter, and the associated manus tracks are diagnostic features of *Chirotherium*, a common and globally distributed ichnogenus from Lower to Middle Triassic continental deposits (Haubold, 1971a, 1984, 2006; Klein and Haubold, 2007; Klein and Lucas, 2010a, 2010b; Lagnaoui et al., 2019; Xing and Klein, 2019). *Chirotherium* tracks have already been reported from the nearby Collcardús tracksite by Mujal et al. (2015). The features of the pes tracks herein reported (especially from IPS85803), including the digit length proportions, with digit III the longest and the shorter digit II followed by digit IV, the relative position of digit I, being slightly separated than and more proximally positioned from digits II–IV, the large and deeply impressed proximal pad of digit V, followed by the thinner impressed distal portion that is bent outwards, and the size of the triangular claw impressions, fall into the range of *C. barthii* (e.g., Haubold, 1971b, 2006), a very characteristic morphotype of this ichnogenus originally described from the Buntsandstein ("Thüringischer Chirotheriensandstein", Anisian) of Germany (Kaup, 1835; Haubold, 2006). Therefore, we refer these tracks to this ichnospecies. The skin impressions display the same pattern as others reported in the literature for the chirotheriid group (e.g., Avanzini, 2000; Fichter and Kunz, 2004; Díaz-Martínez and Pérez-García, 2012; Klein and Niedźwiedzki, 2012; Klein et al., 2013; Díaz-Martínez et al., 2015; Diedrich, 2015; Klein and Lucas, 2018). The trackmakers of *C. barthii* are commonly attributed to pseudosuchian archosaurs (Haubold, 2006), or to stem archosaurs (Klein et al., 2011); the latter may correspond to the stem line that later evolved to the dinosaur lineage (Haubold and Klein, 2000, 2002; Klein and Haubold, 2003).

Ichnogenus *Isochirotherium* Haubold, 1971a

Ichnospecies *Isochirotherium coureli* (Demathieu, 1970)

Isochirotherium cf. *coureli*

Material. From Puigventós, isolated and partially preserved left pes footprint in convex hyporelief (IPS110269) (Figs. 6C, S8).

Description. Semiplantigrade to digitigrade, pentadactyl, longer (11.4 cm) than wide (~7.5 cm) left pes footprint. Impression of digit III is the longest, followed by the slightly shorter digit II imprint, digit IV imprint is notably shorter than digit II, digit I imprint (a faint impression overprinted by a *Rotodactylus* track) is shorter than digit IV. Impressions of digits I to IV are straight and subparallel, with relatively large and rounded claw impressions (separated from the rest of the digit impressions) and with a wide, elongated and oval-shaped distal pad imprint. The metatarso-phalangeal area of digits II, III and IV impressions is outlined by a slightly proximally concave line. Digit V is represented by an oval impression, situated behind the digit group I to IV, being separated from the latter. The digit V impression is laterally oriented and slightly bent outwards. The deepest impressed part of each digit corresponds to their mid-distal portions.

Remarks. The shape and size of the footprint, with digit III only slightly longer than digit II and digit IV much shorter, are diagnostic features of *Isochirotherium* (see Haubold, 1971a), which is known from Olenekian to Ladinian localities (e.g., Gand et al., 2007; Avanzini and Cavin, 2009; Klein and Lucas, 2010b). Another distinctive feature of *Isochirotherium*, differing from other chirotheriid ichnogenera, is the very small size of the manus imprints relative to the pes tracks (Haubold and Klein, 2002); however, this cannot be assessed in the described specimen, as the manus imprint is not preserved. The outline of the impression of digits I to IV resembles that of *I. coureli* (see Klein and Lucas, 2018). This ichnospecies, particularly well-known from several basins of the Western Tethys (e.g., Gand et al., 2007; Klein et al., 2011; Klein and Lucas, 2018), displays a very large impression of the proximal pad of digit V. However, this feature cannot be confirmed for the Puigventós track, as the slab edge is crossing the digit V impression and thus precludes a confident identification. Nonetheless, the outline of this impression suggests a large pad. *Isochirotherium* tracks have already been identified from the nearby Collcardús tracksite (Mujal et al., 2015). One of the Collcardús specimens (*I*.3 in Mujal et al., 2015) displays a large pad of digit V, closely resembling that of *I. coureli* specimens. Considering all these features, all *Isochirotherium* tracks of the Catalan Basin are conferred to *I. coureli*. The trackmakers of this ichnogenus may be referred to archosaurs similar to those of

Chirotherium. Nonetheless, as noted by Klein and Lucas (2010a), the relatively short imprints of pedal digits I and IV with longer digits II and III of *Isochirotherium* have no skeletal counterpart so far.

Ichnogenus *Sphingopus* Demathieu, 1966

Ichnospecies *Sphingopus ferox* Demathieu, 1966

Material. From Montmany, two manus-pes sets and a pes track in a single slab (but from different trackways) (IPS120435) (Figs. 6D, S9A), six isolated pes tracks (IPS120433, IPS120434, IPS120441, IPS120443) (Fig. S9B, C), including a part-counterpart slab (IPS120437), all in convex hyporelief, and multiple tracks, mostly partially preserved in convex hyporelief (not recovered). From Puigventós, one isolated partial right pes track in concave epirelief (IPS110266) (Fig. S9D).

Description. Semiplantigrade to digitigrade pentadactyl pes footprints with elongated slender shape, markedly longer (7.5–11.2 cm) than wide (4.6–6.1 cm). Digit III imprint is the longest and the widest, digit II imprint is shorter than digit III and slightly longer than digit IV, but digit IV imprint is wider (more robust) than digit II imprint. Digit II, III and IV imprints are relatively elongated and distally tapering; they form a compact group, with nearly no separation between digit imprints and with a relatively narrow angulation between digits II and IV (27º–38º, with a mean of 31º). Digit I imprint is more proximally positioned respect the digit II–IV group, partially superimposed to the base of digit II imprint, and outwardly oriented. Digit I to IV imprints are oval-shaped, being digit III proportionally the widest. Imprints of digits II to IV may outline two phalangeal pads each (Figs. 6D, S9A, D). Digits I to IV imprints display claw traces of round (Figs. 6D, S9A, D) to anteriorly elongated oval-triangular (Fig. S9B, C) shape. Digit V imprint is separated from the other digit imprints, in a marked proximal position, it is rotated and bent outwards, and with its base at the height of digit IV imprint. Imprints of digits I to IV seem to display two phalangeal pads each; digit V imprint outlines a wide proximal pad with a thinner distal portion. Imprints of digits II, III and IV are deeper on their distal portions, being digit III imprint the deepest, followed by digit II imprint, and digit IV imprint notably shallower. Digit I and V imprints are the shallowest. Two pes tracks on IPS120435 (from different trackways; Figs. 6D, S9A) have associated digitigrade manus impressions. The manus imprints are notably smaller than the pes impressions. They are nearly as wide as long and preserve four digit imprints, most likely corresponding to digits II to IV. If so, digit II imprint is subequal in length to digit III, which is the deepest; imprint of digit IV is notably shorter than digit II; digit I might be represented by a faint and short impression. The manus track is slightly anteriorly positioned respect to the pes track, at its inner side and at the height of digit III.

Remarks. The longer digit III imprint respect to digits II and IV, the divarication angle, and the trend towards a functionally tridactyl (digits II–IV) pes track are features reminiscent of both *Sphingopus* and *Chirotherium* (e.g., Haubold and Klein, 2000, 2002; Klein and Lucas, 2018), and partially of *Parachirotherium* as well, though this latter ichnogenus displays a higher digits II–IV angulation (Haubold and Klein, 2002; Zouheir et al., 2020). The relatively low angle of digits II and IV (<30º) suggests an attribution to *Sphingopus*. Of note, Klein and Lucas (2018) considered *Sphingopus* a junior synonym of *Chirotherium* (awaiting a comprehensive revision of chirotheriid ichnotaxonomy), because both ichnogenera share several characters, including: "(1) pentadactyl, functionally tridactyl (II–IV) pes with digit III longest; (2) pedal digit V distally curved backward; (3) manus with dominance of digits II, III, and IV, with IV being laterally abducted; and (4) similar trackway measurements" (Klein and Lucas, 2018:168). Therefore, awaiting a further ichnotaxonomic revision, we classify these footprints as *Sphingopus*. The tightly packed pedal digits I to IV imprints, the pedal digit II imprint slightly longer than digit IV, the oval-shaped, relatively wide, pedal digit imprints (especially digit III), and the position of the manus track at the inner side of the pes track are diagnostic features of *S. ferox*, known from the Ladinian of France (Demathieu, 1966, 1985) and the Anisian of Germany (Haubold and Klein, 2002; Klein and Lucas, 2018), and Poland (Brusatte et al., 2011). Such features differ from *S. ladinicus*, from the Anisian of Italy (Avanzini and Wachtler, 2012; Mietto et al., 2020), which instead is a much larger morphotype, with a pedal digit IV imprint longer than digit II, and digit impressions are proportionally thinner and less packed (no superimposition of digit imprints) than in *S. ferox* tracks (Avanzini and Wachtler, 2012). Therefore, we refer the Catalan middle Muschelkalk tracks to *S. ferox*. Note that from the Puigventós locality this ichnotaxon is only represented by a partial footprint; however, the length of the elongated oval-shaped digits, their relative propotions, and their angulation fall within the range of the tracks from the Montmany locality. Therefore, we consider that all these tracks correspond to the same ichnospecies. *Sphingopus* tracks are attributed to dinosauriform trackmakers on the basis of the functionally tridactyl pes tracks (digits II–IV), the cursorial gait inferred from the wide pace angulations and long strides from trackways, and the trend to bipedalism (i.e., lack of manus impressions in some trackways (Haubold and Klein, 2000, 2002; Brusatte et al., 2011). Nonetheless, further synapomorphy-based approaches to identify the potential producers, together with a revision of the ichnotaxonomic status of this track morphotype (Klein and Lucas, 2018), are necessary to confirm this attribution.

Chirotheriid tracks indet.

Chirotheriidae indet.

Material. From Puigventós, an isolated right manus track in convex hyporelief (not recovered) (Fig. S10A); an isolated incomplete track in concave epirelief (IPS110271) (Fig. S10B), and an isolated incomplete track consisting of three digit scratches in convex hyporelief (IPS110270). From Montmany, an isolated scratch track in convex hyporelief (MGSB-26310) (Fig. S2A, D), an isolated manus track including a part-counterpart slab (IPS120443), a large, partially preserved pes track in convex hyporelief (IPS120438), and several partially preserved pes tracks not recovered (Fig. S10C).

Description. A right semiplantigrade manus footprint, 5.4 cm long and 5 cm wide, preserves imprints of digits II, III, IV and V (Fig. S10A). Digit III imprint is the longest, digit IV imprint is slightly shorter than digit III, followed by digit II imprint, while digit V imprint is the shortest. Two phalangeal pad impressions are distinguished in digits II, III and IV. Depth of digit imprints decreases from II to V. Expulsion rims are present between digit imprints, giving the ichnite a roundish outline. The partial track in IPS110271 (Fig. S10B) is composed of three straight, relatively deep and thin grooves with a small lateral expulsion rim where they converge. These traces may correspond to clawed digit tips dragging the surface; they were impressed from the distal (anterior, divergent end) to the proximal (posterior, convergent end) position of each trace, as indicated by the expulsion rim. Two of the scratch traces (possibly representing digits II and III) are more distally positioned than the third one (possibly representing digit I). A track composed of two long parallel grooves with slightly hooked ends, giving it a sigmoid-like shape, is present on IPS110270. A track composed of three long and parallel shallow grooves, with one end slightly convex and the other slightly concave, is visible in MGSB-26310, although being partially overprinted by a *Chelonipus* manus track (Fig. S2D). Such relatively long traces correspond to digits dragged on the surface. The ichnite on IPS120443 is a deeply impressed relatively small digitigrade track, as long as wide (5 cm), composed of three digit imprints very wide at their base and thinning distally, being triangular shaped. Other partially and/or poorly preserved tracks (IPS120438, and multiple not collected tracks) consist of relatively large digit imprints (5–7 cm long, 2–3 cm wide), sometimes displaying large and round claw traces (Fig. S10C). Other not collected specimens from both Puigventós and Montmany localities consist of large (10–15 cm long, ~6 cm wide) oval-shaped tracks, with indistinct digit imprints, and relatively wide expulsion rims.

Remarks. In spite of the fact that these ichnites are incompletely and/or poorly preserved, their shape, size and the relative length and position of digit imprints (when present) are characteristic of the Chirotheriidae ichnofamily and generally of archosaur-line ichnotaxa (Klein and Haubold, 2003). The ichnogeneric identification of the manus tracks from Puigventós (Fig. S10A) and Montmany (IPS120443) is precluded by their isolation from any pes track. From the Montmany locality, other several tracks (not collected) with the same morphology as the manus track from Puigventós have also been identified. The relative positions and sizes of the digit scratches on IPS110271 (Fig. S10B), IPS110270 and MGSB-26310 are comparable to those of chirotheriids. More specifically, these tracks may have been produced during a swimming or buoyant locomotion of the trackmaker. Similar tracks attributed to swimming archosaurs have been reported by Thomson and Droser (2015), Reolid and Reolid (2017) and Mujal et al. (2017) among others. In addition, MGSB-26310 also contains other scratch tracks typically produced in subaqueous conditions, thus supporting such interpretation. The tracks composed of relatively large digit imprints with robust aspect and large round claw traces (e.g., Fig. S10C) cannot be assigned to any specific chirotheriid ichnogenus because of the poor and/or incomplete preservation (i.e., lacking some digit imprints), thus the relative proportions of digit imprints remain uncertain. The oval-shaped tracks with large expulsion rims, despite their poor preservation, can be also referred to chirotheriids, though the lack of clear digit imprints and thus precluding any ichnogeneric identification.

Text S3. Discussion on the distribution of tetrapod ichnotaxa within the middle Muschelkalk palaeoenvironments of the Catalan Basin (NE Iberian Peninsula)

The middle Muschelkalk of the Catalan Basin can be stratigraphically/sedimentologically divided in three main basin units: Lower (Paüls Gypsum), Middle (Arbolí Gypsum/Guanta Sandstone) and Upper (Camposines Gypsum) (Ortí et al., 2018). However, the continental tetrapod fossil record is only known from the Middle Unit (cf. Mujal et al., 2015, 2018; present work).

The Puigventós, Montmany and Collcardús localities are placed in the north-eastern part of the basin (Fig. 2 of the main text) where alluvial plains (building up the Guanta

Sandstone) were already settled in the early stage of the Middle Unit (Ortí et al. 2018). These localities preserve a distal alluvial tetrapod ichnoassociation characterised by relatively abundant and medium- to large-sized chirotheriid tracks.

The Penya Rubí locality is placed in the central part of the basin (Fig. 2 of the main text). The lower part of the succession (including the interval with *Rhynchosauroides*, *Procolophonichnium* and *Rotodactylus*) corresponds to the Arbolí Gypsum evaporitic mudflat, and the upper part (including the sandstone with *Chirotherium*) to the Guanta Sandstone alluvial plain (see also Text S1; Fig. 3A of the main text).

The Pedrera de Can Sallent locality (Mujal et al., 2018) is placed in the north-eastern part of the basin, at the northeast of and relatively close to Collcardús locality (Mujal et al., 2015). However, the ichnoassociation of Pedrera de Can Sallent is *Rhynchosauroides*-dominated, being similar to the lower one of Penya Rubí. Its facies correspond to the Arbolí Gypsum and is placed between the two alluvial plains as depicted in the palaeoenvironmental diagrams of Ortí et al. (2018:fig. 12).

The sedimentological differences between each locality can be directly correlated with different tetrapod ichnoassociations. On the one hand, fine-grained and carbonate facies with strong marine influence (Arbolí Gypsum) are dominated by *Rhynchosauroides* footprints dominate and chirotheriids are (almost) absent (see also section 5.2 from the main text). On the other hand, in relatively coarse-grained facies with relatively less marine influence (Guanta Sandstone) chirotheriids are widely present whilst *Rhynchosauroides* are proportionally much less abundant.

Specific features of each locality give further details of the palaeoenvironmental constraints on tetrapod ichnoassociations. For instance, the presence of hopper crystals on surfaces from the Montmany locality and within the specimen IPS85803 (natural cast of a *Chirotherium barthii* left pes footprint) from the Puigventós locality denote salty waters in these palaeoenvironments. The crystal moulds on IPS85803 appear in the ichnite over the ground upon the footprint was produced (Fig. S7A), but also another hopper crystal grew upon digit IV (Fig. S7F). This suggests that the substrate was under marine (hypersaline) water before and after the trackmaker produced the footprint. The original landscape probably would be composed by a sabkha-like environment, this is, a supratidal plain with salty water and under intense evaporation. The tip impression of digit III of the *Chirotherium* track in IPS85803 displays a rip up clast of reddish mudstone. This indicates that the original substrate where the footprint was impressed was most probably muddy, soft and laminated, as shown by the features of the rip up clast. During the deposition of sandy sediments (which became the natural cast of the footprint), the track was partially eroded. In lateral section, IPS85803 displays cross laminated sandstone, indicating a water current after the impression of the footprint and the formation of hoppers. Most of the *Sphingopus ferox* tracks from the Montmany locality are deeply impressed (Fig. 4D of the main text, Fig. S9), and even if features can be identified, a muddy and soft original substrate can be inferred. Additionally, the Montmany locality also bears relatively large and round moulds of gypsum nodules, as well as thick and deep desiccation cracks, denoting drought periods; also, water escape and load structures have also been observed, pointing to rapid flooding and sedimentation.

The *Chelonipus* trackway (IPS110268; Fig. S3) of the Puigventós locality was impressed under swimming locomotion, thus the substrate was flooded. An oscillatory (bidirectional) flow can be inferred by the presence of wave ripples within the surface (see arrow in Fig. S3A'). Also, the large chirotheriid scratches (IPS110270 and IPS110271; Fig. S10B) indicate the presence of a relatively high water table. In the Montmany locality indeterminate tetrapod swimming traces have also been found, denoting similar conditions; in the same way a *Sphingopus ferox* track from Montmany is overprinted by wave ripples, which smoothed the footprint most likely soon after its impression. Otherwise, *Rhynchosauroides* tracks of IPS110265 (Fig. S5) overprint small wave ripples, indicating that the trackmakers crossed such substrates with a low water log or even in subaerial conditions. Interestingly, the MGSB-26310 slab from the Montmany area preserves small tracks (some even smaller than the scratch tracks) corresponding to a walking gait (i.e., *Procolophonichium* isp.) together with scratch traces indicating swimming locomotion and thus a relatively high water table. This assemblage of tracks from completely different locomotion gaits indicates that the original substrate suffered marked changes in the probable water column covering it, i.e., from flooding to subaerial exposure, being time averaged (cf. Falkingham, 2014). This suggests that the substrate was exposed for a relatively long time, recording different environmental conditions.

In summary, the sedimentological and ichnological characteristics of the Puigventós and Montmany localities point to a changing environment. Periods of relatively low energy environments were alternated with episodes of rapid flooding and increase of the sedimentation rate (i.e., relatively high energy environments), as well as with desiccation periods (i.e., during the development of desiccation cracks and hopper crystals, further denoting salty environments common from sabkha settings).

The Penya Rubí and Pedrera de Can Sallent localities are considered similar in terms of general palaeoenvironmental setting (tidal flats) and stratigraphic position (Arbolí Gypsum unit), as also in terms of tetrapod ichnoassociations. Only minor differences are found in the sedimentological features between both localities: more carbonate (dolostones) in Penya Rubí and more siliciclastic (very fine-grained sandstones) in Pedrera de Can Sallent. Such differences may be linked to a potential (slightly) different source area, with Pedrera de Can Sallent being closer to siliciclastic areas (i.e., to Guanta Sandstone) that developed in early stages of the Middle Unit (cf. Ortí et al., 2018). These minor features leaded to slightly different environments within the tidal flat, with supratidal areas (e.g., sabkha-like) in Pedrera de Can Sallent (Mujal et al., 2018) and intertidal areas with microbial mats in Penya Rubí. Again, this observation supports the hypothesis of palaeoenvironmental constraints on ichnotaxa distribution: despite the different (palaeo-) geographic position of the localities, the ichnoassociations are similar, so they are linked to the facies typology.

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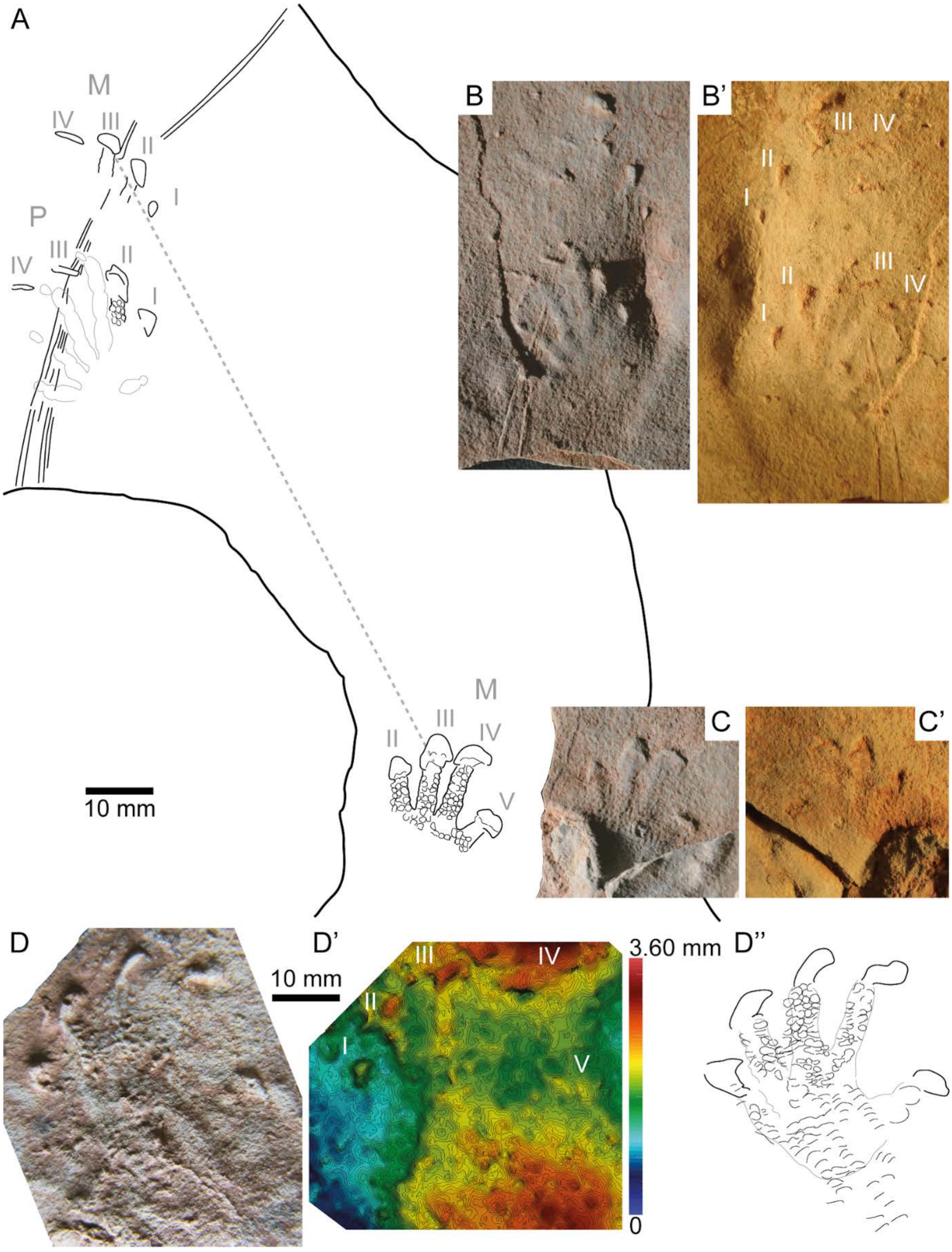

Figure S1. *Procolophonichnium haarmuehlensis* tracks from Penya Rubí. **A–C.** IPS106616a and b, with partial trackway outline in convex hyporelief from IPS106616b (**A**), detailed pictures of the right manus-pes set (pes track overprinted by a *Rhynchosauroides tirolicus* left track) in convex (**B**) and concave (IPS106616a) (**B'**) reliefs, and the left manus convex (**C**) and concave (IPS106616a) (**C'**) reliefs. **D.** Left track with skin imprints in convex hyporelief from IPS106601b, including 3D colour-depth model (**D'**) and interpretive outline (**D''**). M and P correspond to manus and pes tracks, respectively. Roman numbers refer to digit imprints.

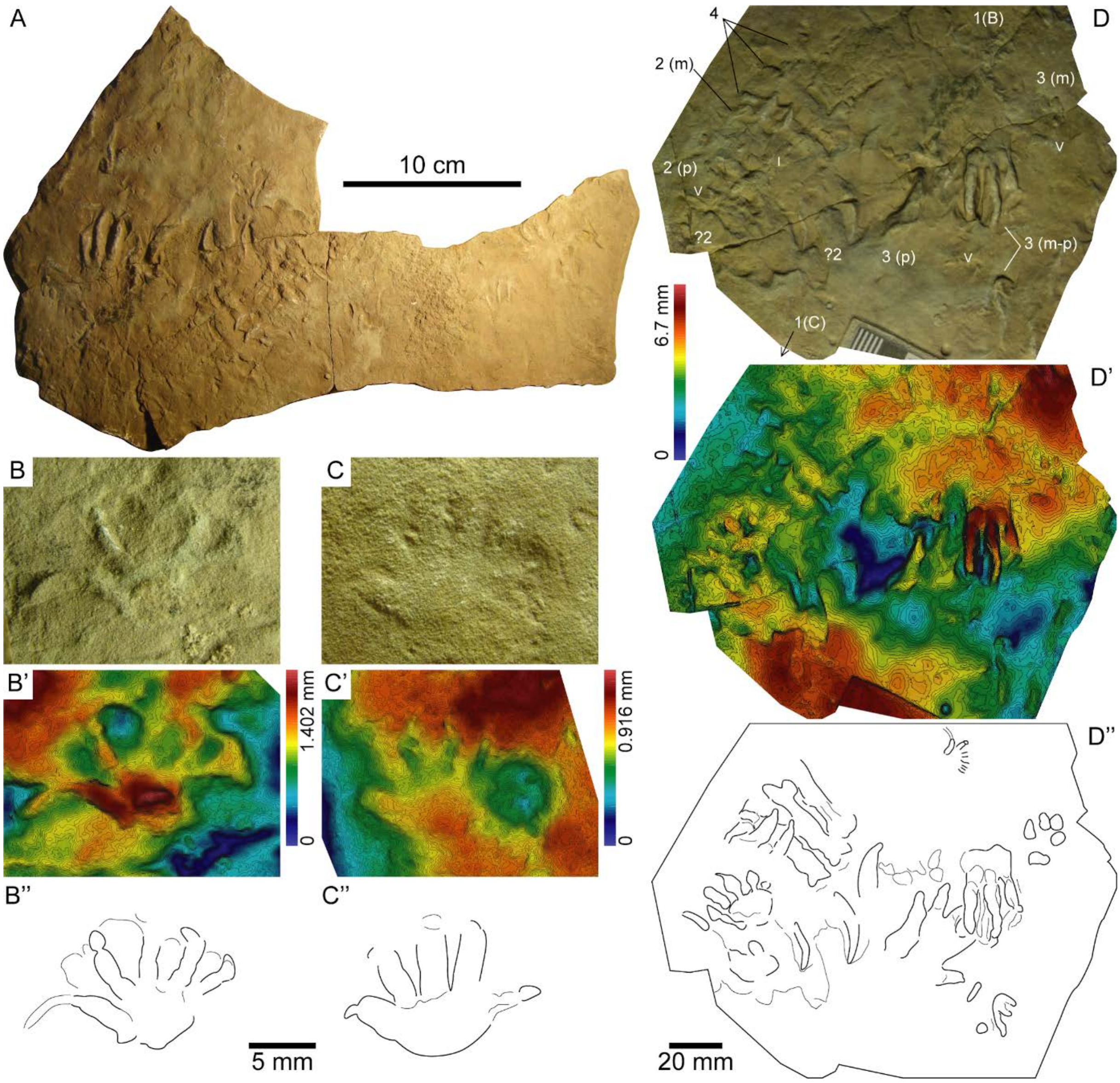

Figure S2. MGSB-26310 slab from Montmany (exact locality unknown) preserving numerous tracks of different tetrapod ichnotaxa in convex hyporelief. **A.** Overview photograph of slab. **B–C.** Tiny *Procolophonichnium* isp. right (**B**) and left (**C**) tracks. **D.** Most densely trampled part of the surface including tracks of: 1, *Procolophonichnium* isp.; 2, *Chelonipus* isp.; 3, *Chirotherium* cf. *sickleri* (two left manus-pes sets); and 4, a large scratch track possibly of a chirotheriid. **B**, **C** and **D** include their 3D colour-depth models (**B'**, **C'**, **D'**) and interpretive outlines (**B''**, **C''**, **D''**). Roman numbers refer to digit imprints; *m* and *p* refer to manus and pes tracks, respectively.

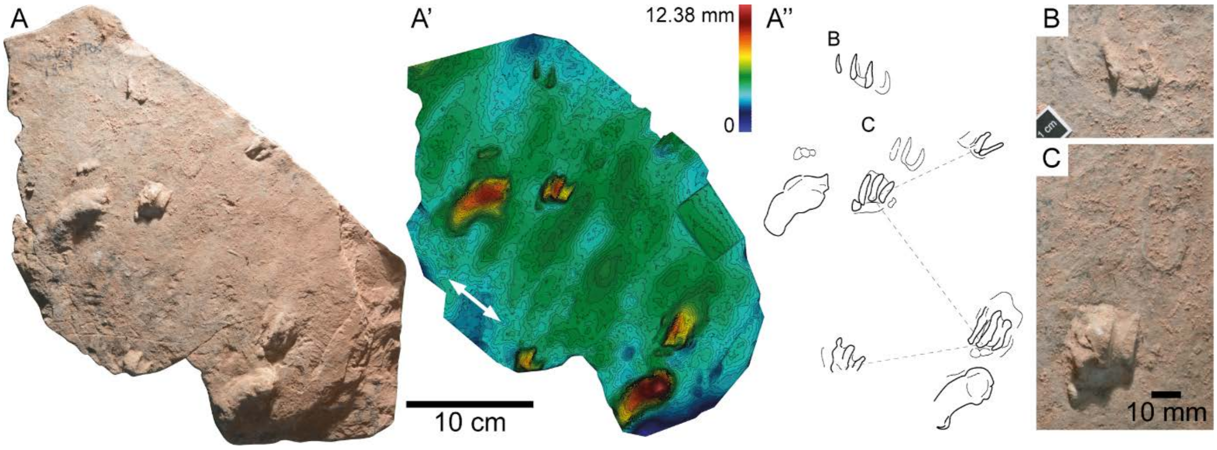

Figure S3. *Chelonipus* isp. tracks from Puigventós (IPS110268), probably forming a trackway. **A.** Overview of the slab with 3D colour-depth model (**A'**) and interpretive outline (**A''**); note the presence of wave ripples with nearly straight crests, identified in the 3D model (white arrow indicates flow direction). **B.** Detail of a shallowly impressed track. **C.** Detail of a deeply impressed track with a shallow impression in front of it.

Figure S4. *Rhynchosauroides tirolicus* tracks from Penya Rubí. **A–E.** Right manus tracks from IPS106601a (**A**, including detail of digit V imprint in **B**), IPS106606 (**C**), IPS106605c (**D**, **E**). **F.** Left manus track from IPS107035b. **G.** Partial left pes track from IPS106602. **H–I.** Right manus-pes couples from IPS106617b (**H**) and IPS106601b (**I**). **J.** Left manus and pes tracks (from different couples) from IPS106617b. **K–L.** Densely trampled surfaces showing tiny details of tracks in IPS106617b (**K**) and smoothed tracks in IPS106603b (**L**). Note the presence of skin impressions in specimens in **A–D, F, G, I–K** (with close ups in **C** and **G**).

Figure S5. *Rhynchosauroides* isp. tracks from Puigventós in concave epirelief (IPS110265). **A.** Entire slab, preserving also wave ripples with straight crests. **B.** Detail of one of the right manus-pes couples. **C.** Detail of a right track. Roman numbers refer to digit imprints.

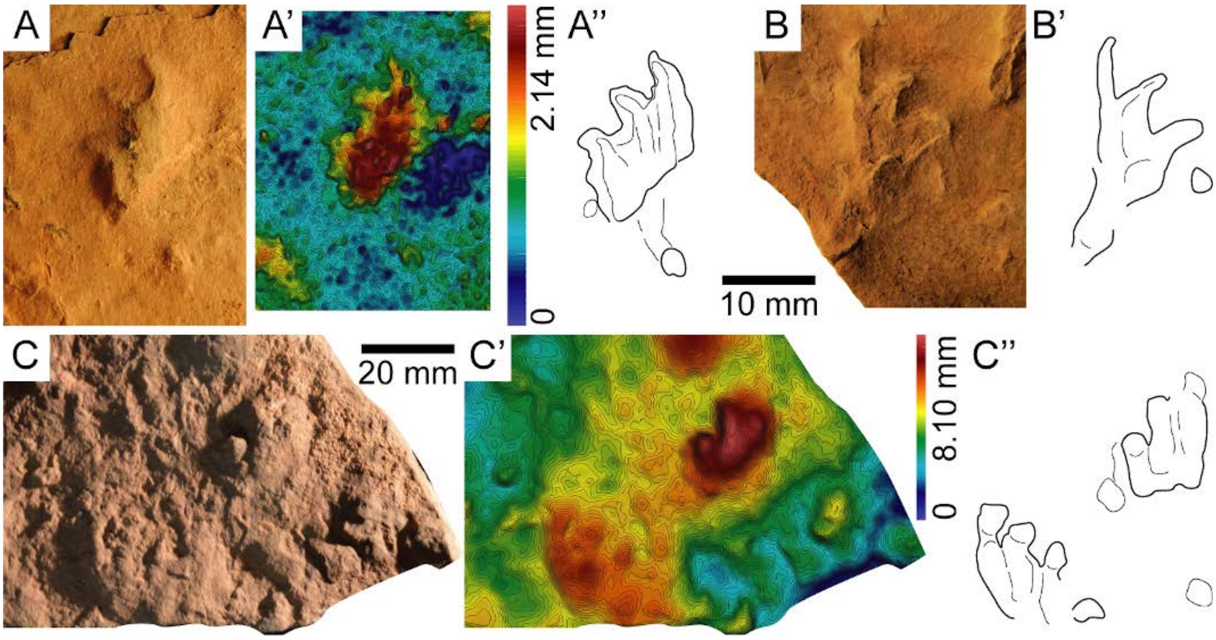

Figure S6. *Rotodactylus* isp. tracks from Penya Rubí (**A**, **B**) and Puigventós (**C**), all in convex hyporelief. **A.** Left track from IPS107033a, with corresponding 3D colour-depth model (**A'**) and interpretative outline (**A''**). **B.** Right track from IPS106611c with interpretative outline (**B'**). **C.** Right and left tracks from IPS110270, with corresponding 3D model (**C'**) and interpretive outlines (**C''**).

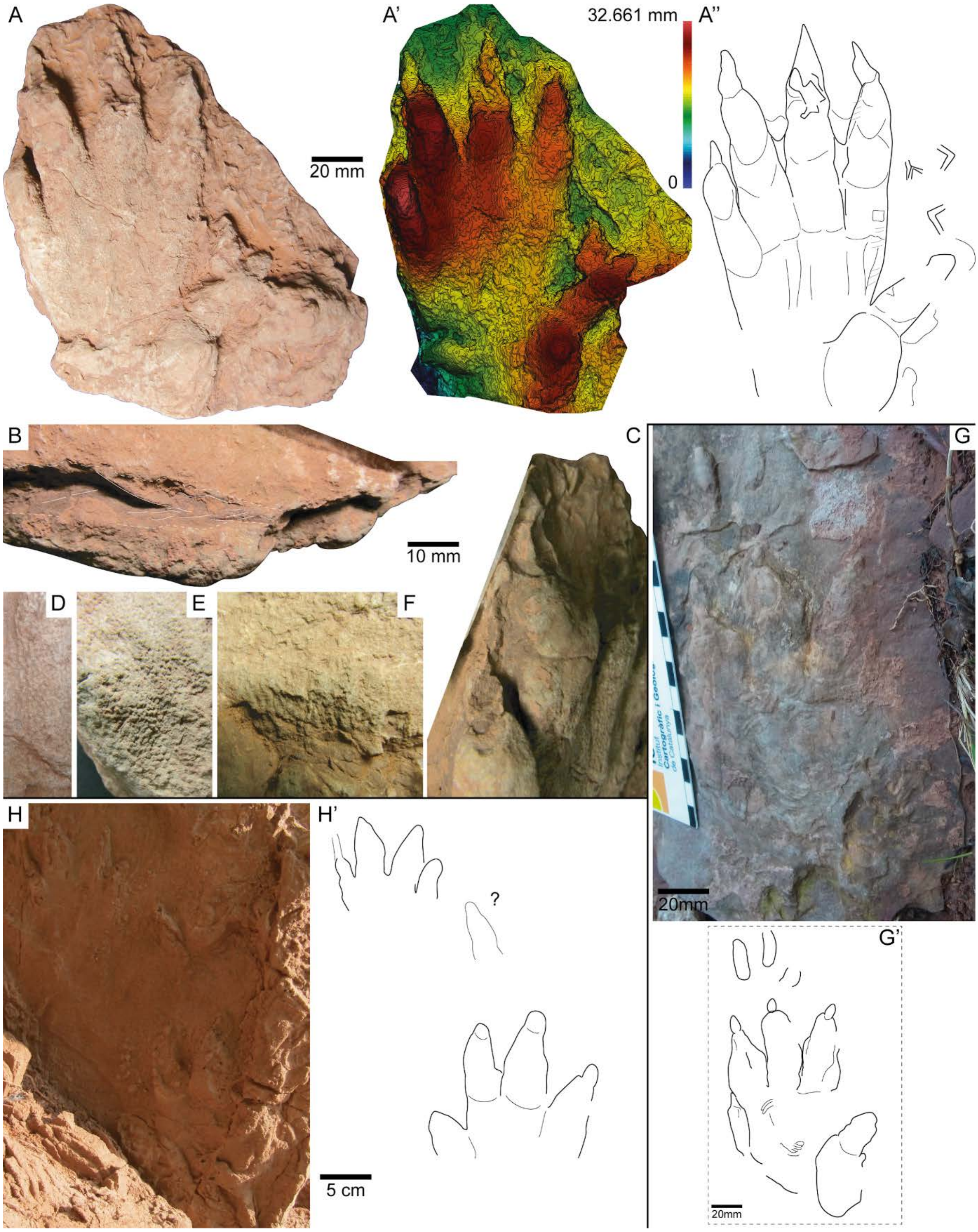

Figure S7. *Chirotherium barthii* tracks from Puigventós (**A–G**) and Penya Rubí (**H**), all in convex hyporelief. **A–F.** Left pes track from IPS85803 including general view with 3D colour-depth model and interpretive outline (**A**, **A'** and **A''**) and details of sedimentary infilling (**B**), claw impressions (**C**) and skin impressions of the digits (**D**), sole (**E**) and lateral side of the digit with dragged scale impressions and an overprinted halite crystal (**F**). **G.** Unrecovered left pes track with partial manus impression from Puigventós, with interpretive outline sketch (**G'**). **H.** Unrecovered right manus-pes couple from Penya Rubí as photograph and interpretive sketch (**H'**).

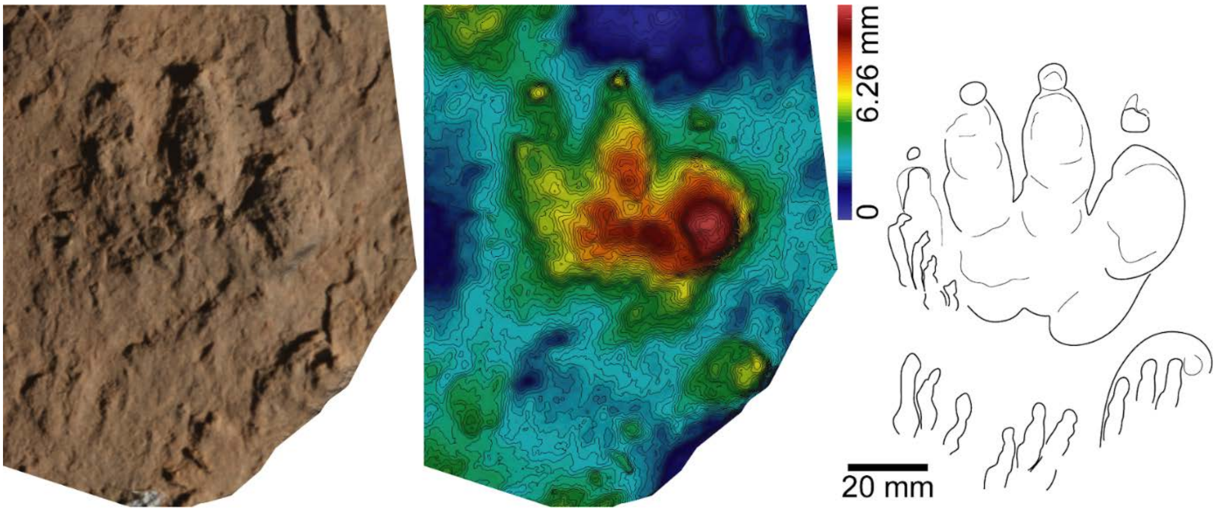

Figure S8. Left pes track of *Isochirotherium* cf. *coureli* from Puigventós in convex hyporelief (portion of the surface of IPS110269) with 3D colour-depth model and interpretive outline. Note the presence of *Rotodactylus* isp. tracks, one overprinting the digit I imprint and another the digit V imprint of *I.* cf. *coureli*.

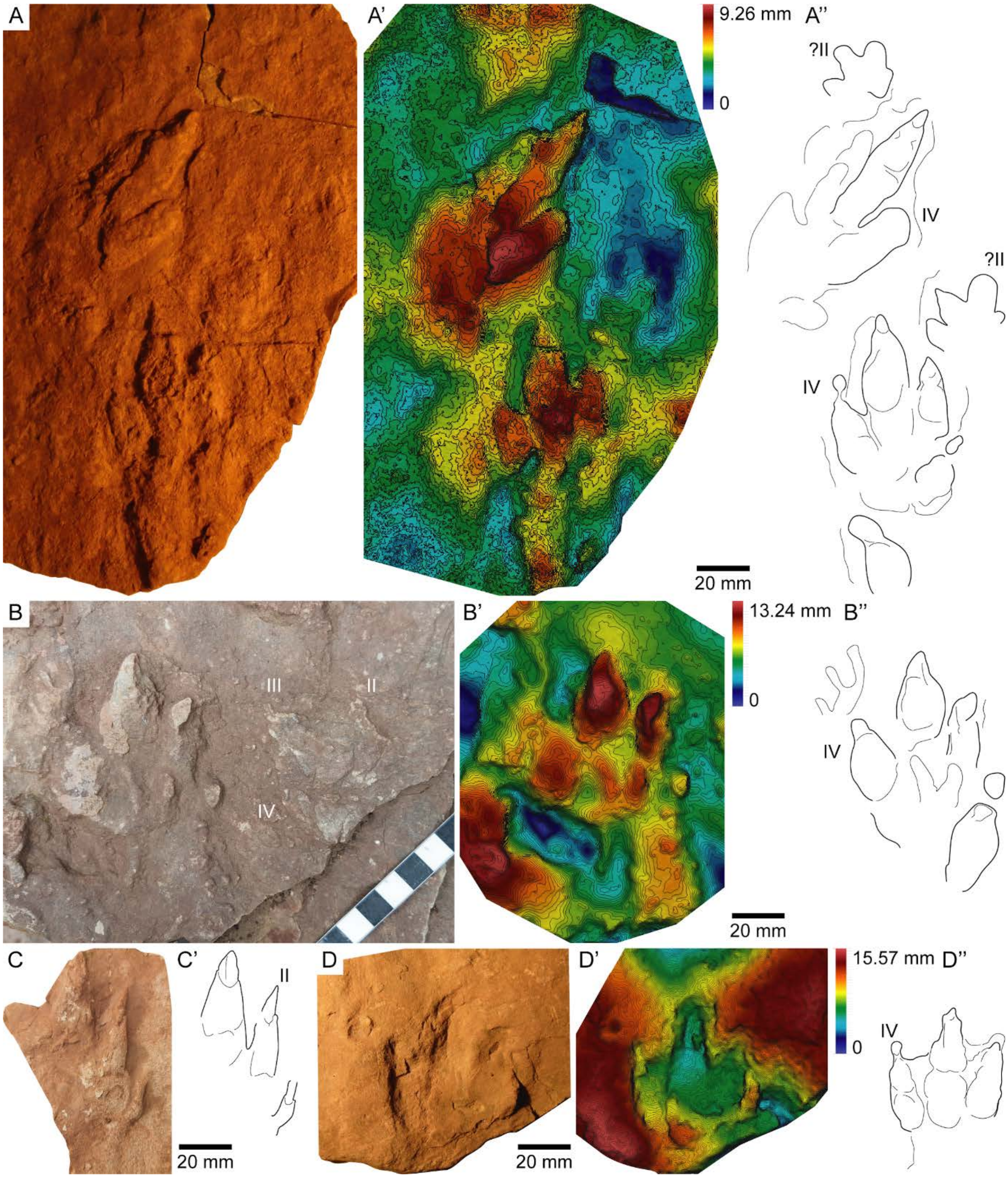

Figure S9. Tracks of *Sphingopus ferox* from Montmany (convex hyporelief; **A–C**) and Puigventós (concave epirelief; **D**). **A.** Two manus-pes sets from the left (top) and right (bottom) sides (IPS120435), with 3D colour-depth model (**A'**) and interpretive outline (**A''**). **B.** Right pes track with two indeterminate small tracks, with 3D colour-depth model (**B'**) and interpretive outline (**B''**), and a partial pes track on the right of the most complete track (IPS120434). **C.** Partial right track preserving digits I, II and III (IPS120441), and interpretive outline (**C'**). **D.** Right pes track lacking the posterior portion (IPS110266) with corresponding 3D colour-depth model (**D''**) and interpretive outline (**D''**). Roman numbers refer to digit imprints.

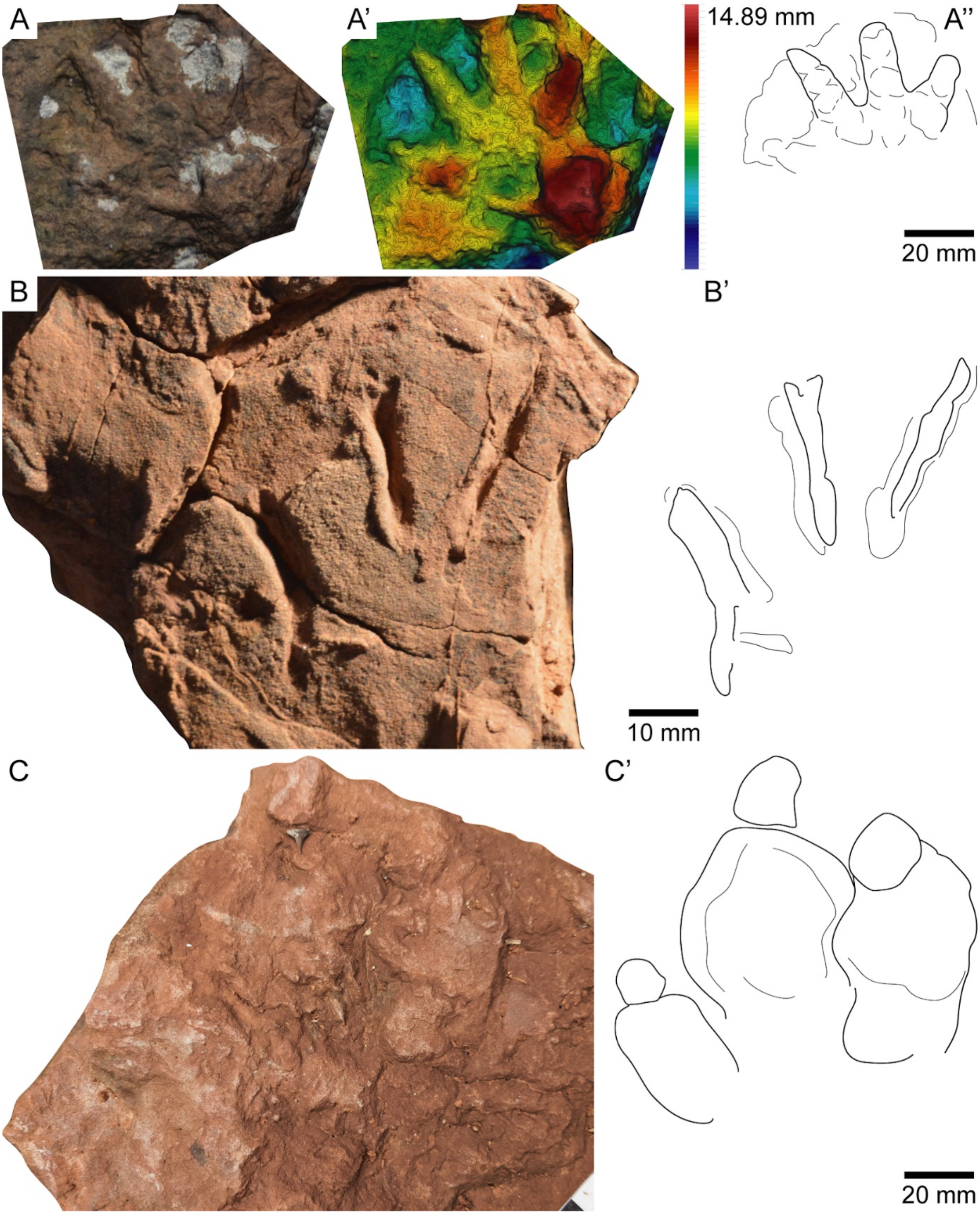

Figure S10. Chirotheriidae indet. tracks from Puigventós (**A**, **B**) and Montmany (C). **A.** Unrecovered right manus track with 3D colour-depth model (**A'**) and interpretive outline (**A''**). **B.** Scratch track, possibly of a pes (IPS110271) with interpretive outline (**B'**). **C.** Unrecovered large partially preserved pes track.

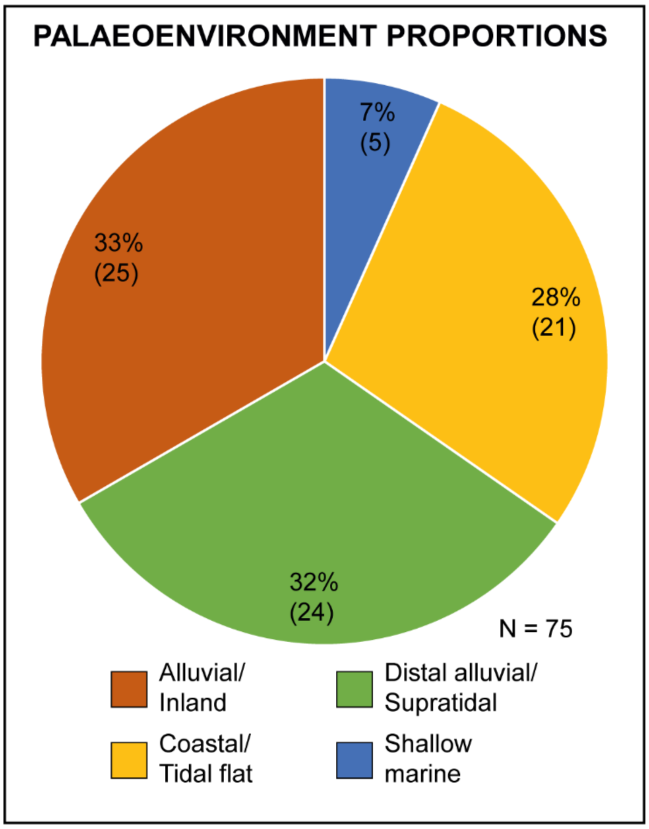

Figure S11. Palaeoenvironmental setting proportions of the Middle Triassic outcrops analysed in this study. The total number of localities surveyed (N) and those assigned to each palaeoenvironmental setting are also shown. Palaeoenvironmental assignments are based on the references of Table S1 and the criteria specified in section 3 of the main text.

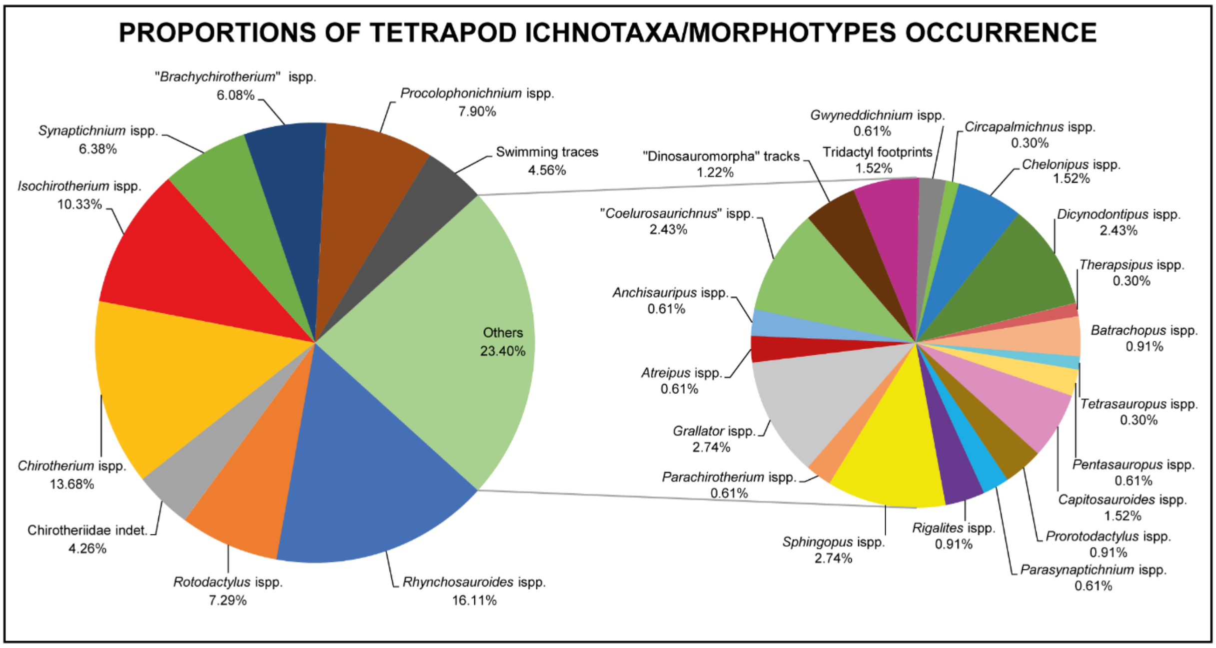

Figure S12. Middle Triassic tetrapod ichnotaxon/morphotype occurrence proportions. Left pie chart includes those ichnotaxa whose percentage occurrences are >4% of the total occurrences recorded. All occurrences representing <4% each respect all occurrences are included in "Others", which are shown in the right pie chart. Data based on the summary presented in Table S1.

Table S1. *(XLSX file)* Global occurrences of Middle Triassic tetrapod ichnotaxa, including specific age interval and palaeoenvironmental settings. Note that the age range of some localities include also the Early and/or Late Triassic. Complete references are included in the next sheet.

Table S2. Global occurrence of each tetrapod ichnotaxon/morphotype in each palaeonvironmental setting from the Middle Triassic. Palaeoenvironmental assignments based on the criteria specified in section 3 of the main text.

Tetrapod ichnotaxon/morphotype	**Shallow marine**	**Coastal/ Tidal flat**	**Distal alluvial/ Supratidal**	**Alluvial/Inland**
Rhynchosauroides ispp.	2	19	16	16
Gwyneddichnium ispp.	0	0	1	1
Prorotodactylus ispp.	0	0	0	3
Rotodactylus ispp.	0	7	7	10
Chirotheriidae indet.	0	2	4	8
Chirotherium ispp.	2	10	16	17
Isochirotherium ispp.	1	8	12	13
Synaptichnium ispp.	0	9	5	7
Parasynaptichnium ispp.	0	1	1	0
"*Brachychirotherium*" ispp.	1	5	5	9
Rigalites ispp.	0	0	1	2
Sphingopus ispp.	0	1	5	3
Parachirotherium ispp.	0	0	1	1
Atreipus ispp.	0	0	1	1
Grallator ispp.	0	0	4	5
"*Coelurosaurichnus*" ispp.	0	1	7	0
Anchisauripus ispp.	0	0	2	0
"Dinosauromorpha" tracks	0	1	2	1
Tridactyl footprints	0	0	2	3
Tetrasauropus ispp.	0	0	0	1
Procolophonichnium ispp.	1	12	7	6
Dicynodontipus ispp.	0	3	1	4
Capitosauroides ispp.	0	1	1	3
Circapalmichnus ispp.	0	0	1	0
Therapsipus ispp.	0	0	1	0
Pentasauropus ispp.	0	0	0	2
Chelonipus ispp.	0	1	4	0
Batrachopus ispp.	0	0	2	1
Swimming traces	3	4	4	4
Total number of occurrences	10	85	113	121
Number of different ichnotaxa/morphotypes	6	16	26	23

Table S3. Percentage (%) of occurrence of each tetrapod morphotype considering the total amount of localities surveyed for each palaeoenvironmental setting from the Middle Triassic. Palaeoenvironmental assignments based on the criteria specified in section 3 of the main text.

Tetrapod ichnotaxon/morphotype	**Shallow marine**	**Coastal/ Tidal flat**	**Distal alluvial/ Supratidal**	**Alluvial/Inland**
Rhynchosauroides ispp.	40.0	90.5	66.7	64.0
Gwyneddichnium ispp.	0.0	0.0	4.2	4.0
Prorotodactylus ispp.	0.0	0.0	0.0	12.0
Rotodactylus ispp.	0.0	33.3	29.2	40.0
Chirotheriidae indet.	0.0	9.5	16.7	32.0
Chirotherium ispp.	40.0	47.6	66.7	68.0
Isochirotherium ispp.	20.0	38.1	50.0	52.0
Synaptichnium ispp.	0.0	42.9	20.8	28.0
Parasynaptichnium ispp.	0.0	4.8	4.2	0.0
“Brachychirotherium” ispp.	20.0	23.8	20.8	36.0
Rigalites ispp.	0.0	0.0	4.2	8.0
Sphingopus ispp.	0.0	4.8	20.8	12.0
Parachirotherium ispp.	0.0	0.0	4.2	4.0
Atreipus ispp.	0.0	0.0	4.2	4.0
Grallator ispp.	0.0	0.0	16.7	20.0
“Coelurosaurichnus” ispp.	0.0	4.8	29.2	0.0
Anchisauripus ispp.	0.0	0.0	8.3	0.0
“Dinosauromorpha” tracks	0.0	4.8	8.3	4.0
Tridactyl footprints	0.0	0.0	8.3	12.0
Tetrasauropus ispp.	0.0	0.0	0.0	4.0
Procolophonichnium ispp.	20.0	57.1	29.2	24.0
Dicynodontipus ispp.	0.0	14.3	4.2	16.0
Capitosauroides ispp.	0.0	4.8	4.2	12.0
Circapalmichnus ispp.	0.0	0.0	4.2	0.0
Therapsipus ispp.	0.0	0.0	4.2	0.0
Pentasauropus ispp.	0.0	0.0	0.0	8.0
Chelonipus ispp.	0.0	4.8	16.7	0.0
Batrachopus ispp.	0.0	0.0	8.3	4.0
Swimming traces	60.0	19.0	16.7	16.0