
1st.
KAMIENNA RIVER
INTERNATIONAL SYMPOSIUM ON
VERTEBRATE PALEOICHNOLOGY
2026

1st KAMIENNA RIVER INTERNATIONAL SYMPOSIUM ON VERTEBRATE PALEOICHNOLOGY

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ABSTRACT BOOK

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Preface

On behalf of Paleoico and our esteemed partners, LOT and Ekomuzeum, it is an honor to present the abstract proceedings of the 1st Kamienna River International Symposium on Vertebrate Paleoichnology, hosted in Starachowice on 12–14 October 2026. Bringing together scholars from across Poland, Mexico, Colombia, Peru, Spain, Italy, Germany and the broader global community, this symposium reflects the crucial role of vertebrate ichnology in interpreting deep time and fostering connections with contemporary society.

The papers collected within this volume span Triassic ichnofaunas in Poland, Jurassic and Cretaceous dinosaur tracksites across Europe and the Americas, Cenozoic mammalian and human trace records, and the geoheritage and museological efforts that cultivate public engagement and regional heritage. My deepest thanks go to each author for their invaluable contributions, and to LOT and Ekomuzeum for making this event possible.

We trust this meeting will accelerate the publication of these exceptional sites, showcase the pioneering work underway in this region, and highlight its remarkable geological wealth. With an unprecedented array of tracksites spanning vast geological eras concentrated within a single landscape, the area stands as a living testament to Earth's history. We hope to inspire international support for the conservation and advancement of these finds, while furthering the potential of paleoichnological tourism locally.

Juan Davi Ferrer

October 2026

Programme

1st Kamienna River International Symposium on Vertebrate Paleoichnology · 12–14 October 2026

DAY I — 12 October 2026

Little Palace, Starachowice, Poland · Scientific sessions; evening programme in Bałtów

09:00–09:45	**Registration & Coffee** — participant check-in and welcome coffee	
09:45–10:00	**Symposium Opening** — welcome remarks by attending authorities	
10:00–10:30	**Local Tourist Organization "MKIW"** — opening remarks and symposium orientation	
10:30–11:00	**1**	**Gerard D. Gierliński** *Diverse Late Jurassic tetrapod ichnotaxa recognized at the Moab Giants land and its vicinity (Utah, USA)*
11:00–11:30	**2**	**Grzegorz Niedźwiedzki** *A brief story about the Borkowice tracksite – what we know and what we don't know after five years (2021–2026) of research at this Early Jurassic site*
11:30–12:00	**Coffee Break**	
12:00–12:30	**3**	**Rubén A. Rodríguez-de la Rosa, Jair Peña-Serrano, Fernando Miranda-Flores, Lizbeth Mariana Delgado-Quiroz, Lucía Capra-Pedol, Jaime Jesús Carrera-Hernández, Juan Pablo Bernal-Uruchurtu, Gerardo Carbot-Chanona, Luis Enrique Gómez-Pérez & Carlos Serrano-Sánchez†** *Maltrata: a Late Pleistocene site preserving megafauna and human footprints*
12:30–13:00	**4**	**Lizbeth Mariana Delgado-Quiroz & Rubén A. Rodríguez-de la Rosa** *Dogs, bears, and cats: the ichnological record of carnivorous mammals in the Cenozoic of México*
13:00–13:30	**5**	**Alejandro Corrales-García, Darin Croft, Rubén A. Rodríguez-de la Rosa, César Augusto Perdomo-Rojas, Daniel Osorio & Andrés Link** *First fossil track of a large native South American ungulate from the Middle Miocene at La Venta (Colombia)*
13:30–14:30	**Lunch Break**	
14:30–15:00	**6**	**Alejandro Corrales-García, William G. Carantón-Mateus, María Isabel Sierra-Rojas & Javier Luque** *Dinosaur footprints from the Lower Cretaceous of Colombia: newly found ichnodiversity and taphonomic perspectives*
15:00–15:30	**7**	**María del Rosario Fernández-Barajas, Erick Prado-Escamilla & Rubén A. Rodríguez-de la Rosa** *A Pleistocene turtle egg (Testudoolithidae Hirsch, 1996) from San Juan Raya, Puebla, México*
15:30–16:00	**8**	**Diego Enrique Lozano-Carmona, María Concepción López-Téllez, Francisco Javier Jiménez-Moreno, Mildred Zepeda-Martínez & Rubén A. Rodríguez-de la Rosa** *A new record of Middle Jurassic dinosaur footprints from México*
16:00–16:15	**Daily Summary** — wrap-up and synthesis of session topics	
16:45	**Departure to Bałtów** — transfer from Starachowice	
17:45	**Visit to Jurapark Bałtów** — guided visit	
19:00–21:00	**Symposium Celebration Dinner** — Restaurant Zapieka, Bałtów	

DAY II — 13 October 2026

Ekomuzeum Introduction; all sessions at Little Palace, Starachowice, Poland

09:00–09:30	**Ekomuzeum Introduction** — welcome back and day overview	
09:30–10:00	**9**	**Gerard D. Gierliński (with Grzegorz Niedźwiedzki)** *New find of the large therapsid tracks in the Triassic of Poland*
10:00–10:30	**10**	**Grzegorz Niedźwiedzki** *Triassic panorama of Poland – dinosaur and other tetrapod tracks from the Early to Late Triassic of Poland*
10:30–11:00	**11**	**Rubén A. Rodríguez-de la Rosa** *Walking among giants: how footprint sites transform local culture and identity*
11:00–11:30	**Coffee Break**	
11:30–12:00	**12**	**Hendrik Klein** *Tracking last chirotheres - morphological diversity in Late Triassic archosaur footprints.*
12:00–12:30	**13**	**Witold Wesołowski & Anna Fijałkowska-Mader** *Geoparks as open-air museums of geological and cultural heritage in the process of enhancing regional tourism attractiveness*
12:30–13:00	**14**	**Félix Pérez Lorente** *La Rioja and its dinosaur empires*
13:00–14:00	**Lunch Break**	
14:00–14:30	**15**	**Giuseppe Leonardi** *Wandering through Gondwana and beyond in search of fossil footprints. A contribution to dinosaur ichnology and paleontological heritage: tourism potential on six continents and several countries*
14:30–15:00	**16**	**Claudia Isabel Sánchez-Alva, Jean-Noël Martínez, Leonardo M. Zevallos-Valdivia & Rubén A. Rodríguez-de la Rosa** *Photogrammetric analysis of dinosaur footprints from the Lower Cretaceous of the Capiza-Tipan site (Arequipa Region, Southern Peru): scientific and social use*
15:00–15:30	**Coffee Break**	
15:30–16:00	**17**	**Felisa Josefina Aguilar-Arellano & Leonardo Hegel Mercado-Millán** *Successes and failures in the development of the Las Águilas paleontological site in Coahuila, Mexico, for tourism*
16:00–16:30	**18**	**Adriana Yanet Miranda-Martínez & Ricardo Servín-Pichardo** *Sustainable tourism and scientific dissemination in ichnological sites of Puebla (Mexico): participation and leadership of local women*
16:30–16:45	**Closing Remarks** — symposium summary and closing ceremony	

DAY III — 14 October 2026

Field trip · Świętokrzyskie Region, Poland

Route: Starachowice → Suchedniów → Zachełmie → Gagaty Sołtykowskie → Borkowice → Starachowice

08:45–09:30	**Start: Ekomuzeum – Museum of Nature and Technology, Starachowice** — meeting point and visit the museum.
09:30–10:00	**Coach transfer** — Starachowice → Suchedniów
10:00–11:00	**Kopulak Quarry, Suchedniów** — walk to the quarry and site visit (limited coach access)
11:00–11:20	**Coach transfer** — Suchedniów → Zachełmie
11:20–12:05	**Zachełmie Nature Reserve** — site visit
12:05–12:50	**Coach transfer** — Zachełmie → Gagaty Sołtykowskie
12:50–13:50	**Gagaty Sołtykowskie Nature Reserve** — site visit
13:50–14:35	**Coach transfer** — Gagaty Sołtykowskie → Borkowice
14:35–15:20	**Borkowice** — site visit
15:20–16:10	**Return by coach** — Borkowice → Starachowice



Abstracts





Diverse Late Jurassic tetrapod ichnotaxa recognized at the Moab Giants land and its vicinity (Utah, USA)

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Since 2009 diverse tetrapod ichnotaxa has been identified in the area where is now located Paleosafari Moab Giants, the educational complex with dinosaur theme park and paleoichnological museum. Moab Giants property is located in the eastern Utah, north from the junction of the highway 191 and the state road 313. Gierliński *et al*. (2010) reported first footprints found at the Late Jurassic Morrison Formation exposed north and east from the junction. Those first finds include: large, 53 cm long, theropod footprint (Fig. 2B) referred to the ichnogenus *Megalosauripus sensu* Lockley *et al*. (1998b); interesting 15 cm long footprint (Fig. 1D) of a juvenile trackmaker of normally much larger ichnogenus *Deltapodus* White and Romano, 1994; the large (22 cm long) ornithischian tridaclyl track (Fig. 2E) previously attributed to the ichnogenus *Stegopodus sensu* Gierliński and Sabath (2008). In the light of the contribution of Klein *et al*. (2022), however the last listed ichnite clearly seems to be more similar to the morphotype named '*Sinoichnites*' left rather by large ornithopods than to stegosaurian ichnogenus *Stegopodus*, which is broader, less symmetrical with shorter toes and especially shorter middle digit.

Construction work on Moab Giants which started in 2014 brought new finds. Among them the specimens addressed to specific ichnotaxa comprise large (44 cm in length) theropod footprint (Fig. 2A) tentatively referred to *Megalosauripus* or *Hispanosauropus* by Lockley *et al.* (2016). The morphology of *Hispanosauropus sensu* Foster (2015) with smaller metatarsophalangeal area and the relatively longer middle toe than it is seen in *Megalosauripus* fits mentioned ichnite better than *Megalosauripus*. The next labeled footprint (large ichnite, 45 cm long) has been described by Lockley *et al.* (2017) as *Deltapodus* (Fig. 2D).

Moreover, Gierliński and Lichota (2018) mentioned additional ichnogera found at the Moab Giants property. This material includes: small theropod footprint (Fig. 1A) resembling *Jialingpus* Zhen, Li and Zhen, 1983; sauropod trackway (Fig. 2C) corresponding with the narrow-gauge trackway morphotype named *Parabrontopodus* by Lockley *et al*. (1994); small ornithopod track (Fig. 1C) very similar to the *Dinehichnus* specimen CU-MWC 198.2 from the Morrison Formation of Boundary Butte in Utah and described by Lockley *et* al. (1998a); small footprint (Fig. 1B) reflecting basal ornithischian foot pattern exhibited in the ichnogenus *Anomoepus* (Hitchcock 1848) Gierliński 1991. *Anomoepus* typically is the component of the Early Jurassic ichnoassemblages and interestingly *Anomoepus*-like tracks are also well known in the Morrison Formation (e.g. Lockley *et al*., 2018). In my opinion they are obviously the anomoepodid tracks but slightly different from the classic Hitchcock's ichnogenus. For example, those Late Jurassic *Anomoepus*-like tracks lack phalangeal pads well defined. Thus, I am doubtful if the name *Anomoepus* should be applied to them directly. They are surely made by different trackmaker from these Early Jurassic ones and more appropriate seems to label them as cf. *Anomoepus* isp.

The last specimen (Fig. 3) listed here, so far not reported nor described, is a very small ichnite, 5.5 cm long and 5 cm wide. It shares such avian feature like the third digit metatarsophalangeal pad as the most proximal pad and lack of the lateral digits' metatarsophalangeal pads. This functionally tridactyl footprint with small medially directed hallux impression. The same ichnites discovered in the Tuchengzi Formation of Liaoning Province (China) has been described as *Pullornipes* by Lockley *et al*. (2006).

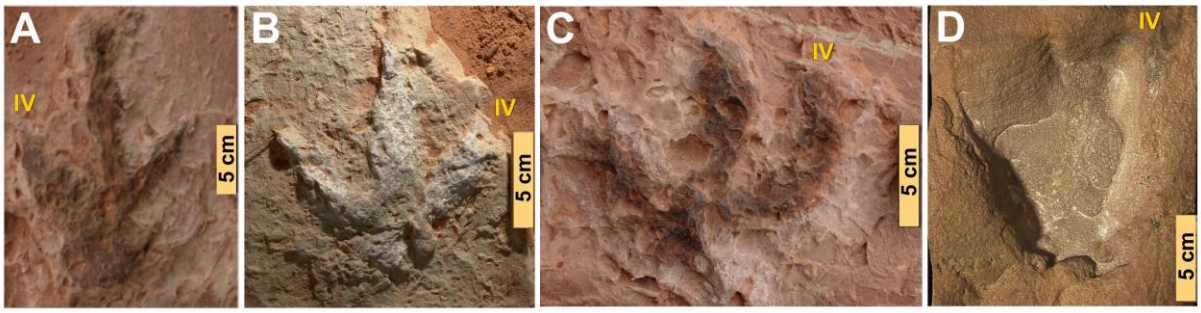

Fig. 1. Small dinosaur tracks from the Morrison Formation of the Moab Giants land and its vicinity: A, *Jialingpus* isp.; B, cf. *Anomoepus* isp.; C, *Dinehichnus* isp.; D, *Deltapodus* isp.

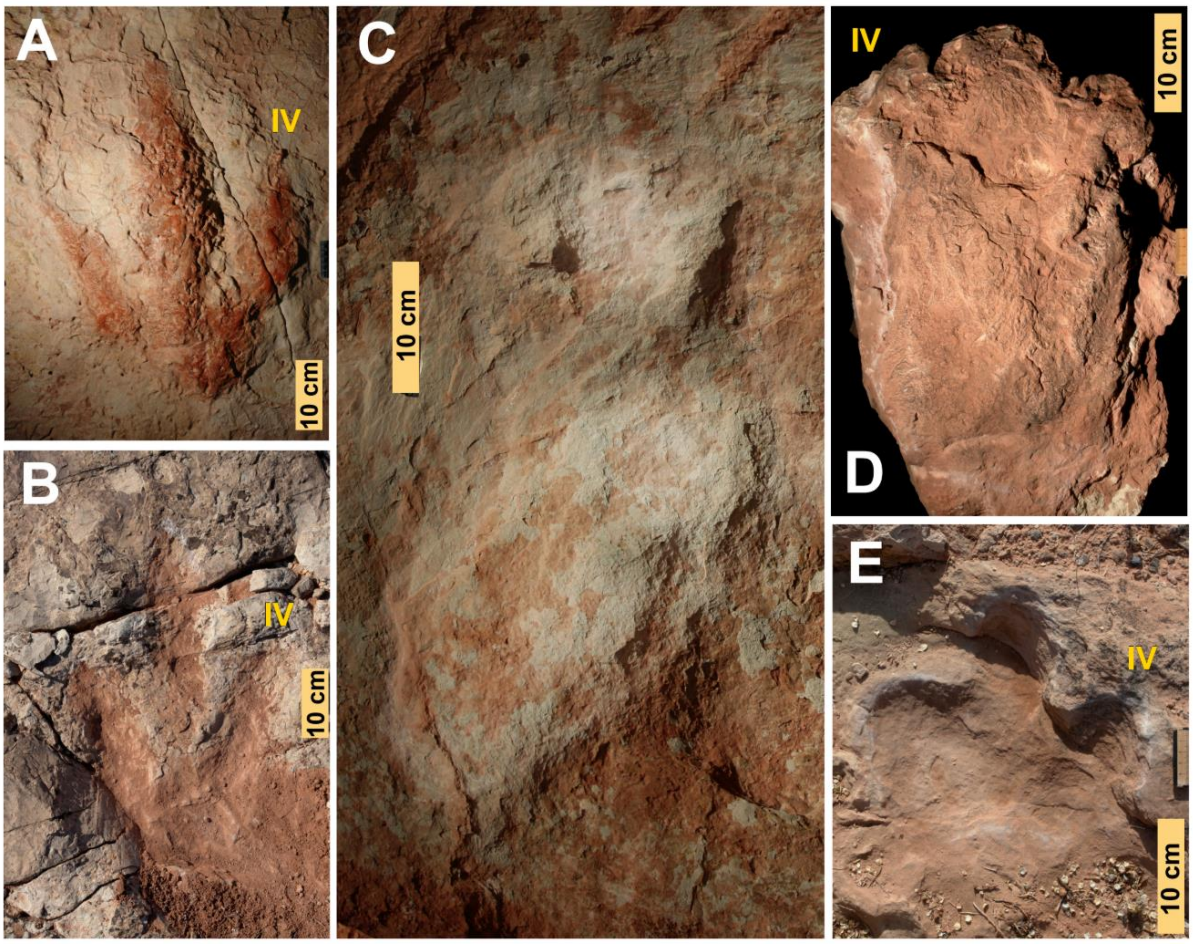

Fig. 2. Large dinosaur tracks from the Morrison Formation of the Moab Giants land and its vicinity: A, *Hispanosauropus* isp.; B, *Megalosauripus* isp.; C, *Parabrontopodus* isp.; D, *Deltapodus* isp.; E, '*Sinoichnites*' isp.

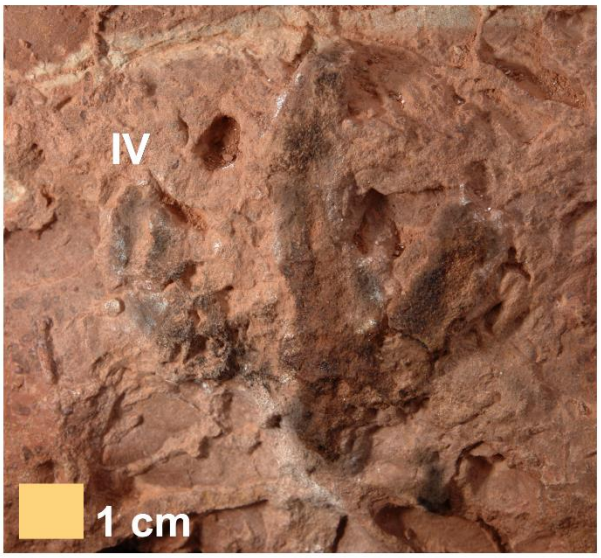

Fig. 3. *Pullornipes* isp. from the Morrison Formation of the Moab Giants land.

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A brief story about the Borkowice tracksite – what we know and what we don't know after five years (2021-2026) of research at this Early Jurassic site

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In July 2021, a new dinosaur tracksite was discovered during a field survey of outcrops along the northern, Mesozoic margin of the Holy Cross Mountains. Preliminary work at Borkowice between 2021 and 2022 revealed it to be one of the richest dinosaur track localities in Poland and Europe. The ichnological record consists of perfectly preserved dinosaur tracks within a sequence of barrier-lagoon deposits of the Upper Hettangian (Lower Jurassic). Many specimens—particularly visible in 3D scans—display three-dimensional natural casts of dinosaur feet, preserving anatomical features and scaly skin impressions in extraordinary detail.

During mining operations in 2023–2024, over 250 track-bearing fragments from two palaeosurfaces were identified, and 127 sandstone blocks were successfully recovered and secured. To date, more than 1,000 dinosaur tracks representing at least seven different ichnospecies have been identified at Borkowice. The finds can be described as a "game changer," revealing the extent of the gaps in the skeletal fossil record within Lower Jurassic deposits on a global scale.

Research and documentation work at Borkowice is entering its final stage; however, the fate of the material gathered on-site remains uncertain, while plans to build a local exhibition and educational centre continue to be of interest to both the municipality and the province. Cooperation with local authorities is essential to ensure the security and protection of this UNESCO-quality geoheritage site.



Maltrata: a Late Pleistocene site preserving megafauna and human footprints

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A new Late Pleistocene vertebrate tracksite was found near the town of Maltrata, in western Veracruz, Mexico. The track-bearing sediments are interpreted as a cohesive flow; Carbon-14 analysis yielded an age of 12,800 years before present. It measures 1,056 m in length and 355 m in width, with a total surface area of 176,721 m², thus representing the largest vertebrate tracksite in Mexico (Fig. 1A).

Currently, pupal chambers attributed to Hymenoptera represent the only known invertebrate traces (Fig. 1B). Bird traces are scarce, the best-preserved is an isolated flamingo track showing morphological similarities to the ichnogenus *Phoenicopterichnum* (Fig. 1C). Other ichnofossils include mammalian coprolites.

Most of the tracks belong to mammals. Among Xenarthra, a partial trackway related to Cingulata is present (Fig. 1D). Several tracks and trackways belonging to giant ground sloths (ichnofamily Megatherichnidae) have also been recorded (Fig. 1E). Pes impressions are sub-oval in shape with a conspicuous, triangular, medially directed claw impression, reflecting the pedolateral condition of ground sloths (Fig. 2A). The ichnogenus *Falciformichnus* is present (Fig. 2B); it has been previously reported from the Late Pleistocene of North America, making the record from Maltrata the second one. Notably, juvenile individuals are also represented through their tracks.

Among Artiodactyla, isolated, small- and large-sized camelid footprints have been found (Fig. 2C, D). Isolated footprints representing cervids are also present.

Proboscidean footprints are known through manus and pes impressions; those of mammoths are larger in size, compared to those of gomphotheres (Fig. 2E).

A rare finding consists of large, entaxonic tracks related to Toxodontia, representing only the second such record, preceded by a Pleistocene tracksite in Brazil (Fig. 2F).

Scarce tracks belonging to Perissodactyla (mainly Equidae and Tapiridae) have been recorded. Although horses are represented by isolated tracks, rare examples showing foot-sediment interaction have also been discovered. While horses and tapirs have an extensive osteological fossil record across several Pleistocene localities in Mexico, these footprints from Veracruz represent the first record of horse and tapir tracks from the Pleistocene of Mexico.

Members of Carnivora (specifically Felidae and Ursidae) are also present at the Maltrata tracksite. Tracks of a large felid are rare; one retains well-preserved metacarpal and digital pads and measures 23 cm in diameter (Fig. 2G). Its enormous size suggests the presence of the American Lion (*Panthera atrox*). A few tracks related to Ursidae have been discovered (Fig. 2H); their large size suggests an individual with a hip height of 1.60 m.

One of the most striking discoveries is that of human tracks and trackways. These are entaxonic and exhibit the typical human configuration characteristic of Hominidae (Fig. 2I). Notably, these tracks are mostly associated with tracks and trackways of giant ground sloths, suggesting hunting interaction (Fig. 2J-L)—an idea supported by the discovery of limestone and flint tools in direct association with the track-bearing layer.

The state of Veracruz occupies the entire eastern region of Mexico. It was previously stated to shed "*very little light on the earliest human occupations*"; however, it has also been suggested that natural funnels between ancient coasts and mountains served as coastal penetration routes for early human inhabitants along the Gulf coast. The ichnofossiliferous site of Maltrata, Veracruz, strongly supports this hypothesis.

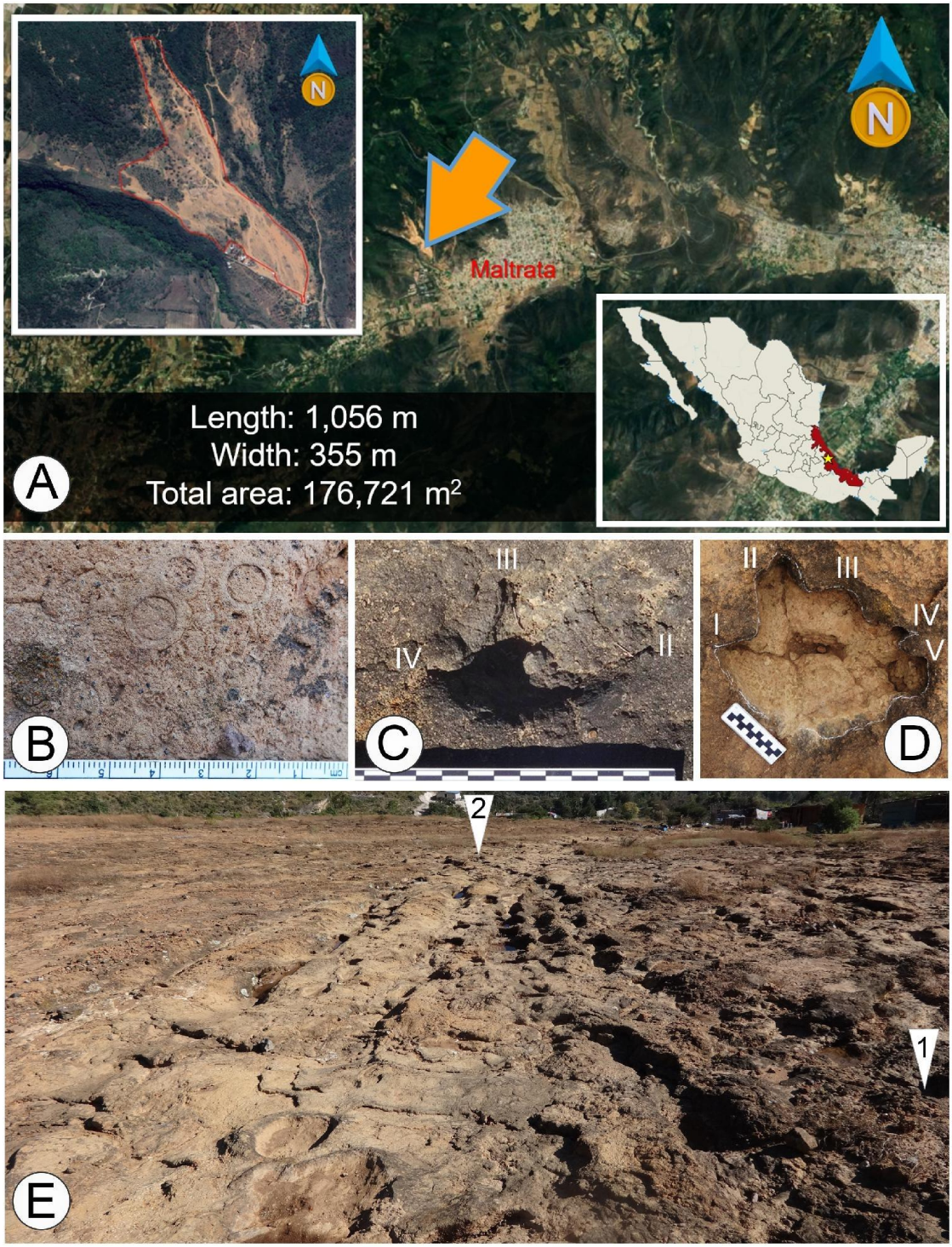

Fig. 1.- A) Geographic location and size of the Maltrata Ichnofossiliferous Site, in the state of Veracruz, eastern coast of Mexico. B) Pupal chambers attributed to Hymenoptera. C) Isolated flamingo track with morphological similarities to the ichnogenus *Phoenicopterichnum*. D) Right pes impression belonging to a partial trackway related to Cingulata (Xenarthra). E) Tracks and trackways of giant ground sloths (Ichnofamily Megatherichnidae); these trackways frequently exhibit a sigmoidal direction. In this case, the trackway starts at 1 and ends at 2. Roman numerals indicate the digit numbers.

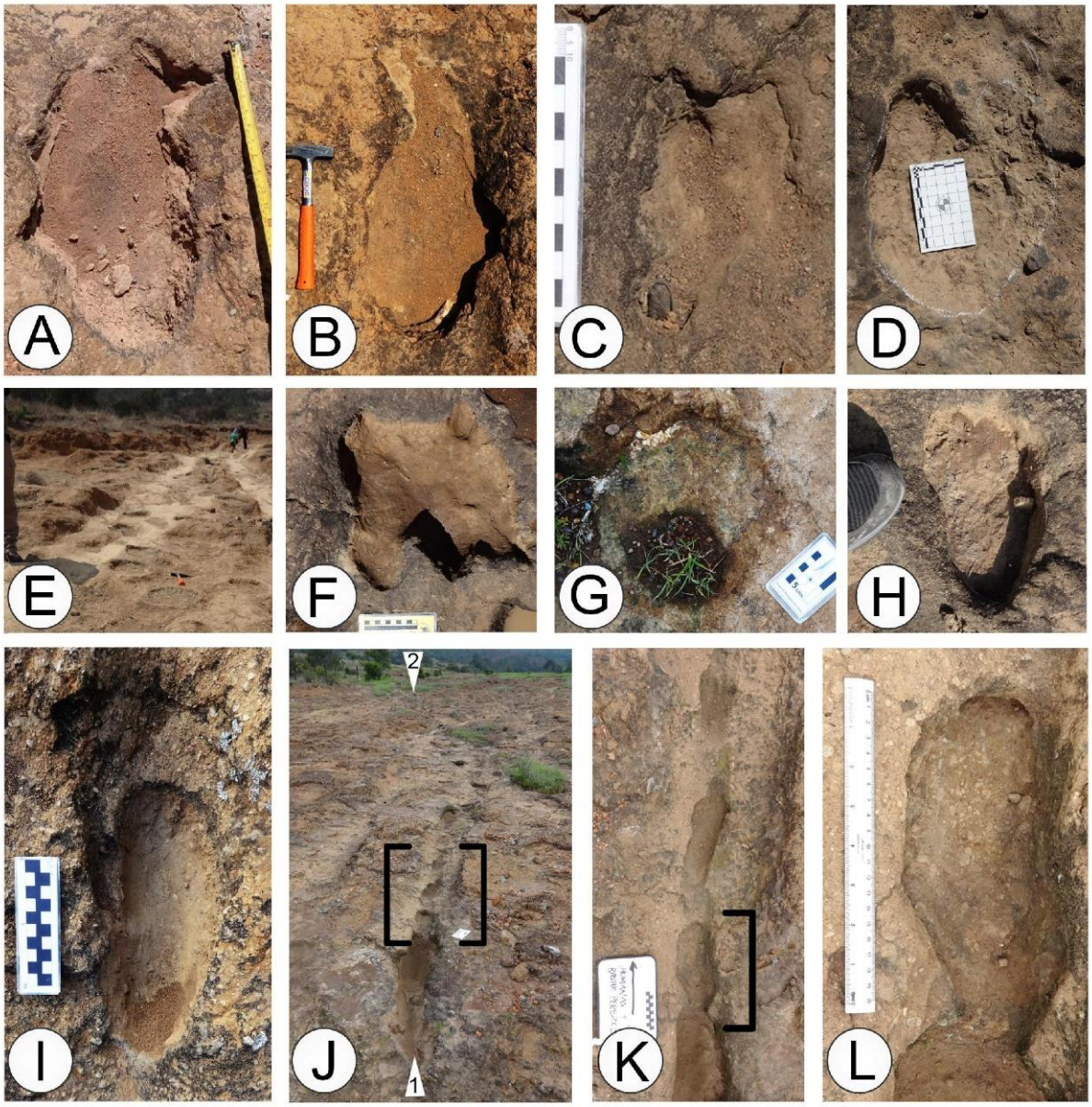

Fig. 2.- A) Giant ground sloth left pes impression; note the medially-directed, sub-triangular claw at the upper right part of the photograph. B) Giant ground sloth right pes impression related to the ichnogenus *Falciformichnus*. C) Small-sized and D) large-sized camelid tracks, suggesting the presence of Lamini and Camelini camelids, respectively. E) Tracks belonging to Proboscidea, in this case related to Gomphotheriidae. F) Isolated mammal track related to Toxodontidae. G) Large felid track; note the large metacarpal pad as well as the two well-preserved digital pads at the left. H) Large track related to Ursidae. I) Well-preserved right human pes impression within a right pes impression of a giant ground sloth. J) Giant ground sloth trackway (starting at 1 and ending at 2); the square brackets indicate three human tracks, shown in K. K) Three human tracks preserved within the giant ground sloth trackway shown previously; the partial square bracket indicates the left human track shown in L.

Dogs, bears, and cats: the ichnological record of carnivorous mammals in the Cenozoic of Mexico

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The Cenozoic vertebrate paleoichnological record of Mexico includes a significant diversity of bird and mammal tracks—primarily from artiodactyls—along with a few records of proboscideans. This evidence comes from several localities across the country (Fig. 1). Localities in the states of Chihuahua, Jalisco, Puebla, Zacatecas, Hidalgo, and recently, Veracruz and Baja California Sur, preserve ichnological evidence of mammals of the Order Carnivora. This work presents a synthesis of the known record of carnivorous mammal tracks in the Cenozoic of Mexico, focusing primarily on Canidae, Ursidae, and Felidae, as well as tentatively Mustelidae (Fig. 2; Delgado-Quiroz et al., 2025).

Until recently, canids were represented only by an isolated footprint from late Pleistocene sediments at Villa Alegría, Puebla. However, a new locality from Zacatecas has yielded tracks attributable to a borophagine canid (Fig. 2A), while Late Pleistocene canid coprolites are known from the state of Hidalgo (Bravo-Cuevas *et al*., 2017). A large bone-bearing coprolite of an unidentiffied carnivore was discovered at the Late Pleistocene of Veracruz (Fig, 2B).

Ursid tracks have been identified at three localities at the Sierra Tarahumara of western Chihuahua, spanning the towns of Basaseachi, San Juanito, and Bocoyna. These tracks have been attributed to an Oligocene age, although they may potentially be of a more recent age. The morphology of these tracks—specifically the presence and arrangement of claw impressions—allows for the identification of distinct locomotor strategies and potential dietary habits, ranging from herbivorous-omnivorous to hypercarnivorous forms (Fig. 2C-E). Additionally, a Miocene-Pliocene ursid track has been recorded in the Teocaltiche Paleobasin of northeastern Jalisco (Fig. 2F), its morphology allows to relate it to the genus *Indarctos*. Added to this record is a Late Pleistocene isolated track from Maltrata, Veracruz, that suggests a large-sized ursid with a hip height estimated in 1.60 m (Fig. 2G).

The Teocaltiche Paleobasin preserves felid tracks assigned to the ichnotaxon *Mitsupes dugesii*, attributed to a machairodontine felid (Fig. 2H). Pleistocene tracks attributed to *Smilodon* are known from the Pie de Vaca locality in Tepexi de Rodríguez, Puebla. Added to this record is a large Late Pleistocene track from Veracruz, consistent with a felid similar in size to *Panthera atrox* (Fig. 2I).

Finally, possible mustelid tracks has been reported from Monte Escobedo, Zacatecas and from the Pliocene of Baja California Sur (Fig. 2J), where the presence of a poorly preserved ursid track has also been proposed. The discovery of two new localities in the southern state of Zacatecas—dating from the Miocene to the Pliocene—provides new insights; one of these preserves an assemblage of camelid, proboscidean, and bird tracks, alongside three isolated prints that stand out due to their distinct morphology and claw marks, suggesting small-sized carnivores.

This synthesis represents a valuable source regarding the diversity and distribution of these organisms. This evidence demonstrates that tracks constitute a significant source of information regarding the diversity of the order Carnivora, especially in contexts where osteological remains are scarce or absent. Integrating these records expands our knowledge of the diversity and geographic distribution of carnivorous mammals in Mexico and offers new perspectives for understanding the vertebrate communities that inhabited these paleoenvironments during the Cenozoic.



Fig. 1.- The ichnological record of mammals related to Carnivora, from the Cenozoic of Mexico. This record includes tracks of Canidae (dogs), Ursidae (bears), Felidae (cats), Mustelidae (*e.g.*, badgers, weasels, etc.) and coprolites or fossil feces. The states bearing mammal traces are Baja California Sur, Chihuahua, Hidalgo, Jalisco, Puebla, Veracruz and Zacatecas.

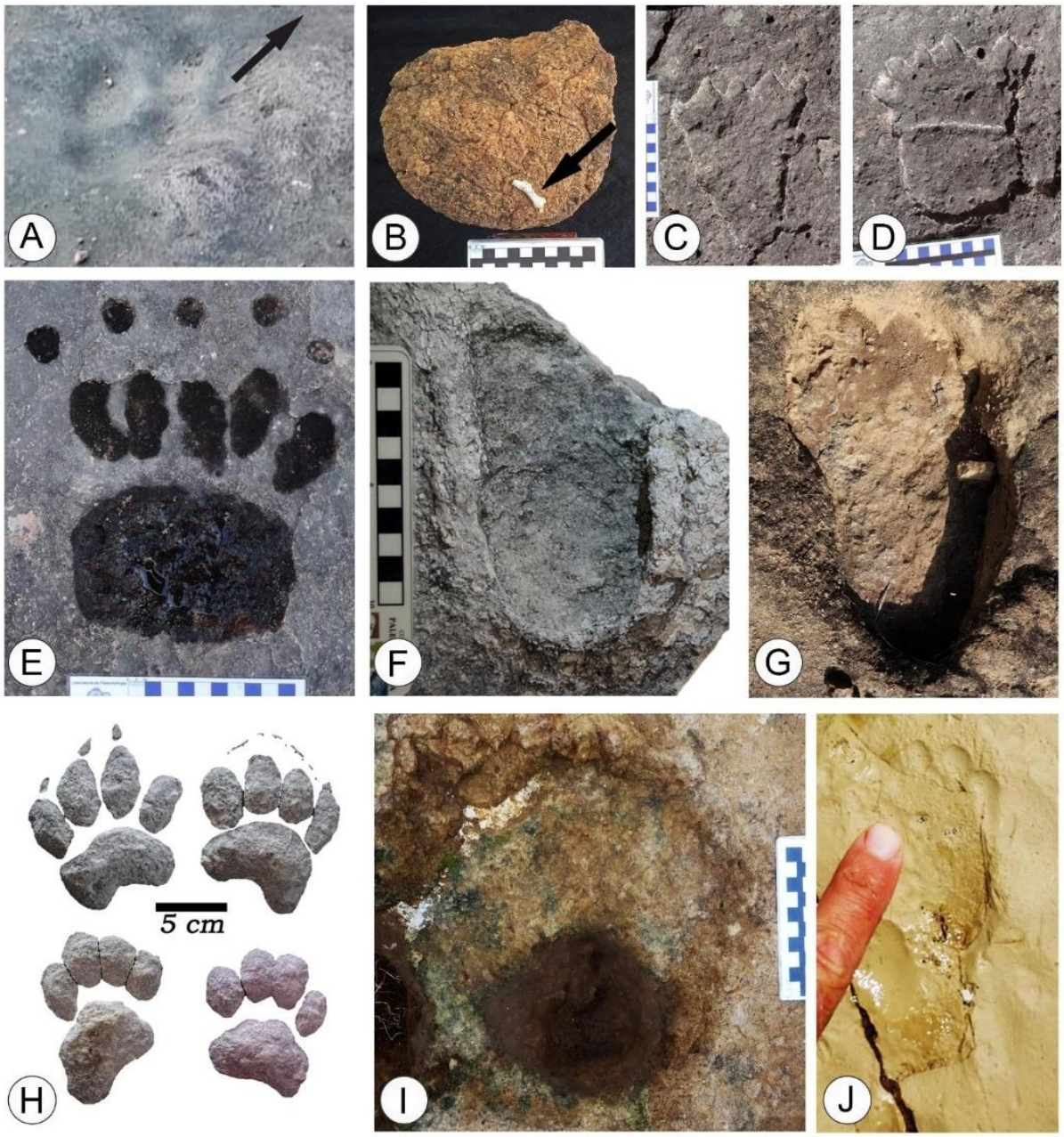

Fig. 2.- A representative sample of mammal ichnofossils related to the order Carnivora in Mexico. The ichnotaxonomic diversity documented at the country's principal paleontological sites is illustrated. A) A borophagine canid track in the field at a new locality (Huanusco) from the state of Zacatecas; arrow points to the direction of travel. B) Carnivore coprolite from the Late Pleistocene Maltrata site in the state of Veracruz; arrow points to a bone fragment. Small ursid footprints from the Oligocene at the Sierra Tarahumara, western Chihuahua: manus impression (C) and pes impression (D). E) Large ursid footprint from the Oligocene at the Sierra Tarahumara; note the circular impressions representing large claw marks. F) Small ursid pes impression from the Teocaltiche Paleobasin, northern Jalisco; it preserves a subtriangular claw impression and a mud rim. G) Late Pleistocene isolated ursid track from Maltrata, Veracruz; it measures 35 cm in length and 17 cm in maximum width. H) Tracks of the ichnotaxon *Mitsupes dugesii* Rodríguez-de la Rosa & Guzmán (2012), attributed to a machairodontine felid; the pair above are the manus impressions and the tracks below are the pes impressions, preserved in convex hyporelief. I) Large Late Pleistocene felid track from Veracruz; it is 23 cm in diameter, a size consistent with footprints related to *Panthera atrox*. J) Mustelid track from Pliocene sediments from the state of Baja California Sur.

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First fossil track of a South American Native Ungulate in the Middle Miocene of La Venta, Colombia

Alejandro Corrales-García, Darin Croft, Rubén A. Rodríguez-de la Rosa, Cesar Augusto Perdomo-Rojas, Daniel Osorio & Andrés Link

The Middle Miocene of La Venta is one of the most diverse Neogene fossil vertebrate assemblages in South America of mammals yielding >150 different taxa living in a complex mosaic of wetlands, large water bodies and terrestrial ecosystems. Most paleobiological data from La Venta has been driven by studies on macrofossils and more recently by studies on isotopes and inchnology, but until now no fossil footprints have been recorded at La Venta. In 2025, we found an isolated mammal footprint, here we provide its description and inferences about the potential trace-makers. The footprint is both tridactyl and mesaxonic with no evidence of claws or hoof marks.

Lateral digits are similar in shape and size, while the central digit is notably smaller and does not go deep in the sediment. We estimated body size to be at least 530 kg based on the minimum area (136.6 cm^2) but could be much heavier if the total area of the footprint is included. Given the large body size, only a few mammalian candidates – known to date at La Venta - could have produced this footprint: including two species of astrapotheres (*Granastrapotherium snorki* and *Xenastrapotherium kraglievichi*) or two of the largest notoungulates (*Pericotoxodon platignathus* and *Huilatherium pluriplicatum*). Given that the few fossil tracks assigned to Toxodonts are very different from the one included in this study and that podial morphology of astrapotheres and leontiniid toxodonts is quite scarce, we are unable to assign this specimen to a new or already known ichnofossil.

The scarcity of Miocene tracksites in South America, and the fact that there are no modern analogs of South American Native Ungulates raises the importance of new tracks as an additional source for better understanding the relatively unknown paleobiology of some of the largest mammals in the Miocene of South America.



Dinosaur footprints from the Lower Cretaceous of Colombia: newly found ichnodiversity and taphonomic perspectives

Alejandro Corrales-García, Carantón–Mateus, William G., Sierra-Rojas, Maria Isabel and Luque, Javier

Dinosaur remains from equatorial South America are rare, and fossil evidence from Colombia is especially scarce. In 2020, six ornithopod footprints preserved on a sub–vertical bedding plane were reported in the Bata Formation (Lower Cretaceous) in Santa María (Boyacá, Colombia). Since then, although research received relatively high media attention, subsequent popular science communication led to the town's embrace of the discovery, with the town adopting the potential producer, an iguanodon-like ornithopod, as its mascot and icon. Outreach among the local community in a collaborative effort with professionals has led to new discoveries of tracks along the Bata River valley. In the present study we present an update on newly discovered footprints and trackways in this same locality.

The new set of trace fossil evidence includes over 33 individual footprints of various sizes and diverse dinosaur affinities (Fig. 1). Many tracks are preserved as isolated footprints in giant fallen blocks along the margins and riverbed of the Rio Batá, covering a transect of ~400 m upstream. Additionally, two stratigraphically-close trackways were identified *in situ*. Furthermore, multiple instances of dinoturbation were recognized in the vertical plane of the fallen blocks as subrectangular, pillar-like structures, or concave up detached, semicircular structures of different lithology than the surrounding host rock (Fig. 2).

Notably, most tracks are large tridactyl footprints, thus the diversity of potential trace-makers is mostly constrained to representatives of theropoda and ornithopoda (Fig. 1a–b). Although the distinction between both kinds of producers in large-sized individuals is contentious, morphological features and metrics are enough in some instances to confirm the presence of both groups in the Batá Formation. On the other hand, suboptimally preserved footprints are potentially thyreophorans and sauropods in origin with a degree of uncertainty (Fig. 1c–d).

The Batá Formation consists of a thick succession of conglomerates and sandstones with mudstone intercalations, interpreted as deposited along the palaeoshoreline of an epicontinental seaway during the Valanginian–Hauterivian (ca. 132 Ma). Accordingly, the newly discovered footprints are also variable in grainsize infill, most commonly having coarser grainsizes in comparison with the host rock, allowing for differential preservation to happen, and recognition of footprints in the field as positive hyporeliefs, positive epireliefs, and full reliefs. Diverse modes of preservation and erosion at different planes offer taphonomic evidence that contributes to a broader refinement of environmental interpretation in the area. Lastly, this case study highlights the significance of popular science and the importance of maintaining connections with community leaders as fundamental to subsequent discoveries.



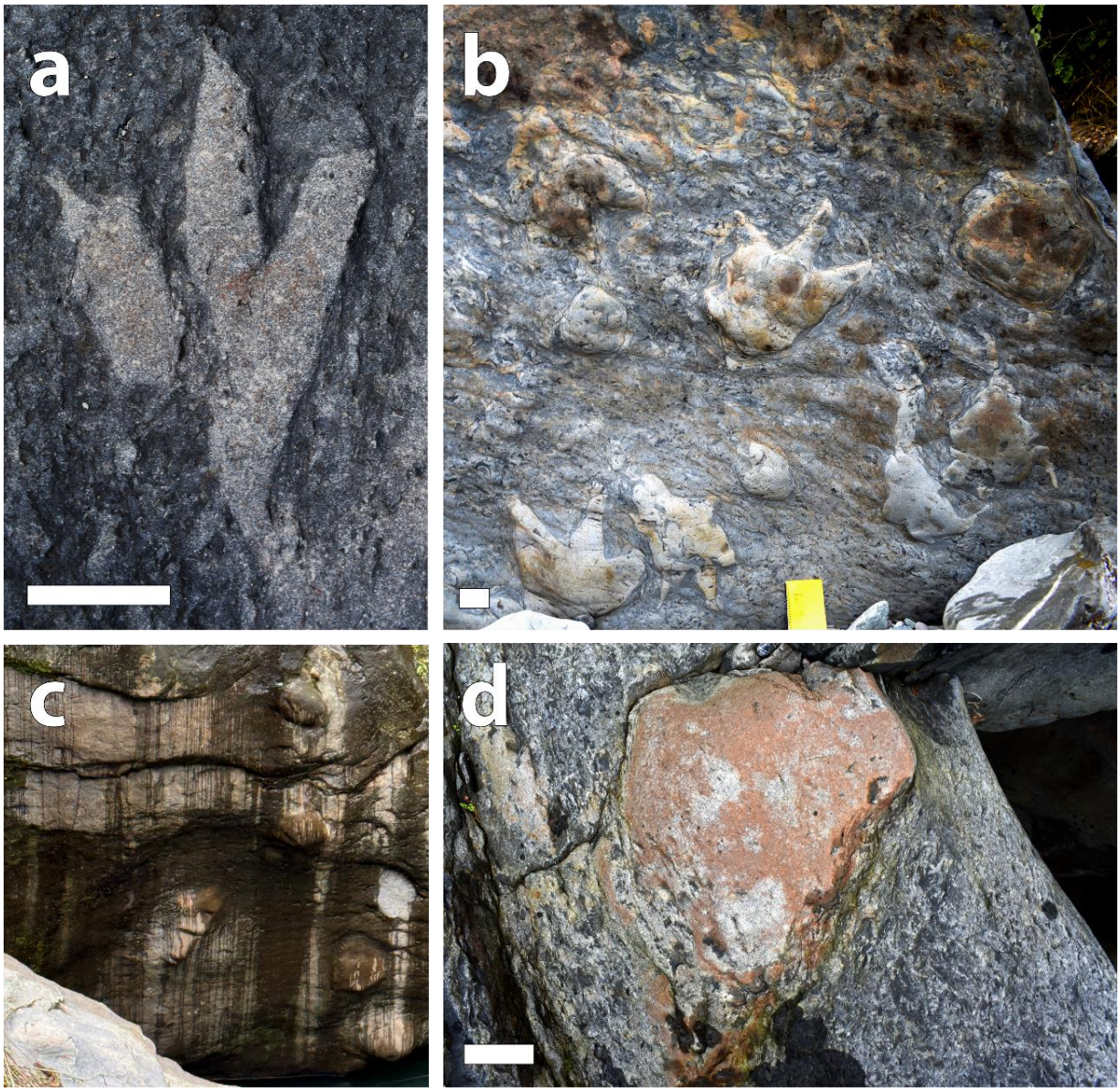

Fig 1. Footprint diversity of the Batá Formation. a) Small isolated theropod footprint preserved as positive epirelief; b) fallen block with multiple footprints and a short trackway preserved as positive hyporeliefs; tridactyl footprints producers are likely ornithopods; c) *in situ*, strata-crossing trackway preserved as positive hyporelief; producer is potentially a sauropod; d) long and penetrative isolated footprint preserved as positive hyporelief; producer is potentially a thyreophoran. All scales = 10 cm.

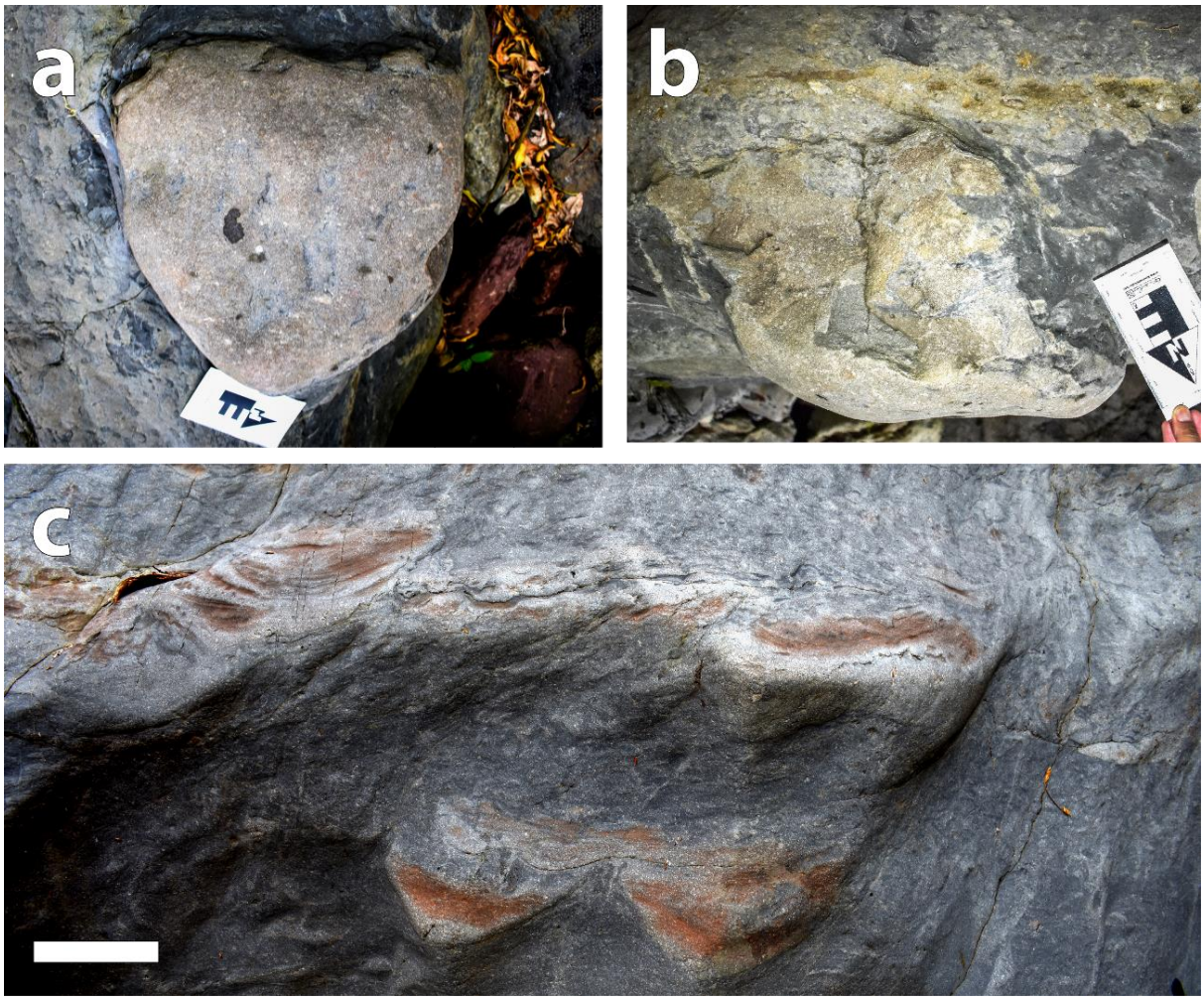

Fig. 2. Dinoturbation structures of the Batá Formation. a) Unassigned isolated footprint, bedding-plane view, preserved as positive hyporelief; b) same footprint in vertical (cross-sectional) view, displaying deep penetration and infill source from the overlying sand level; c) Concave-up sand-filled structures detached from their source sediment layer. All scales = 10 cm.

A Pleistocene turtle egg (Testudoolithidae Hirsch, 1996) from San Juan Raya, Puebla, México

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Traditionally, fossil eggs are considered subjects of study within vertebrate paleoichnology, even though they represent direct evidence of a particular group of Amniota.

In the Pleistocene of Mexico, fossil eggs have only been reported as belonging to the Family Phoenicopteridae, or flamingos (Cruz et al., 2023). In this case, the egg was collected from Pleistocene sediments within the urban area of the town of San Juan Raya, Puebla. The discovery occurred during the excavation of a water well within a light brown alluvial horizon composed of homogeneous sediments, predominantly sandy in grain size (Fig. 1A). This layer unconformably overlies—approximately 10.5 m above—the early Cretaceous calcareous shale and sandstone strata of the San Juan Raya Formation (Fig. 1A, white asterisk). Between the alluvial horizon and the marine deposits, a few centimeters above the latter, a conglomerate level was identified. This level consists of clasts ranging from 0.5 to 1 cm in size, where equid dental remains were located. The stratigraphic relationship between these deposits reveals a sequence comprising the marine strata of the San Juan Raya Formation, followed by the conglomeratic level, and finally the alluvial deposit horizon from which the egg was recovered (Fig. 1A, red arrowhead).

In external view, the egg has a diameter of 3.7 cm (Fig. 1B); however, tomographic analysis shows that the egg is sub-spherical, with a maximum diameter of 4.27 cm (Fig. 1C).

It corresponds to a hatched egg, as it contains no skeletal remains inside, and the shell is fragmented into small, polygonal pieces. Other fragments surrounding the specimen and concave areas on the lower surface suggest that it originally formed part of a nest; nevertheless, the specimen described here is the most conspicuous.

The egg bears an eggshell with an external rough surface. The interpretation that this is a hatched egg is supported by scanning electron microscopy observations, which reveal the inner parts of the crystalline units, some of these exhibit calcium absorption craters resulting from the utilization of this element during embryonic development (Fig. 1D, white arrowheads), exfoliation features are also seen. Furthermore, small, narrow, widely spaced pores are observed (Fig. 1D, black arrowheads),

The overall shape of the crystalline units (Fig. 1E)—sub-rectangular and sub-rounded toward the mammillary zone—suggests that this is a turtle egg (Testudines Linnaeus, 1758). The aragonite crystalline units are fan-shaped with radially arranged crystals (Fig. 1E); these crystalline units measure 120 µm in outer width and 220 µm in thickness. Additionally, the crystalline units show morphological similarities to those observed in eggs of the family Kinosternidae (Acuña-Mesén et al., 2001); therefore, this study represents a reliable record of the Oofamily Testudoolithidae (Hirsch, 1996) in Pleistocene sediments of Mexico.

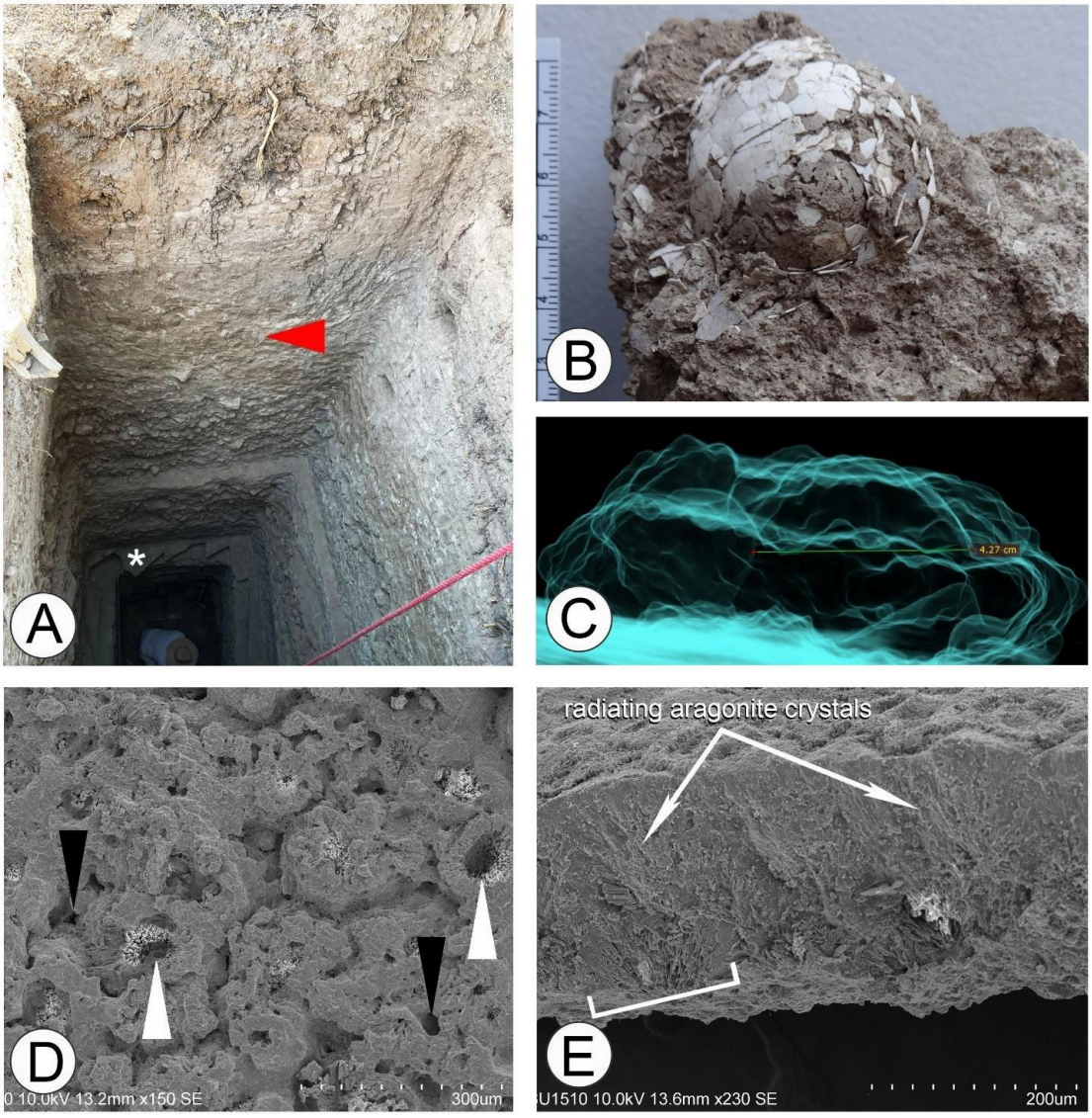

Fig. 1 - Fossil egg from the Pleistocene of Mexico. A) Excavation of a water well where the fossil egg was recovered (red arrowhead) from Pleistocene sediments of the town of San Juan Raya, Puebla, the white asterisk indicate the Early Cretaceous strata of the San Juan Raya Formation. B) External view of the egg, note the small polygonal pieces of the eggshell. C) Tomographic image of the egg, it is sub-spherical in general shape. D) Internal view of the eggshell, note the calcium absorption craters resulting from the utilization of this element during embryonic development (white arrowheads), note as well the small pores (black arrowheads). E) Crystalline units of the shell, note the fan-shape and radially arranged aragonite crystals. The white bracket indicates a single crystalline unit.

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A new record of Middle Jurassic dinosaur footprints from México

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The ichnological record of Jurassic dinosaurs in Mexico is scarce. The only Jurassic ichnofossil evidence is in the south and central-west of the country; in the localities of Santa María Xochixtlapilco, Huajuapan de León (Ayuquila Basin, Toarcian), Río Ñumí, Tlaxiaco (Tlaxiaco Basin, Bajocian) both in the state of Oaxaca and, in Chuta, Lázaro Cárdenas, Michoacán (Middle Jurassic–Early Cretaceous?).

This ichnofauna includes footprints and traces of sauropods, theropods, ornithischians, ankylosaurs and possibly Chirotheriidae. Therefore, the objective of this study is to document the first record of dinosaur footprints in San Mateo Mimiapan, Zacapala, Puebla, correlate it with the ichnological record of dinosaurs in southern Mexico (western equatorial Pangaea) during the Jurassic and evaluate the geotourism approach of the locality.

The footprints are found *in situ* in the locality of El Ahuehuete, associated with undetermined permineralized trunks of *ca.* 10 m. This area features a succession composed mainly of fine conglomerate and coarse to medium sandstone, deposited in a fluvial environment.

The ichnites were preserved in a medium to fine sandstone deposit, located towards the top of the succession. Based on its composition and stratigraphic relationships, this succession is preliminarily correlated with the Otlaltepec Basin (Otlaltepec Fm.) and tentatively with a Middle Jurassic (Bathonian) age. A photographic record was made and digital images were obtained.

The morphology of the footprints was described and the morphometric parameters were calculated based on specialized literature. Two consecutive footprints were located (one step?), preserved as concave epireliefs, they are tridactyl, digitigrade, mesaxonic and asymmetrical (rhomboid). They are almost as long as they are wide, measuring 30-39 cm respectively; the digits are II-26 cm, III-30 cm, IV-23 cm, thin and acuminate with sharp claw impressions.

The total interdigital divergence angle is 85°. The step length is 80cm, with an angle of ~160°. The individual would be of intermediate size with an acetabular height of ~1.50 m, a length of ~4-6 m, and a body mass of ~110-487 kg. These footprints are the first indirect evidence of dinosaurs in San Mateo Mimiapan, Zacapala, Puebla. The paleoenvironmental context during the Early–Middle Jurassic was characterized by extension and transtension associated with the fragmentation of the west-equatorial margin of Pangaea, generating continental basins limited by faults and topographic highs.

This configuration controlled the evolution of these sedimentary basins and conditioned the configuration of terrestrial habitats. In this sense, the theropod ichnofauna in southern Mexico is composed of a remarkable morphometric diversity, for example, footprints from 10cm to 73cm long, this is correlatable with the location of each basin, since the smallest are found in the Ayuquila and Otlaltepec basin (this study) and the largest in the Tlaxiaco basin.

The paleobiogeographic context derived from this discovery, integrated with the paleobotanical record and sedimentological data, gives El Ahuehuete significant potential as a geopaleontological heritage site and, consequently, high geotourism value. Integrating this data will allow for the reconstruction of the Jurassic landscape of San Mateo Mimiapan and the development of future conservation and outreach strategies for the benefit of the community.

New find of the large therapsid tracks in the Triassic of Poland

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New find of the large therapsid tracks is reported from the informal lithostratigraphic unit known as the Krynki Beds, from the northern slope of the Holy Cross Mts. In August 2026, these footprints were found at the recently disused quarry in Parszów. Niedźwiedzki *et al*. (2007) argued for the Middle Triassic age of the Krynki Beds and described from Parszów the tracks labeled as *Chirotherium* cf. *sickleri* and cf. *Characichnos* isp. Newly discovered material exhibits morphology attributed to the ichnogenus *Therapsipus* Hunt *et al*., 1993.

These tracks are found in two excavated places. The isolated manus-pes set (Fig. 1) with pentadactyl pes slightly longer than wide (23 cm long and 20 cm wide) and tetradactyl manus impression wider than long (19 cm long and 22 cm wide) is located at GPS coordinates N51°4'41.98" and E20°55'13.08". Closely to this, at GPS coordinates N51°4'41.8" and E20°55'13.38", is located short trackway (Fig.2) with the very similar tracks. All show *Therapsipus* characteristics such as: generally large footprints, more or little less than 20 cm in length; pentadactyl pes wider then long with the middle digit longest; tetra- or pentadactyl manus wider than long with digit III and IV longest and subequal in length; broad trackway with very short steps.



Fig. 1. *Therapsipus* isp., the isolated manus-pes set from the Krynki Beds in Parszów.



Fig. 2. *Therapsipus* isp., short trackway from the Krynki Beds in Parszów.

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Triassic panorama of Poland – dinosaur and other tetrapod tracks from the Early to Late Triassic of Poland

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The vertebrate paleoichnological record provides a wealth of valuable information for palaeobiological and palaeoecological studies. Traces of animal life activity (tracks, burrows, coprolites, etc.) are abundantly represented in the fossil record. Over the past 35 years, a rich ichnological record has been identified in Triassic deposits across three regions of Poland: Silesia, the Holy Cross Mountains, and the Tatra Mountains, together yielding over 100 sites featuring primarily footprints/trackways, some also with abundant coprolite assemblages.

The stratigraphic range spans deposits from the earliest to the latest Triassic—an exceptional feature within the European geological record. Polish sites have yielded traces of some of the earliest Avemetatarsalia, rich Early and Middle Triassic archosaur-therapsid ichnofauna assemblages, and diversified Late Triassic dinosaur tracksites. Recent in-depth studies of coprolites have provided exceptional data highlighting their significance.

While the traditional reconstruction of Poland's Triassic fauna has relied primarily on skeletal remains, ichnological finds offer an even richer, alternative source of information regarding the ecological and evolutionary changes that occurred in this part of Pangea.

Walking among giants: how fossil footprint sites transform local culture and identity

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This paper discusses sites in Mexico and Peru as examples of how local identity and culture can be transformed through fossil sites preserving trace fossils. Various ichnofossil localities and paleontological discoveries have enabled nearby communities to develop a strong sense of belonging and experience significant cultural growth.

During the 1980s and 1990s, a series of dinosaur discoveries brought southeastern Coahuila into the global spotlight. Late Cretaceous (Campanian) fossil remains were discovered near the town of Rincón Colorado (Fig. 1A-E)—most notably *Velafrons coahuilensis*, a crested hadrosaur—alongside three sites containing theropod dinosaur footprints (Fig. 1E). Today, this fossil-bearing zone is a federally protected natural area. The town features a small museum and paleo-sculptures of dinosaurs (Fig. 1A-D). A notable initiative involved naming the town's streets after these organisms—for example, “Calle Tiranosaurios” (Tyrannosaurs *Street*) and “Calle Picos de Pato” (*Duck-bill Street*) (Fig. 1D).

The tracksite of Las Águilas, also in southeastern Coahuila, preserves trackways left by a hadrosaur herd, and tracks of tyrannosaurs and ornithomimids (Fig. 1F). Visitors there traverse wooden walkways designed to allow for the observation of the tracks without damaging them (Fig. 1G). Likewise, several areas containing ornithopod and theropod tracks have been discovered in north-central Sonora. In all these instances, the sites are open to both the general public and specialists.

In 1990, a site preserving dinosaur footprints was discovered in Lower Cretaceous sediments of the San Juan Raya Formation, at San Martín Atexcal, Puebla (Fig. 2A). Driven by a strong sense of local pride, residents installed a mesh barrier to prevent visitors from touching the tracks (Fig. 2B). 3D scanning work is currently underway to digitally preserve this site. Dinosaur footprints have been discovered near Santa Ana Teloxtoc, where inhabitants constructed a small museum and local residents make dinosaur figures using plant fibers (Fig. 2C).

In 2002, it was discovered a dinosaur tracksite near Querulpa Chico, southern Peru (Fig. 2E). This discovery sparked a major conservation effort that culminated in the creation of the "Dinosaur Park, Petrified Tracks, Querulpa" a themed site featuring life-size sculptures of various species (Fig. 2F, G). Similarly, a site containing Early Cretaceous titanosaur (Sauropoda: Titanosauria) tracks is located near Capiza-Típan, also in southern Peru (Fig. 2H). Situated along the road to Típan, the site is currently being studied with a view to its conservation and an assessment of its cultural impact and social role within the region.

Developing community paleontological routes transform tracksites into geotourism destinations managed by local residents. This type of development should be structured around three key pillars: 1) Local residents must receive training in science communication and basic paleoichnology to serve as local guides; it formalizes jobs, reduces migration, and fosters local pride. 2) Infrastructure around the ichnofossil site can be designed for low environmental impact, with elevated walkways protecting the footprints, educational panels regarding the discovery should be included. 3) The influx of visitors drives the opening of community eateries, craft workshops inspired by local fossil fauna, ensuring that economic benefits go directly to local families.

This strategy transforms a static scientific resource—such as tracksites—into an engine for local economic development and a hub for active conservation.



Fig. 1.- A) Aerial view of the town of Rincón Colorado (General Cepeda, Coahuila); a small paleontological museum is viewed in the central part of the photograph. B) Dinosaur paleosculpture outside the museum at Rincón Colorado, viewed by Giuseppe Leonardi, a prominent paleoichnologist. C) Three paleoichnologists on their way to Rincón Colorado; from left to right: the author, Richard McCrea, and Giuseppe Leonardi. D) Giuseppe Leonardi looking at the street signs for Picos de Pato and Tiranosaurios ("Duck-billed Dinosaurs" Street and "Tyrannosaurs" Street). E) Tyrannosaur trackway outcropping close to the town of Rincón Colorado. F) Las Águilas tracksite, at General Cepeda, Coahuila; a photograph taken shortly after its discovery. G) Las Águilas tracksite with the walkways designed to allow for the observation of the dinosaur tracks.



Fig. 2.- A, B) General view of the San Martín Atexcal tracksite, ornithopod, theropod and sauropod tracks are known from the Lower Cretaceous sediments of the San Juan Raya Formation; local residents installed a mesh barrier to prevent visitors from touching the tracks (see the lower portion of the photograph in B). C) Entrance of the Hicupa museum at Santa Ana Teloxtoc. D) Small handcrafted dinosaur figure made from plant fibers by the inhabitants of Santa Ana Teloxtoc. E) Lower Cretaceous dinosaur tracksite near Querulpa Chico, Aplao District, Castilla Province, southern Peru. F) Entrance of the "Parque de dinosaurios, Huellas petrificadas, Querulpa ("*Dinosaur Park, Petrified Tracks, Querulpa*"). G) Life-sized dinosaur sculptures are shown along the park corridor. H) Early Cretaceous tracksite, near the Capiza–Típan road, southern Peru, preserving titanosaur (Sauropoda: Titanosauria) tracks; the photograph shows the team studying the site.



Tracking last chirotheres – morphological diversity in Late Triassic archosaur footprints

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The evolution and radiation of Triassic archosaurs is abundantly recorded by both body- and ichnofossils. Different developments in foot morphology and gait are reflected in numberless, excellently preserved footprints and trackways known by characteristic morphotypes and ichnofamilies seen in chirotheriids, rotodactylids, grallatorids and others. In particular the development of the functionally tridactyl pes from a principally pentadactyl pes pattern has been demonstrated in the ichnogenus *Chirotherium*, showing increasing reduction of pedal digits I and V during the Middle and Late Triassic (Klein and Lucas, 2021, 2025). An additional aspect is the acquisition of bipedality. While in the Middle Triassic chirotheriids and rotodactylids show large morphological diversity representing various basal archosauriform to crocodile- and dinosaur-line archosaur groups (Haubold, 1999; Haubold and Klein, 2002), the Late Triassic period is mostly thought to show a strong decline of chirotheriids versus the increase of dinosauriform ichnotaxa. The latter obviously mirrors the early rise and diversification of dinosaurs. The ichnogenus *Brachychirotherium* that is abundantly preserved in Late Triassic deposits up to the Triassic-Jurassic boundary is often considered the 'last chirothere', reflecting extinction of many basal archosaur groups during this period (Klein et al., 2023).

In recent years it has been shown that Late Triassic chirothere diversity is larger than formerly assumed, including different *Brachychirotherium* such as *B. hassfurtense*, *B. thuringiacum* and *B. parvum.* Furthermore the ichnogenus *Chirotherium* shows 'survivors' from the Middle Triassic such as *Chirotherium postchirotherioides*. Other chirotheriids of uncertain affinities such as '*C.*' *lulli* and '*C.*' *wondrai* do not match the *Chirotherium* diagnosis and could possibly reflect new chirotheriid ichnogenera still to be introduced (Klein and Lucas, 2021). Thus far *Brachychirotherium* is known from different parts of the globe such as Europe, North Africa, southern Africa, North America, Greenland, South America and Asia (China). *Chirotherium postchirotherioides*, originally described as *Parachirotherium postchirotherioides* from Middle Triassic deposits of Germany (Rehnelt, 1950) thereafter has been identified also from Late Triassic strata in Morocco (Lagnaoui et al., 2012).

This Late Triassic record can now be confirmed by recent discovery of a footprint in the Hassberge Formation (Late Triassic, Carnian) of Germany. While restudying materials from former excavations in the Coburger Sandstein of this unit, the author detected an isolated pes print that is identical in shape with *C. postchirotherioides* by mesaxonic digit group II-IV, short, posteriorly shifted digit I and strongly reduced digit V. Obviously this ichnospecies and its producer, probably crown-group archosaurs, had a wider spatial and temporal distribution than originally known. Together with footprints assigned to the ichnogenera *Apatopus* (Phytosauria), *Rotodactylus* (Dinosauromorpha), *Brachychirotherium* (Rauisuchia/Aetosauria), *Atreipus-Grallator* (Dinosauromorpha-Dinosauria-Theropoda) and *Evazoum*, *Eosauropus* (Sauropodomorpha), they prove a diverse archosaur community with nearly global distribution (D'Orazi Porchetti et al., 2026; Klein and Lucas, 2021).

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Geoparks as open-air museums of geological and cultural heritage: contributions of the Polish Geological Institute – National Research Institute to the Holy Cross Mountains UNESCO Global Geopark and the Kamienna Valley Geopark Project

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UNESCO Global Geoparks are single, unified geographical areas where sites and landscapes of international geological significance are managed through an integrated approach combining protection, education and sustainable development. Although geological heritage forms the basis of every geopark, the concept also includes biodiversity, cultural heritage, local traditions and the historical relationship between communities and the Earth's resources. A geopark can therefore be understood as an open-air museum in which the landscape itself presents the geological history of a region and the ways in which people have used and transformed it.

A UNESCO Global Geopark does not constitute a separate legal form of nature protection. Its operation relies on existing national and local regulations, cooperation between institutions and an effective management body. The area must have clearly defined boundaries, a coherent network of geosites and geological heritage of confirmed international importance. It must also have adequate infrastructure, educational programmes and a long-term development strategy.

The management structure usually brings together local authorities, scientific institutions, protected-area administrations, museums, tourism organisations, schools, non-governmental organisations, entrepreneurs and local communities. The managing body coordinates geosite conservation, interpretation, education, tourism development and international cooperation. Local residents play a central role because the geopark model aims to strengthen their identification with the region and create economic opportunities based on its distinctive heritage.

Geoparks support sustainable development primarily through geotourism and geoeducation. Geological trails, visitor centres, museums, field workshops, publications and digital resources help residents and visitors understand the processes that shaped the landscape. These activities can support local accommodation providers, guides, food producers, craftspeople and cultural institutions. The geopark also raises awareness of issues such as the sustainable use of natural resources, climate change, natural hazards and the protection of geodiversity.

Every UNESCO Global Geopark participates in the Global Geoparks Network and the relevant regional network, such as the European Geoparks Network. This cooperation involves the exchange of knowledge and good practices, joint projects, conferences and promotional activities. UNESCO evaluates geoparks regularly. The designation therefore requires continuous work rather than a single successful application.

In Poland, the institution responsible for coordinating cooperation between national geoparks and the European Geoparks Network is The Polish Geological Institute – National Research Institute (PGI-NRI), which performs the tasks of the Polish Geological Survey. Under the Geological and Mining Law, these tasks include coordinating activities related to geodiversity protection and environmental geology. This responsibility provides an institutional basis for the Institute's involvement in the documentation, protection and promotion of Poland's geological heritage.

PGI-NRI has a long tradition of combining geological research with public education. Its specialists have prepared geological maps, inventories of geosites, scientific assessments, museum exhibitions, educational publications and concepts for geological trails and visitor centres. Research conducted by the Institute provides the evidence needed to identify the most valuable geosites, determine their scientific significance and explain their relationship with landscape development and human activity. PGI-NRI researchers also participated in documenting caves and former quarries, developing geotourism routes and preparing educational materials.

The Institute's contribution to the Holy Cross Mountains Geopark predates the UNESCO application. In 1991, Tymoteusz Wróblewski from the Holy Cross Branch of the Institute developed the concept of the Chęciny–Kielce Geological Landscape Park Its implementation, with minor modifications, led to the creation of the Holy Cross Mountains UNESCO Global Geopark.

The Holy Cross Mountains UNESCO Global Geopark provides an example of how this model operates in Poland. The geopark covers approximately 526 km² and includes the municipalities of Kielce, Chęciny, Morawica, Nowiny and Piekoszów. Cooperation between these municipalities began with a partnership agreement in 2015. In 2017, they established the Association of Municipalities "Geopark Świętokrzyski", which became the formal management organisation. The geopark joined the UNESCO Global Geoparks Network in 2021.

The area contains an exceptional record of sedimentary rocks ranging from the Cambrian to the Quaternary. Its geological heritage includes marine and terrestrial deposits, structures created during several tectonic phases, karst landforms and extensive evidence of historical mining and quarrying. Representative geosites include Kadzielnia, Wietrznia, Ślichowice, Miedzianka, the Raj Cave, the Szewce quarry and the Chęciny area. The Chęcińska Valley, with its folded rock formations, historical quarries, mining remains and medieval castle, expresses the close relationship between geology, landscape and cultural development.

The Holy Cross Mountains Geopark combines this geological heritage with nature conservation, local history and living traditions. Geoeducation centres, museums, geological trails, regional guides, local associations and cultural groups contribute to its programme. Former industrial sites and quarries have gained new educational and tourism functions. In this way, the geopark transforms scientific knowledge into accessible interpretation and uses heritage conservation to support regional tourism and local identity.

In 2020, PGI-NRI and the Association of Municipalities "Geopark Świętokrzyski" formalised their cooperation through a partnership agreement. The Institute supports the geopark with scientific expertise, geological documentation, educational content and promotional activities. Cooperation also includes the preparation of geotourist maps and guidebooks, participation in conferences and network meetings, as well as the development of materials presenting Polish UNESCO Global Geoparks.

This model of cooperation benefits both sides. Geoparks gain access to verified scientific information and specialist knowledge, while PGI-NRI can communicate the results of geological research to wider audiences. Geoparks also provide a practical setting in which geological knowledge supports education, tourism planning, local development and dialogue about natural resources. The cooperation between the geological survey and local management organisations therefore helps translate scientific evidence into public value.

The Kamienna Valley Geopark Project represents another major initiative developed with the participation of PGI-NRI. Professor Grzegorz Pieńkowski proposed the original idea in publications issued in 2004, 2008 and 2009. He outlined the approximate boundaries of the geopark, identified 14 geosites and proposed four educational geocentres. In 2011, Anna Fijałkowska-Mader, Hanna Wojtyna and Dominik Szrek prepared an expanded project concept at PGI-NRI.

The proposed geopark extends along the Kamienna River valley from the Niekłań area in the west to Bałtów in the east. It covers approximately 1,230 km² across six counties. The concept expanded the original inventory to 29 geosites and assessed them in terms of scientific value, educational potential, visitor appeal, accessibility and required infrastructure.

The geological setting reflects the location of the area on the northern Permian-Mesozoic margin of the Holy Cross Mountains. Triassic sandstones and subordinately limestones occur w southern part of Geopark, Lower Jurassic sandstones in central part, whereas Upper Jurassic limestones, in north-eastern part, in Krzemionki-Bałtów area.. Older Devonian rocks appear locally at Doły Opacie and Podole, while Quaternary deposits, including loess, postglacial sediments and river deposits, influence the modern landscape.

The geosites document a wide range of geological processes and environments. Triassic rocks preserve evidence of rivers, dunes, deltas, lagoons and shallow seas, as well as vertebrate tracks and deposits associated with historical iron-ore extraction. Lower Jurassic successions contain important palaeontological sites, including

dinosaur tracks and nesting traces at Gagaty Sołtykowskie. Upper Jurassic limestones, visible near Bałtów and Skarbka Dolna, record marine sedimentation, reef development and later karst processes.

The project also includes outstanding evidence of tectonic deformation and landscape evolution. The angular unconformity at Doły Opacie is a boundary reveals between two structural levels: the Variscan one, represented by Middle Devonian dolomites, and the Alpine one, represented by Lower Triassic sandstone-mudstone heterolith. The rock outcrops of "Piekło pod Niekłaniem", developed in Lower Jurassic sandstones, together with the Upper Jurassic limestone outcrops exposed in the Kamienna River gorge at Bałtów, exemplify the role of lithology and erosional processes in shaping the present-day relief.

Industrial and archaeological heritage constitutes an equally important component of the proposed geopark. The Kamienna Valley developed as one of Poland's major historical mining and metallurgical regions. Former mines, quarries, ironworks and industrial settlements demonstrate how local communities used geological resources over centuries. The prehistoric flint mines at Krzemionki and archaeological sites at Rydno extend this relationship between humans and geology far into the past. The project therefore connects palaeontology and stratigraphy with archaeology, mining history and industrial heritage.

The concept proposed four complementary geoeducation centres. Rogowice would focus on palaeontology, weathering processes and connections with the Górna Krasna nature reserve. Starachowice would serve as the administrative centre and interpret dinosaur discoveries together with the history of iron production. Krzemionki would present prehistoric flint mining and Neolithic settlement, while Bałtów would provide palaeontological workshops and access to educational trails through the eastern part of the valley.

A unified information system would connect these centres with the network of geosites. The planned infrastructure included information boards, directional signs, geosite markers, paths, footbridges, viewing platforms and rest areas. Educational programmes, publications, a website and specialised guide training would provide consistent interpretation throughout the area.

The proposed management model brought together municipalities, PGI-NRI, universities, conservation institutions, landscape park authorities, tourism organisations and local action groups. A Programme Council would provide scientific and strategic guidance, while a Management Board would coordinate implementation, promotion and geosite protection.

The Kamienna Valley Geopark Project demonstrates how geological heritage can provide a framework for integrating sites that are currently promoted separately. A coherent geopark could connect dinosaur tracksites, Jurassic cliffs, former mines, metallurgical monuments and archaeological sites within one regional narrative. By presenting the valley as a record of geological processes and human adaptation to natural resources, the project could strengthen geoeducation, improve cooperation between institutions and create a distinctive tourism product based on the identity of the Kamienna Valley.

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La Rioja and its dinosaur empires

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To manage the flow of visitors, general itineraries have been drawn up – one for each of the rivers that flow through the area – and seven archaeological sites have been fitted with information boards, fencing and QR codes containing explanations. Finally, and for the same purpose, a carillon has been installed in the town hall of one of the villages, featuring a door from which a dinosaur emerges, stomping noisily and roaring, and a paleo-adventure park has been built where visitors can take part in a variety of activities, with separate areas for children and adults.

Initially, the work involved clearing and surveying sites, followed by the publication of scientific studies, which became more established from 1979 onwards; there are now more than 300 published papers. This development went hand in hand with raising awareness of this unique feature of the area and, to some extent, contributed to its development. The need arose to address this new situation through relevant legislation, and work began on adapting the site by installing replicas of dinosaurs and other reptiles (crocodiles and a pterosaur) and creating visitor routes with signposts, QRs and fencing. At the same time, centres were opened – true museums, as they fulfil the three basic requirements: the safekeeping of fossils, visitor services and research.

The attribution of fossil footprints to dinosaurs began in the 1920s and 1930s, although the first publication in a scientific journal dates from 1971. Research teams began arriving in 1979, organising fieldwork, summer courses, scientific lecture series and other activities.

Although the number of footprints can be deduced from the publications, this figure has not been updated for around 10 years, when the recorded number stood at over 9,415. Since then, the number of sites discovered and footprints studied has been increasing year on year; this year, two new sites have been published, two others are in press, one is in preparation and another known site from which we will be collecting data shortly.

Of these two types of fossils, La Rioja is characterised by the large number of footprints that have been preserved. This abundance is due to three factors: on the one hand, the sedimentary environment—a mix of fluvial and lacustrine conditions with large waterlogged areas and shallow-water shorelines; on the other hand, the metamorphism that has consolidated the loose sediments; and finally, the folding that has left many surfaces with a dip similar to that of the relief, favouring the outcrop of extensive sections with stratigraphic tops, most of which are fossil-bearing.

Part of La Rioja is covered by continental sediments from a sedimentary basin known as the Cameros Basin, which also extends into the neighbouring provinces of Soria and Burgos and is palaeontologically notable for its sites containing dinosaur footprints and fossilised bones. The age of the continental sediments ranges from the Titonian to the Abian, and so the ‘Wealdian’ period has also been applied to them.

Dinosaur tracks and musealization

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The fossil footprints of dinosaurs arouse great attraction and deserve convenient outdoor and indoor musealization, on condition that the material is of quality, appreciable by the public, accompanied by replicas of the trackmakers, and explained by panels or guides, within an environment with adequate logistical services. However, achieving this is not easy, as cases from several countries where the author has worked illustrate.

The Rio do Peixe basins (Paraíba, Brazil), reported in 1924 and studied in depth by the author and others over 50 years (1975–2026), yielded over 600 dinosaurs across 98 stratigraphic levels in 42 ichno-localities; it took from 1975 to 1992 of insistence with authorities to have the area declared a "Monumento Natural Vale dos Dinossauros." A similar effort with desert dinosaur and mammal tracks of the Botucatu Formation in Araraquara (São Paulo, Brazil) led, between 1976 and 2003, to the extraction and musealization of 60 sandstone slabs from the city's sidewalks.

At the Lavini di Marco (Rovereto, Italy), paths and observation areas were organized shortly after study began in 1989, but the site remains unfenced and lacks basic visitor facilities. The dinosaur footprint museum at Lerici castle (La Spezia, Italy) has recently closed, and the author's life-size trackmaker statues have been abandoned. The countless footprints of the Dampier Peninsula (Kimberley, Australia) cannot be musealized, both because of tidal exposure and because the land belongs to Aboriginal communities who rightly restrict access. Important environmental difficulties likewise affect dinosaur tracks from the Amazon region (Itaguatins, Tocantins River, Brazil).

By contrast, the Bolivian Andes sites of Toro-Toro (Potosí, discovered 1968, studied by the author from the 1980s) and Cal Orck'o (Sucre, studied since 1998) were successfully protected, becoming the "Geoparque Andino Torotoro" (2017) and a "Parque Cretácico Municipal FANCESA" (2006) respectively.

Even so, slabs bearing dinosaur tracks are sometimes difficult to house in museums—judged heavy, bulky and abrasive—and are occasionally found piled in courtyards rather than displayed in galleries.



Photogrammetric analysis of dinosaur footprints from the Lower Cretaceous of the Capiza-Tipan site (Arequipa Region, Southern Peru): scientific and social use

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At the site known as Capiza, located in the district of Tipan (Castilla Province, Arequipa, southern Peru), there is an important record of dinosaur footprints (ichnites) of great scientific value. These footprints constitute crucial fossil evidence for the study of terrestrial organisms that inhabited the region during the Early Cretaceous and for understanding the local paleoenvironmental conditions of that time. This site has significant heritage value and is considered an important resource for the tourism and educational development of the Capiza-Tipan area, representing a resource of not only scientific but also social relevance. Despite its great potential, this site is exposed to natural and anthropogenic erosion due to its proximity to a road and a dip of at least 46°, highlighting the lack of effective conservation and outreach strategies. Furthermore, the information provided on a panel located on the opposite side of the road has gaps in the geological and paleobiological framework and lacks a formal interpretation of the footprints, limiting its use for tourism, education, and conservation initiatives.

In this study, the site information is supplemented by correcting its stratigraphic position, originally attributed to the Upper Jurassic Gramadal Formation: the quartzitic sandstone lithology suggests that it belongs to the Lower Cretaceous Hualhuani Formation. A photogrammetric study of the outcrops identifies damages and areas requiring intervention to preserve the integrity of the footprints. The photogrammetry improves the analysis of footprints distribution and allows for a detailed and systematic study to better understand the paleoichnological record of Capiza. The information obtained is fundamental for developing protection and conservation strategies, as well as geotourism and educational proposals with potential socio-economic impact for the population of Tipan.



Fig. 1. Location and stratigraphic context of the Capiza dinosaur tracksite (Hualhuani Formation, Lower Cretaceous), showing palaeoshoreline setting and current-direction indicators used to identify aquatic swim traces.
Titanosaur (Sauropoda: Titanosauria) affinities of the Capiza tracks, with manus/pes silhouettes and estimated hip height derived from footprint length.

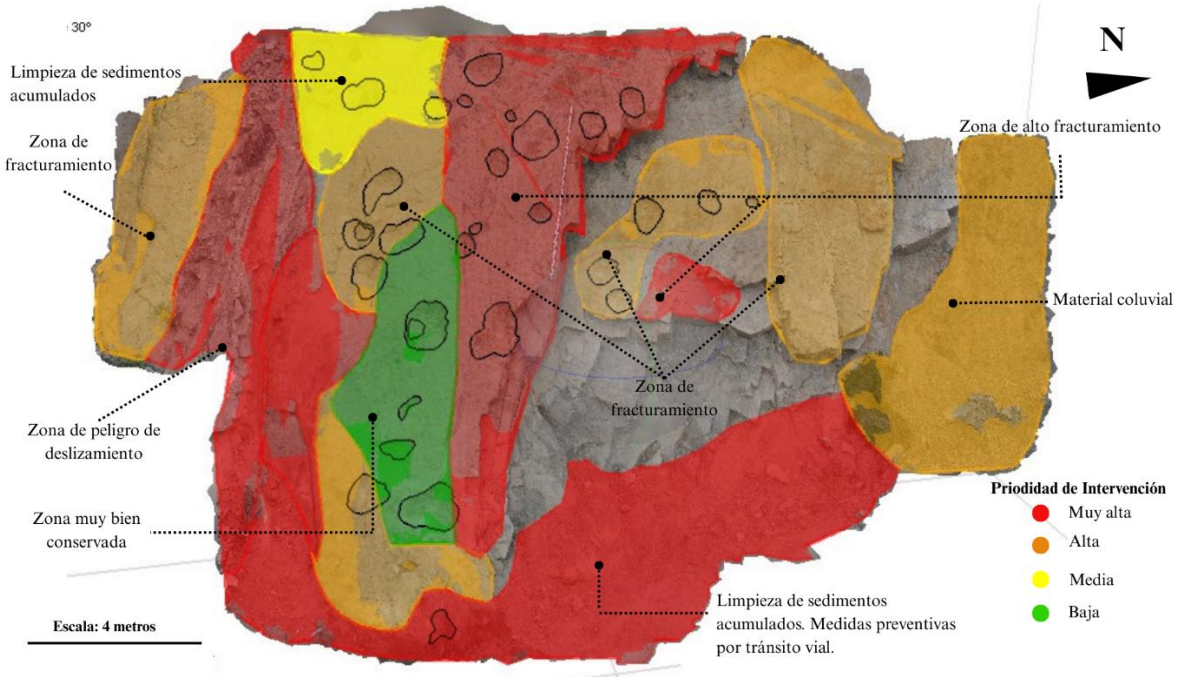

Fig. 2. Photogrammetric damage-priority map of the Capiza tracksite outcrop, showing zones of fracturing, colluvial cover and landslide risk requiring intervention.



Fig. 3. Field view of the Capiza tracksite outcrop along the road to Típan, Arequipa Region, southern Peru.

Successes and failures in the development of the Las Águilas paleontological site in Coahuila, Mexico, for tourism

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The paleontological site of Las Águilas is located in the municipality of General Cepeda, Coahuila, Mexico. It is known for its Late Cretaceous dinosaur fossil record, including both bones and tracks. In terms of its ichnological record, it is currently one of the sites with the largest number of identified hadrosaur and theropod tracks in Mexico. From the year of its discovery, the site began to gain recognition as a place to learn about how dinosaurs walked. The problem, however, was that the necessary administrative and legal steps were not taken to facilitate these activities, and the community living near the site—which owns the access roads and land where this evidence was preserved 72 million years ago—was not included in the process. In 2009, the National Institute of Anthropology and History (INAH), through the INAH Coahuila Center, carried out various activities aimed at promoting, protecting, and conserving the site, and even supported the community's proposal to develop ecotourism activities at the paleontological site, which included a trail to prevent visitors from walking over the ichnological evidence, a botanical garden, and a community museum.

In the case of the INAH, the site was registered as a paleontological site, with a designated area to govern the activities that may be carried out there, with the goal of protecting and conserving the paleontological evidence, as well as providing the community with information on their rights and obligations regarding the stewardship of paleontological heritage, and proposing a system for managing and monitoring visitors.

At the time, the proposed and implemented activities demonstrated that the community had taken ownership of the project and would continue these efforts, in addition to collaborating with the INAH to protect and conserve the site. In reality, the expectations regarding the number of visitors and the revenue this would generate did not match what actually happened on a day-to-day basis. The distance to the paleontological site, the condition of the access roads, and the time required to reach the site compared to the enjoyment visitors derived from the experience meant that visitor numbers were low and inconsistent.

Furthermore, like any project, it initially received support from various levels of government to provide salaries and/or financial resources for the construction and maintenance of the infrastructure; once that support was withdrawn, the project began to feel like a burden rather than a benefit. Furthermore, there is now a generational shift among those who initially launched the project, with new community members stepping in to replace them. This requires working with them and resuming training on what constitutes a paleontological site featuring ichnites, the characteristics of its protection and conservation, as well as other requirements that must be met under Mexico's existing administrative and legal regulations.

This presentation, we aim to reflect on each of the stages the paleontological site has gone through, the challenges facing its protection and conservation, and what it means for the site to function as a tourist attraction.



Sustainable tourism and science communication at ichnological sites in Puebla, Mexico: participation and leadership of local women

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Puebla's ichnological heritage is an exceptional resource for science communication, conservation, and sustainable tourism involving local communities. This study examines the experiences of San Juan Raya, San Martín Atexcal, and Pie de Vaca in Tepexi de Rodríguez, together with recent discoveries at Santa Ana Teloxtoc, Santa Catarina Tehuixtla, and San Lucas Teteletitlán.

In San Juan Raya, the community's incorporation into the Tehuacán-Cuicatlán Biosphere Reserve encouraged community-based geotourism and gradually transformed local perceptions of fossils. In the past, many specimens were bartered for food or other goods; today, they form part of interpretive tours focused on conservation. Women participate as guides and in the organization and administration of tours, while also providing general tourism services such as food and lodging. These activities complement income from handicrafts and agriculture in a context marked by male migration to the United States. Community members become involved from an early age, and young women and men are already being trained in basic paleontological and geological knowledge and leading tours, helping transmit local knowledge across generations.

San Martín Atexcal preserves dinosaur footprints on a steeply inclined rock layer; however, paleontological tourism has not yet been consolidated. The site faces erosion, the loss of footprint casts, and looting, including the theft of several footprints years ago. Pie de Vaca preserves mammalian footprints and is associated with the Tlayúa Mixtec Regional Museum, which has been led by a woman since 2025. Through her position, she promotes the participation and leadership of other women in the region.

Recent dinosaur footprint discoveries at Santa Ana Teloxtoc, Santa Catarina Tehuixtla, and San Lucas Teteletitlán reveal undeveloped tourism potential and underscore the urgent need to document and protect this heritage. Together, these cases demonstrate that science communication and sustainable tourism can support conservation, diversify local economies, strengthen intergenerational participation, and increase women's involvement in decision-making.

Author Index.

Page numbers refer to the abstract(s) of each author or co-author, including their references.

Aguilar-Arellano, Felisa Josefina 42
Bernal-Uruchurtu, Juan Pablo 12–14
Capra-Pedol, Lucía 12–14
Carantón-Mateus, William G. 20–22
Carbot-Chanona, Gerardo 12–14
Carrera-Hernández, Jaime Jesús 12–14
Corrales-García, Alejandro 19–22
Croft, Darin 19
Delgado-Quiroz, Lizbeth Mariana 12–18
Fernández-Barajas, María del Rosario 23–24
Fijałkowska-Mader, Anna 34–37
Gierliński, Gerard D. 7–10, 26–27
Gómez-Pérez, Luis Enrique 12–14
Jiménez-Moreno, Francisco Javier 25
Klein, Hendrik 32–33
Leonardi, Giuseppe 39
Link, Andrés 19
López-Téllez, María Concepción 25
Lozano-Carmona, Diego Enrique 25
Luque, Javier 20–22
Martínez, Jean-Noël 40–41
Mercado-Millán, Leonardo Hegel 42
Miranda-Flores, Fernando 12–14
Miranda-Martínez, Adriana Yanet 43
Niedźwiedzki, Grzegorz 11, 26–28
Osorio, Daniel 19
Peña-Serrano, Jair 12–14
Perdomo-Rojas, César Augusto 19
Pérez Lorente, Félix 38
Prado-Escamilla, Erick 23–24
Rodríguez-de la Rosa, Rubén A. 12–19, 23–25, 29–31, 40–41
Sánchez-Alva, Claudia Isabel 40–41
Serrano-Sánchez, Carlos† 12–14
Servín-Pichardo, Ricardo 43
Sierra-Rojas, María Isabel 20–22
Wesołowski, Witold 34–37
Zepeda-Martínez, Mildred 25
Zevallos-Valdivia, Leonardo M. 40–41

