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Dinosaur tracks from the Late Cretaceous Sabinas Basin (Mexico)

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Abstract

In 2003 vertebrate tracks attributed to pterosaur, crocodiles, turtles, hadrosaurs and sauropods have been reported from a locality close to Sabinas (Coahuila) in the Sierra Madre Oriental (Maastrichtian). Three trackways of medium-sized theropods could be observed. Evenly spaced parallel scratches forming a trackway might have been left by a swimming pterosaur. Furthermore a clear tetradactyl imprint, with claw marks only can be temptatively assigned to a pterosaur. So far, we have observed tracks of theropods only and probable prints of pterosaurs. The purported turtle tracks are small paired and tripled very faint scratches that have been produced by a xiphosuran arthropod. These are the first limulid tracks from Mexico. Another locality, Santa Helena, close to the village of Melchior Musquiz (Campanian) yields several surfaces with dinosaur fooprints. The best preserved trackway is attributed to a large theropod.

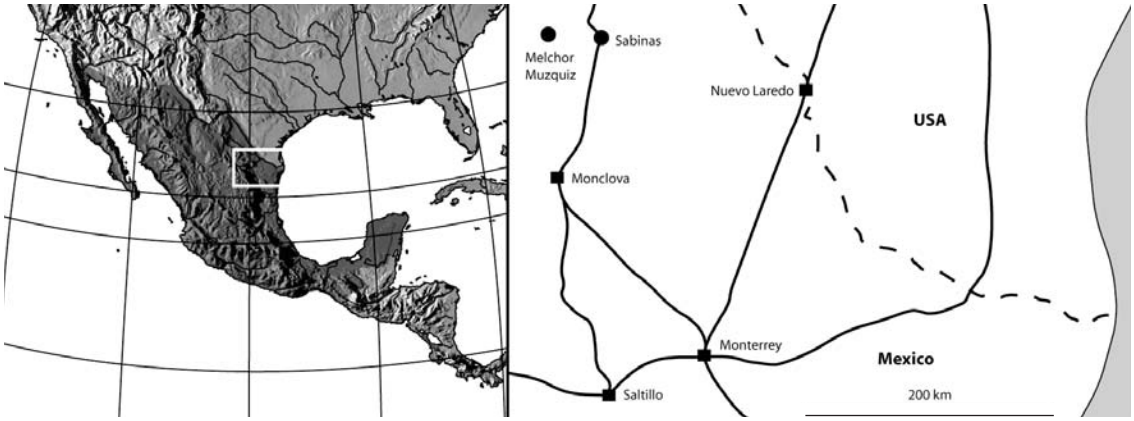


Fig. 1: Geographic location of studied outcrops.

Introduction

The Sierra Madre Oriental in Mexico is a Late Cretaceous – Early Paleogene 1350 km long thrust and fold belt that originates south of the Rio Bravo and runs parallel to the Gulf of Mexico to the volcanic arc that separates North America from Central America. The basin that developed in the North and East of the Sierra Madre has been referred to as the Difunta fore deep basin. The Difunta Group has a thickness of more than 6 km and ranges from Latest Campanian to the Early Eocene (Soegaard et al., 2003). We report here on two recently discovered track localities that are situated within the southern Sabinas basin (Fig. 1). The first, located near the village of Melchor Múzquiz, is in the Campanian Olmos Formation. The second, close to Sabinas, is in the Maastrichtian Escondido Formation. Both formations are the lateral equivalent of the Potrerillos Formation that forms the upper part of the Difunta Group.

Santa Helena|Melchor Múzquiz

The first locality, Santa Helena, is close to the village of Melchor Múzquiz and has been discovered by PASAC (Palaeontólogos Aficionados de Sabinas A.C.) member Hector Porras Muzquiz. It is situated in the Olmos Formation (Campanian). The outcrop lies in a small arroyo on the private Ranch Santa Helena 6 km to the North of Melchor Múzquiz; the geographic location is N 27° 54' 47.7", W 101° 34' 20.8" (GPS Datum NAD 27). The track bearing section is made up of thin-bedded sandy siltstones with ripple marks alternating with thicker medium-grained sandstone bodies with low angle cross bedding. Three different surfaces with a dip of 6° to 204° S yield dinosaur footprints. All footprints are tridactyl, longer than wide, with digit III being the longest. Claw marks are visible in all examples; therefore they can be attributed to theropod dinosaurs. The best preserved trackway has been made by a large theropod (FL: 42 cm; hip-height < 168 cm) on a cross-bedded sandstone that shows ripple marks. Only three paces are preserved, but its overall morphology indicates that it possessed broad, well-padded toes. One peculiar feature is the presence of a caudally protruding heel impression (Plate 1, E). The trackway width is 79 cm and the animal was walking with a speed of < 3.5 km|h. Isolated footprints do also occur on a lower and a higher level, and although they range in size from 35 to 50 cm, the overall morphology appears similar (Plate 1, F). The ichnological documentation and the ichnotaxonomic attribution of Late Cretaceous theropod prints are still in its infancy. Moreover, footprints of similar size and morphology are known from the coeval Cerro del Pueblo Formation in the Parras basin east of Saltillo (pers. obs.). Although reported in several abstracts (Rodríguez-de la Rosa et al., 2003, 2004), a detailed account is still missing. We strongly suggest to include all the theropod tracks in a detailed study before a closer assignment to any ichnotaxon is attempted. Apart from vertebrate tracks, indeterminate bones of hadrosaurs and fragments of wood have been found in the close vicinity. Up to now the Olmos formation has yielded an almost complete skeleton of a hadrosaur (*Kritosaurus*) and a yet undescribed femur of an ankylosaur (Museum of PASAC, Sabinas).

Rancho Soledad|Sabinas

Members of PASAC discovered the Rancho Soledad locality, in February 2003. They thoroughly cleaned the surface and made casts of some of the vertebrate footprints, put on display in their museum in Sabinas. Subsequently, these footprints have been attributed to turtles, ornithopod dinosaurs, crocodiles with tail drag impressions, birds and theropods (Rodríguez-de la Rosa et al., 2003); according to these authors the track surface is in the Olmos Formation and was formed in a lacustrine environment.

The Rancho Soledad site is located 8 km southwest of Sabinas (Coahuila) in the Sierra Madre Oriental (Mexico). The exact geographic position is N 27°45' 15.9", W 101° 13' 33.3"(GPS Datum NAD 27). The track bearing surface lies in a small arroyo and dips with 4°|44° N and forms part of the Escondido Formation (Maastrichtian). Due to the low angle dip of the strata and a rather poor outcrop situation only a small section could be logged. The outcrop is built up of silty marls and marly clays. Some surfaces show ripple marks. Throughout the section there are remains of oysters and invertebrate trace fossils (*Planolites* sp., *Thalassinoides* sp.) can be observed (Fig. 2). Ripple marks are asymmetric and were formed by a current coming from NW. A detailed mapping was undertaken in March 2005. The surface has a size of 32 m² and shows 32 individual footprints (Fig. 3). 27 of those tracks are tridactyl with digit III being the longest; pace angulations vary from 160 to 180°; these

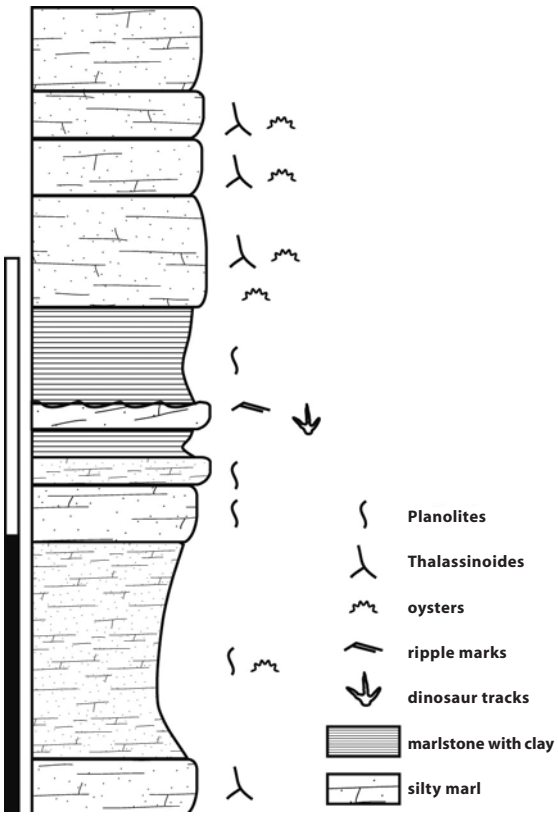


Fig. 2: Geological section of Soledad tracksite. Scale bar is 1 m.

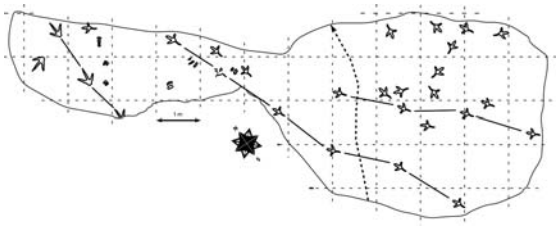


Fig. 3: Map of the soledad tracksite. Dotted line indicates limulid trackway.

tracks are attributed to theropods. Three trackways of medium-sized theropods can be followed for 3.5, 4.5 and 7 m respectively (Fig. 3). Trackway 1 and 2 run towards east (110°) whereas trackway 3 goes in a more north-western direction (70°). Most of the theropod footprints reveal distinct imprints of the metatarsus but otherwise no details are visible due to the poor preservation. However, they are fairly deep and have been produced when the substrate was still waterlogged. This can be demonstrated in one left pes in trackway 1. Already present ripple marks were deformed through the impact of the theropod foot (Plate 1, C). In the southern part of the surface, several shallow footprints show, that the track maker possessed slender and narrow digits and a slim foot (Plate 1, A). The footprints indicate gracile, medium-sized theropods with a hip height between 1.2–1.4 m respectively and varying speeds (< 4, 9 and 13 km|h). Other tracks on the same surface appear rather enigmatic (Plate 1, A). There are evenly spaced parallel scratches in pairs forming a trackway of 3 m. We think that those are faint manus impressions that might have been left by a swimming pterosaur. Furthermore an isolated clear tetradactyl imprint (Plate 1, C). with claw marks is preserved nearby. It is definitively not of crocodilian origin (Rodríguez de la Rosa et al., 2003), which would only have three claw marks. We temptatively assign this track to a pterosaur. The supposed tail-drag marks occur as an isolated elongate, banana-shaped impression, which turned out to be a crack widened by erosion of a burrow.

Other tracks occur as small paired, very faint scratches that can be followed for 4 m, having a trackway width of 15 cm (Plate 1, D). They occur as negative epichnia in pairs of three obliquely oriented, sometimes four parallel scratches (size: 3 cm). These are interpreted as the imprints of the 4th leg of a limuloid arthropod. They were most likely produced by an animal of about 20 cm carapace width that was barely touching the ground when swimming, leaving only three and sometimes four imprints of the blades of its pusher leg. They are attributed to the ichnotaxon *Kouphichnium* and represent the first limuloid tracks from Mexico.

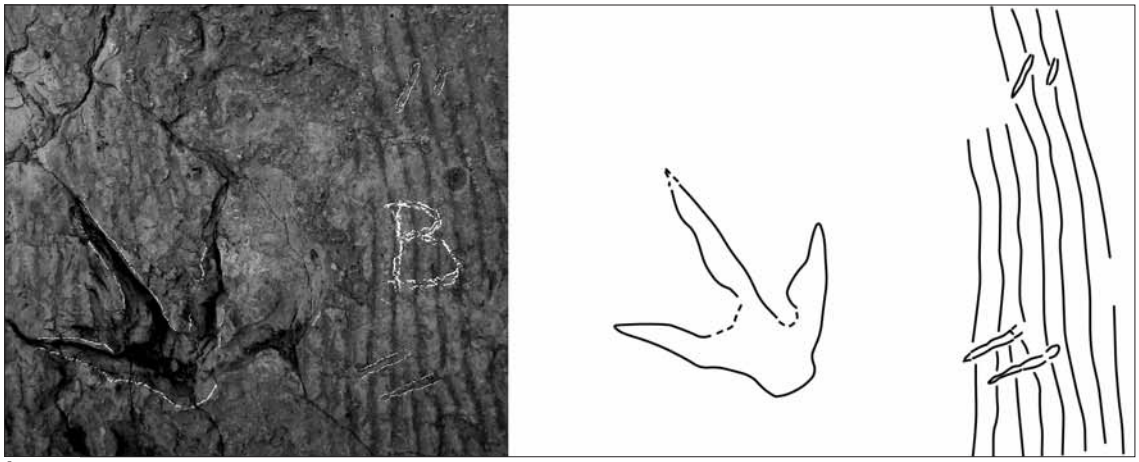
Conclusions

The Late Cretaceous ichnocoenoses of the Sabinas fore deep basin to the north of the Sierra Madre Oriental demonstrate a moderate diversity of vertebrate and invertebrate tracks. The tracks from the Olmos formation indicate the repetitive presence of fairly large theropods that inhabited a brackish delta to marginal marine environment. The ichnocoenoses from the coeval Cerro del Pueblo Formation in the Parras basin are up to now much more diverse, including tracks and trackways of pterosaurs, small and medium-sized theropods, probable hadrosaur ichnites, as well as titanosaurid sauropods (pers. obs.) The reported highly diverse ichnocoenoses from the Escondido Fm near Sabinas (Rodríguez-de la Rosa et al., 2004) is a misinterpretation and just artefacts of weathering and erosion. So far, we have only observed tracks of theropods and questionable prints of pterosaurs. Moreover, the purported bird prints turned out to be shallow tracks of a theropod with slender feet. We can also conclusively demonstrate that the scratches occurring as tripled pairs and forming a veritable trackway, attributed to turtles, are indeed those of a merostomate arthropod. Furthermore, the presence of oysters, burrows of crustaceans as well as a trackway of a merostomate arthropod indicate a deposition in a marine or at least brackish water environment: This seems to be in accordance with the position of the ancient coastline (Moran-Zenteno 1994). Neither sedimentological nor palaeontological evidence for a deposition in a lacustrine environment were found.

Acknowledgments

We would like to cordially thank the Aficionados de Palaeontólogia from P.A.S.A.C. in Sabinas, especially Regulo Zapata, Raul Guajardo and Hector Porras Múzquiz for sharing with us their discoveries. Their support in the field and the gastronomical experience are greatly acknowledged. Many thanks go also to Arturo Gonzalez-Gonzalez (Museo del Desierto, Saltillo) and José-López Espinoza (»Pato«) for their help and assistance in logistics. The financial support by the Fritz Sarasin Fonds of the Freiwillige Akademische Gesellschaft Basel is greatly acknowledged.

Plate 1: Vertebrate and invertebrate tracks from the Santa Helena and Soledad tracksites
A: Outline of theropod fooprint (left) and probable swimming trace of pterosaur (left); photograph and outline drawing; Soledad site.
B: right theropod footprint with deep metatarsus impression; note deformation of ripple marks. Soledad site.
C: Photograph and outline drawing of probable pterosaur pes; Soledad site.
D: Trackway segment of limuloid arthropod (*Kouphichnium*); Soledad site.
E: large theropod pes print; Santa Helena site.
F: medium sized theropod pes print; Santa Helena site.



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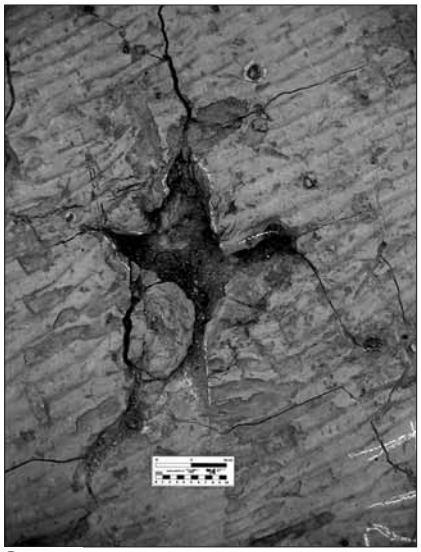

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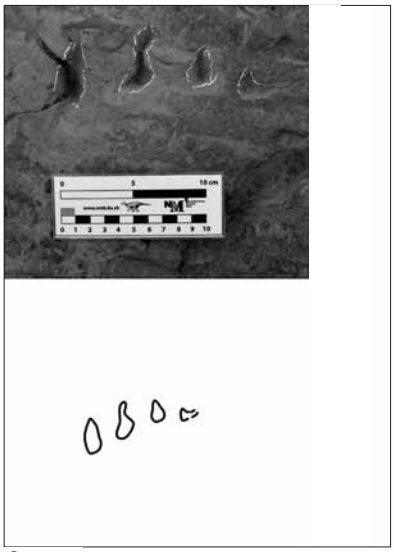

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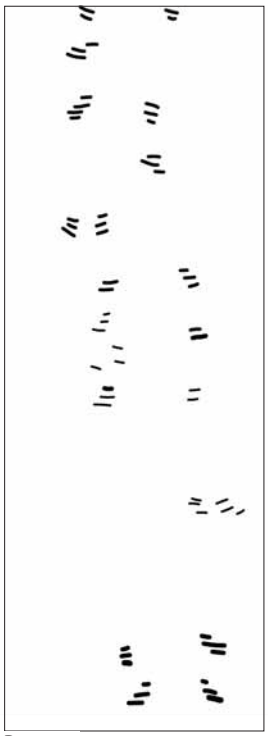
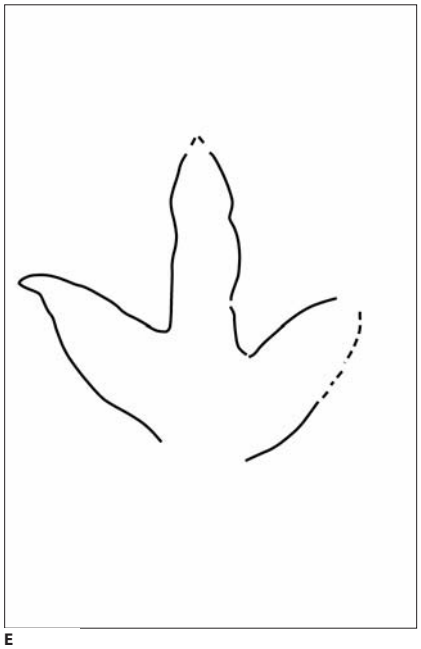


D

30 cm



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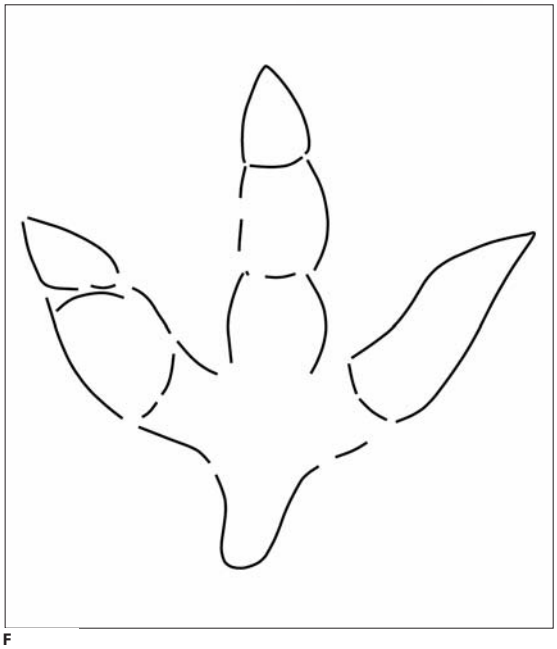

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