THE CROCODILE TRACK HATCHERICHNUS,
FROM THE UPPER JURASSIC OF ASTURIAS (SPAIN)

MARCO AVANZINI1, LAURA PIÑUELA2, JOSÉ IGNACIO RUIZ-OMEÑACA2 AND JOSE CARLOS GARCIA-RAMOS2

1 Museo Tridentino di Scienze Naturali, Via Calepina 14, I-38120 Trento, Italy;
2 MUJA, Museo del Jurásico de Asturias, Rasa de San Telmo, 33328, Colunga, Asturias, España, Depto. de Geología.
Universidad de Oviedo, C/ Jesús Arias de Velasco, s/n, 33005 Oviedo, Asturias, Spain

Abstract—Crocodylomorph footprints are described from the Late Jurassic (Kimmeridgian) coastal and deltaic units of the northern Spain (Asturias). They are included in the ichnogenus Hatcherichnus. Possible trackmakers are here interpreted as basal neosuchian crocodiles (including Thalattosuchia) such as Goniopholididae or Telosauridae.

INTRODUCTION

The presence of crocodilian footprints in the Late Jurassic of Asturias was reported for the first time by García-Ramos et al. (2006). Avanzini et al. (2007) labelled two of these tracks as morphotype D and related them to the ichnogenus Hatcherichnus Foster and Lockley, 1997. New material found along the Asturian coast, in the last four years, has allowed us to complete a preliminary description and to confirm the presence of this ichnogenus in the Late Jurassic of the Iberian Peninsula.

All the described tracks come from the Lastres Formation outcropping near Argüero, Tazones and Villaverde (Fig. 1) along the Asturian coast. This formation is Kimmeridgian in age (Dubar and Mouterde, 1957; Olóriz et al., 1988; García-Ramos and Gutiérrez Claverol, 1995) and consists of gray sandstones, mudstones, marls and occasional conglomerate levels. The general setting of the Lastres Formation is considered a fluvial-dominated deltaic system (García-Ramos and Gutiérrez Claverol, 1995). The tracks are well-preserved as natural casts and are currently stored at the MUJA (Museo del Jurásico de Asturias).

SYSTEMATIC ICHNOLOGY

Hatcherichnus Foster and Lockley, 1997

Referred specimens - MUJA011, MUJA0363, MUJA0367, MUJA0688, MUJA1041, MUJA1994 (Fig. 2)

FIGURE 1. Geological sketch of the Asturias region (northern Spain). The Late Jurassic outcrops of Villaverde (1), Argüero (2), Tazones (3) that yielded the described footprints are indicated by dots.
**Description** - Mid-sized footprints. Pes tetradactyl and digitigrade (L = 7.5 – 15.0 cm, W = 8.75 – 15.5 cm). Digit III is the longest, digit II second longest, digits I and IV nearly equal in length and about 25% shorter than digit II. Digit I and II are slightly curved laterally. Digit III generally straight and digit IV slightly medially curved. Short triangular claw impressions are preserved on the digit tips. Digits I-IV divergence angles vary between about 60° to 65°. The base of digits II-IV is generally connected by an arched pseudo-plantar impression. Digits are generally covered by elongate furrows left by the skin (scale or tubercles) during the foot movement (i.e. MUJA1994) (Fig. 2F). In specimen MUJA0367, the hypiceps between all the digits are covered by parallel elongated skin marks (Fig. 2C). In the specimen MUJA0363 a “plantar” portion of the footprint is preserved (Fig. 2D). It appears elongated and roughly triangular in the proximal portion. No trace of digit V is recognizable. The manus tracks are generally poorly preserved as a faint trace in front and external to the pedal prints. They are apparently tridactyl with only digits I-III preserved (L: 6.2, W: 8.5); digit I and II are nearly parallel and slightly separated from digit III (Figs. 2B, 2E).

**Remarks** - The footprints described here are relatively large and much wider than *Batrachopus* Hitchcock, 1845, and their general outline is stouter (Olsen and Padian, 1986). Their general morphology also differs from some recently described crocodilian tracks found in the Early Cretaceous of Soria (Spain; Pascual Arribas et al., 2005) in having shorter pedal digit impressions and digitigrade manual prints.

Asturian tracks are very similar to the ichnogenus *Hatcherichnus* because of their comparable dimensions and general morphology (Foster and Lockley, 1997). In both forms, pedal digits I and II are medially rotated, digit III is the longest, digits IV and I are of the similar length and with similar triangular and pointed claws. As stated by Avanzini et al. (2007), the only difference consists in the presence of scratch marks with elongated and nearly parallel structures recognizable in the regions between digits II-III-IV and along some of the digits. Such structures, similar to those described by McAllister (1989) and Romano and Whyte (2003), seem to be related to locomotion on stiff mud in shallow water, with the penetration of the distal part of the foot in the substrate and the partial impression of a proximal interdigital web connecting the digits II-IV (Lockley et al., 1992). The presence of a web is also suggested by the relatively short length of digit traces: medial web connecting the digits could have controlled the penetration of the digits in the substrate. Tetradactyl pes is typical of the extant crocodiles. A similar pes structure is recognizable in our material suggesting a trackmaker morphologically very close to modern crocodiles. The body length of the trackmakers, inferred from the Asturian footprints, probably varies between 2 and 4 meters.

Foster and Lockley (1997) suggest that *Hatcherichnus* may represent tracks from a relatively large neosuchian crocodilomorph. Based on the skeletal findings in the European Late Jurassic (Kimmeridgian) this proposal seems very probable also for our specimens. Large basal neosuchian crocodilomorphs (including thalattosuchians; Gasparini et al., 2006) such as Goniopholididae and Teleosauridae are documented in the shallow lagoonal and swamp-like environments of England, Switzerland, Spain, Portugal, France and Germany (Salisbury et al., 1999; Schwarz, 2002; Karl et al., 2006). Remains of Goniopholididae are mainly found in freshwater deposits with periodic brackish influences in the Late Jurassic and the Cretaceous (Schwarz, 2002: 186). These types of crocodiles that could have been up to four meters in length were adapted to an amphibious lifestyle but still capable of terrestrial locomotion. Teeth similar to those of *Goniopholis* Owen, 1842 are known in the Kimmeridgian of Tazones, Villaviciosa (Lastres Formation, García-Ramos et al., 2002: 127 upper left), although assigned to Crocodyliformes indet. (Ruiz-Omeñaca et al., 2006: fig. 1) because of their many plesiomorphic characters. *Goniopholis aberglyphaeus* Schwarz, 2002 has been described in the Kimmeridgian of Portugal (Guimarota/Leiria, Alcobaça Formation; Schwarz, 2002), testifying goniopholidid presence in the Kimmeridgian of the Iberian Peninsula.

**FIGURE 2.** Photos and interpretive outline drawings of some of the best defined crocodilian tracks from Asturias. A, MUJA1041 pedal print, B, MUJA0111 manual print, C, MUJA0367 pedal print, D, MUJA0363 pedal print, E, MUJA0688 manus-pes couple, F, MUJA1994 manus-pes couple. Scale bar for all footprints = 5 cm.
Teleosaurid remains are relatively common in the Kimmeridgian of the Asturian coast (García-Ramos et al., 2002, p. 127-128; 2006, p. 102-103); postcranial remains have been described in Ribadesella (Teleosauridae indet., Lastres Formation; Martínez et al., 1995) and isolated teeth in Colunga and Ribadesella (cf. Machimosaurus sp., Tereites Formation; Ruiz-Omeñaca et al., 2007).

Based on the osteological characters of the teleosaurid Machimosaurus Meyer, 1838, Krebs (1967) proposed an open sea as an in-life habitat for this genus. Sedimentological characteristics of the Machimosaurus-bearing rocks, however, led various authors to interpret the depositional environment as a shallow lagoon (Meyer, 1994; Karl and Tichy, 2004; Karl et al., 2006).

The occurrence of the tracks in relatively saturated sediment suggests that the trackmaker was moving in or near shallow water. Scratch marks interpreted as half-swimming traces are a common feature of the Argüero, Tazones and Villaverde ichnosites. The presence of a short (proximal) interdigital web however (Fig. 2C) supports an amphibious rather than a totally aquatic lifestyle for the trackmaker. Although it seems possible that the Asturian Hatcherichnus trackmaker was a teleosaurid, occasionally moving along the coast (Karl and Tichy, 2004), it seems more reasonable to identify it as an unknown goniopholidic crocodile like Goniopholis (Fig. 3).

CONCLUSIONS

The described ichnological material is produced by a large crocodilyiform and related to the Late Jurassic ichnogenus Hatcherichnus, which has also been identified in the Late Jurassic of western North America. Large neosuchian crocodylomorphs (including thalattosuchians) such as the teleosaurid Machimosaurus or more probably the goniopholidic Goniopholis, are suggested as a trackmaker for the Asturian footprints.

ACKNOWLEDGMENTS

Financial support was provided by the Principado de Asturias and the University of Oviedo (Protocol CN-04-226), by the Spanish Government (Ministry of Science and Innovation, Project CGL2007-62469 7BTE) and Museo Tridentino Scienze Naturali. The authors thank Martin Lockley (Denver) and Jesper Milán (Copenhagen) for their comments on the manuscript.

REFERENCES


Karl, H.V. Groning, E., Carsten, B., Schwarz, D. and Knotschke, N., 2006, The Late Jurassic crocodylids of the Langenberg near Oker, Lower Saxony (Germany), and description of related materials (with remarks on the history of quarrying the "Langenberg Limestone" and Oberknicken Sandstone"). Clausthaler Geowissenschaften, v. 5, p. 59-77.


FIGURE 3. Life reconstruction of Goniopholis simus. Length of the animal is approximately 2 m. Modified from Karl et al. (2006).


Owen, R., 1842, Report on British fossil reptiles. Part II. in Report of the Eleventh Meeting of the British Association for the Advancement of
Science, held at Plymouth in July, 1841, p. 60-204.