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Rusophycus from the Middle Ordovician of Barrancos-Oliva de la Frontera (Portugal-Spain) and Eastern Alborz Mountains (Iran)

Rusophycus do Ordovícico Médio de Barrancos-Oliva de la Frontera (Portugal-Espanha) e do leste das Montanhas de Alborz (Irão)

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Sumário: *Rusophycus leifeirikssoni* é descrito nas formações Lashkerak, Irão (parte inferior da Unidade 2) e Colorada, na Zona de Ossa-Morena, atribuídas ao Ordovícico Médio e correspondendo a ambientes deposicionais similares. Na Formação Colorada descreve-se ainda uma nova icnoespécie de *Rusophycus*, interpretada como comportamento de busca de alimento e abundante na famosa Pedreira do Mestre André.

Palavras-chave: *Rusophycus leifeirikssoni*, *Rusophycus* isp. nov., *antepiraia inferior*, *praia afora superior*, Ordovícico Médio, Gondwana

Key words: *Rusophycus leifeirikssoni*, *Rusophycus* nov. isp., lower shoreface, upper offshore, Middle Ordovician, Gondwana

Rusophycus Hall 1852 was one of the first fossils to be attributed to behaviors (feeding, resting, molting, hiding, hunting or nesting) of trilobites and other trilobitomorpha. Here we describe two interesting occurrences of this ichnogenus in Middle Ordovician high latitude, storm-influenced, wave-dominated shoreface and offshore transition facies from northern Gondwana, namely the Deh-Molla section in eastern Alborz Mountains (Iran) (Neto de Carvalho and Bayet-Goll, 2023), and in different sections from Barrancos-Oliva de la Frontera area, in the Ossa-Morena Zone at the border region of Portugal and Spain (Jensen et al., 2016).

The Ordovician Lashkerak Formation (Fm.) in the Alborz Mountains evolved from braided rivers and incised valleys system to transgressive incised-valley-fill successions which, in turn, became transgressed by a wave-dominated shoreface-offshore complex and a mixed fluvial- and wave-influenced delta (Bayet-Goll et al., 2022).

The Ordovician from the Barrancos-Enciñasola area, along the border region between Portugal and Spain, comprises a thick succession of shales, siltstones and sandstones/quartzites of the Barrancos Fm. and Colorada Fm., locally rich in trace fossils but poor in body fossils. While the Barrancos Fm. is well known for the *Nereites-Gordia-Dictyodora* and *Oldhamia* ichnoassociations (“*Phyllocytes* shales”; Jensen et al., 2016), the *Rusophycus leifeirikssoni* Bergström 1976 (cf. Fillion and Pickerill, 1990; Mángano and Buatois, 2004)

Colorada Fm. ichnology only recently started to be revealed (see Jensen et al., 2016). The transition between these formations is Darriwilian, based on graptolites and acritarchs (Piçarra et al., 2011; Jensen et al., 2016). This gradational transition can be observed in the Ardila river section and the Mestre André quarry (Municipality of Barrancos, Portugal), a famous ichnosite studied for more than a century (Jensen et al., 2016).



Fig. 1. *Rusophycus leifeirikssoni* from the Deh-Molla section, eastern Alborz mountains (silicone cast).

occurs in the Deh-Molla (Fig. 1) and Serra de la Corte (Fig. 2A) sections in storm-generated,

medium-to-coarse grained sandstones. They are deep burrows, with steep anterior part, sometimes with the cephalic shield impression, and wide and bilobed posterior side, showing thick scratches perpendicular to the median furrow. The lower part of the Colorado Fm. yields rare 2-4 cm wide, mostly straight, *Cruziana furcifera* and *C. cf. almadenensis* with faintly developed longitudinal scratch-marks meeting the central furrow at very acute V-angles, some with clear evidence of tunneling. The Colorado Fm. also yields a new ichnospecies of *Rusophycus* (Fig. 2B) close to the Mestre André quarry, where a 1,5 m sandstone-pelite succession located 5 m above the base of the Colorado Fm.

shows 128 specimens associated to *Cruziana* isp., *Skolithos linearis*, *Monocraterion* isp. and *Planolites* isp.. The yet unnamed ichnospecies of *Rusophycus* is characterized by a steeply inclined triangular anterior portion, probably the result of multiple phases of tail-down burrowing, also represented by multiple superimposed impressions evidencing readjustment. The randomly oriented, multiple-*Rusophycus* assemblages likely indicate the exploitation of resource-rich environments in detritus feeding aggregations.



Fig. 2. A - *Rusophycus cf. leifeirikssoni* (Ru - sectioned) intersected by *Skolithos piperock* ichnofabric (Sk - some examples) indicating sand-flat deposition in the lower part of the Colorado Formation; Sierra de la Corte section. B - *Rusophycus nov. isp.*; Mestre André quarry. A and B are trace fossils left in the outcrop

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