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Drill hole predation on tubes of serpulid polychaetes from the Upper Cretaceous of Cuba

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ABSTRACT

The fossil record of drill holes in shelled invertebrates is focused primarily on bivalves and gastropods as prey. The still limited reports on drill holes in serpulid polychaetes are principally recorded from Cenozoic deposits and restricted to Europe and Antarctica. This study documents drill holes on the serpulid polychaete *Pyrgopolon onyx* from the Upper Cretaceous (Maastrichtian) of Pepito Tey (central Cuba). The oval-shaped drill holes, attributed to the ichnospecies *Oichnus ovalis*, were primarily caused by naticid gastropods, probably by individuals of *Gyrodes* sp. known from the same formation. Using five methods, the study on an assemblage of 53 non-moldic specimens shows that >17.0 and <22.2% of the specimens was drilled. This narrow range suggests that these methods can be used successfully for any time period for cylindrical shells including serpulids and scaphopods, if the specimens of the sample are reasonably well-preserved. Drill holes were randomly positioned with respect to the side of the tubes, but drill holes are preferentially located between the ribs and in the middle part to slightly towards the posterior end of the tube, suggesting that naticids selected the drill hole location efficiently on polychaetes with ornamentation already by the Cretaceous. The reasons for drilled tubes of *P. onyx* are probably related to the withdrawal of their soft body deep inside the tube and/or because of the presence of a calcareous operculum closing off the aperture. The record of drilling predation in *Pyrgopolon* is restricted to Cretaceous deposits, which may represent a bias in predation research focused only on Cretaceous specimens. More research on drilling predation of serpulids should be performed to better understand the function of ornamentation in deterring drilling, to determine how common drilling was on serpulids in deep time, and to evaluate the paleobiogeography of drilling predation.

1. Introduction

The fossil record of predation in marine invertebrate shells has received a considerable interest because predator–prey interactions provide insight in paleoecological reconstructions, evolutionary trends, and behavior of predators (e.g., Kitchell et al., 1981; Kelley and Hansen, 1993; Kelley et al., 2001; Kowalewski et al., 1998; Harper et al., 2011; Huntley and Kowalewski, 2007; Martinell et al., 2010; Chattopadhyay et al., 2013; Mallick et al., 2014; Klompmaker and Kelley, 2015). The most studied evidence of predation in the fossil record is the presence of holes drilled in invertebrate shells (e.g., Kabat, 1990; Kowalewski et al., 1998; Klompmaker et al., 2013), mainly in bivalves and gastropods (e.g., Kabat, 1990; Kelley and Hansen, 2003; Klompmaker, 2009; Klompmaker and Kelley, 2015). However, drill holes occasionally have also been documented from other groups such as scaphopods, ostracods, decapod crustaceans, barnacles, brachiopods, echinoderms, chitons, and serpulid polychaetes (Yochelson et al., 1983; Reyment et al., 1987; Leighton, 2003; Złotnik and Ceranka, 2005; Klompmaker, 2011; Martinell et al., 2012; Johnsen et al., 2013; Klompmaker et al., 2013, 2014, 2015; Rojas et al., 2014). Currently, only a few studies have reported on predation of serpulids, mostly on drill holes in Cenozoic serpulids: Eocene (Savazzi, 1995), Miocene (Sanfilippo, 1999), Pliocene (Sanfilippo, 1999; Klompmaker, 2012; Martinell et al., 2012), and Holocene (Morton and Harper, 2009; Morton and Salvador, 2009). Furthermore, only two detailed studies exist, both on Cenozoic serpulids (Klompmaker, 2012; Martinell et al., 2012). From Mesozoic deposits, we only know of a study by Müller (1969) documenting some drill holes in polycheates from the Maastrichtian of Belgium, whereas other works only briefly mentioned holes in Cretaceous serpulids (Jäger, 1983; Macellari, 1984; Savazzi, 1995; Jäger and Kočí, 2007; Seilacher et al., 2008). Aditionally, studies on drilling in serpulid polychaetes are restricted to European and Antarctic deposits thus far. Thus, Klompmaker (2012) emphasized the need for more studies and expressed that drill holes in fossil serpulids

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would be expected in assemblages from other regions to improve both the temporal and geographic coverage of this predator–prey interaction. Here we report on and assess new evidence of drill holes on tubes of *Pyrgopolon onyx* Morton, 1834, from the Pepito Tey locality, Cantabria Formation, Upper Cretaceous (Maastrichtian) of central Cuba. We also compare and contrast drilling predation to previous studies and a potential predator is inferred.

2. Geological and geographical setting

The specimens come from a small deposit of the Cantabria Formation at the Pepito Tey locality, Cienfuegos province, central Cuba (Fig. 1). The Cantabria Formation forms part of the infill of the Cienfuegos sedimentary Basin. The formation was first named and described by Kantchev et al. (1978) and its deposits are only exposed in the Cienfuegos province. The unit is assigned to the Cretaceous (upper Maastrichtian) based on its foraminifers and rudist associations (Seiglie and Ayala-Castanares, 1963; Kantchev et al., 1978; Rojas-Consuegra, 2004; Lex, 2013). The occurrence of the ammonite *Pachydiscus neubergicus* (von Hauer, 1858) indicates an age not younger than the early late Maastrichtian for a part of this unit (Kantchev et al., 1978; Pszczółkowski, 2002).

The deposits of the Cantabria Formation consist principally of biogenic, thick-bedded to massive limestones consisting of biocalcarenites and biocalcirudites. Sandy limestones, marls, and nodular limestones also occur (Kantchev et al., 1978; Pszczółkowski, 2002; Lex, 2013). The fauna of this unit is composed principally of large benthic foraminifers, gastropods, algae, bivalves, ammonites, corals, tube worms, and echinoids (Kantchev et al., 1978). Among the bivalves, the unit is known for its abundant rudist fauna (Kantchev et al., 1978; Rojas-Consuegra, 2004). The deposits of the Cantabria Formation have been interpreted as a neritic marine sequence (Rojas-Consuegra, 2004; Lex, 2013).

The tubes of the polychaete *P. onyx* reported here are found in a biodetritic, sometimes friable, calcareous clay marl. The fossils were found associated with orbitoid foraminifers and echinoids. In Cuba, *P. onyx* was previously recorded from Upper Cretaceous rocks of the San Pedro and Cantabria Formations by Kantchev et al. (1978).

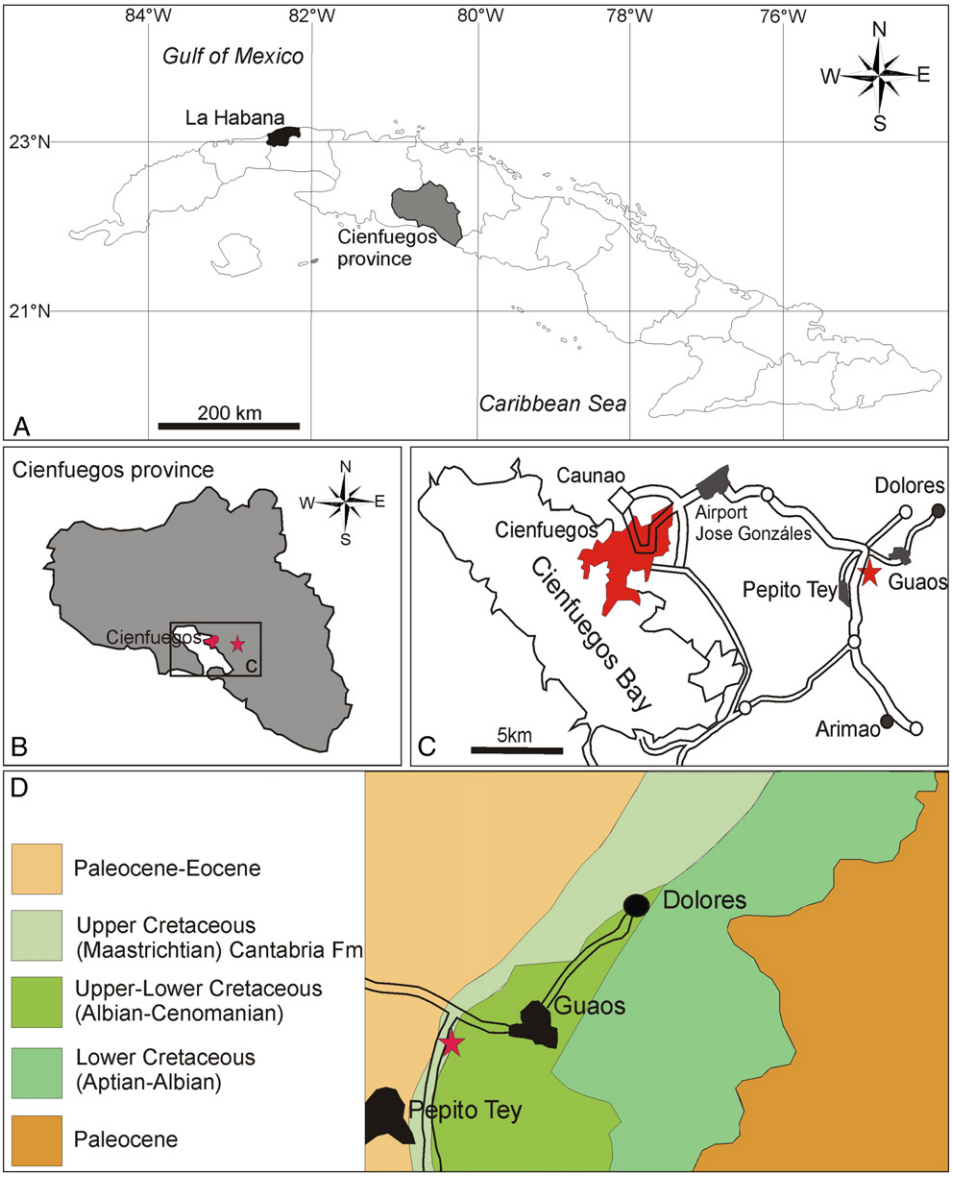

Fig. 1. Geographic location (A–D) of the study area (star) and the geological setting (D) of the Pepito Tey locality in the Cienguegos province, central Cuba.