In situ hermit crab (Anomura, Paguroidea) from the Oligocene Pysht Formation, Washington, USA

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With 2 figures

Abstract: An unusual fossil in situ paguroid hermit crab is here reported from the Oligocene Pysht Formation, Washington (USA). Paguroid specimens preserved within their host gastropod shells are rare in the fossil record. Only a few reports of in situ paguroid hermit crabs preserved within their host gastropod shells have been reported from the Cenozoic.

Key words: Crustacea, Decapoda, Anomura, Paguroidea, Oligocene, Pysht Formation, USA.

1. Introduction

We report on a paguroid crab specimen preserved in situ within a shell of Priscofusus stewarti Tegland, 1933 (Gastropoda, Fusinidae). This is the first record of a hermit crab from the Oligocene Pysht Formation, Washington (USA). Although the preservation of the studied specimen does not allow a precise systematic assignment, this report is important due to the scarce samples of fossil hermit crabs preserved in situ within their host gastropod shell. So far, relatively complete in situ Cenozoic paguroids have been described from the Eocene of Austria (Fraaije & Polkowsky 2016), Italy (Garassino et al. 2009) and Russia (Jagt et al. 2006), from the Oligocene of Japan (Karasawa 2002), and from the Miocene of New Zealand (Hyden & Forest 1980) and The Netherlands (Jagt et al. 2006).

2. Geological setting

The Pysht Formation is one of three including the Hoko River, Makah, and Pysht formations, which are part of the Twin River Group, an Eocene to Oligocene deposit exposed in a northward-dipping homoclinal sequence along the northwestern coast of the Olympic Peninsula of Washington (Snavely et al. 1978; Prothero et al. 2009). The Twin River Group unconformably overlies pillow basalts and breccias of the Crescent Volcanics (MacLeod & Snavely 1973; Snavely & MacLeod 1977; Snavely et al. 1978). The Pysht Formation was named after the Pysht River, which flows into the Strait of Juan de Fuca at Pillar Point (Snavely et al. 1978). The Pysht Formation is exposed for 18 km from Pillar Point State Park east to approximately 3.5 km west of Low Point along the Strait of Juan de Fuca near the northwest tip of the Olympic Peninsula in Clallam County, Washington as shore-cliff exposures and wave-cut terraces (Gower 1960; Addicott 1976; Snavely et al. 1978) (Fig. 1). The Pysht Formation consists of gray to olive-gray massive mudstone, san-
dy siltstone, with conglomerate and sandstone interbeds (SNAVELY et al. 1978). Thickness ranges from 1,100 to 1,400 m (SNAVELY et al. 1978) to up to 2000 m (PROTHEO et al. 2001). Based on magnetostratigraphy, the lower Pysht Formation has been correlated with Chrons C11r–C8r (26.5–30.5 Ma) and the uppermost Pysht Formation with Chron C6Cr and C6Cn3n (23.7–24.7 Ma), making the Pysht Formation late early Oligocene to latest Oligocene in age (PROTHEO et al. 2001). Foraminiferal biostratigraphy place the Pysht Formation in the Oligocene Zemorrian Stage (Nesbitt et al. 2010). Foraminifera indicate an outer slope to bathyal depositional environment in cold water (Goedert et al. 2003; Peckmann et al. 2003).

The Pysht Formation is highly fossiliferous, with many fossils contained within calcareous concretions. Bentonic foraminifera (RAU 1964), molluscs (DURHAM 1944; ADDICOTT 1976; SQUIRES 1989; SQUIRES & GOEDERT 1994; KIEL & GOEDERT 2007), crustaceans (RATHBUN 1926; BERGLUND & GOEDERT 1996; SCHWEITZER & FELDMANN 1999; EAST 2006), and marine tetrapods (OLSON 1980; BARNES et al. 1994; DYKE et al. 2011; MAYR & GOEDERT 2016; PEREDO & UHEN 2016; VÉLEZ-JUARBE 2017) have been previously described from the Pysht Formation.

3. Material

One small specimen including pereiopods, dorsally compressed, crushed in dorsal view and preserved in situ within a Priscofuscus stewarti gastropod shell. The specimen is housed at The Burke Museum of Natural History and Culture, Invertebrate Paleontology Collections, University of Washington, Seattle, Washington, USA.

Abbreviations: UWBM IP – The Burke Museum of Natural History and Culture, Invertebrate Paleontology Collections, University of Washington, Seattle, Washington, USA. P1–P3 first to third pereiopods.
4. Systematic paleontology

Order Decapoda Latreille, 1802  
Infraorder Anomura MacLeay, 1838  
Superfamily Paguroidea Latreille, 1802  
Family, genus and species indet.

Fig. 2. Paguroid hermit crab specimen preserved in a Priscofusus stewarti gastropod shell, UWBM IP 110567. C: carapace, P1–P3: first to third pereiopods. Scale bar equals 1 cm.

Examined material: UWBM IP 110567, one crushed and poorly preserved specimen including pereiopods preserved in situ within a Priscofusus stewarti gastropod shell.

Locality: The sole specimen was collected from wave-cut terraces of the Pysht Formation near the mouth of Deep Creek at UWBM locality no. B9416 (Fig. 1).

Geological age: Oligocene.

Measurements: Carapace shield not measurable; Priscofusus stewarti gastropod shell – total length: 13 mm; maximum width: 7 mm (at the last coil).

Description: Carapace shield very crushed, poorly preserved, partially covered dorsally by the inhabited shell; it seems longer than wide. ?Right P1 cheliped with sub-triangular carpus; sub-rectangular P1 palm dorsal and ventral margins smooth, slightly convex; triangular index rounded distally; dactylus slender, index incurved downward; oc-
clusal margin of P1 dactylus straight, with alternate small rounded teeth; stout triangular P1 index, with some posterior rounded teeth bigger than those of dactylus; smooth outer surface of P1 palm and carpus; ?left cheliped covered by right cheliped; left and right P2–P3 equal, exceeding cheliped; P2–P3 elongate, smooth, with a transverse median depression along length of merus and carpus; elongate, curved dactylus. P4–P5 not observables. Cephalic appendages not preserved.

Discussion: The systematics of extant Paguroidea makes use of morphological characters such as antennules, pleopods, maxillipeds or pereiopods, and several internal and ventral characters to distinguish genera and species of each family whereas the dorsal carapace or chelipeds proxy characters (sensu Schweitzer 2003), mainly preserved as fossils, are mostly used on fossil specimens (Fraaije et al. 2017). Though the P1 cheliped is preserved, it does not allow us to recognise its homo- or heterochely. Therefore, the lack of above-mentioned diagnostic characters in the studied specimen hampers its systematic assignment both to extant and fossil families and genera described to date among the Paguroidea. The only possible remark is that the apparent absence in the studied specimen of any kind of ornamentation on the preserved P1–P3 and the P1 probably being isochelous could suggest that it does not belong to the Diogenidae and Paguridae, which usually have more or less ornamentated pereiopods and P1 heterochelous (Zariquey Alvarez 1968; McLoughlin 2003).

The studied specimen is preserved in situ within a small gastropod shell, slightly deformed due to the different hardness of the mineralized shell, assigned to Priscofusus stewarti due to its similarities to described species of Priscifusus from the overlying Clallam Formation (Addicott 1976). This is the first report of a pagurid hermit crab from the Oligocene Pysh Formation of Washington.

5. Taphonomy

Twenty-five paguroid specimens, many preserving both chelipeds and in some cases the walking legs, were reported from the underlying Late Eocene Hoko River Formation (Schweitzer & Feldmann 2001). Preservation of a paguroid associated within its host gastropod shell is scarce in the fossil record (see Jagt et al. 2006 and references therein). However, empty gastropod shells with signs of hermit crab inhabitation are quite common in the fossil record (e.g., Walker 1992; Feldmann et al. 2019).

Dunbar & Nyborg (2003) speculated that the paucity of fossil hermit crabs associated with gastropod shells is due to hermit crabs abandoning their host gastropod shells and climbing upward through the sediment during times of stress, such as burial. In preliminary experiments with shelled Pagurus samuelis, Dunbar & Nyborg (2003) found that if buried rapidly with dry sand, hermit crabs did not abandon their shells and died where buried. In contrast, when buried slowly, P. samuelis dug up through the sediment, often carrying the shell with them. In additional experiments with the same species, but with combined sand and seawater, Shives & Dunbar (2010) found the orientation of the aperture during burial was a significant factor in whether hermit crabs abandoned the shell or not, with hermit crabs buried aperture up much more likely to abandon. Those authors suggested that when the aperture was down, shell architecture may cause sediment to flow over the shell and settle around the organism allowing the crab to push upward against the sediment overburden. In contrast, when the aperture faces upward, sediment can fill the internal volume of the shell. This may cause the hermit crab to extend outward, allowing more sediment to infiltrate the shell and eventually inhibiting the hermit crab from retreating inward. This may result in the hermit either succumbing to anoxia while partially extended from the shell, or abandoning the shell altogether in an effort to escape the burial. In either case, the hermit crab may then be deposited partially or fully disarticulated from the shell. It is therefore not surprising that other authors, such as Walker (1992), found fossil pagurized gastropod shells lacking the associated pagurid.

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