

Virtual dissection and lifestyle of a 165 -million-year-old female polychelidan lobster



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ABSTRACT

Polychelidan lobsters are fascinating crustaceans that were known as fossils before being discovered in the deep-sea. They differ from other crustaceans by having four to five pairs of claws. Although recent palaeontological studies have clarified the systematics and phylogeny of the group, the biology of extant polychelidans and - first of all - their anatomy are poorly documented. Numerous aspects of the evolutionary history of the group remain obscure, in particular, how and when polychelidans colonized the deep-sea and became restricted to it. Surprisingly, the biology of extant polychelidans and the anatomy of all species, fossil and recent, are poorly documented. Here, X-ray microtomography (XTM), applied to an exceptionally well-preserved specimen from the La Voulte Lagerstätte, reveals for the first time vital aspects of the external and internal morphology of *Voulteryon parvulus* (Eryonidae), a 165-million-year-old polychelidan: 1) its mouthparts (maxillae and maxillipeds), 2) its digestive tract and 3) its reproductive organs. Comparisons with dissected specimens clearly identify this specimen as a female with mature ovaries. This set of new information offers new insights into the feeding and reproductive habits of Mesozoic polychelidans. Contrasting with other Jurassic polychelidans that lived in shallow-water environments, *V. parvulus* spawned in, and probably inhabited, relatively deep-water environments, as do the survivors of the group.

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1. Introduction

Polychelidan lobsters are fascinating crustaceans that were first described as fossils in the Late Jurassic of Southern Germany before being recognized half a century later in extant deep-water environments during the celebrated Challenger Expedition (Wyville Thompson, 1873). By contrast to lobsters and shrimps, they are

characterized by an unusual dorso-ventrally flattened shape and the presence of four to five pairs of chelate appendages (Fig. 1A) that makes them unique among decapods and often regarded as the sister group of Eureptantia (i.e. lobsters, hermit crabs and true crabs). Unlike extant polychelidans which are restricted to deep-water and blind, Mesozoic representatives of the group display prominent bulbous eyes (Fig. 1B, C). The majority of fossil polychelidan lobsters described to date are associated with shallow-water settings (e.g. Garassino and Schweigert, 2006; Audo et al., 2014a, 2014b) and have faunal associates that are typical of these marine environments. The deepest occurrence of fossil polychelidans is the La Voulte Lagerstätte (Charbonnier, 2009; Audo, 2014) which is supposed to have been deposited in bathyal conditions (Charbonnier et al., 2007a). Although recent studies based on exoskeletal characters have helped to clarify many aspects of their phylogeny (Ahyong, 2009; Karasawa et al., 2013; Audo, 2014), still very little is known concerning the internal anatomy of both

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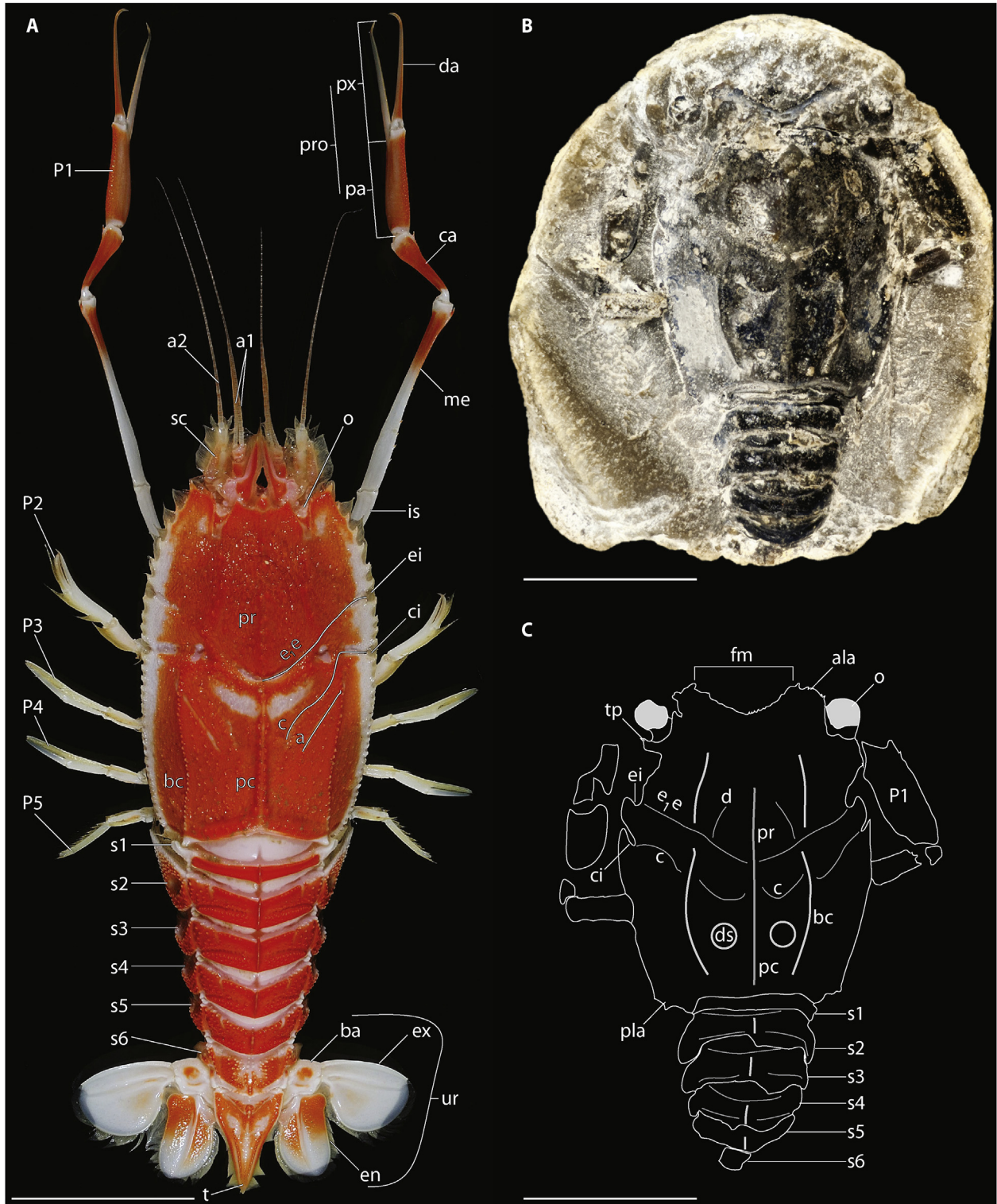


Fig. 1. Dorsal morphology of recent and fossil polychelidan lobsters. **A**, *Polycheles coccifer* Galil, 2000 (♂) from Papua New Guinea, Tami Island, Huon Gulf, ca 410 m (©Tin-Yam Chan, National Taiwan Ocean University; CP3645, Biopapua expedition 2010; see Galil, 2013 for details). **B, C**, *Voulteryon parvulus* Audo, Schweigert, Saint Martin and Charbonnier, 2014 (♀) from the Middle Jurassic La Voulte Lagerstätte, France. Abbreviations: **a**, branchiocardiac groove; **a1**, antennula; **a2**, antenna; **ala**, anterolateral angle; **ba**, basipodite; **bc**, branchial carina; **c**, postcervical groove; **ca**, carpus; **ci**, postcervical incision; **d**, gastro-orbital groove; **da**, dactylus; **ds**, disc-shaped structure; **e.e**, cervical groove; **ei**, cervical incision; **en**, endopod of uropod; **ex**, exopod of uropod; **fm**, frontal margin; **is**, ischium; **me**, merus; **o**, eye; **P1–P5**, pereopods 1–5; **pa**, palm; **pc**, postcervical carina; **pla**, posterolateral angle; **pr**, postrostral carina; **pro**, propodus; **px**, pollex; **s1–s6**, pleonite 1–6; **sc**, scaphocerite; **t**, telson; **ur**, uropod. Scale bars: 2 cm in A and 5 mm in B.

fossil and extant representatives of the group. The only anatomical description of an extant polychelidan is that of *Polycheles typhlops* Heller, 1862 which concentrates on the reproductive system to the exclusion of the other vital organs (Cabiddu et al., 2008). The

exceptional preservation of the fossils from the La Voulte Lagerstätte gave us the chance to use X-ray microtomography (XTM) as a non-invasive tool to explore for the first time the internal and external anatomy of a Middle Jurassic (Callovian; ca 165 Ma)

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