

Short Article

Three-dimensionally preserved *Triops* sp. (Crustacea, Branchiopoda) from a Miocene volcanoclastic sediment in Ota City, Gunma Prefecture, central JapanTANAKA Gengo¹, TAKAKUWA Yuji¹ and ISHIHARA Katsuhiko²¹ Gunma Museum of Natural History

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Abstract : A three-dimensionally preserved *Triops* sp. (Crustacea, Branchiopoda) was discovered in a Miocene volcanoclastic sediment (Midorimachi Formation) in Ota City, Gunma Prefecture, central Japan. This is only the third report of the three-dimensionally arthropod fossils preserved in volcanoclastic sediments in the world. Although the exoskeleton of the fossil specimen has disappeared, fine detail of the external mold was preserved because it had been filled with fine-grained volcanoclastic sediments. The mode of preservation is somewhat similar to that of the Pompeian specimens in Italy. The fossil *Triops* is the first record from Japan.

Key Words : Branchiopoda, Japan, Miocene, three-dimensionally preservation, *Triops*, volcanoclastic sediment, Ota City, Gunma Prefecture, Midorimachi Formation

Introduction

Exceptionally well-preserved fossil specimens (Konservat Lagerstätten) are extremely important as evidence of evolution of organisms. The Burgess Shale (Briggs *et al.*, 1994) and Chengjiang Biota (Hou *et al.*, 2007) are among the most famous fossil Lagerstätten in the world because they confirm the early evolution of metazoans. These fossils show detailed preservation, despite them being two-dimensionally preserved (Burgess-type preservation). Fossils showing three-dimensional preservation are called the Orsten-type and have specimens dating from the Precambrian onward (Duncan and Briggs, 1996; Smith, 2003; Waloszek, 2003; Dong *et al.*, 2004; Yin *et al.*, 2007). The fossils showing Orsten-type preservation are preserved in calcium phosphate with varying degrees of fidelity, and reveal early animal ontogenetical development, arthropod phylogeny, and morphological stability.

Recently, an exceptionally well-preserved three-dimensional fossil Lagerstätte was discovered in a Silurian volcanoclastic sediment (Briggs *et al.*, 1996; Siveter *et al.*, 2003, 2004). In the volcanoclastic sediment, the fossils were preserved as cast molds coated by clay minerals. Such preservation in volcanoclastic sediments is very interesting when we consider the taphonomic process of fossils. Crawford *et al.* (2008) reported the decapod fossils filled with argillaceous volcanic tuff from the Miocene Monte León Formation of Patagonia, Argentina. Here we report a three-dimensionally preserved arthropod *Triops* sp. (Triopsidae, Phyllopora, Crustacea) from the Miocene volcanoclastic sediment from central Japan. This is

the third cases of a three-dimensionally preserved arthropod fossil specimen ever to be found in volcanoclastic sediments in the world.

Geological setting

The volcanoclastic rock, which contained the *Triops* sp., was collected from the Tertiary marine sediment from the Kanayama Hills. Suto *et al.* (1976) identified this rock as the Yunoíri Tuff Member a member of the Yabutsuka Formation in the Hachióji Hills. Kurihara (2003) reported two gastropods belonging to the genus *Conus* from this area and suggested that the occurrences of this genus are related to the late Early to early Middle Miocene Climatic Optimum period. Takakuwa (2004) recognized *Bathynomus* (Isopoda) and *Isocrinus?* (Isocrinida) from this locality. Nomura *et al.* (2003) identified this rock from the Kanayama Hills as the Yunoíri Tuff Member on the basis of the occurrence of larger foraminifera *Miogypsina* gr. *kotoi* and dated a fission track age (14.9 ± 0.5 Ma) from the tuff. This member is comparable to the Haratajino Formation of the Tomioka Group in of Oishi and Takahashi (1990). However, Takahashi and Yanagisawa (2003) named it the Midorimachi Formation on the strength of the differences in lithological, depositional, environmental, and structural geological features compared to the type locality of the Yunoíri Tuff Member. Furthermore, they determined the geologic age of the formation to be from 16.7 to 16.4 Ma based on the biostratigraphy of diatoms (Zones D33 – D35: Yanagisawa and Akiba, 1998). In the present study, we follow the Takahashi

and Yanagisawa (2003) for the geologic age depositional time of this volcanoclastic sediment.

Systematic Palaeontology

We followed the classification by Martin and Davis (2001).

CRUSTACEA Brünnich, 1772

BRANCHIOPODA Latreille, 1817

PHYLLOPODA Preuss, 1951

NOTOSTRACA Sars, 1867

TRIOPSIDAE Keilhack, 1909

TRIOPS Schrank, 1803

Triops sp.

Figure 1C

Description: Only the posterior part of the carapace and

approximately eight body rings of the fossil specimen were preserved. The posterior part of the carapace is characterized by two triangular-shaped protrusions, and each protrusion is bounded by a sulcus of small curvature. Each protrusion has a maximum length and width of about 1 mm. The maximum width transverse length of the preserved carapace is approximately 5 mm, and the total length of the preserved body rings is approximately 3 mm. The maximum width of each ring is approximately 300 μ m, and its cross-section is triangular in shape. Each peak of the triangular ring runs parallel to the sagittal direction of the body. The original exoskeleton of the fossil is not preserved and is visible as an external cast. The external cast is composed of white, brown, green, or black very fine volcanoclastic sediments.

Remarks: According to Martin and Davis (2001), Notostraca

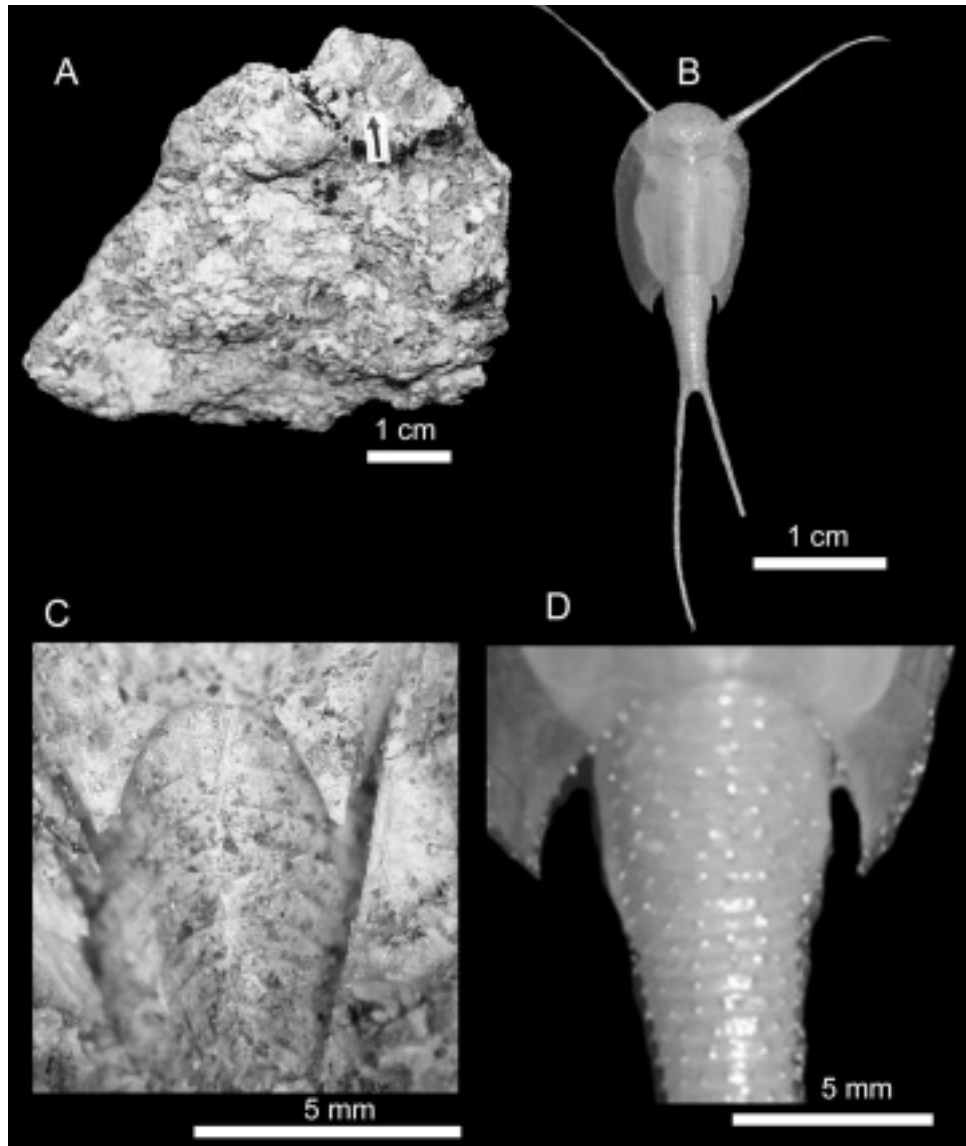


Fig. 1 A. Miocene volcanoclastic sedimentary rock containing *Triops* sp. (near arrowhead) from Ohta City, Gunma Prefecture, Japan. B. Recent specimen of *Triops longicaudatus*. C. close up photomicrographs of the *Triops* sp. (GMNH-PI-3201) from the Miocene sediment. The posterior part of carapace and approximately eight rings are preserved. D. Close up of the posterior part of the carapace and several rings of Recent *T. longicaudatus*.

is only composed of one family Triopsidae. The family triopsidae is classified into genus *Triops* and *Lepidurus* (Tasch, 1969). The posterior carapace of the fossil specimen of *Triops* sp. is similar to the Recent *Triops longicaudatus* specimen in shape. However, *Triops* sp. differs from *T. longicaudatus* in its triangular cross-section of the rings. The fossil record of the genus *Triops* has been reported from the Early Triassic onward, and the living specimen (*T. cancriformis*) is cosmopolitan (Tasch, 1969). *Triops* tends to prefer temporary waters (such as rice fields) that dry out regularly (Tasch, 1969). *Triops* sp. that lived in such a temporary pond may have been transported with volcanoclastic debris and buried alive in the relatively deep-sea, which is a characteristic habitat of large isopods and crinoids. Such a mode of preservation is somewhat similar to that of the Pompeian specimens in Italy and an albatross specimen from the Aoga-shima Island, Japan (Kobayashi, 1971). Furthermore, Chappell *et al.* (1951) have reported the mold of a rhinoceros in basalt lava from Washington USA. The bodies of these mammals and birds have been preserved as hollow objects with small pieces of bone fragments. The preservation of *Triops* sp. resembles these cases, although no parts of the original body have been preserved in this specimen. The volcanoclastic sediment containing *Triops* sp. contains many shell fragments, indicating that chitin decomposition was selectively activated in the sediment. The present study also suggests that the genus *Triops* had already colonized Japan in the late Early Miocene.

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群馬県太田市の中新統火山碎屑性堆積物中より 発見された三次元保存を示すカブトエビ化石 (甲殻綱, 鰓脚類) について

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要旨：三次元的に保存されたカブトエビ化石（甲殻綱，鰓脚類）が群馬県太田市の中新統の火山碎屑性堆積物（緑町層）中より発見された。火山碎屑性の堆積物中に三次元的に保存された節足動物の化石としては，世界的にも三例目となる重要な報告である。化石標本の外骨格は失われており，外型の鋳型のみが細粒の火山碎屑性の堆積物で充填されることによって，細部まで保存されていた。その保存様式は幾分，イタリアのポンバイ人の標本に似ている。カブトエビ化石は日本初の報告である。

キーワード：鰓脚類，日本，中新世，三次元保存，カブトエビ，火山碎屑性堆積物，太田市，群馬県，緑町層