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Preliminary report on the trace fossil *Thalassinoides* from the Middle to Upper Jurassic Kiritani Formation (Tetori Group) in the Kiritani area, southern Toyama Prefecture

Satoshi Hirasawa
Department of Geology and Mineralogy, Graduate School of Science, Kyoto University
Kitashirakawa-Oiwakecho, Kyoto 606-8502, Japan

富山県南部桐谷地域に分布する中－上部ジュラ系手取層群桐谷層より産出した生痕化石タラシノイデス*Thalassinoides*について（予報）

平澤　聡
京都大学大学院理学研究科地質学鉱物学教室
606-8502　京都市左京区北白川追分町

本稿では富山県南部桐谷地域の手取層群桐谷層（中－上部ジュラ系九頭竜亜層群相当層）から産出した生痕化石タラシノイデス*Thalassinoides*について予察的に報告する。この生痕化石は2008年10月、著者により本層中部をなす灰色細粒砂岩から採取された。標本はタラシノイデス*Thalassinoides*の3次元的な棲管構造の一部であり、層理面に平行するT字ないしY字状に分岐した棲管と、これにほぼ垂直なシャフトの基部からなる。表面には棲管内彫刻の痕跡はなく、滑らかである。また棲管破断面に対称性の高い同心円状の裏打ち構造が認められる。タラシノイデス*Thalassinoides*は甲殻類の移動摂食痕であると解釈されている。手取層群では甲殻類化石の産出は下部白亜系石徹白亜層群から数例知られるのみで、その下位の九頭竜亜層群および相当層から報告されていない。したがって本標本は、手取層群において甲殻類の存在を示唆する最も古い化石記録といえる。

キーワード：生痕化石，タラシノイデス，桐谷層，手取層群，ジュラ系
Key words：trace fossil、*Thalassinoides*、Kiritani Formation、Tetori Group、Jurassic

Introduction

This report is brief description of the trace fossil *Thalassinoides* isp., whose trace-maker is considered to be crustaceans, from the Jurassic marine Kiritani Formation of the Tetori Group distributed in the Kiritani area, southern Toyama Prefecture. The specimen, TOYA-Fo-3029, which is reposited in the Toyama Science Museum, was collected by the author in October 2008.

Crustacean fossil records are very scarce in both body and trace fossils from the Tetori Group. The trace fossil *Thalassinoides* isp. mentioned below is the first and oldest fossil intimating the existence of crustaceans in the group.

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Institutional abbreviation. TOYA, Toyama Science Museum.

Geological Setting

The Upper Mesozoic Tetori Group is distributed in northern central Japan (Fig. 1.A). The Tetori Group is subdivided into the Middle to Upper Jurassic Kuzuryu Subgroup (mainly marine beds), upper Jurassic to Lower Cretaceous Itoshiro Subgroup (brackish and terrestrial sediments intercalated with marine formations) and Lower Cretaceous Akaiwa Subgroup (terrestrial deposits) in ascending order (Maeda, 1961; Fujita, 2003; Goto, 2007). The marine Kuzuryu Subgroup has a wide distribution in and around the upper reach areas of Kuzuryu-gawa River located at eastern Fukui Prefecture (Fig. 1. A).

The Kiritani Formation is firstly reported by Imamura (1933) as a "trigonia-ammonoid fossils bed". After that, Maeda (1958) and Nozawa et al. (1981) geologically redescribed that this formation is Upper Jurassic marine sediments correlated to the upper part of the Kuzuryu Subgroup. The geological age of the Kiritani Formation is thought to be Middle Oxfordian based on ammonoid (Sato and Westermann, 1991), whereas radiolarian assemblage indicates Callovian to early Tithonian in age (Kashiwagi and Hirasawa, 2010). The Kiritani Formation is narrowly exposed in the Kiritani area of southern Toyama Prefecture (Figs.1.A, B). The formation displays an overall fining-upward succession: the gravelly lower part, sandstone-dominated middle part and bioturbated dark shale in the upper part (Fig. 2). Abundant trace fossils such as *Phycosiphon*, *Planolites*-type horizontal burrows, *Schaubcylindrichnus* and *Skolithos*-type vertical burrows are yielded from the upper part (Hirasawa et al., 2010).

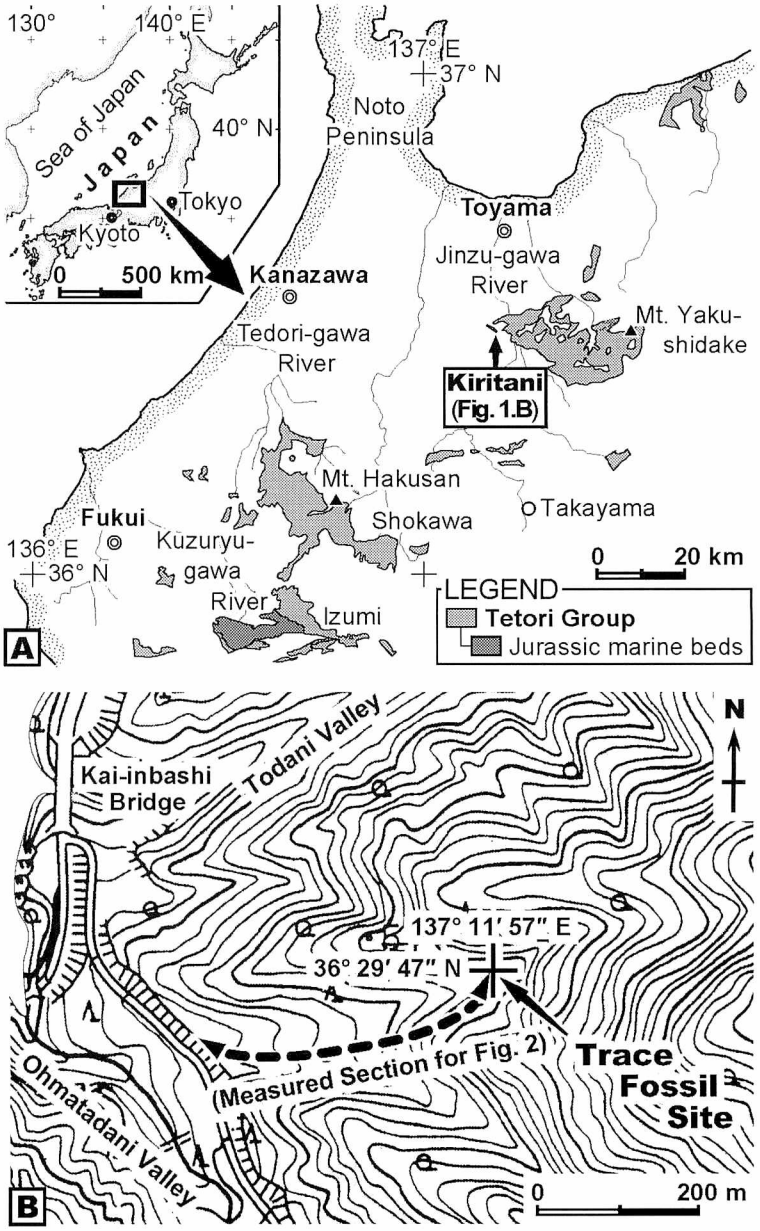

Fig. 1. Index maps showing the trace fossil locality. A) Distribution of the Upper Mesozoic Tetori Group, modified after Maeda (1961). B) Trace fossil locality in the Kiritani area. Using the 1 : 25,000 scale topographic map "Inotani", published by Geological Survey of Japan.

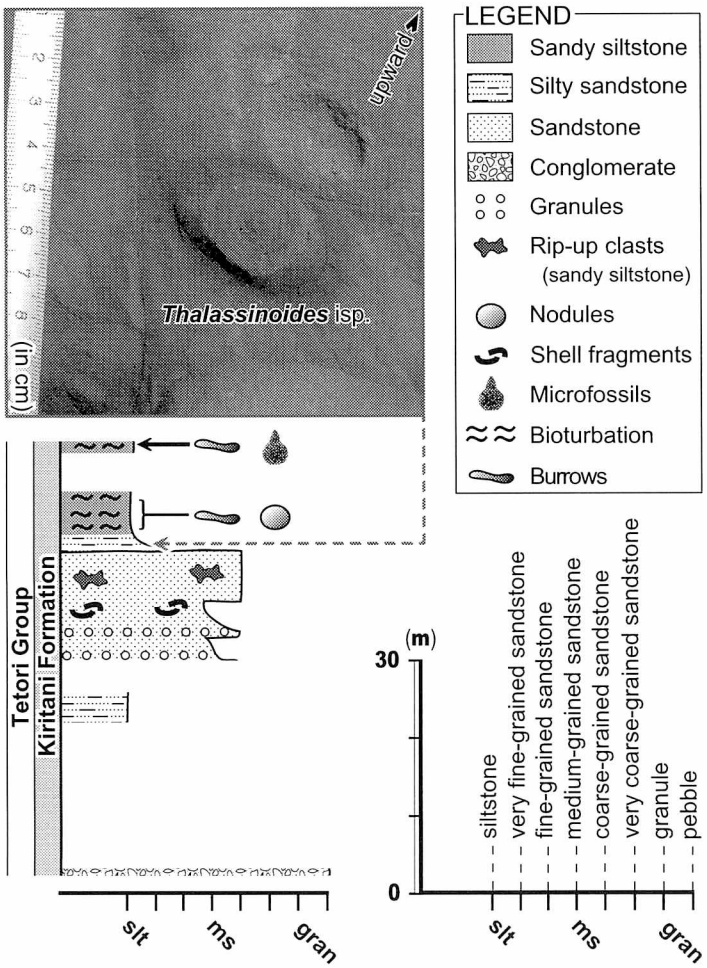

Fig. 2. Columnar section of the Middle to Upper Jurassic Kiritani Formation and an outcrop photograph of the trace fossil bearing horizon. Columnar section is modified after Hirasawa et al. (2010).

Preliminary description on the specimen

The trace fossil specimen was obtained from poorly sorted, dark-gray silty fine-grained sandstone of the middle part of the Kiritani Formation (Fig. 2). The trace fossil is a fragment of cylindrical burrow of a three-dimensional branching system. The specimen is consisted of a horizontal burrow with a vertical shaft base and damaged horizontal branch. The whole sizes are 5.5 cm in length, 1 to 2.5 cm in width, 3 cm in height and about 2 cm in maximum burrow diameter (Figs. 3.A, B). The branch connecting horizontal burrow with a vertical shaft base is mostly lacked, only preserved its junction part. Internal burrow surrounded by symmetrical concentric laminated lining is in the center of the horizontal branch (Fig. 3.A). The internal burrow and lining are laterally connected with lateral side of the horizontal burrow at high-angle, so that exhibiting T- or Y-shaped branch bifurcation (Fig. 3.B). The basal part of the vertical shaft continuously bulges upward from one terminal of the horizontal burrow. Diameter of the horizontal burrow is constant to some extent, while the vertical shaft tapering to a point (Figs. 3.A, B). The internal burrow is nearly oval in cross-section, approximately 0.5 cm in diameter. The concentric laminated lining is composed of five to six laminar walls (Fig. 3.A). Each lining is 0.1 cm thick. The burrow surface is smooth, not showing bioglyphs and other external wall sculptures (Fig. 3.B). Reddish-brown iron oxide/hydroxide minerals partly cover the fossil surface.

The trace fossil is identified as *Thalassinoides* isp., judging from the following four characters: 1) cylindrical burrows forming three-dimensional branching, 2) T- or Y-shaped horizontal burrow bifurcation, 3) smooth surface and 4) concentric lining (Fig. 3.C). In the specimen, the internal burrow is in the center of the horizontal branch and the symmetrical concentric lining consisted of nearly isothick laminae (Fig. 3.A). This is unique characters because *Thalassinoides* commonly has "successive laminae larger at bottom and side, and thinnest or absent at the top" (Chamberlain, 1978; see Fig. 3.C). But it is difficult to identify the specimen at the ichnospecies level due to its incomplete preservation, especially largely lacking the three-dimensional branching system.

Significance of the trace fossil from the Kiritani Formation

Thalassinoides had not been described from the Tetori Group, so this is the first specimen reported. Ichnogenus *Thalassinoides* Ehrenberg, 1944 is interpreted as feeding and dwelling burrows of crustaceans because the burrows are sometimes associated with their body fossils (Häntzschel, 1975). The trace fossil is yielded from Cambrian to Holocene in age (Chamberlain, 1978; Sprechmann et al., 2004).

Very few fossil crustacean records are known form the Tetori Group. Kato and Karasawa (2006) described a carapace fossil of glypheoid lobster from the Lowest Cretaceous marine deposits (Berriasian Mitarai Formation) of the Itoshiro Subgroup in the Shokawa area (Fig. 1.A). Additionally, Nomura and Shimizu (2008) reported some scalpellomorph barnacles from the formation. However, crustacean records are not known from the Middle to Upper Jurassic Kuzuryu Subgroup. Thus, *Thalassinoides* from the Callovian to lower Tithonian Kiritani Formation is the oldest fossil evidence which intimates the existence of crustaceans in the Tetori Group.

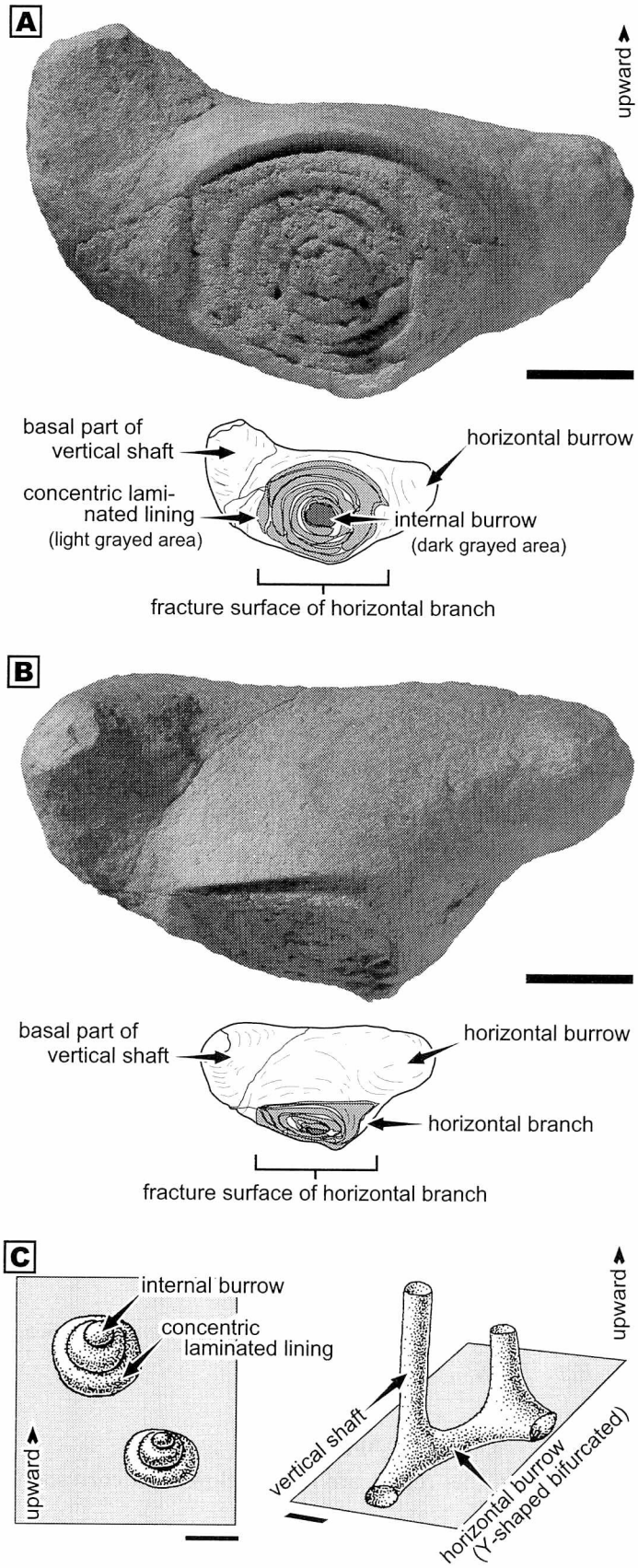

Fig. 3. *Thalassinoides* isp., TOYA-Fo-3029; Middle to Upper Jurassic Kiritani Formation, Kiritani, Toyama Prefecture, with schematic drawings. Scale bars indicate 1 cm. A) Lateral (outcrop surface) side. B) Upper side. C) Schematic drawings of *Thalassinoides*, modified after Wetzel (1987).

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Appendix

The place and formation names used in this report are listed below with correspondent Japanese characters, in alphabetical order.

Akaiwa, 赤岩 ; Fukui, 福井 ; Hakusan, 白山 ; Inotani, 猪谷 ; Izumi, 和泉 ; Itoshiro, 石徹白 ; Jinzu-gawa, 神通川 ; Kai-inbashi, 海韻橋 ; Kanazawa, 金沢 ; Kiritani, 桐谷 ; Kuzuryu, 九頭竜 ; Kuzuryu-gawa, 九頭竜川 ; Kyoto, 京都 ; Mitarai, 御手洗 ; Noto, 能登 ; Ohmatadani, 大亦谷 ; Shokawa, 荘川 ; Tedori-gawa, 手取川 ; Todani, 卜谷 ; Takayama, 高山 ; Tokyo, 東京 ; Toyama, 富山 ; Yakushidake, 薬師岳.