Akihiko SUZUKI[1] and Shin KUBOTA[2]：Traces of the predatory gastropod (ichnospecies *Oichnus simplex*) found in shells of *Spondylus* sp. (Mollusca, Spondylidae) washed ashore at Shirahama Town, Wakayama Prefecture, Japan

鈴木明彦[1]・久保田　信[2]：和歌山県白浜町に打ち上げられたウミギク属貝殻に見られる穿孔痕 *Oichnus simplex*

Introduction

Molluscan shells, such as those belonging to the ichnogenus *Oichnus* Bromley, 1981, are frequently characterized by the presence of circular holes, which are traces produced by predatory gastropods. Predator-prey relationships have been studied extensively in the modern benthic realm (Carter 1968; Carriker 1981; Kabat 1990) and in the fossil record (Taylor 1970; Kelley 1988; Kowalewski et al. 1998), and among the most extensively studied indicators of biotic interactions are predatory drilling holes, as these provide considerable information on predator-prey relationships (Vermeij 1987; Kelley 1988; Kowalewski et al. 1998).

In July to August 2015, predated shells of the spondylid bivalve *Spondylus* sp. were collected at Shirahama Town in Wakayama Prefecture (Kubota 2015). Here we describe the drill holes produced by predatory gastropods in the shells of *S.* sp., and discuss the ichnology of drill holes and other aspects of predator-prey relationships.

Materials and methods

More than 600 specimens of *S.* sp. were collected on Kitahama beach at the Seto Marine Biological Laboratory of Kyoto University in Shirahama Town in Wakayama Prefecture (Kubota 2015). Of these specimens, 14 with drill holes and three entier specimens were subjected to morphometric analysis. Measurements of shell height were performed using digital calipers, and pictures of drill holes in *S.* sp. shells were captured under a stereomicroscope.

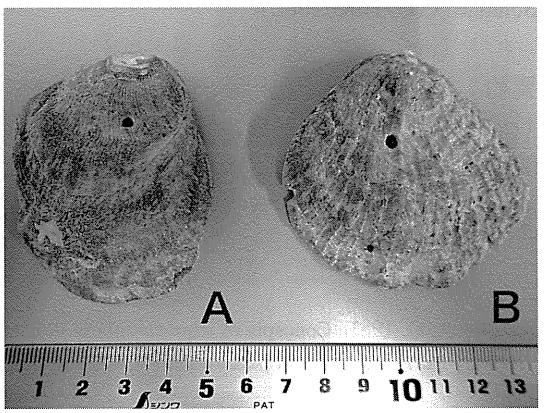

Fig.1 Hole patterns on the left shells of *Spondylus* sp. found on Kitahama beach at the Seto Marine Biological Laboratory, Kyoto University.

Results and discussion

Circular to subcircular drill holes that completely penetrated the shells of the smaller bivalve shells are shown in Fig. 1. The holes bored through the shells appeared to be randomly distributed.

Specimen A, shell height 64.49mm, had a hole with a diameter of 3.35mm (Fig. 2A). Specimen B, shell height 63.37mm, had a hole with a diameter of 3.42mm (Fig. 2B). Specimen C, shell height 50.65mm, had a hole with a diameter of 2.54mm (Fig. 3). Circular holes measured ca. 2.5 to 3.5mm in diameter. When the hole of specimen C was cut to produce a transverse section (Fig. 3A), the depth of the hole was 1.92mm and the depth-to diameter ratio was <1 (Fig. 3B).

Circular to subcircular holes bored in *S.* sp. shells were only observed on the left valves, and not on the right valves

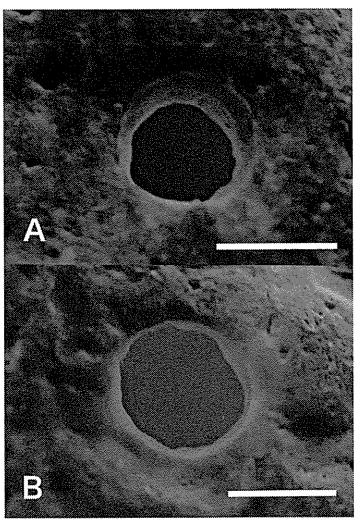

Fig.2 Typical holes drilled by the ichnospecies *Oichnus simplex* (Muricid predation) in the valves of *S.* sp. Scale bar: 2mm.

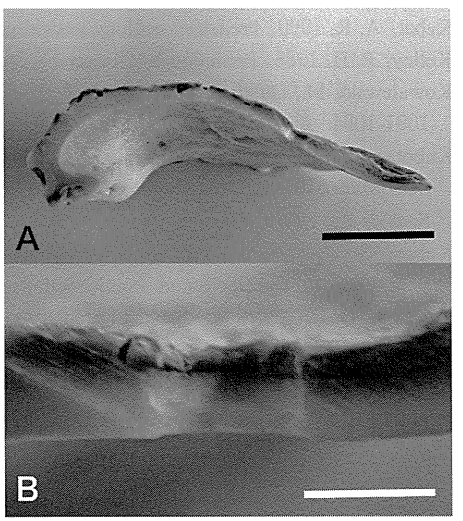

Fig.3 Cross section of a valve of *S.* sp.
A. Vertical section of the left shell along the length of a drill hole. Scale bar: 2cm.
B. Close-up of the cross section of the hole drilled by *Oichnus simplex*. Scale bar: 2mm.

(Fig. 1). This is because the right valves of *S.* sp. were attached to the substrate, leaving the left valves exposed to the environment and susceptible to attack by predators. We found that only small *S.* sp. shells had holes, and that larger shells did not; it was considered that this was because the large shells were too thick to for predators to penetrate. Further, the positions of the holes on the shell appeared to be random and no obvious patterns were recognized (Fig. 1).

In transverse section, the holes were slightly conical and perpendicular to the shell surface. The walls of the holes appeared to be smooth. Based on the cylindrical morphology of the drilled holes, the predators likely belonged to the ichnotaxon, *Oichnus simplex* Bromley, 1981. This type of predation is widespread among muricid whelks (Bromley 1981; Kabat 1990), which are common in shallow seas where they prey on epifunal mollusks (Kabat 1990; Ishida 2004).

Numerous muricid whelks (32 species in 20 genera) have been reported in the Shirahama area (Kubota and Koyama 2002). Among these species, shallow water species were most likely to be hole borers. Future research will identify the potential gastropod prey of these muricid whelks.

Acknowledgments

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要約：2015年7～8月，和歌山県白浜町の海岸に打ち上げられた多数のウミギク属貝殻を採集した．これらの貝殻には，しばしば円形の穿孔痕が見受けられたので，穿孔痕の生痕学的特徴とそれから予測される捕食－被食関係について考察した．その結果，これらの穿孔痕は *Oichnus simplex* に同定され，アクキガイ科巻貝の捕食活動によるものと推定された．

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