Akihiko SUZUKI[1] and Satoi ARAI[2]：Globular *Gastrochaenolites* produced by the rock-boring bivalve *Nettastomella japonica* from Cape Koetoi, Wakkanai, Hokkaido

鈴木明彦[1]・新井　慧[2]：北海道稚内市声問岬の打ち上げ礫に見られるヨコヤマスズガイとその穿孔痕

Introduction

Hard bottom environments often bear rock-boring traces produced by boring organisms, such as bivalves, gastropods, brachiopods, barnacles, polychaete annelids, sponges and bryozoans. Members of ichnogenus *Gastrochaenolites* have primarily been observed in rocky substrates that likely represent shallow marine facies（Bromley 1992, 1994）, and club-shaped borings can mainly be attributed to boring bivalves（Kelly and Bromley 1984）.

In June 2020, several rock-boring bivalves and beach rocks bearing the ichnogenus *Gastrochaenolites* were collected on a boulder beach at Cape Koetoi, Wakkanai, Hokkaido. Here, we briefly describe the characteristics, distribution and taxonomic significance of Gastrochaenolites, as well as associated rock-boring bivalves.

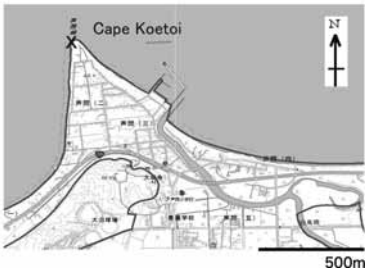

Fig.1 Map showing the location of Cape Koetoi in Wakkanai City, Hokkaido.
X: Sample location.

Materials and methods

The Wakkanai area in northern Hokkaido is dominated by Cretaceous sedimentary rocks and overlaid by Cenozoic sedimentary rocks（Osanai et al. 1959）. The Paleogene system of rocks is mainly a product of terrestrial sedimentation, while the Neogene system is a product of active volcanism and marine sedimentation.

The study site, Cape Koetoi, is located at the northern point of Wakkanai, Hokkaido（Fig. 1）. The geology at the site consists mainly of mudstone and fine-grained sandstone of the Koetoi Formation, which has been assigned to the Late Miocene based on diatom biostratigraphy（Fukusawa 1985）. The beach is dominated by mudstone cobbles and boulders, with small amounts of fine-grained sandstone. Bored cobbles and boulders are also abundant along the strand line of the shore. Clavate borings produced by bivalves are numerous, but several cylindrical borings are also recognized.

Samples were examined using a hand lens and under a stereomicroscope, and images were captured using a digital camera（Olympus Tough Tg-5, Olympus Corp., Japan）. Cobbles and boulders bearing recent trace fossils were identified based on comparisons with the ichnological literature（Bromley 1992, 1994; Donovan 2011, 2013）, and the descriptive terminology of borings follows Kelly and Bromley（1984）.

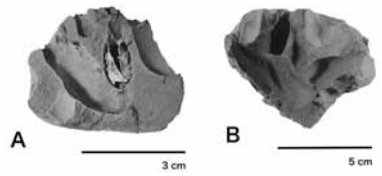

Fig.2 Boring traces of *Nettastomella japonica.*
A. *Nettastomella japonica* existed in mudstone.
B. Boring traces of *Nettastomella japonica*（＝*Gastrochaenolites orbicularis*）in mudstone.

Systematic ichnology

Ichnogenus Gastrochaenolites Leymerie, 1842

Type ichnospecies: Gastrochaenolites lapidicus Kelly and Bromley, 1984

Other species: See Donovan（2011）.

Diagnosis: "Clavate borings in lithic substrates. The aperture region of the boring is narrower than the main chamber and may be circular, oval, or dumb-bell shaped. The aperture may be separated from the main chamber by a neck region, which in some cases may be widely flared. The main chamber may vary from subspherical to elongate, having a parabolic to rounded truncated base and a circular to oval cross section, modified in some forms by longitudinal ridges or grooves to produce an almond- or heart-shaped section "（after Kelly and Bromley, 1984; p. 797）

Remarks: Gastrochaenolites borings are excavated principally by endolithic bivalves, but also by recent coralliophilid gastropods（Bromley 1994）.

Gastrochaenolites orbicularis Kelly and Bromley, 1984（Fig. 2, 3）

Material: Recent borings in five mudstone cobble samples damaged during sampling(Fig.2). One boring is almost complete and has been cast in latex(Fig.3).

Locality: Boulder Beach, Cape Koetoi, mudstone of the Koetoi Formation.

Description: Smooth *Gastrochaenolites*, circular in cross-section throughout;

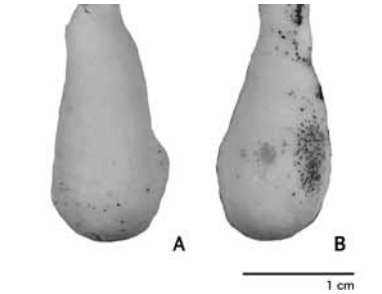

Fig.3 *Gastrochaenolites orbicularis* from Cape Koetoi.
Latex cast of the same specimen.

main chamber orbicular; neck region elongate in type specimen, but may be short.

Remarks: The orbicular main chamber and circular cross-section to the neck distinguish this species from similar taxa. Borings of this type are produced by the genus *Jouannetia*. Borings may show evidence of an inconspicuous thin lining.

Gastrochaenolites lapidicus is "acutely conical" with its widest diameter situated close to its base（Kelly and Bromley 1984; Donovan 2013）. *G. turbinatus* is "acutely conical", with the widest diameter situated close to its base（Kelly and Bromley 1984）. *G. ornatus* can be distinguished from *G. orbicularis* by having a less globular main chamber, and a base with a circular sculpted bioglyph（Kelly and Bromley 1984; Donovan 2011）. Based on the above characteristics, the *Gastrochaenolites* borings of the Koetoi samples are identified as considered to belong to *G. orbicularis.*

Discussion

Specimens at the study site were generally in good condition, and a variety of club-shaped borings were recognized as belonging to the ichnogenus *Gastrochaenolites.* Among the collected samples, clasts of large *Gastrochaenolites* borings were frequently observed, and several were associated with rock-boring clams. The smaller borings are similar to *Gastrochaenolites orbicularis*, bearing an orbicular chamber（Kelly and Bromley 1984）. The small clavate borings described here were identified as attributed to *G. orbicularis* according to the taxonomy of Kelly and Bromley（1984）. Pleistocene examples of *G. orbicularis* are also described from southwestern Hokkaido, Japan（Suzuki and Enya 2020）.

In addition, the bivalves that produced these borings were preserved（Fig. 2）. The shells in these specimens were identified as belonging to the boring pholadid（Fig. 4）, *Nettastomella japonica*（Yokoyama）,（Okutani 2000）, which is characterized by having a thin shell that is well inflated and globular. The shells have an anterior area ornamented by radial and concentric riblets, and posterior area ornamented only by concentric sculpturing. The right posterior end of each shell project beyond left valve. Fossil examples of *N. japonica* are also reported from the Japan Sea borderland, northeast Japan（Shinada and Amano 1995）.

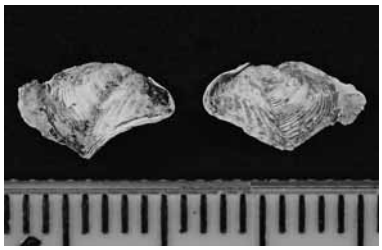

Fig.4 *Nettastomella japonica* from Cape Koetoi.

Acknowledgments

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要約：2020年 6 月，北海道稚内市声問岬において，ヨコヤマスズガイ *Nettastomella japonica*（ニオガイ科）を含む泥岩の礫を採集した．これらの礫は，海岸を構成する新第三系中新統声問層に由来するものである．礫中のヨコヤマスズガイの貝殻を取り除き、巣穴の形態を検討した．その結果，巣穴は岩石穿孔性生痕 *Gastrochaenolites orbicularis* に同定された．

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