

Akihiko SUZUKI¹ and Takafumi ENYA² : Clavate *Gastrochaenolites* produced by the rock-boring clam *Penitella kamakurensis* from Aonae Beach on Okushiri Island, Hokkaido
鈴木明彦¹・圓谷昂史² : 北海道奥尻島青苗海岸の打ち上げ礫に見られるカモメガイとその穿孔痕

Introduction

Gastrochaenolites ichnogenus are club-shaped borings in rocky substrates that can mainly be attributed to boring bivalves (Kelly and Bromley 1984). The ichnogenus, which occurs in Cambrian to Holocene marine strata (Taylor and Wilson 2003), has primarily been observed in rocky substrates, which likely represent shallow marine facies (Bromley 1994, 2004).

In June 2017, some rock-boring bivalves and beach cobbles bearing the ichnogenus *Gastrochaenolites* were collected on Aonae Beach, Okushiri Island, Hokkaido. Here, we briefly describe the characteristics, distribution and taxonomic significance of *Gastrochaenolites* and associated rock-boring bivalves.

Materials and methods

Okushiri Island lies on the western side of Oshima Peninsula in southwestern Hokkaido, which is dominated by Cretaceous plutonic rocks and overlaid by Cenozoic sedimentary rocks (Hata et al. 1982). The paleogene system of rocks is a product of active volcanism and terrestrial sedimentation, while the Neogene is a product of active volcanism and marine sedimentation.

The study site, Aonae Beach, is located on the southern coastline of Okushiri Island, Hokkaido (Fig. 1). The geology at the site consists mainly of mudstone and siliceous shale of the Senjo Formation, which has been assigned to the Middle Miocene based upon diatom biostratigraphy (Hata et al. 1982). The beach is dominated by mudstone cobbles and boulders (Fig. 2), with small amounts of some siliceous shale. Bored cobbles and boulders are also abundant in the stranded line on the shore. Clavate borings bored by bivalves are rich in number, but some cylindrical and tube-like ones are recognized.

Samples were examined by a hand lens and stereomicroscope, and images were captured using a digital camera (Olympus Tough Tg-5, Olympus Corp., Japan). Cobbles bearing recent traces were identified based on comparisons with the ichnological literature (Bromley 1994, 2004; Donovan 2011, 2013), and the descriptive terminology of borings follows Kelly and Bromley (1984).

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 sub-spherical 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)

Remarks: *Gastrochaenolites* borings are excavated principally by endolithic bivalves, but also by Recent

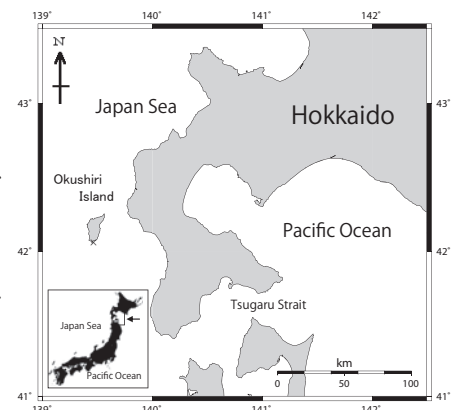


Fig.1 Map showing location of Aonae Beach in Okushiri Island, Hokkaido. X: Sample location.



Fig.2 Mudstone boulder bearing rock-boring clams washed up on Aonae Beach.

coralliophilid gastropods (Bromley 2004).

Gastrochaenolites cf. anauchen Wilson and Palmer, 1998 (Fig. 3)

Material: Recent borings in three mudstone cobble samples damaged during sampling. One is almost complete and has been cast in latex.

Locality and horizon: Aonae Beach, Okushiri Island. Mudstone cobbles of the Senjo Formation (Middle Miocene).

Description: Borings with smooth sides and circular cross sections throughout their length. Boring expands gradually beyond the aperture, with greatest diameter at approximately three-fourths of the depth. Bases of boring are rounded. Neck region is often obscure due to abrasion. Base of chamber smoothly curved, not sculptured.

Remarks: *Gastrochaenolites anauchen* is similar to *G. lapidicus*, except that it lacks a well-defined “neck region” (Wilson and Palmer 1998). *Gastrochaenolites turbinatus* is “acutely conical” with its widest diameter situated close to its base (Kelly and Bromley 1984). *Gastrochaenolites ornatus* can be distinguished from *G. anauchen* by having a less globular main chamber, and a base with a circular sculpted bioglyph (Wilson and Palmer 1998). Based on the above description, these materials are similar to *G. anauchen*. The *Gastrochaenolites* borings collected from Aonae Beach are identified as belonging to *G. cf. anauchen* because of incomplete preservation of the neck region of the borings.

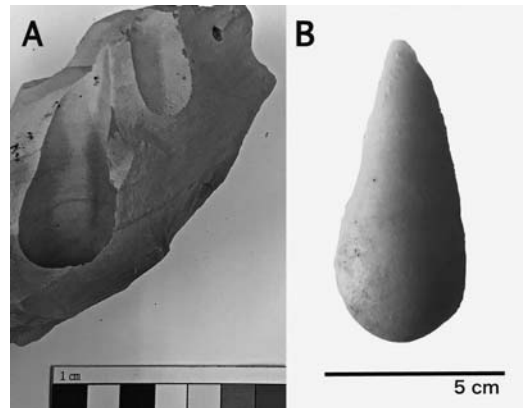


Fig.3 *Gastrochaenolites cf. anauchen* Wilson and Palmer, from Aonae Beach.

A. Boring in mudstone; the specimen was broken to retrieve the bivalve shell.
B. Latex cast of the same specimen.

Discussion

Preservation of specimens at the study site was generally good, 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 collected, and few were associated with rock-boring clams. The clavate borings described here were identified as *Gastrochaenolites cf. anauchen* according to the taxonomy of Wilson and Palmer (1998).

In addition, the bivalves that produced these borings were preserved (Fig. 4). The shells in these specimens were identified as belonging to the boring pholadid, *Penitella kamakurensis* (Yokoyama) (Okutani 2000), which is characterized by having a thin shell that is well inflated and gaping at both ends, and an anterior margin reflected over the umbo. *Penitella kamakurensis* has a variety of shell forms due to the hardness of the host rocks (Ito 1994).



Fig.4 *Penitella kamakurensis* (Yokoyama) from Aonae Beach.

The borings of Recent *Penitella* are similar to *Gastrochaenolites turbinatus*, bearing a clear neck region (Kelly and Bromley 1984), suggesting that the borings of *P. kamakurensis* are similar to those of *G. anauchen* in that they lack a neck region. Thus, Recent *Penitella* species likely produce a variety of clavate borings and belong to some are related to some of the *Gastrochaenolites* species. The diversity of clavate borings in *Penitella* is probably attributed to shell form and the hardness of host rocks (Ito 1994).

The borings of Aonae samples are probably assigned to slender forms because of the pointed shell (P-type: Ito 1994) of *P. kamakurensis* rich in softer rocks such as mudstone.

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要約：2017年6月，北海道奥尻町青苗海岸において，カモメガイ *Penitella kamakurensis*（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千豊層に由来するものである。礫に含まれていたカモメガイの貝殻を取り除き，それらの巣穴を検討した結果，岩石穿孔性生痕 *Gastrochaenolites* cf. *anauchen* Wilson and Palmer に同定された。

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