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A new species of *Neoberingius* (Gastropoda: Buccinidae) from the Lower Miocene Morozaki Group in Aichi Prefecture, central Japan

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Abstract

Neoberingius minamichitaensis sp. nov. is described from the upper Lower Miocene Yamami Formation (Morozaki Group) in Utsumisanbi, Minamichita-cho, Chita-gun, Aichi Prefecture and Utsumi Formation (Morozaki Group) in Akanotani, Noma, Mihama-cho, Chita-gun, Aichi Prefecture. This species can be inferred to have lived on the muddy bottom of the bathyal zone. *Neoberingius* and its related genus *Beringius* fossils are rare, and this is the first report of their discovery in Aichi Prefecture, central Japan which is thought to represent the southern limit of *Neoberingius* fossils. It has been revealed that during the Early Miocene, the distribution of *Neoberingius* expanded from around Kamchatka to the deep waters of present-day Aichi Prefecture, Japan. The discovery of this species is regarded as crucial for understanding the migration, distribution, and evolution of this genus.

Key words: Miocene, Mollusca, *Neoberingius*, Buccinidae, systematic, Morozaki Group

1. Introduction

The Lower Miocene Morozaki Group is mainly distributed in the southern part of the Chita Peninsula, Aichi Prefecture (Fig. 1). The group is notable for the discovery of various deep-sea fossils (Hachiya, 1993; Excavation team of the deep-sea fossils from the Morozaki Group, 2022). For example, crinoids (Oji, 1990), sea urchins (Amemiya et al., 1994), starfish (Kato and Oji, 2013), crustaceans (Karasawa et al., 2017), and fish (Nishimoto and Ujihara, 1979; Ohe and Kawase, 1995; Ohe, 2016) have been described. Katada et al. (2024) also investigated the changes in chemical composition during fossilization of lanternfish from the upper Lower Miocene Yamami Formation, Chita Peninsula, Japan, compared to modern/living lanternfish. Among these, molluscan fossils have been relatively well studied. Shikama and Kase (1976) identified 33 species and Shibata (1977) identified 69 species from the group. Yamaoka (1993b) summarized these studies and described 51 molluscan fossil species.

Recently, two relatively well-preserved large buccinid gastropods were found in old private collections; one is in Kenji Yui's collection, another is in Yoshiaki Mizuno's collection, from the Morozaki Group. As the result of examination, it has been determined that these specimens are an undescribed species of the genus *Neoberingius* of the subfamily Beringiinae Golikov and Strabogatov, 1975.

The subfamily Beringiinae Golikov and Strabogatov, 1975 consists of *Beringius* Dall, 1887 and *Neoberingius*

Habe and Ito, 1965 (Kantor and Sysoev, 2006). In Japan, no fossil has been identified under the genus *Neoberingius*. On the other hand, the following species of *Beringius* have been described: *Beringius hobetsuensis* (Matsui, 1950) from the Oligocene Momijiyama Formation in Hokkaido (Matsui, 1950) and the upper Eocene to lower Oligocene Tanami Formation in Wakayama Prefecture (Katto and Masuda, 1978); *B. mitsuchii* Kanehara, 1937 from the Lower Miocene Mizunoya Formation in Fukushima Prefecture; *B.*? *hanzoganensis* Yokoyama, 1928 from the Pliocene Ushigakubi Formation in Niigata Prefecture; *B. magarikawaensis* Nomura and Zinbo, 1937 from the Pliocene Hanezawa Formation in Yamagata Prefecture; *B. behringii indentatus* Dall, 1919 from the Lower Pleistocene Daishaka Formation in Aomori Prefecture (Iwai, 1965). In addition, *Beringius pressulus* Titova, 1986, and *B. titovae* Sinelnikova, 2005 were recorded respectively from the Eocene and Oligocene of Kamchatka (Gladenkov et al., 2005).

The genus *Neoberingius* includes the following extant species: *Neoberingius frielei* (Dall, 1895) and *N. frielei miyauchii* (Habe and Ito, 1972) (Kantor and Sysoev, 2006). They reside from Northeast Honshu and northwards, through Hokkaido, the Kuril Islands, the Bering Sea, and the Aleutian Islands at depths of 50 to 317 m (Higo et al., 1999; Kantor and Sysoev, 2006).

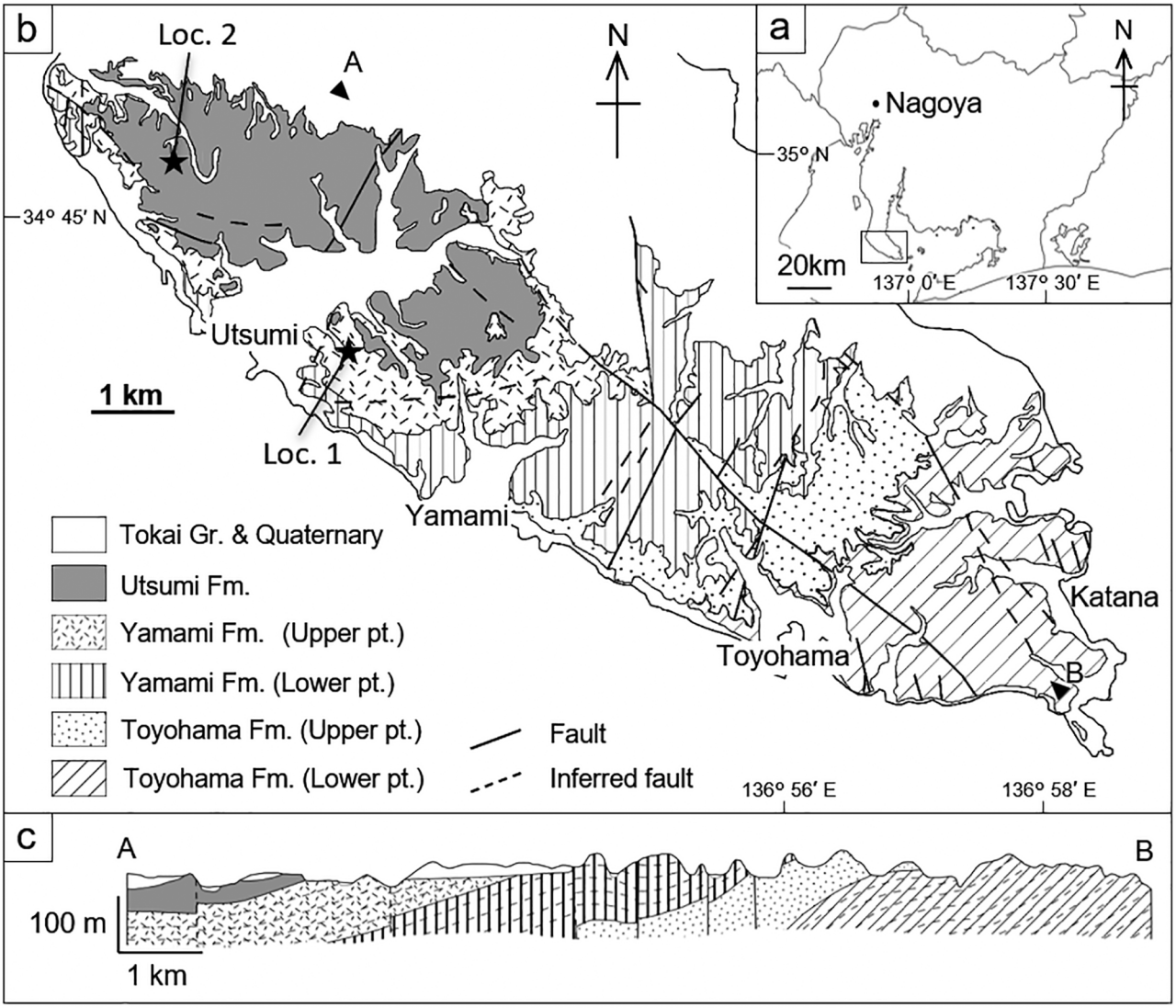

Fig. 1. a, Index map of Aichi Prefecture, central Japan. Black rectangle shows the inset area in fig. 1b. **b,** Geological map of the Morozaki district. Loc. 1 and Loc. 2 indicate the collection sites of holotype and paratype, respectively. **c**, Geological cross section between triangles A and B in fig. 1b. Geological map and cross section in figs. 1b and 1c are modified from Kondo and Kimura (1987).

2. Geological setting and locality

The Morozaki Group is subdivided into four formations: Himaka (thickness of over 200 m), Toyohama (thickness of about 400 m), Yamami (thickness of about 220 m) and Utsumi Formation (approximately 100 m thick) in ascending order (Fig. 1). Those conformably overlap each other (Shibata, 1977; Yamaoka, 1993a). Two specimens herein described were obtained from the upper part of the Yamami Formation (Fig. 1b; Loc.1) and the lower part of the Utsumi Formation (Fig. 1b; Loc. 2). The upper part of the Yamami Formation consists of alternating layers of mudstone and tuff, while the lower part of the Utsumi Formation is comprised of alternating layers of sandstone and mudstone (silt and shale) (Kondo and Kimura, 1987). Both fossil specimens were recovered from mudstone of the two localities. The age of the middle part of the Toyohama Formation and the uppermost part of the Utsumi Formation is assigned to the middle to upper part of the diatom zone *Crucidenticula sawamurae* (about 18–17 Ma) (Ito et al., 1999).

Recently, a mudstone bed in the Yamami Formation, just below the turbidite bed with fish fossils, was dated to 17.4 Ma based on paleomagnetic data (Hoshi and Matsunaga, 2024).

In addition, according to Shibata (1977), the molluscan fossil assemblage from the upper part of the Yamami Formation and the Utsumi Formation corresponds to the *Neilonella-Periploma* assemblage.

3. Systematic description

Family Buccinidae Rafinesque, 1815
Subfamily Beringiinae Golikov and Strabogatov, 1975

Genus *Neoberingius* Habe and Ito, 1965

Type species: *Beringius frielei* Dall, 1895, by original designation.

***Neoberingius minamichitaensis* sp. nov.**

(Figs. 2, 3)

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[New Japanese Name: Minamichita-Naga-Bai]

Aulacofusus sp., Yamaoka, 1993b, p. 74, pl. 5, fig. 17.

Diagnosis: Shell large, attaining 158.0 mm, and ratio of spire to shell height large, 60 percent. Number of spiral cords 16 in body whorl and 8 in penultimate whorl.

Description: Shell large, attaining 158.0 mm, elongated fusiform, rather thin. Spire elevated and acuminated with nine convex whorls. Spire occupying 60% of shell height. Protoconch two whorls, large (five mm in diameter) and paucispiral. Whorls rounded, moderately inflated with shallow suture, and with eight rather slender and distinct spiral cords. Sixteen spiral cords on body whorl. Interspaces of cords about twice as wide as spiral cords. In basal part of body whorl, width of spiral cords becoming narrower than interspaces. Morphology of aperture unknown, but siphonal canal short.

Measurements: Height of shell, 158.0 mm; Diameter, 64.0 mm; Height of spire 95.0 mm (holotype).

Material examined: NUM-Fa734 (holotype; Fig. 2) and NUM-Fa735 (paratype; Fig. 3). Both specimens are housed in the Nagoya University Museum (NUM). The holotype was collected by Mr. Kenji Yui, and the paratype was collected by Mr. Yoshiaki Mizuno.

Comparisons and affinities: The new species is similar to *Neoberingius frielei miyauchii* (Habe and Ito, 1972), which lives on muddy bottoms at depths of 50 to 200 m in northeast Honshu, Hokkaido, and the Bering Sea. The new species can be distinguished from *N. frielei miyauchii* by its larger size, larger ratio of spire to shell height, and thinner spiral cords. The new species also resembles the fossil species, *Beringius hobetsuensis* (Matsui, 1950). However, the new species can be distinguished from *B. hobetsuensis* by its taller spire and less inflated body whorl. The new species can also be discriminated from the fossil species, *Beringius mitsuchii* Kanehara, 1937 by having shallower sutures. *Neoberingius minamichitaensis* new species can be separated from *Beringius pressulus* Titova, 1986, reported from the Eocene of Kamchatka, by its thinner spiral cord and shorter siphonal canal.

Associated fauna: *Ennucula* cfr. *osawanoensis* (Tsuda), *Carinineilo takeharai* (Shibata), *Neilonella*

isensis Shibata, *Neilo* (*Multidentata*) *multidentata* (Khomenko), *Propeamussium tateiwai* Kanehara, *Palliolum* (*Delectopecten*) *peckhami* (Gabb), *Periploma mitsuganoense* Araki, *Tectonatica ichishiana* Shibata, "*Chlanidota*" *mitsuganoensis* Shibata and "*Megasurcula*" cfr. *osawanoensis* (Tsuda).

Etymology: The name is derived from the type locality, Minamichita-cho.

Type Locality and Horizon: Utsumisanbi, Minamichita-cho, Chita-Gun, Aichi Prefecture, central Japan. The upper Lower Miocene Yamami Formation of the Morozaki Group (Fig. 1b; Loc. 1).

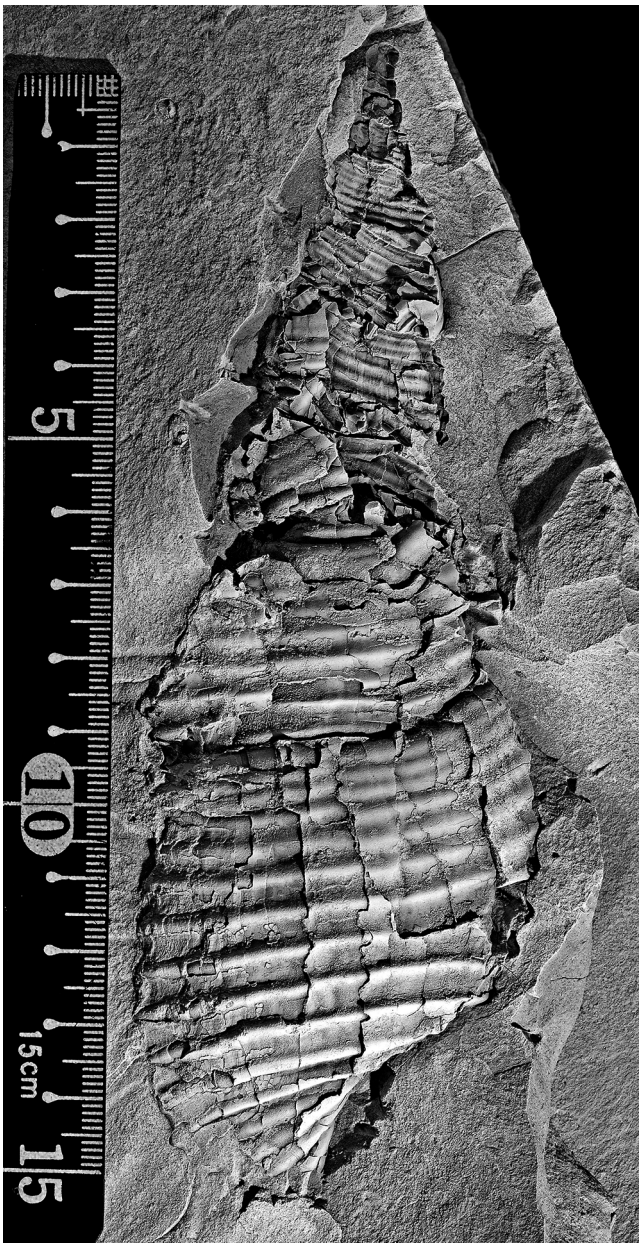

Fig. 2. *Neoberingius minamichitaensis* sp. nov. Holotype, NUM-Fa734, dorsal view.

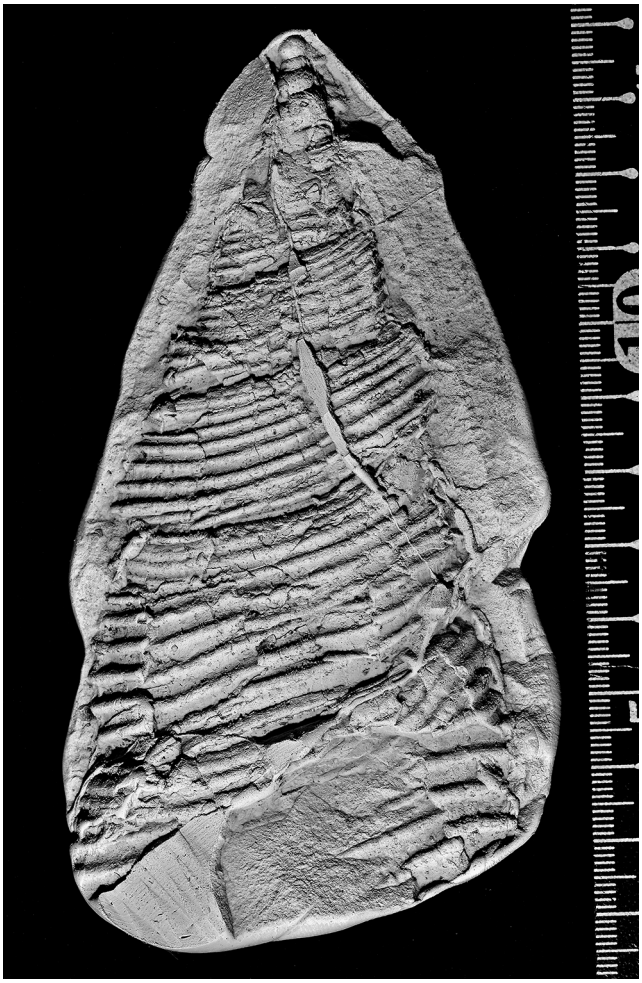

Fig. 3. *Neoberingius minamichitaensis* sp. nov. Paratype, NUM-Fa735, spire lacking body whorl.

4. Discussion

This new fossil species can be inferred to have lived on the muddy bottom of the bathyal zone, based on the associated fauna, the habitat depth of extant counterpart of the genus, and the lithology of the strata. For example, *Neilonella isensis* Shibata, *Propeamussium tateiwai* Kanehara, *Periploma mitsuganoense* Araki, *Tectonatica ichishiana* Shibata, and "*Chlanidota*" *mitsuganoensis* Shibata, are the main components of the *Neilonella-Periploma* assemblage in the Ichishi Group distributed in Mie Prefecture, and the habitat of this assemblage is estimated to be a muddy bottom in the bathyal zone (Shibata, 1970). In addition, *Neilo* (*Multidentata*) *multidentata* (Khomenko) was a cold-water element (undercurrent water of the Oyashio system) (Amano et al., 2000).

Neoberingius and *Beringius* fossils are rare, and this is the first report of *Neoberingius* in Japan. It has been revealed that during the Early Miocene, *Neoberingius* expanded its distribution from around Kamchatka to the deep waters of present-day Aichi Prefecture, Japan.

Furthermore, the origin of the genus *Neoberingius* is thought to be Middle Miocene (Titova, 1994), but this discovery has revealed that its origin dates back to the Early Miocene. The discovery of this species is regarded as crucial for understanding the migration, distribution, and evolution of this subfamily.

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