

A fossil of *Angaria delphinus* (Linnaeus, 1758) (Mollusca: Gastropoda) from Late Neogene of central Japan, and its paleontological significance

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Abstract

An angariid fossil was obtained from the lowermost Pliocene Osozawa Member of the Akebono Formation, Shizukawa Group, at Osozawa, Nakatomi-cho, Minamikoma-gun, Yamanashi Prefecture. This is accompanied with the warm-water molluscs of the latest Miocene to the earliest Pliocene Zushi Fauna. As the result of this study, it is confirmed that this is identical to *Angaria delphinus* (Linnaeus). From the occurrences of this species, it can be stated that the sea region south of the Kanto region, central Japan, was under a tropical marine climate during the earliest Pliocene. This report is the oldest fossil record of *Angaria* from Japan.

Key words: *Angaria delphinus*, lowermost Pliocene, Akebono Formation, tropical marine climate.

Introduction

In June of 1999, an angariid fossil was found by Mr. Takashi Ishibashi, from the late Neogene formation at Osozawa, Nakatomi-cho, Minamikoma-gun, Yamanashi Prefecture (Fig. 1). A fossil *Angaria* is so rare that there are few reports of its occurrence from the Tertiary in Japan. This occurrence suggests the existence of the tropical or subtropical marine climates in the South Fossa Magna region as shown by the faunal analysis of the molluscan assemblages (Tomida, 1996). The purpose of this paper is to describe the fossils of *Angaria delphinus* (Linnaeus, 1758) and to discuss its paleontological significance.

Systematics

Family TROCHIDAE

Genus *Angaria* Röding, 1798

Angaria delphinus (Linnaeus, 1758)

(Fig. 2)

Selective synonymy:

The living synonymy - *Turbo delphinus* Linnaeus, 1758, 764; *Turbo distortus* Linnaeus, 1758, 764; *Delphinula laciniata* Lamarck, 1822, 229; *Delphinula aculeata* Reeve, 1842, 103; *Delphinula incisa* Reeve, 1842, 103; *Delphinula atrata* Reeve, 1843, pls. 1, 2, 3; *Delphinula coronata* A. Adams, 1850, 51; *Delphinula euracantha* A. Adams, 1850, 51; *Delphinula martini* A. Adams, 1854, 42, pl. 27, fig. 8.

The fossil synonymy - *Angaria delphinus* sensu MacNail, 1960, 29, pl. 16, figs. 6, 11-12; Noda, 1988, 33, pl. 15, figs. 3a, b; *Angaria distorta* sensu Okumura & Takei, 1993, 139, pl. 31, figs. 14a, b.

Material: A mature specimen (MFM112201) is obtained from Osozawa, Nakatomi-cho, Minamikoma-gun, Yamanashi Prefecture (138° 25' 5" E, 35°26' 44" N).

Description of specimen: Shell rather large, thick, solid, depressed and elongate globose. Spire low, slightly elevated, coiling about four in number and almost flat near apex. Body whorl large and ornamented with many spinous spiral cords, and many largely imbricate axial threads. Suture widely deep with a flat sutural ramp

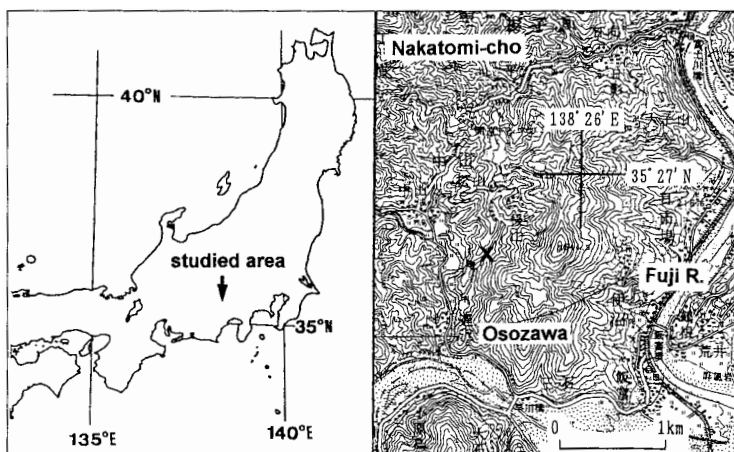


Fig. 1. Index map showing the fossil locality.

(Reproduced from 1/50,000 quadrangle of "Minobu" by Geographical Survey Institute of Japan). × = fossil locality.

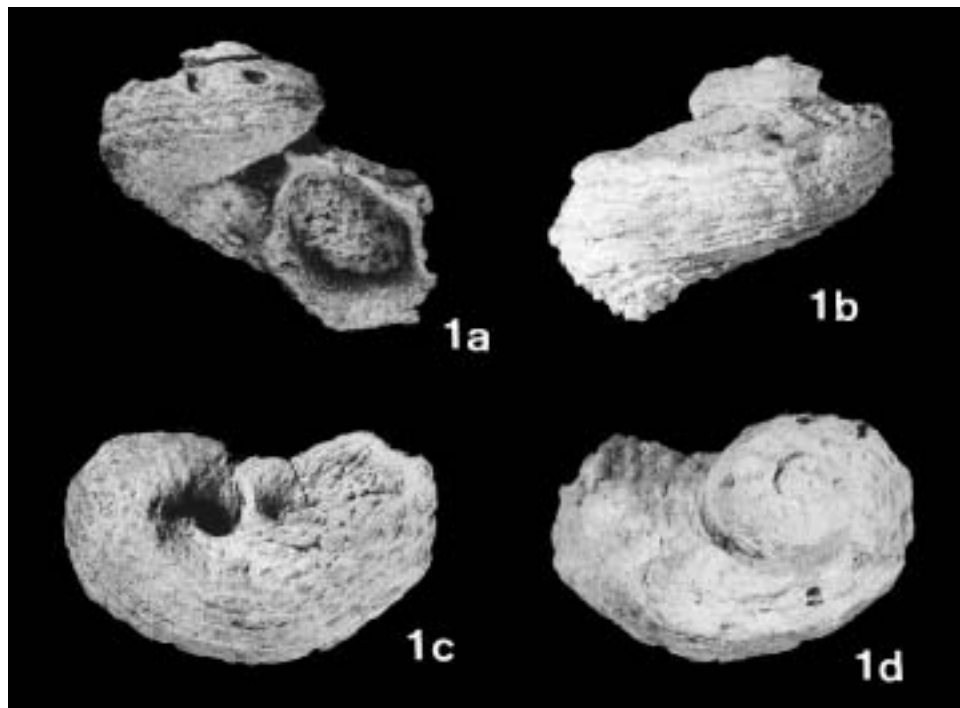


Fig. 2. *Angaria delphinus* (Linnaeus, 1758), 1a. apertural view; 1b. dorsal view; 1c. basal view; 1d. apical view, X1 (MFM112201). (All figures in natural size, and with whitening).

ornamented with eight rows of granulated spiral striae and many undulate axial nodes on the teleoconch whorls but many largely imbricate axial threads on the last whorl. Shoulder angular and carinate with a row of short spines. Basal margin ornamented with many rows of minor spines. Last whorl descended to an aperture. Aperture circular: margin angular. Umbilicus widely and deeply opened.

Measurements: Maximum diameter 44.5mm; height 38.7mm; aperture height 26.7mm (MFM112201).

Horizon: Osozawa pebbly sandstone Member of the Akebono Formation, Shizukawa Group (See Tomida, 1996, p. 93; Tomida et al., 2004, p. 87).

Descriptive remarks: This specimen is assignable to *Angaria delphinus* (Linnaeus, 1758) in having a large, thick, solid, depressed and elongated globose shell with a low and almost flat spire, a large body whorl ornamented with many spinous spiral cords and many axial undulations, a widely deep suture, a flat sutural ramp, an angulated shoulder with a row of short spines, an almost circular aperture, and a widely deep umbilicus.

Distribution: This living species ranges rarely from south of Boso Peninsula to Kyushu, in 10-20 meters of depth, and commonly in Ryukyu Islands, in 3-10 meters of depth in Japan. Poppe and Goto (1993) mentioned that it ranges from south of the Ryukyu Islands to the northern coast of Australia; westwards to the Andaman Sea-coast of Thailand; eastwards to Bougainville and further south again to New Caledonia and the Fiji Islands; the Philippines, where *Angaria delphinus* is very common, can be considered as the center of its distribution (Fig. 3).

Fossils of *Angaria delphinus* were described by MacNail (1960) from the upper Pliocene Yontan and Naha Limestones, and by Noda (1988) from the upper Pliocene Shinzato Formation in Okinawa Prefecture. A fossil of *Angaria distorta* was described by Okumura & Takei (1993) from the upper Pliocene Ananai Formation, Tonohama Group, at Tonohama, Yasuda-cho, Aki-gun, Kochi Prefecture. This species is synonymy of *Angaria delphinus*. Therefore the present report is the oldest fossil record from Japan.

Discussion

The present angariid fossil was found from the lowermost Pliocene Osozawa Member of the Akebono Formation. The earliest Pliocene corresponds to the period of remarkable marine climatic warming which indicates the major raise in global sea level shown at ca. 5 Ma (Blow Zone N18) presented by Malmgren & Berggren (1987). The Osozawa pebbly sandstone Member yields the warm-water molluscs belonging to the Zushi Fauna (Ozawa & Tomida, 1992), such as *Ethalia maxima* (Shuto), *Chlorostoma narusei* Shibata, *Astraea omorii* Shibata, *Turbo (Lunatica) robustus* Tomida & Ozawa, *Turbo (Batillus) priscus* Ozawa & Tomida, *Bolma virgata* (Ozaki), *Hartungia typica* Bronn, *Glycymeris osozawaensis* Kanno, *Pinctada fucata* (Gould), *Amussiopecten iitomiensis* (Otuka), *Chlamys miurensis* (Yokoyama), *Megacardita panda* (Yokoyama) and *Meiocardia samarangiae* Bernard et al. This molluscan association contains many tropical species like *Angaria delphinus* (Linnaeus). That is to say, *Angaria delphinus* (Linnaeus) is now living in the tropical regions in the Indo-Western Pacific Ocean, from south of Boso Peninsula, but mainly

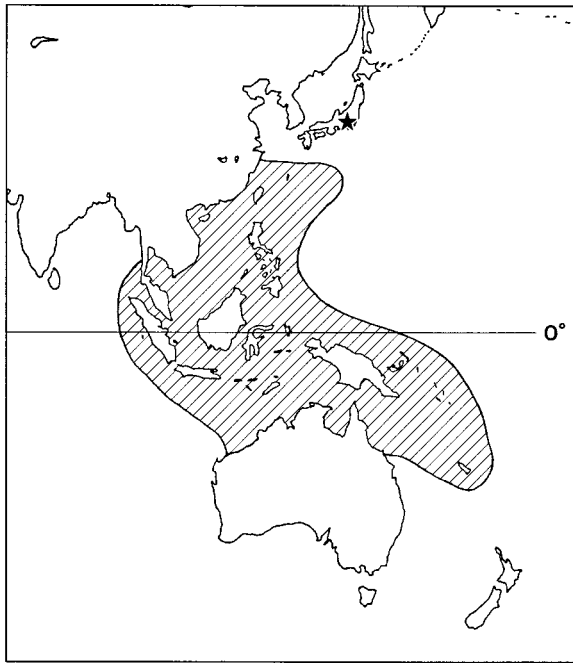


Fig. 3. Geographical distribution of *Angaria delphinus*.
 = locality (Osozawa) of present species.
 ▨ living *Angaria delphinus*

from south of Ryukyu Islands, Philippines, Indonesia, Fiji, to northern Australia. The fossil occurrence of this species suggests that the south of the Kanto region, central Japan (35.5° N), was under a tropical marine climate during the earliest Pliocene, as also mentioned by Ozawa & Tomida (1992) and Tomida (1996).

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References

- Adams, A. (1850), On the animal of *Liotia*; with descriptions of new species of *Delphinula* and *Liotia*, from the Cumingian Collection. *Proc. Zool. Soc. London*, pt. 18, 1850, 50–52.
- Adams, A. (1854), Descriptions of a new genus and of several new species of gasteropodous MOLLUSCA, from the Cumingian Collection. *Proc. Zool. Soc. London*, 42, pl. 27.
- Lamarck, J. B. P. A. de M. de (1822), 5 Histoire naturelle des animaux sans vertèbres, 6 (2), 229–232.
- Linnaeus, C. (1758), *Systema naturae*, ed. 10, tom. 1, 823 pp., Holmiae.
- MacNail, F. S. (1960), Tertiary and Quaternary gastropoda of Okinawa. *Geol. Sur., Prof. Pap.*, no. 339, 1–148, pls. 1–19.
- Malmgren, B. A. and Berggren, W. A. (1987), Evolutionary changes in some late Neogene planktonic foraminiferal lineage and their relationship to paleoceanographic changes. *Paleoceanography*, 2, 445–456.
- Noda, H. (1988), Molluscan fossils from the Ryukyu Islands, southwest Japan Part 2. Gastropoda and Pelecypoda from the Shinzato Formation in the middle part of Okinawa-jima. *Sci. Rep., Inst. Geosci., Tsukuba*, 9, 29–85, pls. 5–19.
- Okumura, K. and Takei, T. (1993), Molluscan assemblage from the Late Pliocene Ananai Formation, Kochi Prefecture, southwest Japan. *Bull. Mizunami Fossil Mus.*, 20, 133–183, pls. 27–40.
- Ozawa, T. and Tomida, S. (1992), The Zushi Fauna - Late Miocene - early Pliocene warm marine water molluscan fauna of Japan -. (in Japanese with English abstract) *Bull. Mizunami Fossil Mus.*, 19, 427–439, pl. 59.
- Poppe, G. T. and Goto, Y. (1993), *Recent Angariidae*. 32 pp., Mostra mondiale malacologia, L'Informatore Piceno Ed., Ancona.
- Reeve, L. A. (1842), Descriptions of new species of *Delphinula*, a genus of pectinibranchiate Mollusks (Family TURBINACEA). *Proc. Zool. Soc. London*, 102–104.
- Reeve, L. A. (1843), *Conchologia Iconica*. Monograph of the genus *Delphinula*. *Conchologia Iconica*, 5, 5 pls.
- Röding, P. F. (1798), *Museum Boltenianum... Pars secunda continens Conchylia etc.* 199 pp., Hamburg.
- Tomida, S. (1996), Late Neogene tropical and subtropical molluscan faunas from the South Fossa-magna region, central Japan. *Bull. Mizunami Fossil Mus.*, no. 23, 89–140, pls. 24–34.
- Tomida, S., Mizuno, Y. and Okumura, Y. (2004), Additional materials of *Turbo (Batillus) priscus* Ozawa and Tomida, 1996, from the Late Neogene of central Japan. *Bull. Mizunami Fossil Mus.*, 31, 87–89, fig. 2.

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