

## New discovery of nautilids from the Eocene Miyara Formation, Ishigaki Island

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### Abstract

Ishigaki Island (Okinawa, Japan) is known to expose the Eocene Miyara Formation. Although a few marine invertebrate fossils have been reported from the Miyara Formation of the island, records of nautilids are extremely rare. Here, we report a new discovery of two specimens interpreted as nautilids from this formation. Due to poor preservation, the specimens were identified only to the superfamily level, as Nautilaceae gen. et sp. indet. To our knowledge, this represents the second confirmed report of nautilids from the island.

### Introduction

Ishigaki Island (Yaeyama Islands, southwestern Ryukyu Islands, Japan) lies along the Ryukyu subduction zone, where the Philippine Sea Plate subducts beneath the Eurasian Plate and the forearc is associated with an accretionary prism. On Ishigaki Island, the Tomuru Formation (arguably Permian) and Fusaki Formation (Jurassic) are exposed, which are overlain unconformably by the middle-upper (Lutetian to Bartonian) Eocene Miyara Formation. The Miyara Formation consists mainly of conglomerate, sandstone, siltstone/shale, and limestone, and it is conformably overlain by volcanoclastic rocks and lavas of the Nosoko Formation (Foster et al., 1960; Shirao et al., 1976; Kaneko et al., 2003). These Eocene units are in turn unconformably overlain by Pleistocene reef-derived limestones of the Ryukyu Group (Ohama Formation; Kaneko et al., 2003).

The Miyara Formation is regarded as shallow-marine deposits that lithologically divided into calcareous and non-calcareous deposits. The calcareous deposits are characterized by gray or black limestone yielding calcareous algae and larger benthic foraminifera (Yabe, 1920; Hanzawa, 1935; Johnson, 1964; Ujiie & Miyagi, 1973). Although marine invertebrate fossils are generally scarce in the Ryukyu Islands with the exception of corals, the non-calcareous deposits of the Miyara Formation yielded mollusks and echinoderms (MacNeil, 1964; Noda et al., 2001; Kaneko et al., 2003).

In the Okinawa Prefectural Museum and Art Museum, several fossils from the Miyara Formation are housed. From historical collections of the museum from Ibaruma, Ishigaki Island, SN recovered a specimen that had been catalogued as sandstone (OPM-R-00714-1), but is here reinterpreted as

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a nautilid fossil. In addition, a new specimen (OPM-FI-00526) was collected from the Eocene Miyara Formation at Hirakubo, Ishigaki Island (fig. 1). Here we describe and illustrate these two specimens. For consistency throughout this paper, the specimen previously referred to as OPM-R-00714-1 is herein renumbered as OPM-FI-00527. All figured specimens in this paper are housed in the Okinawa Prefectural Museum and Art Museum with registered numbers (OPM-FI).

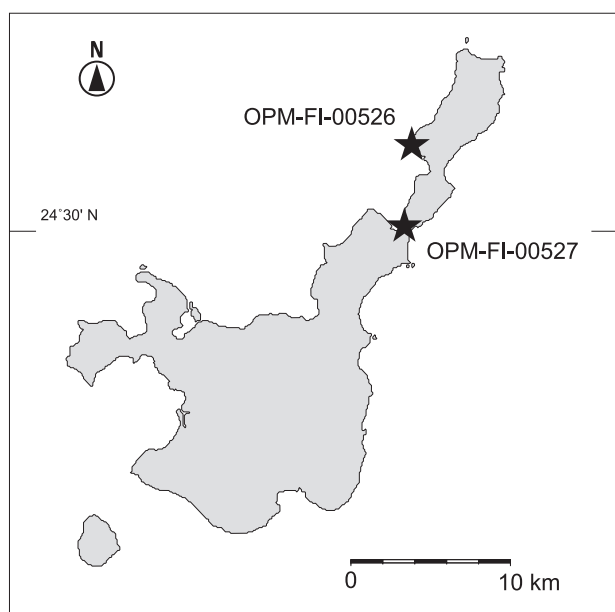


Figure 1. Map showing the fossil localities on Ishigaki Island.

### Material and Methods

We documented two nautilid specimens (OPM-FI-00526 and OPM-FI-00527) from the Miyara Formation of Ishigaki Island. Although conch characters are often not measurable due to poor preservation, we examined conch diameter and geometry (whorl width, whorl height, and ventral shape), as well as ribs and the suture line, recording their presence/absence where preserved. We follow the systematic framework of Teichert (1964) and use the conch-character terminology of Tajika et al. (2020).

### Results

The two nautilid specimens documented in this paper are illustrated in figures 1 and 2.

### Systematic Paleontology

Class Cephalopoda Cuvier, 1797

Order Nautilida Agassiz, 1847

Superfamily Nautilaceae de Blainville, 1825

Nautilaceae gen. et sp. indet

Locality: Hirakubo, Ishigaki Island (OPM-FI-00526), Ibaruma, Ishigaki Island (OPM-FI-00527).

Stratigraphy: Miyara Formation (Eocene).

Material: Crushed and compacted conch from a blue-gray claystone bed of the Miyara Formation (OPM-FI-00526). Internal mold from a reddish-brown sandstone bed of the Miyara Formation (OPM-FI-00527).

Description: OPM-FI-00526 is a crushed and flattened conch, with an approximate conch diameter of 250 mm. The umbilicus is very narrow to nearly closed. On the outermost whorl, a faint, slightly sinuous line is present and may represent a suture trace; no ribbing or other flank ornamentation is discernible. On the innermost whorl, a zig-zag line is preserved on the flank; this may represent the suture trace, but it could alternatively be a taphonomic artifact (e.g., fractures). Owing to compaction, the venter is not observable, and whorl width cannot be measured. A phosphatized structure resembling a siphuncle is preserved near the ventral margin of the outermost whorl, although its identity remains uncertain (Plate 1C).

OPM-FI-00527 is a distorted specimen, with a maximum measurable diameter of approximately 75 mm. The whorl section is very depressed, although exact conch parameters cannot be measured because of deformation. The venter is flat, 20–30 mm wide, and may represent a distorted keel. The umbilicus is

probably very narrow to nearly closed. The suture line is not observed.

Comparison: The nautiliconic (planispiral and involute) coiling is consistent with a nautilid affinity. In OPM-FI-00526, if the zig-zag line on the innermost whorl(s) represents a true suture trace (rather than a compaction-related artifact or fracture pattern), the specimen may be comparable to Mesozoic pseudonautilids such as *Pseudaganides* or *Pseudonautilus*, or Mesozoic–Cenozoic *Hercoglossa* which are characterized by strongly sinuous sutures. However, the lack of additional diagnostic characters (e.g., observable venter, measurable whorl section/width, and reliably identified siphuncle position) precludes more specific identification. OPM-FI-00527 resembles some Paleogene nautilids (e.g., *Eutrephoceras*, *Hercoglossa*, and *Cimomia*) in its involute coiling and depressed (inflated) whorl section, but deformation prevents reliable morphometric comparison. The coiling is also broadly similar to the Cretaceous genus *Cymatoceras* and Oligocene *Neocymatoceras*; however, cymatoceratids typically bear prominent radial ribbing, which is not observed in OPM-FI-00527. The conspicuous flat venter, possibly representing a distorted keel, may recall *Deltoidonautilus* and Cretaceous *Deltocymatoeras* if this feature is primary rather than taphonomic. Because the suture line is not preserved and other diagnostic characters are lacking, OPM-FI-00527 cannot be confidently assigned beyond a general nautilid affinity.

The fossil record of Paleogene nautilids in the western Pacific is scarce. To date, only a few nautilid specimens have been reported from Ishigaki Island. *Eutrephoceras japonicum* was listed by Kizaki (1985), although without illustration or description. The first confirmed record of nautilids were documented by Noda et al. (2001), who reported *Aturia yokoyamai* and

*E. japonicum* from a sandstone bed of the Miyara Formation. The locality from which those specimens were recovered lies approximately 10km south of the locality (Hirakubo), which yielded OPM-FI-00526. Although the taxonomic assignments of our specimens remain uncertain, this represents the second report of Cenozoic (Paleogene) nautilids from the island. Additionally, to our knowledge, no other nautilid fossils have been documented from the surrounding region.

#### Acknowledgments

We thank Mr. Fumio Higa in Ibaruma, for permitting SN and AT to conduct fieldwork.

#### 石垣島宮良層から産出したオウムガイ上科の新標本について

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#### 要旨

沖縄県の石垣島には始新統宮良層が分布することが知られており、何例かの海生無脊椎動物化石の報告があるが、オウムガイ類の記録は極めて稀である。本稿では、宮良層から産出したオウムガイ類と解釈される2標本の発見について報告する。保存状態が悪いため、今回検討した2標本は上科レベルまでの同定に留め、Nautilaceae gen. et sp. indet. とした。現在知られている限り、本報告は石垣島から産出するオウムガイ類の確実な記録としては2例目となる。

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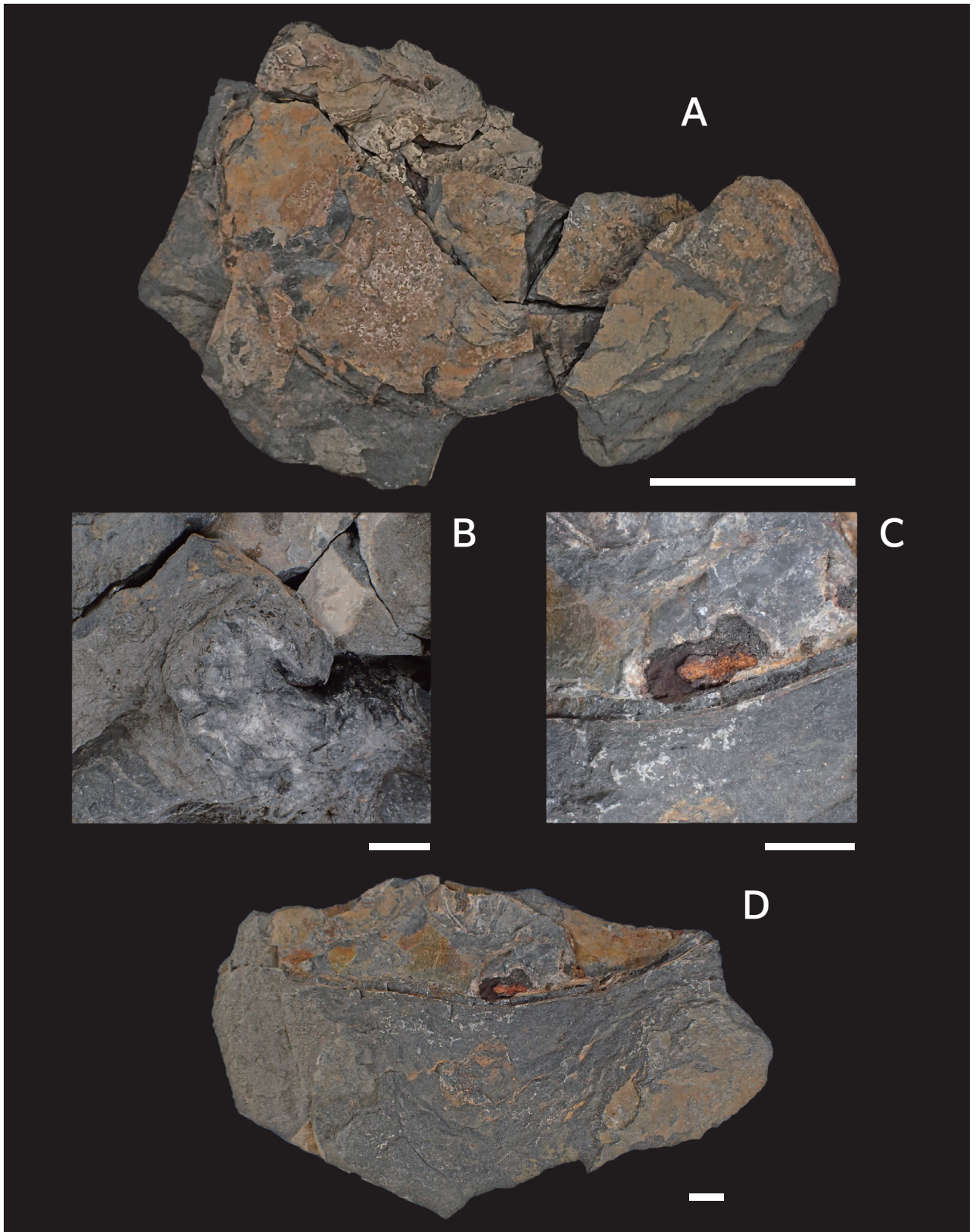


Plate 1. Nautilaceae gen. et sp. indet. (OPM-FI-00526) A. Outermost whorl, B. Innermost whorl, C. Phosphatized siphuncle-like structure (enlarged view of D), D. Another fragment of outermost whorl. Scale bars represent: 100 mm (A); 10 mm (B, C, D).

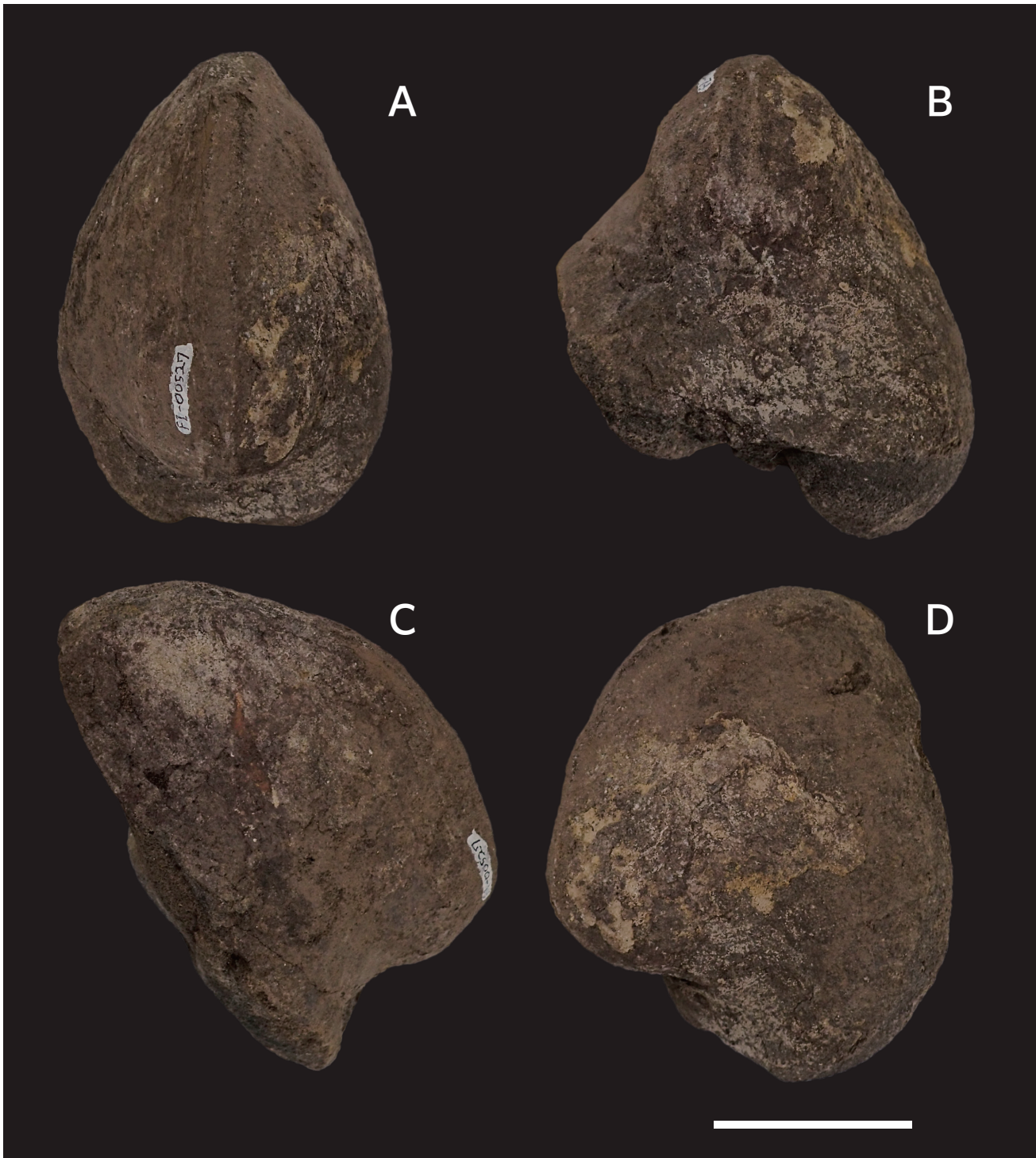


Plate 2. Nautilaceae gen. et sp. indet. (OPM-FI-00527) A. Ventral view, B. Probable apertural view, C. Right lateral view, D. Left lateral view. Scale bar represents 50 mm.