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First Record of a Hyolith (Paleozoic Mollusca) from Japan

By

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Abstract Discovery of hyoliths from the Gedinnian bed of the Lower (to Middle?) Devonian Fukuji Formation in central Japan constitutes the first occurrence of this group from Japan. The operculum shows features much in common with *Joachimilites* MAREK, 1967 that was previously known only from the Ordovician bed in Bohemia. It now appears that the genus ranges from the Ordovician (Caradocian) to Early Devonian. The Fukuji species, *Joachimilites fukujiensis*, is described as new.

Introduction

Hyolitha, which has been considered as an extinct class of Mollusca (MAREK & YOCHELSON, 1964, 1976) or an extinct phylum that shared the same ancestor with Mollusca (RUNNEGAR *et al.*, 1975), have not previously been found in Japan. In September, 1986, during our field research of the Paleozoic rocks in the Fukuji area, central Honshu, Japan, we discovered the hyolith specimens from the Lower (to Middle?) Devonian Fukuji Formation. In this paper we document the first occurrence of a hyolith from Japan, which provides further information for understanding the systematics of this group.

Our material includes three small fragmentary conchs and external molds of an operculum. The conchs are poorly preserved, making examination of their gross morphology difficult, but the operculum clearly shows the characteristics of its outer and inner surfaces. We concluded that the Fukuji species can be regarded as a new species of *Joachimilites* MAREK, 1967, the genus previously known only from the Caradocian of Bohemia.

Occurrence

The material was recovered from a black calcareous sandy shale unit of the Fukuji Formation at a small exposure (National Science Museum Paleontological Collection Locality no. 45–10–2) along a small path on the southeast flank of the Mt. Sorayama, west of Fukuji, Kamitakara-mura, Gifu Prefecture, central Japan (Fig. 1). The Fukuji Formation is restricted its distribution in a small area of 1.4 km long and

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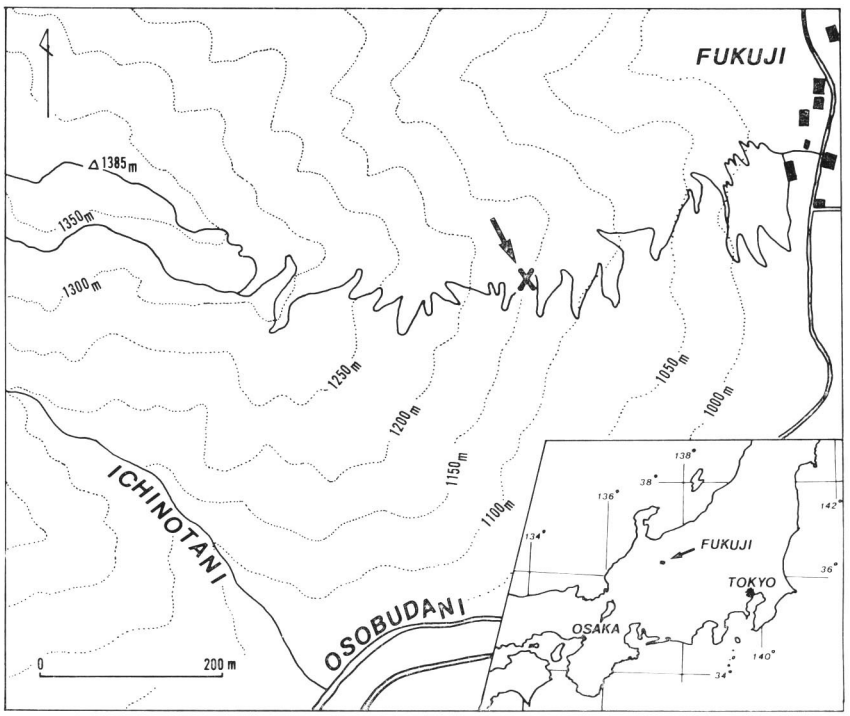

Fig. 1. Location of Fukuji area and fossil locality.

0.4 km wide, about 260 m in total thickness (NIIKAWA, 1980), richly fossiliferous and composed mainly of dark-gray limestone with subordinate amounts of black calcareous sandy shale and pale green tuff. Owing to the rarity of reliable fossils for age determination, the formation has not yet been definitely dated. However, previous studies have indicated that the formation ranges from the Gedinnian to Emsian (or questionably to Eifelian) (HAMADA, 1959a, b, 1971; RESEARCH GROUP FOR THE PALAEOZOIC OF FUKUJI, 1973; OKAZAKI, 1974; KOBAYASHI & HAMADA, 1974, 1977; IGO *et al.*, 1975; OHNO, 1977; KUWANO, 1986). NIKO (unpublished data) has found that the hyolith-bearing bed is stratigraphically the same as OHNO's (1977) Bed B, from which IGO *et al.* (1975) reported the earliest Gedinnian conodont *Icriodus w. woschmidti*. However, OHNO (1977) and KUWANO (1986) have thrown doubt on IGO *et al.*'s (1975) identification of the conodont. On the other hand, KUWANO (1986) found the occurrence of the late Early Gedinnian conodont, *Icriodus postwoschmidti*, in the limestone which is just in contact with Bed B. Considering these results, the hyolith-bearing bed can be dated as within the Gedinnian.

Systematic Paleontology

Phylum Mollusca CUVIER, 1797
Class Hyolitha MAREK, 1963
Genus *Joachimilites* MAREK, 1967
Type-species.—*Joachimilites novaki* MAREK, 1967.

Joachimilites fukujiensis n. sp.
(Figs. 2 A–D)

Description. — This conch is known from three specimens, two of which are too poorly preserved to examine characteristics of their gross morphology. The other specimen (Fig. 2 B) shows the dorsal surface, although it lacks the apertural end and is more than 11.2 mm long. By the outer shape, it is speculated that the cross-section is fan-shaped (Fig. 2 A). Height/width ratio is about 0.7. It is almost straight (not bend), with an apical angle of about 10°. Ventral surface is well rounded, while the dorsal surface possesses a strong, round-topped longitudinal median ridge, both sides of which are wider than the median ridge and flat or weakly concave. Lateral sides of the conch are keeled. Remaining external surface seen in part near the apertural end shown in Fig. 2 B is smooth, although it seems to be obliterated by erosion. An external mold of one of the two poorly preserved specimens shows a severely deformed ventral surface with very fine, regularly spaced growth lines over the surface. The growth lines in this specimen are widely arched toward the aperture, suggesting the presence of a similar-shaped arched ligula at the ventral side of the aperture.

Silicone-rubber replicas of the external molds of the operculum clearly show the delicate structure of the outer and inner surfaces. The operculum, 3.7 mm wide and 2.9 mm high, is subtrigonal in shape. On the outer surface is a narrow cardinal and a wide conical shield, both appear smooth. Weakly inflated, paired rooflets are present between the two shields, which are separated from both shields by sharp depressions. The angular bend of the operculum is 155°. The conical shield is subdivided into two parts by a deep, wide V-shaped median sulcus on the outer surface. On the inner surface is a ridge with distinct depressions on both sides of it, all corresponding to the rooflets and depressions on the outer surface. This inner surface is also characterized by having one pair of long, distinct clavicles, one pair of small cardinal processes with a row of fine, radially arranged cardinal teeth on the base, and a single central process. These clavicles are highly elevated and reinforced. Also, there is a row of cardinal teeth on the base of cardinal processes, which are arranged radially.

Discussion. — SINCLAIR (1946) listed 383 known hyolith species, of which 54 were from the Devonian. The great majority of the species, however, were simply assigned to two genera *Hyolithes* EICHWARD, 1840 and *Orthotheca* NOVAK, 1887. More recent clarification of morphology, systematics and biology of the hyoliths has been covered in papers by SYSSOEV (1958) and MAREK (1963, 1967). These studies have indicated that the hyoliths were largely diversified during the Paleozoic and can

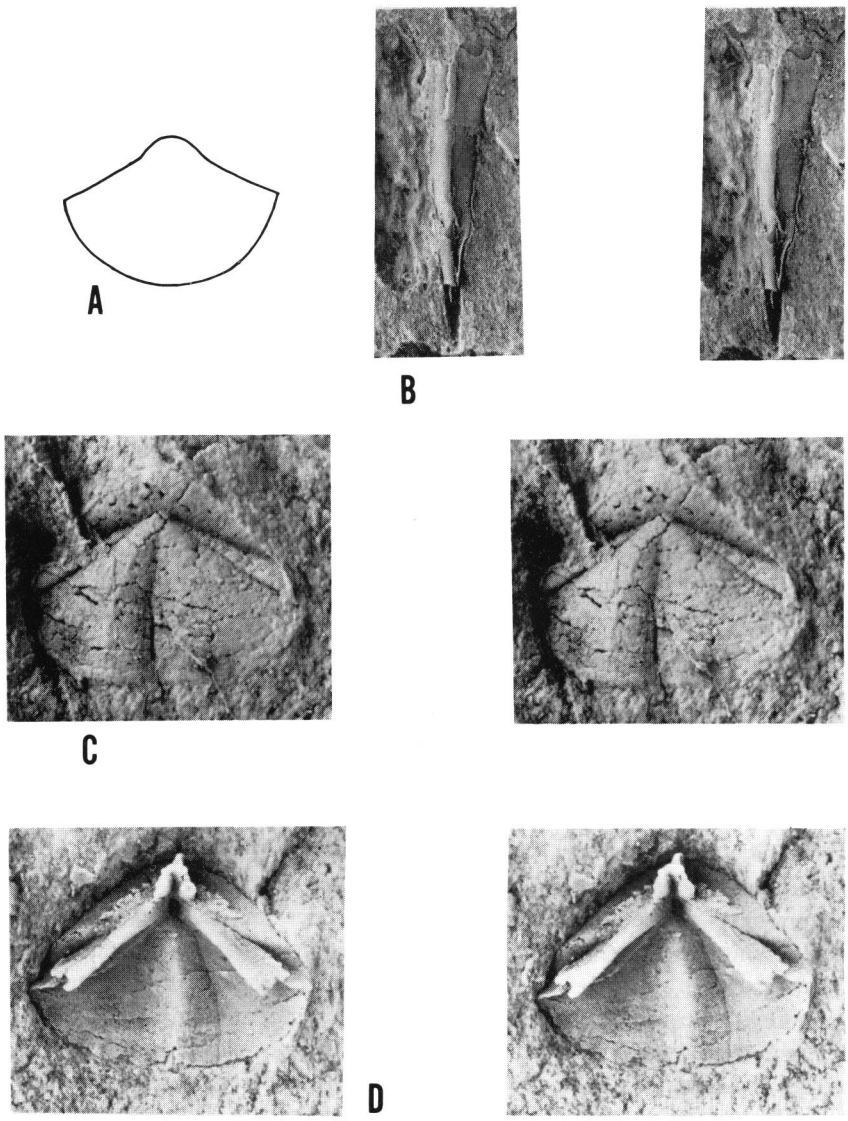

Fig. 2. *Joachimilites fukujiensis* n. sp. A, presumed outline of cross section of the conch; B, stereo pair of dorsal side of the paratype, NSM-PM15378, ×2; C, stereo pair of outer surface of the holotype, NSM-PM15377, ×10; D, stereo pair of inner surface of the holotype, ×10. C and D are silicon rubber replicas.

be divided into many genera that include several families within the group. The genera and families were established mainly based on the species from the Lower Paleozoic in rather limited areas, while the studies of hyoliths from the Upper Paleozoic are quite rare. MAREK (1967) noted that the operculum and conch are the most im-

portant structures for hyolith systematics, but the latter is a little less so. In general, however, the fossilized conch and operculum are found separately and articulated specimens are quite rare. In order to provide reliable systematics for the hyoliths, we still need more complete specimens (both operculum and conch intact).

The Fukuji specimens were found with these components separated, but we speculate that they are from a single species because the occurrence was in a very narrow stratigraphic interval of a small exposure and also because the operculum and cross section of the conch are similar in shape and size. These specimens have a very characteristic operculum which is monoclaviculate and as described above. These features are almost identical with those of *Joachimilites* MAREK, 1967. The only difference is that the Fukuji species has a V-shaped median ridge on the conical shield of the inner surface of the operculum whereas the others do not. Even though the conchs are poorly preserved, the assumed fan-shaped cross-section with keeled lateral sides, and the very fine growth lines on the conch surface further suggest that the Fukuji specimens should be assigned to *Joachimilites*.

Further, the operculum of the Fukuji species is similar to that of *Joachimilites novaki* MAREK, 1967, the type species of the genus, but differs in that the size of the former is much smaller, the shape is more trigonal, the cardinal processes are shorter and smaller than the type species. Also, the conical shield has a V-shaped median ridge on the inner surface and the cardinal teeth are present only on the bases of the cardinal processes in the Fukuji species, both absent in the type species.

Comparison of the Fukuji species with other known Devonian ones is difficult. This is because that many of the other species were described based solely on conchs. Such classification makes precise genus and species assignment obscure.

Figured specimens. — Holotype, NSM-PM15377 (operculum); paratype, NSM-PM15378 (conch).

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