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First occurrence of *Haugia* cf. *variabilis* (d'Orbigny) (Ammonoidea) from the Lower Jurassic of the Uminoura area, western Kyushu, Japan

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Abstract. ***Haugia*** **cf.** ***variabilis*** **(d'Orbigny) has been found in the upper part of the Idenohana Formation in the Uminoura area, Kumamoto Prefecture. This species is originally known from the Upper Toarcian** ***H. variabilis*** **Subzone of the** ***Lytoceras jurense*** **Zone in western Europe. This occurrence combined with our analyses of the lithofacies and sequence stratigraphy suggests that the Idenohana Formation is conformably overlain by the Kyodomari Formation.**

Key words: Ammonoid, ***Haugia*****, Idenohana Formation, Kyodomari Formation, Uminoura, Upper Toarcian**

Introduction

The stratigraphy and sedimentology of the late Paleozoic–Mesozoic clastic sequence in the Kurosegawa Terrane, Southwestern Japan, are relevant to understanding the structural history of this terrane and, by extension, the Japanese Islands. Stratigraphic sequences in the Uminoura area, Kumamoto Prefecture, western Kyushu, belonging to the Sakamoto Subbelt of the Kurosegawa Terrane, have been described previously (Tamura, 1959a, b, 1960; Orita, 1962; Matsumoto and Kanmera, 1964; Tamura and Murakami, 1987, 1988), and have been assigned a middle Permian–early Cretaceous age, based on fossils from allochronous blocks, including an olistolith and pebbles in conglomerates (Tamura, 1959a; Orita, 1962; Tamura and Murakami, 1987). We recently discovered an early Jurassic ammonoid specimen from a well-stratified synchronous sequence in the Uminoura area (Ohta and Sakai, 2003), and in the present study we describe this specimen and discuss its relevance for the depositional age of the sequence. The specimen described and figured herein is in the National Science Museum, Tokyo, with the prefix NSM PM.

Note on stratigraphy

Mesozoic sequences in the Uminoura area, western Kyushu, are made up of the Idenohana, Kyodomari, and Sakamoto Formations, in ascending order (Figures 1, 2; Ohta and Sakai, 2003). These have conformable contacts with one another (Ohta and Sakai, 2003) and each formation exhibits a fining-upward sequence: The Idenohana Formation begins with conglomerate, passes through sandstone, and ends in silty shale (Figure 2). The Kyodomari Formation begins with limestone breccia, followed by turbiditic sandstone and shale towards the top of the sequence. The Sakamoto Formation is a sequence of slump beds, conglomerate, sandstone and shale towards the upward sequence.

The ammonoid specimen (NSM PM 16811) described herein was collected from the upper part of the Idenohana Formation (Figures 1, 2). These beds consist of silty shale that has been intensively bioturbated and is poorly sorted within a given bed, but the beds are well stratified and laterally traceable overall (Figure 2). Graded, fine sandstones (1–2 cm in thickness) with parallel or ripple laminae make up

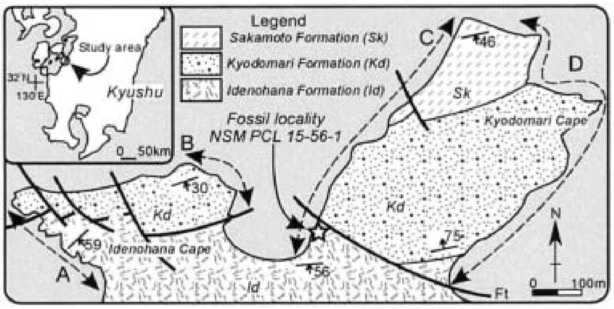

Figure 1. Index and geological maps of the Uminoura area, Kumamoto Prefecture, western Kyushu. Four traverses (A–D) correspond to columns in Figure 2.

rhythmic intercalations. These lithological characteristics match those of an autochthonous distal turbidite deposited in a lower-slope environment (Ohta and Sakai, 2003).

Systematic paleontology

Superfamily Hildoceratoidea Hyatt, 1867
Family Hammatoceratidae Buckman, 1887
Subfamily Phymatoceratinae Hyatt, 1867
Genus ***Haugia*** Buckman, 1888

Haugia cf. ***variabilis*** (d'Orbigny, 1842)

Figure 3

Compared.—
Ammonites variabilis d'Orbigny, 1842, p. 350, pl. 113, figs. 1–4.
Harpoceras variabilis (d'Orbigny). Wright, 1884, p. 455, pl. 67, figs. 1–6; pl. 68.
Haugia variabilis (d'Orbigny). Buckman, 1888, p. 146, pl. 25, fig. 2; Dean *et al.*, 1961, p. 484, pl. 73, fig. 4; Guex, 1972, pl. 2, fig. 1.
Haugia variabilis variabilis (d'Orbigny). Gabilly, 1975, p. 82, pl. 10, figs. 7–8, pl. 12, figs. 1–2, pl. 13, figs. 1–2.
Haugia cf. *variabilis* (d'Orbigny). Ohta and Sakai, 2003, p. 680, fig. 9.

Type.—Type specimen (lectotype) was designated by Buckman (1887) as d'Orbigny's original type (1842, p. 350, pl. 113, figs. 1–2), from France (the exact location is ambiguous).

Material.—NSM PM 16811. Outer mold of secondarily distorted shell, moderately large, 115 mm in maximum preserved shell diameter.

Locality.—NSM PCL 15-56-1 (= Loc. 31 of Orita, 1962; Loc. A of Tamura and Murakami, 1988; Loc. 2 of Ohta and Sakai, 2003; NSM PCL: National Science Museum, Paleontological Collection Locality): a low cliff at Kyodomari Cape, the Uminoura area, Kumamoto Prefecture, western Kyushu (Figures 1, 2).

Description.—Right side of shell only is preserved. Whorl is compressed and moderately evolute, with moderately wide (width of umbilicus (U) = 44 mm at the maximum preserved diameter) and shallow umbilicus and rounded umbilical shoulder. Shell surface is ornamented with strong, regularly spaced ribs. Ribs are prorsiradiate at mid-flank, then become arcuate and directed somewhat backwards on ventro-lateral shell, and are strongly tuberculate at umbilical shoulder and weakly so at mid-flank and ventro-lateral shoulder (Figure 3A). Strength of tubercles on umbilical shoulder changes irregularly accompanied with growth. Some ribs are biplicate and fasciculate and are branching at umbilical tubercles, with secondaries being weaker than primaries. Intervals between ribs on inner whorls are slightly broader than those on outer whorls; however, strength of ribs and tubercles are the same as on outer whorls. Whorl cross-section is subfastigate on inner whorls and subelliptical with obtuse ventro-lateral shoulder on preserved outermost whorl (Figure 3B). Keel and suture are not observable.

Comparison.—*Haugia* includes many species (e.g., *H. ogerieni*, *H. navis*, *H. malagma*, *H. illustris*, *H. jugosa*, *H. eseri*, *H. occidentalis*, *H. paupera*, *H. compressa*). *H. variabilis* is distinguished from other species of the same genus by having arcuate ribs that are directed backwards, narrow whorls, a wide umbilicus, a small expansion rate of the whorl, and irregular ornamentation (Buckman, 1890).

The shell morphology of *H. variabilis* exhibits a wide intraspecific variation (Wright, 1884; Buckman, 1890). There are two distinct varieties: (1) a typical form (including the lectotype) with slightly convex shells having arcuate ribs with irregular ornamentation, and (2) a form with coarser and more irregular ornamentation, which has been termed ''var. a'' (Wright, 1884; Buckman, 1890). A representative of the latter is illustrated in Wright (1884, pl. 68). The earlier growth stage of this form ($U < 45$ mm; measured from Wright, 1884, pl. 68, fig. 1) has a coarser and more irregular ornamentation than does the later growth stage ($45 < U < 55$ mm). Ornamentation fades away on the final half-whorl ($U > 55$ mm). Thus, the specimen described here is comparable to the earlier growth stage of ''var. a'' in Wright (1884).

H. variabilis (Neumayr) is distinguished from *H. japonica* by its more irregular ornamentation, with the secondary ribs being weaker than the primary ribs. *H. japonica* was originally described and figured in Naumann and Neumayr (1890), and was illustrated in a photograph by Kobayashi (1935). The holotype of *H. japonica* was collected in the Mitoda, Sakawa-machi, Takaoka-gun, Kochi Prefecture, but its exact stratigraphic placement is unknown (Hayami *et al.*, 1963).

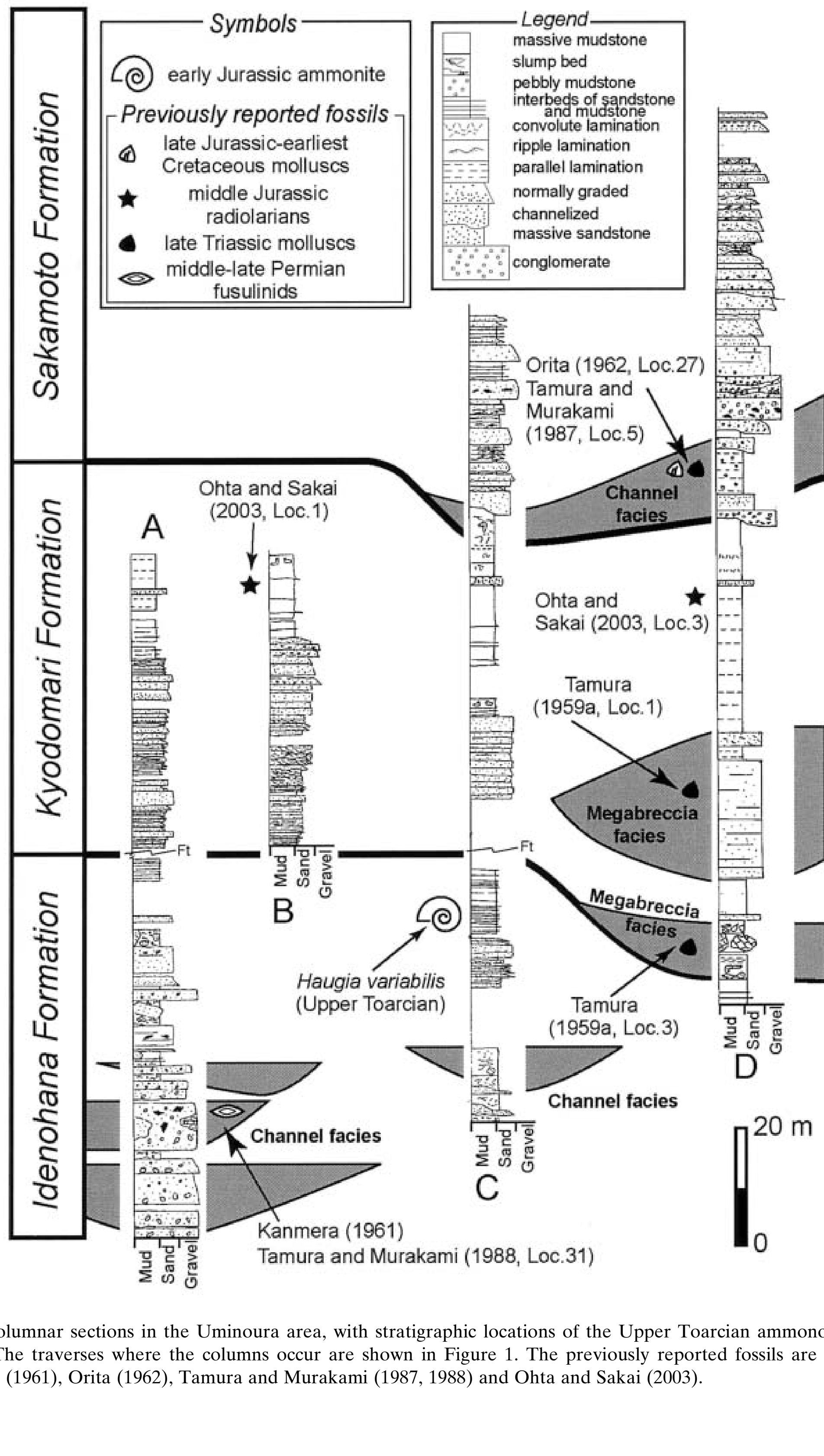

Figure 2. Columnar sections in the Uminoura area, with stratigraphic locations of the Upper Toarcian ammonoid and previously reported fossils. The traverses where the columns occur are shown in Figure 1. The previously reported fossils are based on Tamura (1959a), Kanmera (1961), Orita (1962), Tamura and Murakami (1987, 1988) and Ohta and Sakai (2003).

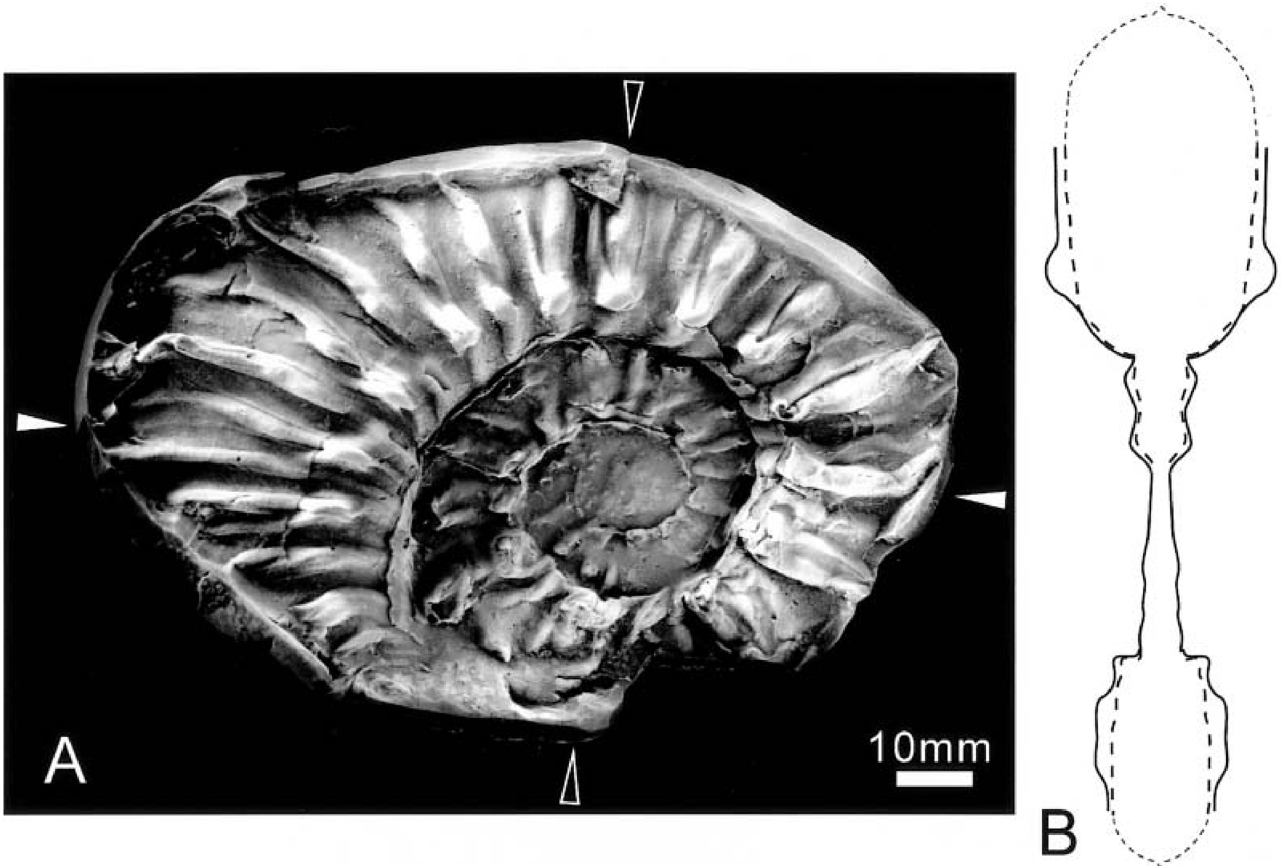

Figure 3. Upper Toarcian ammonoid from the Idenohana Formation. **A.** *Haugia* cf. *variabilis* (d'Orbigny), right lateral view (rubber cast from outer mould), NSM PM 16811. Preserved diameters at the solid and open triangles are 115 and 79 mm, respectively. The original shell diameter cannot be measured, because the venter is not completely preserved. Widths of umbilicus (U) at the solid and open triangles are 44 and 34 mm, respectively. **B.** Reconstructed median cross-section. The dashed line shows the intercostal whorl cross-section.

Referral to the genus *Yokounia*, which is endemic to western North America (Jacobs and Smith, 1996), is excluded based on rib morphology, because *Yokounia* has gently sinuous to rectiradiate ribs.

Occurrence.—Upper Toarcian, *H. variabilis* Subzone of the *Lytoceras jurense* Zone in the British Isles, Germany and France (Arkell, 1956; Dean *et al.*, 1961; Mouterde *et al.*, 1971; Gabilly, 1975).

Geological implications

Sequences assigned to the Idenohana and Kyodomari Formations (see Ohta and Sakai, 2003) have hitherto been correlated with middle Permian–upper Triassic strata, based on the fusuline foraminifers *Verbeekina sphaera* Ozawa, *Neoschwagerina simplex* Ozawa, *Yangchienia compressa* (Ozawa), *Schubertella giraudi* (Deprat) (Kanmera, 1961; Matsumoto and Kanmera, 1964) and the bivalve molluscs *Tosapecten suzukii* (Kobayashi), *Halobia* spp., and *Pleuromya* spp. (Tamura, 1959a, 1960; Orita, 1962; Matsumoto and Kanmera, 1964; Tamura and Murakami, 1988) (Figure 2). However, these fossils are of allochronous origin in submarine-channel facies or slope-margin megabreccias (Ohta and Sakai, 2003; Figure 2). In fact, Tamura and Murakami (1987) reported the cooccurrence of late Triassic and late Jurassic–earliest Cretaceous fossils in an allochronous slump conglomerate (Loc. 5 of Tamura and Murakami, 1987; Figure 2).

The specimen of *Haugia* cf. *variabilis* described here was collected from a synchronous distal turbidite facies in the upper part of the Idenohana Formation (Figure 2). This ammonoid is a representative of the Upper Toarcian fauna (*H. variabilis* Subzone of the *Lytoceras jurense* Zone) in Europe (Arkell, 1956;

Dean *et al.*, 1961; Mouterde *et al.*, 1971; Gabilly, 1975) and implies that the depositional age of the upper part of the Idenohana Formation is Late Toarcian (Figure 2).

In addition, well-stratified black shale of the overlying Kyodomari Formation contains the Bajocian–early Bathonian radiolarians *Cyrtocapsa mastoidea* Yao, *Unuma typicus* Ishikawa and Yao, *Tricolocapsa plicarum* Yao, and *Zartus jurassicus* Pessagno (Figure 2; Ohta and Sakai, 2003). These contemporaneous radiolarians and ammonite imply that the Kyodomari Formation conformably overlies the Idenohana Formation without a significant time gap. Lithofacies analysis and sequence stratigraphy (Ohta and Sakai, 2003) are concordant with these ages. These new age data are key to understanding the stratigraphy, geology and structural history of not only the Uminoura area but also the Sakamoto Subbelt of the Kurosegawa Terrane.

Furthermore, occurrences of *Haugia variabilis* have been hitherto recorded only in northwestern Europe (e.g., d'Orbigny, 1842; Wright, 1884; Buckman, 1888; Arkell, 1956; Dean *et al.*, 1961; Mouterde *et al.*, 1971; Guex, 1972; Gabilly, 1975). Our finding of this species from western Pacific suggests that its geographic distribution might extend to the western Pacific at least.

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