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Late Jurassic ammonoid from the Arimine Formation in the Arimine area, Toyama Prefecture, northern Central Japan*

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富山県有峰地域の有峰層から産出した後期ジュラ紀アンモノイド

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Key words：Late Jurassic, Tetori Group, Kuzuryu Group, Arimine Formation, Higashisakamori-dani, Ammonoid
キーワード：後期ジュラ紀，手取層群，九頭竜層群，有峰層，東坂森谷，アンモノイド

富山県富山市有峰地域の東坂森谷に分布する上部ジュラ系有峰層から，アンモノイド３種，*Perisphinctes* (*Kranaosphinctes*) *matsushimai*，*Perisphinctes* (*Perisphinctes*) cf. *ozikaensis*，*Taramelliceras* sp.が産出したので記載する．*Perisphinctes* (*Kranaosphinctes*) *matsushimai* は直径25 cm以上にもなるアンモノイドであり，これまで有峰地域からも報告されている．*Perisphinctes* (*Perisphinctes*) cf. *ozikaensis* は九頭竜層群からは2例目の発見であり，完模式標本は宮城県牡鹿半島から報告されている．*Taramelliceras* sp. は有峰地域の真川から報告例があるが，東坂森谷からは初めての発見である．これらのアンモノイドは有峰層が後期ジュラ紀の中期オックスフォーディアン期を示唆するものであり，ジュラ紀の地史，古生物学的研究の一助になると考えられる．

1. Introduction

The Jurassic-Cretaceous Tetori Group, which is distributed in the Hakusan and Jinzu regions in northern Central Japan, is divided into the Kuzuryu, Itoshiro and Akaiwa subgroups in ascending order in the latter region (Maeda, 1961). On the other hand, Kawai and Nozawa (1958) already divided the Tetori Group in the Jinzu Region into the Higashisakamori, Nagatogawa and Atotsugawa formations in ascending order. After that, several lithostratigraphic unit names are used for the Jurassic to Cretaceous sediments in the Jinzu Region (e.g. Omura, 1973; Ui, 1981; Shigeno, 2003; Kashiwagi and Hirasawa, 2010). Matsukawa et al. (2014) re-examined the stratigraphy of the Mesozoic deposits in the Jinzu Region and divided them into the Tetori Group and the overlaying the Jinzu Group. The Tetori Group, which includes marine deposits, in the Arimine area, southeastern Toyama

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Prefecture is divided into the Magawa and Arimine formations in ascending order (Matsukawa et al., 2014). Sano (2015) reviewed the geological age of the Tetori Group and proposed a new interpretation that the Mesozoic deposits in the Jinzu Region are composed of the Upper Jurassic Kuzuryu Group and Lower Cretaceous Jinzu Group. Yamada (2017) scrutinized study history of definition on the Tetori Group and proposed that the Tetori Group (*sensu lato*) is divided into the Kuzuryu Group and Tetori Group (*sensu strico*). We follow the proposal by Yamada (2017) for the group names and follow the stratigraphic classification of the Kuzuryu Group by Matsukawa et al. (2014).

To date, abundant Jurassic ammonoids have been reported from the Kuzuryu Group in the Hakusan Region (e.g., Yokoyama, 1904; Maeda, 1952; Maeda, 1961; Sato, 1962; Sato et al., 2003; Sato and Yamada, 2005, Matsukawa et. al., 2007; Matsukawa and Fukui, 2009; Sano et al., 2013; Handa et al., 2014). On the other hand, since Kawai and Nozawa (1958), there have been no reports of ammonoids from the Kuzuryu Group in the Arimine area until recently. Matsukawa et al. (2008) reported *Perisphinctes* (*Kranaosphinctes*) *matsushimai* and Sato et al. (2012) reported *Perisphinctes* (*Perisphinctes*) cf. *ozikaensis* from the Arimine Formation in the Higashisakamori-dani Valley. Sato and Yamada (2014) reported a new Jurassic ammonoids assemblage including *Subdiscosphinctes hachiyai* whose diameter is more than 40 cm from the tributary of the Makawa River.

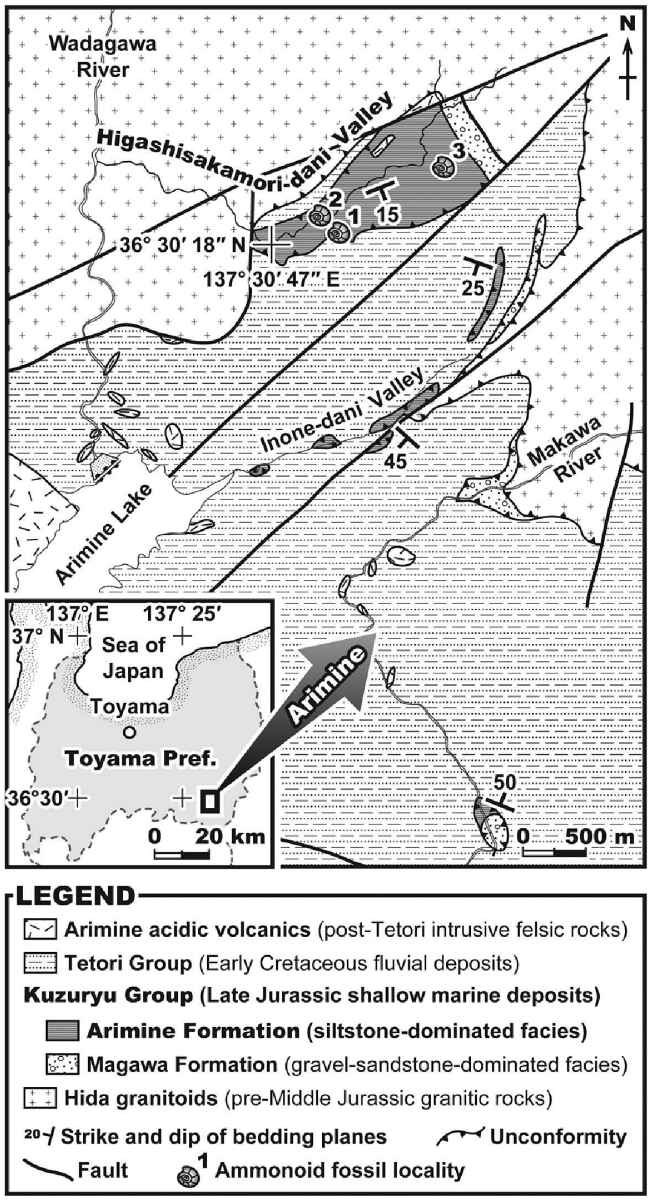

Fig. 1 Index and simplified geological maps of the Arimine area. Modified after Kawai and Nozawa (1958), Takenami and Maeda (1959), and Nozawa and Sakamoto (1960).

In this paper, we describe the ammonoids from floats of the Arimine Formation in the Arimine area. The specimen TOYA-Fo-7277 was collected by one of the co-authors (S.H.) in 2008. The other specimens TOYA-Fo-7275 and TOYA-Fo-7276 were collected by co-authors (M.F.) in 2017. All the specimens are housed in the Toyama Science Museum.

2. Geological setting

The Middle to Late Jurassic Kuzuryu Group is narrowly distributed in the northern Central Japan (Maeda, 1961; Sano, 2015). Its main distribution spreads on the Kuzuryu (upper reach of the Kuzuryugawa River, eastern Fukui Prefecture) and Arimine (upper reach of the Wadagawa River, southeastern Toyama Prefecture) areas. The Kuzuryu Group is composed of terrigenous, shallow-marine deposits showing an upward-fining succession from basal conglomerate to upper muddy stones as a whole (Maeda, 1961; Masuda et al., 1991). These deposits record three transgression events occurred in the Tetori basin during Jurassic time, that is, the first Bathonian-Callovian, the second Oxfordian and the third Tithonian ages (Sano et

al., 2013; Sano, 2015). In the Jurassic period, the basin was located in a low-paleolatitude region adjacent to eastern margin of the Sino-Korean Craton (Sohma and Kunugiza, 1993; Hirooka et al., 2002, 2003).

The Arimine area, where yielded the ammonoids described here, is located in the southeastern Toyama Prefecture (Fig. 1). In this area, the pre-Middle Jurassic Hida granitoids, Late Jurassic shallow marine Kuzuryu Group and Early Cretaceous fluvial Tetori Group are distributed (Fig. 1). Distribution of the Kuzuryu Group is restricted along Higashisakamori-dani Valley, Inone-dani Valley and Makawa River (Fig. 1). These groups are locally intruded by the Arimine acidic volcanics (Omura, 1973), which are mainly rhyolitic intrusive rocks. The Kuzuryu Group unconformably overlies or is in fault contact with the Hida granitoids, and is unconformably overlain by the Tetori Group (Maeda, 1961; Sohma and Kunugiza, 1993; Matsukawa et al., 2014). Zircon SHRIMP U-Pb ages of the granitoids are approximately 200-300 Ma (Kunugiza et al., 2010). Depositional ages of the Kuzuryu Group are determined on the basis of several index fossils as mentioned later. Upper part of the Tetori Group (= that of the Jinzu Group) is younger than late Early Cretaceous (Aptian-Albian) by using fission-track analysis of zircons extracted from its tuffaceous sandstone (Matsukawa et al., 2014).

The Kuzuryu Group distributed in the Arimine area consists of the sandstone-conglomerate-prone Magawa and muddy stone-dominated Arimine formations in ascending order (Maeda and Takenami, 1957a; Kawai and Nozawa, 1958; Matsukawa et al., 2014). The former is conformably overlain by the latter (Maeda and Takenami, 1957a; Kawai and Nozawa, 1958; Matsukawa et al., 2014). The both formations are included within the second-stage transgressive deposits (Sano, 2015). They are suggested to have been formed in an embayment opened northward and extended westward or southwestward (Maeda and Kawabe, 1963, 1966). The Magawa Formation reflects more littoral setting than the Arimine Formation (Maeda, 1961). According to Maeda and Takenami (1957b), sedimentary environment of the Arimine Formation is a small enclosed bay where a large volume of sediments was supplied from hinterland mountains. Mode of occurrences of the molluscan fossils infers rapid deposition occurred in quite sea-bottom (Takenami and Maeda, 1959; Sato and Yamada, 2014). In addition, periodically storm-influenced shoreface environment is also recognized in some horizons (Hirasawa, 2016, 2017).

The Magawa Formation yields marine molluscan fossils, for example, ammonoids such as *Discosphinctes* sp., *Scapnitodites* ? sp. (as spelled in the original text of Matsukawa et al., 2014, p. 153, probably *Scaphitodites* Buckman, 1924 cited in Arkell et al., 1957, p. L282) and *Cadoceras* sp. (Kawai and Nozawa, 1958; Maeda, 1962; Maeda and Kawabe, 1963, 1966; Matsukawa et al., 2014) and bivalves including *Pinna* sp., *Myophorella* (*Promyophorella*) *toyamaensis*, *M.* (*P.*) aff. *obsolete*, *M.* (*P.*) cf. *orientalis*, *Nipponitrigonia kobayashii*, *Vaugonia ariminensis*. According to these fossils, the Magawa Formation is considered to be Oxfordian (*M.* (*P.*) *toyamaensis*: Maeda and Kawabe, 1966), Early Oxfordian-Early Kimmeridgian ages (*Discosphinctes* sp. and *Scapnitodites* ? sp. (*sic*): Matsukawa et al., 2014) or Kimmeridgian-Tithonian (*M.* (*P.*) cf. *orientalis* and *M.* (*P.*) aff. *obsolete*: Kawai and Nozawa, 1958).

The Arimine Formation occurs such marine index fossils as ammonoids, radiolarians and trigonid bivalves (Maeda and Takenami, 1957a; Kawai and Nozawa, 1958; Takenami and Maeda, 1959; Maeda, 1962; Maeda and Kawabe, 1963, 1966; Matsukawa et al., 2008; Hirasawa and Kashiwagi, 2008; Kashiwagi and Hirasawa, 2010; Sato et al., 2012; Sato and Yamada, 2014). Some of them, however, have no descriptions and pictures of the ammonoids (Sato, 2008). This formation is assigned to the middle Oxfordian age on the basis of the ammonoids such as *Perisphinctes* (*Kranaosphinctes*) *matsushimai* and *P.* (*Dichotomosphinctes*) *kiritaniensis* belonging to *Perisphinctes matsushimai* Assemblage Zone (Matsukawa et al., 2008; Sato and Yamada, 2014). These ammonoids are essential elements consisting of the Paleo-Pacific or Tethysian fauna (Sato and Yamada, 2014). Further, the radiolarian

fossils from the stratum indicate the middle Oxfordian to early Kimmeridgian in age, and imply a northern Tethysian assemblage containing Boreal elements (Kashiwagi and Hirasawa, 2010, 2013). Trigonid bivalves are exemplified as *Myophorella* (*Promyophorella*) *hidensis*, *M.* (*P.*) *magawensis*, *M.* (*P.*) *obsoleta*, *M.* (*P.*) cf. *orientalis*, *M.* (*P.*) *tetoriensis* and *Nipponitrigonia kobayashii* and *Vaugonia ariminensis* (Maeda and Takenami, 1957a; Maeda, 1962; Maeda and Kawabe, 1963, 1966). They are suggested to be indicate Oxfordian (*M.* (*P.*) *hidensis, M.* (*P.*) *magawensis* and *M.* (*P.*) *tetoriensis*: Maeda and Kawabe, 1966), younger than late Oxfordian (*M.* (*P.*) cf. *orientalis,* Maeda and Takenami, 1957a) or late Kimmeridgian (*M.* (*P.*) *obsoleta*: Takenami and Maeda, 1959) in age.

To sum up, biostratigraphically the Magawa and Arimine formations are at least Middle Oxfordian strata. The latter is correlatable with the uppermost part of the Kuzuryu Group distributed in the Kuzuryu area (Kawai and Nozawa, 1958; Maeda, 1961), where the ammonoid assemblage zones are established by Sato and Westermann (1991). Although tuffaceous deposits are also intercalated with the Arimine Formation (Maeda and Takenami, 1957a; Hirasawa et al., 2010), their radiometric ages have not yet been reported.

3. Kuzuryu Group observed in the Higashisakamori-dani Valley

Both the Magawa and Arimine formations are observed in the Higashisakamori-dani Valley where is the type locality of the Arimine Formation (Matsukawa et al., 2014). Especially, the latter is well-exposed along the upper and middle reaches of the valley (Fig. 1). Bedding attitudes frequently vary from dipping southeast to southwest, and striking northeast (-southwest) to northwest (-southeast) due to minor faults or folds. Thickness of the Magawa and Arimine formations are 30-200 m (Maeda and Takenami, 1957a; Kawai and Nozawa, 1958; Takenami and Maeda, 1959; Matsukawa et al., 2014) and 150-200 m (Maeda and Takenami, 1957a; Kawai and Nozawa, 1958; Takenami and Maeda, 1959; Matsukawa et al., 2014), respectively.

3-1. Magawa Formation

The Magawa Formation is predominantly composed of alternating beds of granule to boulder conglomerate and fine- to coarse-grained sandstone, with intercalation of dark sandy siltstone. Gravels of conglomerate are mostly granitic and poorly- to well-rounded. Conglomerate and sandstone are very poorly-sorted, frequently containing siltstone rip-up clasts and molluscan shell fragments. Sandy siltstone is moderately bioturbated in general.

3-2. Arimine Formation

The Arimine Formation dominantly consists of dark, sandy mudstone and siltstone intercalated with grayish white, very fine- to medium-grained sandstone (Fig. 2A, B). Muddy stones tend to be homogeneous or mottled owing to strong bioturbation (Fig. 2B). Clustered small burrows (phycosiphoniform, Fig. 2B, C) and muddy stone- or sandstone-filled larger burrows (e.g. horizontal *Planolites* and vertical *Skolithos*-like traces, Fig. 2C, D) commonly contribute to bioturbation. In some cases, the larger burrows transform into ellipsoidal or irregular-shaped calcareous nodules. Muddy stone infillings of *Planolites* and *Skolithos*-like burrows preserve microfossils such as radiolarians, sponge spicules and echinoderm ossicles (Hirasawa and Kashiwagi, 2010). Fossils such as ammonoids, bivalves (Fig. 2E, F) and plant fragments (Fig. 2F, G) are often contained in the muddy deposits. Intercalated sandstone is moderately to poorly-sorted arkose laminated or slightly to strongly bioturbated (Fig. 2A). The laminated sandstone beds are generally characterized by erosional bases, amalgamation, normal grading and parallel laminations, which exhibit Bouma T_a, T_b and T_{ab} turbidites (Fig. 2B). Thickness of the sandstone beds

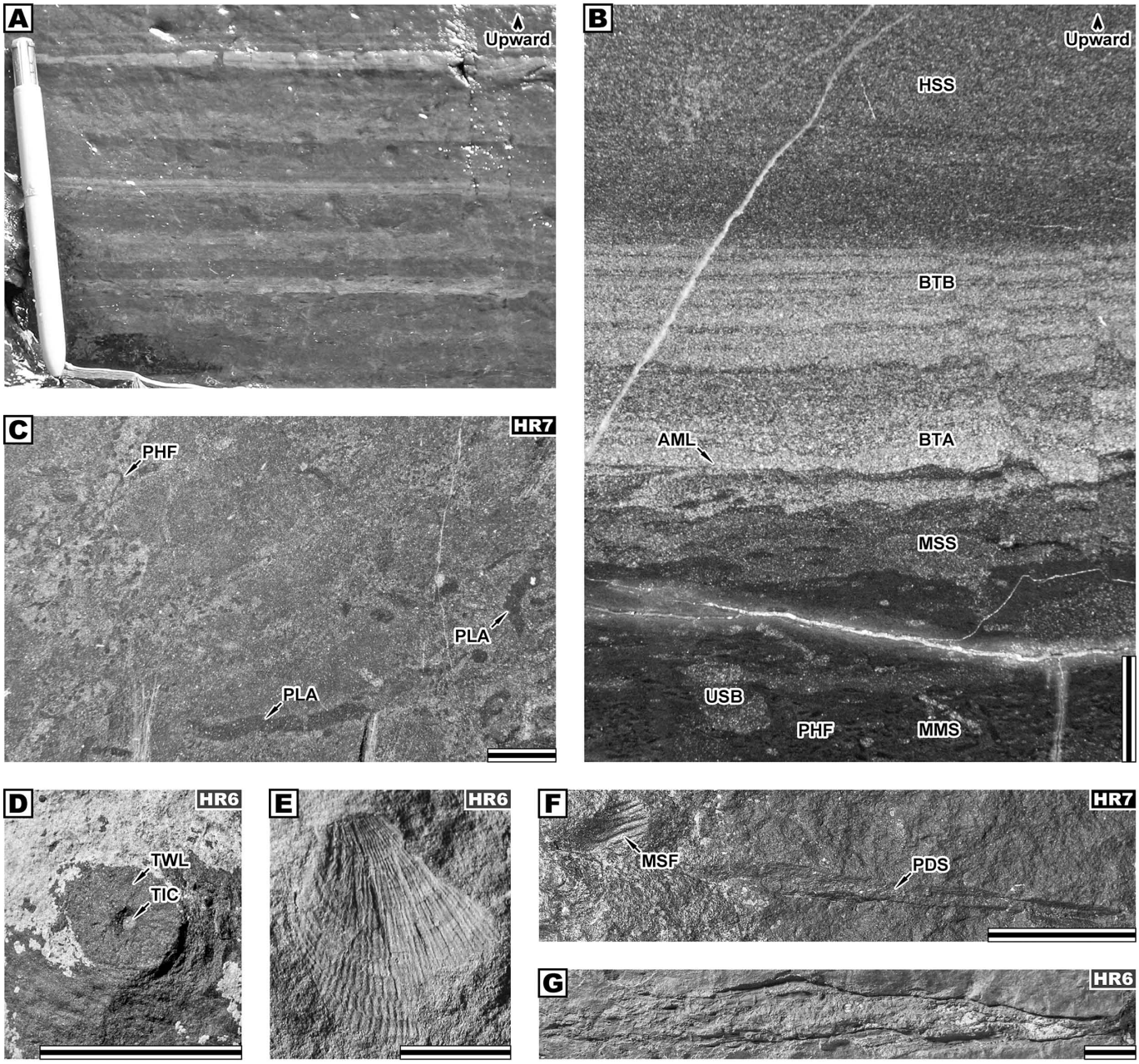

Fig. 2 Lithologies representing the Arimine Formation and its ammonoid-bearing rocks. (A-C) Primary and biogenic sedimentary structures (A, outcrop; B, vertical polished slab; C, polished surface parallel to a bedding plane of the rock). (A) Rhythmically alternating beds of sandstone (grayish white-light gray horizons) and mud- to siltstones (dark gray horizons). Several sandstone layers are obscured due to bioturbation. (B) Turbidite (very fine- to fine-grained sandstone) beds intercalated between lower mottled and upper homogeneous sandy siltstone layers. Note the turbidites clearly showing Bouma T_a and T_{ab} divisions with a partially amalgamated base. Phycosiphoniform and unidentified sandstone-filled burrows are observed in a basal mottled mudstone interval. (C) Intensely bioturbated, muddy very fine-grained sandstone exhibiting a phycosiphoniform-*Planolites* ichnofabric. (D-G) Fossils co-occurring with the ammonoid specimens (D-F, fracture surfaces nearly parallel to bedding planes; G, fracture surface perpendicular to bedding). (D) Transverse section of a vertical *Skolithos*-like trace fossil characterized by a thick wall surrounding a thin inner core. Grayish white areas around the burrow are thin carbonate vein. (E) Disarticulated pectinid bivalve shell. (F) Molluscan shell fragment and plant debris. (G) Partially silicified wood. Abbreviations: AML, amalgamation; BTA, Bouma T_a; BTB, Bouma T_b; HR6, host rock of TOYA-Fo-7276, sandy siltstone; HR7, host rock of TOYA-Fo-7277, muddy very fine-grained sandstone; HSS, homogeneous sandy siltstone; MMS, mottled mudstone; MSF, molluscan shell fragment; MSS, mottled sandy siltstone; PDS, plant debris; PHF, phycosiphoniform; PLA, *Planolites*; TIC, thin internal core; TWL, thick wall; USB, unidentified sandstone-filled burrow. All scale bars indicate 1 cm.

ranges from several centimeters to rarely over one meter, so that lithofacies change from muddy stone-dominated to sandstone-dominated alternations. Occasionally sandstones and muddy stones rhythmically alternate to form normal flysch-like successions (Fig. 2A). Sandstone is less fossiliferous compared to the muddy stones. The Arimine Formation is erosionally overlain by the basal gravel bed of the Tetori Group, which consists of poorly-sorted but well-rounded granitic boulder conglomerate.

Systematic descriptions of ammonoid

Specimen described here is kept in the Toyama Science Museum. The following abbreviations were used in the descriptions. D for diameter, UD for umbilical diameter, UD/D for ratio of umbilical diameter to diameter, H for whorl height, W for whorl width. Measurements are in mm.

Perisphinctes (*Kranaosphinctes*) *matsushimai* (Yokoyama)

Fig. 3

Perisphinctes (*Perocerites*) *Matsushimai* (*sic*) Yokoyama. 1904, p.3, pl.I, fig.1. (holotype)

Kranaosphinctes matsushimai Yokoyama. Fukada, 1949, p.24, pl.5, fig.5; Sato, 1962, p.86, pl.II, figs.4-8: pl.XI, fig.7; Suzuki and Sato, 1972, p.214, fig.2; Shimonoya and Takahashi, 1990, pl.24, figs.2-4: pl.25, figs.1-4: pl.26, figs.1-3; Itoigawa Educational Committee, 1996, p.57, photo 168; Fukui City Museum of Natural History, 1997, pl.II-D; Hachiya and Mizuno, 2004, pl.12, fig.68 (1,2)

Perisphinctes (*Kranaosphinctes*) cf. *matsushimai* Yokoyama. Takahashi, 1969, p.75, pl.13, fig.3: pl.14, fig.5

Perisphinctes (*Kranaosphinctes*) ? sp., Takahashi, 1969, p.76, pl.12, fig.2

Perisphinctes (*Kranaosphinctes*) *matsushimai* Yokoyama. Toyama Paleontological Research Club, 2007, p.13 (12)

Perisphinctes (*Kranaosphinctes*) *matsushimai* (Yokoyama). Sato and Yamada, 2014, p.36-41, figs.11-13

Material: Register number TOYA-Fo-7277, A slightly deformed outer mould collected by Satoshi Hirasawa in October 2008, from a float found in a branch of Higashisakamori-dani Valley (Fig. 1-1). D (long axis of specimen) ca. 264; UD ca. 129 (UD/D ca. 0.48); H (preserved last whorl) ca. 73; W/2 more than 18.

Description: Planulate, coiling moderately evolute, compressed whorl with open umbilicus and bluntly rounded venter, overlapping only the part of the secondary ribs of the preceding whorls; in earliest stage less than 5 cm in diameter is lost. In intermediate stage, about 5 to 12 cm in diameter, primary ribs are regularly dense, radiate, sharp. In adult stage more than 12 cm in diameter, ribs gradually become wider and rounded, however, keeping a constant interval. Number of primary ribs per last preserved whorl is 34, par inner whorl 46; Secondary ribs branched off four or five at the ventral margin; Constrictions are deep, slightly oblique to ribbing, accompanying single rib is behind at the last constriction of the preserved whorl.

Observation: The present specimen is not complete, however, partly preserved and reach the adult stage. A few shell fragments of the last whorl remain linearly on the ventral margin of the inner whorl. The present specimen whose ornamentation shows gradual change is considered to belong to the subgenus *Kranaosphinctes* of genus *Perisphinctes* according to the features of radiate, sharp and dense ribs with regularly branching secondary at the ventro-lateral shoulder, obliquely running deep constrictions and so on. The present specimen is lost a part of the inner whorl and more or less compressed by *post-mortem* compression, though most parts maintain the original features.

Comparisons: The specimen studied herein is judged to be conspecific with *Perisphinctes* (*Procerites*) *Matsushimai* (*sic*) by Yokoyama (1904, p.86, pl. I, fig. 1). The genus of this species was later reclassified as a genus of *Kranaosphinctes* by Fukada (1949), and this assignment continues to be adopted by later authors. The number of ribs in the inner whorl of the present specimen is about 46, and it is close to that of the type specimen, and deep constrictions are

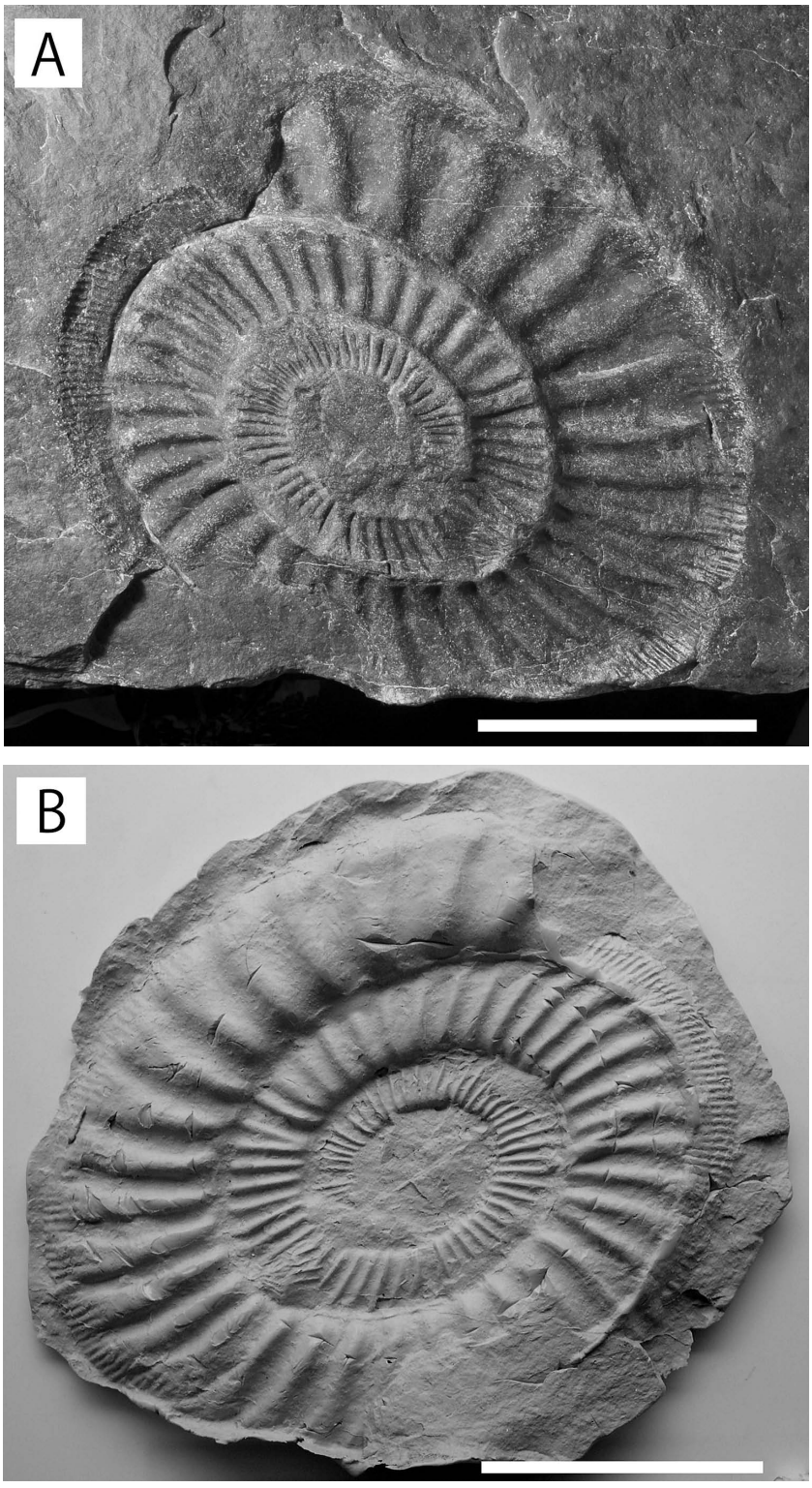

Fig. 3 *Perisphinctes* (*Kranaosphinctes*) *matsushimai* (Yokoyama) (TOYA-Fo-7277) from the Arimine Formation. Scale bar is 10 cm. A, Lateral view of the outer mould; B, Rubber cast from A.

also similar to those of the type specimen (D=138 mm). The whorl shape and ornamentation of this specimen gradually change while maintaining the same property from immature to the adult stage. This is one of the most important characteristics of the genus *Kranaosphinctes,* as discussed by Arkell (1935-1948) and adopted by almost all later authors.

Geological Formation: We can judge Arimine Formation, Kuzuryu Group, from the age of the ammonoid, the lithology of the rock containing the specimen and geological surroundings around the locality.

Geological age: Middle Oxfordian.

Occurrence: A branch of Higashisakamori-dani Valley (Fig. 1-1).

Perisphinctes (*Perisphinctes*) cf. *ozikaensis* Fukada

Fig. 4

Perisphinctes (*Perisphinctes*) *ozikaensis* Fukada, 1950, p.212, pl.I, fig.1.

Material: Register number TOYA-Fo-7276, A slightly deformed inner mould collected by Masato Fujita in July 2017, from a float found in Higashisakamori-dani Valley (Fig. 1-2). D (long axis of specimen) ca. 168; UD ca. 89 (UD/D ca. 0.53); H (preserved last whorl) > 40; W unknown (compressed and only incomplete one side preserved).

Description: Coiling very evolute, inner whorls overlapped by next whorl only on the ventral part; primary ribs are rectiradiate; secondary ribs usually covered by the outer whorl are partly observable on the whorl, branch off three or four at the ventral margin; number of primary ribs per last whorl is about 39; primary ribs change shape to widely spaced swells on the preserved last whorl.

Observation: The specimen at hand is an inner mould of imperfect whorl. Characters of ribs varying according to the growth stage are not so clear. The ribbing on the preserved last whorl, however, seems to indicate the change of ribbing as slightly distant wavy swellings. Therefore definitive identification is impossible, but it can be said that the specimen belongs probably to the genus *Perisphinctes* s.s. in general outline as described above.

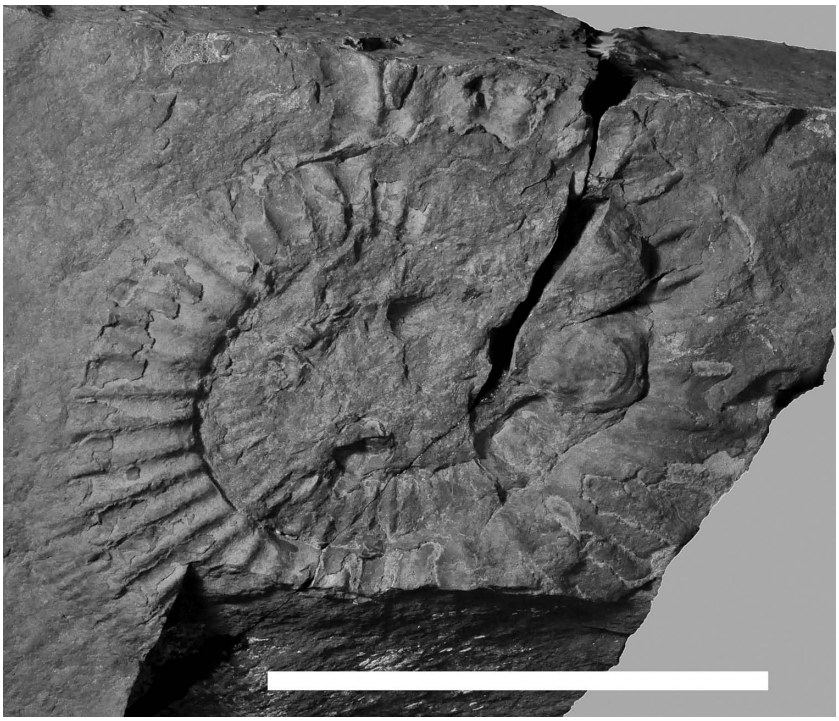

Fig. 4 *Perisphinctes* (*Perisiphinctes*) cf. *ozikaensis* Fukada (TOYA-Fo-7276) from the Arimine Formation. Scale bar is 10 cm.

Comparison: *Perisphinctes* s.s. has been discovered from dispersed sites of Japan (Fukada, 1950; Kato et al., 1977; Sato et al., 1986, 2012). Holotype of *Perisphinctes* (*Perisphinctes*) *ozikaensis* discovered from the Oshika Peninsula, Miyagi Prefecture, northeast Japan is a large but strongly deformed outer cast, measuring about 50 cm along the long axis of deformed whorls (Fukada, 1950, Pl. I, fig. 1). Many of the others are larger than 40 cm in size (Kato et al., 1977, fig. 2; Sato et al., 1986,

fig. 2). On the other hand, small size *Perisphinctes* (*Perisphinctes*) cf. *ozikaensis* (D=17cm) similar to holotype has already been reported from Higashisakamori-dani Valley, near the former locality (Sato et al., 2012; fig. 2). The present specimen seems to *Perisphinctes* (*Perisphinctes*) cf. *ozikaensis* because the ribs appear distant wavy swellings on the preserved last whorl instead of sharp ribs. Both ornamentation and size are similar.

Geological Formation: Arimine Formation of Kuzuryu Group as above.

Geological age: Due to imperfect specimen, accurate identification is not possible, however, above resemblance to *Perisphinctes* s.s. suggests the Oxfordian age.

Occurrence: Higashisakamori-dani Valley (Fig. 1-2)

Taramelliceras sp.

Fig. 5

Material: Register number TOYA-Fo-7275, A small outer mould with only the outermost whorl remaining, poor state of preservation. The present specimen collected by Masato Fujita in July 2017, from a float found in a branch of Higashisakamori-dani Valley (Fig. 1-3). D (long axis of specimen) ca. 30.4; UD ca. 7.7 (UD/D ca. 0.25); H (preserved last whorl) > 15; W unknown (compressed and only incomplete one side preserved).

Remarks: Discoidal, coiling is very involute, very small umbilicus. Ribbing is prominent, biconcave on the flank, with pronounced sharp forward bend at middle flank. Ribs are sharp, simple, biplicate at middle flank. Fine free ribs inserted near the aperture area. Partially bulging of the ribs is observable at ventrolateral shoulder and the knick point, though row of tubercles is not observable because the shell is juvenile. The present specimen seems to be similar to Taramelliceras cf. costatum (Sato and Yamada, 2014, fig. 9).

Geological Formation: Arimine Formation of Kuzuryu Group as above.

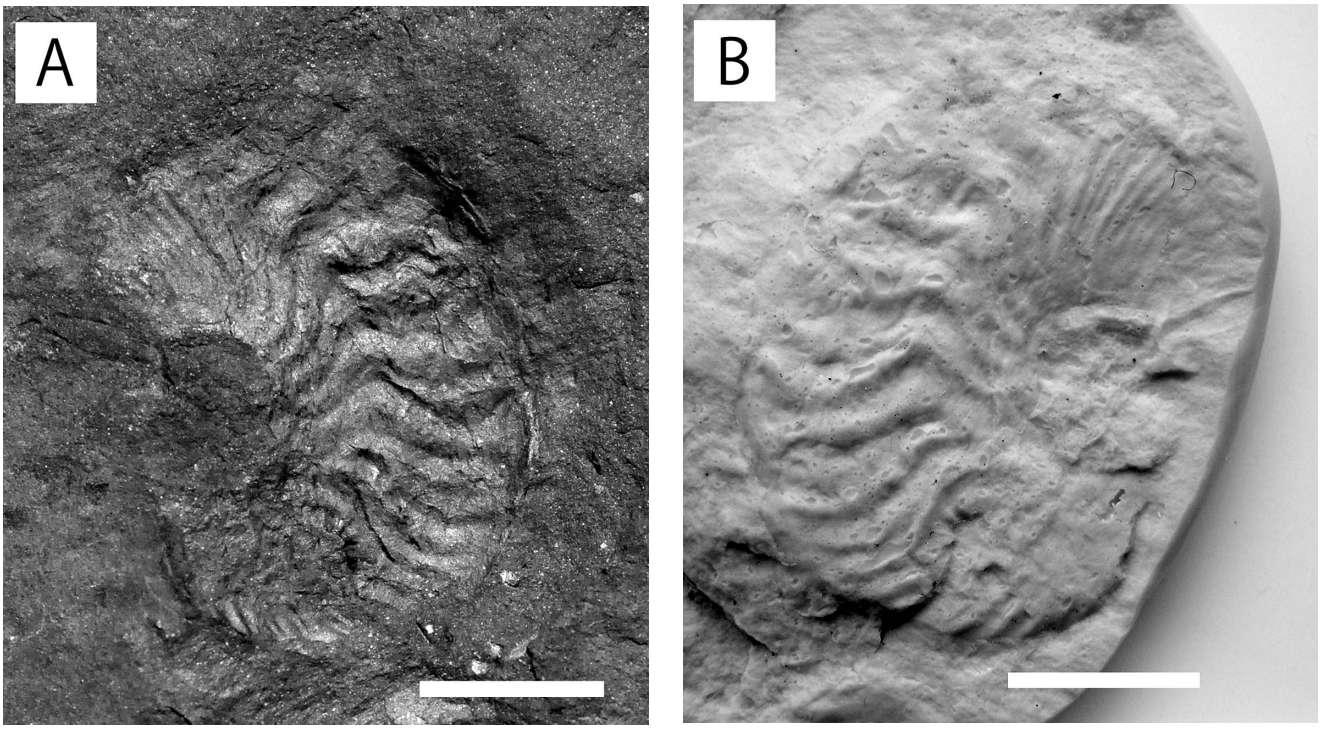

Fig. 5 *Taramelliceras* sp. (TOYA-Fo-7275) from the Arimine Formation. Scale bar is 1 cm. A, Lateral view of the outer mould; B, Rubber cast from A.

Geological age: *Taramelliceras* ranges from Callovian to Kimmeridgian in age.

Occurrence: A branch of Higashisakamori-dani Valley (Fig. 1-3).

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* : in Japanese

** : in Japanese with English abstract

<地名・地層名>

Akaiwa, 赤岩; Arimine, 有峰; Arimine acidic volcanics, 有峰酸性火山岩類; Arimine Formation, 有峰層; Arimine Lake, 有峰湖; Atotsugawa Formation, 跡津川累層; Fukui, 福井; Hakusan, 白山; Hida granitoids, 飛騨花崗岩類; Higashisakamori-dani, 東坂森谷; Higashisakamori Formation, 東坂森累層; Inone-dani, 猪根谷; Itoshiro, 石徹白; Jinzu, 神通; Jinzu Group, 神通層群; Kuzuryu, 九頭竜; Kuzuryu Group, 九頭竜層群; Kuzuryugawa, 九頭竜川; Magawa Formation, 真川層; Makawa, 真川; Miyagi, 宮城; Nagatogawa Formation, 長棟川累層; Oshika Peninsula, 牡鹿半島; Sino-Korean Craton, 中朝地塊; Tetori Group, 手取層群; Toyama, 富山; Wadagawa, 和田川.