

DESIGNATION OF THE TYPE SECTION OF THE TETORI GROUP AND
REDEFINITION OF THE KUZURYU GROUP, DISTRIBUTED IN CENTRAL JAPANToshihiro YAMADA¹ and Shin-ichi SANO²¹ Botanical Gardens, Faculty of Science, Osaka City University, Kisaichi, Katano, Osaka 576-0004, Japan² Graduate School of Science and Engineering for Research, University of Toyama, 3190 Gofuku, Toyama, Toyama 930-8555, Japan

ABSTRACT

Recent stratigraphic reviews suggested that the Kuzuryu Subgroup should be excluded from the Tetori Group (*sensu lato*), as in the original definition of the group by Oishi (1933b). Here, we redefine the Tetori Group following Oishi's (1933b) definition and designate the Itoshiro area in the Kuzuryu region, Fukui Prefecture, the Hakusan Geological Region, central Japan as the type section. We also propose a definition of the Kuzuryu Group involving some modification of Maeda's (1961) Kuzuryu Subgroup.

Key words : Tetori Group, Kuzuryu Group, Jurassic, Early Cretaceous, central Japan

山田敏弘・佐野晋一（2018）手取層群の模式地の指定と九頭竜層群の再定義．福井県立恐竜博物館紀要 17：89–94.

近年行われた層序学的総括の結果、大石（1933b）の初定義のように、手取層群（広義）から九頭竜（龍）亜層群を除くことが提案された。本報告では、この大石（1933b）の定義に従い手取層群を再定義するとともに、その模式地として福井県九頭竜地域の石徹白地区を指定する。また、前田（1961）による九頭竜亜層群を一部改変し、九頭竜層群を提唱する。

Middle Jurassic to Lower Cretaceous deposits are widely distributed in the Hokushinetsu and Hida Districts of central Japan (Fig. 1). Collectively, Maeda (1961) classified these deposits as the Tetori Group following a comprehensive stratigraphic study. Although Maeda (1961) also included the Upper Cretaceous Asuwa and Omichidani Formations in the Tetori Group, the currently prevailing usage of the Tetori Group does not include these two formations, based on their contexts (Sano, 2015; Yamada, 2017). Therefore, the Middle Jurassic to Lower Cretaceous part of the Tetori Group (*sensu* Maeda, 1961) is referred to as the Tetori Group *sensu lato* (*s.l.*) in this note.

Maeda (1961) divided the Tetori Group (*s.l.*) into three subgroups: the Kuzuryu (Middle to Upper Jurassic), Itoshiro (Upper Jurassic to Lower Cretaceous), and Akaiwa (Lower Cretaceous), in ascending order. According to Maeda (1961), the Kuzuryu Subgroup consists mostly of marine sediments, and the Itoshiro and Akaiwa Subgroups are composed of non-marine sediments. This “canonical stratigraphic scheme” has long been

widely used, although recent reviews (Sano, 2015; Yamada, 2017) indicate that part of the Kuzuryu Subgroup should be excluded from the rest of the Tetori Group (*s.l.*) based on recent ammonoid biostratigraphic studies, especially on the Itoshiro Subgroup (e.g., Sato et al., 2003, 2008; Sato and Yamada, 2005, 2014).

We held a seminar at the 2018 Annual Meeting of the Palaeontological Society of Japan to discuss how we could incorporate recent progress in biostratigraphy and tectonics into the definition of the Tetori Group. After considering the opinions of the attendees, we formally define the Tetori Group herein by designating type sections in the Itoshiro area, the Hakusan Geological Region, central Japan (Figs. 1 and 2). We also propose that the Kuzuryu Group (redefined herein) be restricted to the Middle to Upper Jurassic deposits along the Itoshirogawa and Kuzuryugawa Rivers (Figs. 1 and 2). The problems regarding the current definition of the Tetori Group (*s.l.*) are summarized briefly below, and details are available in previous reviews (Sano, 2015; Yamada, 2017).

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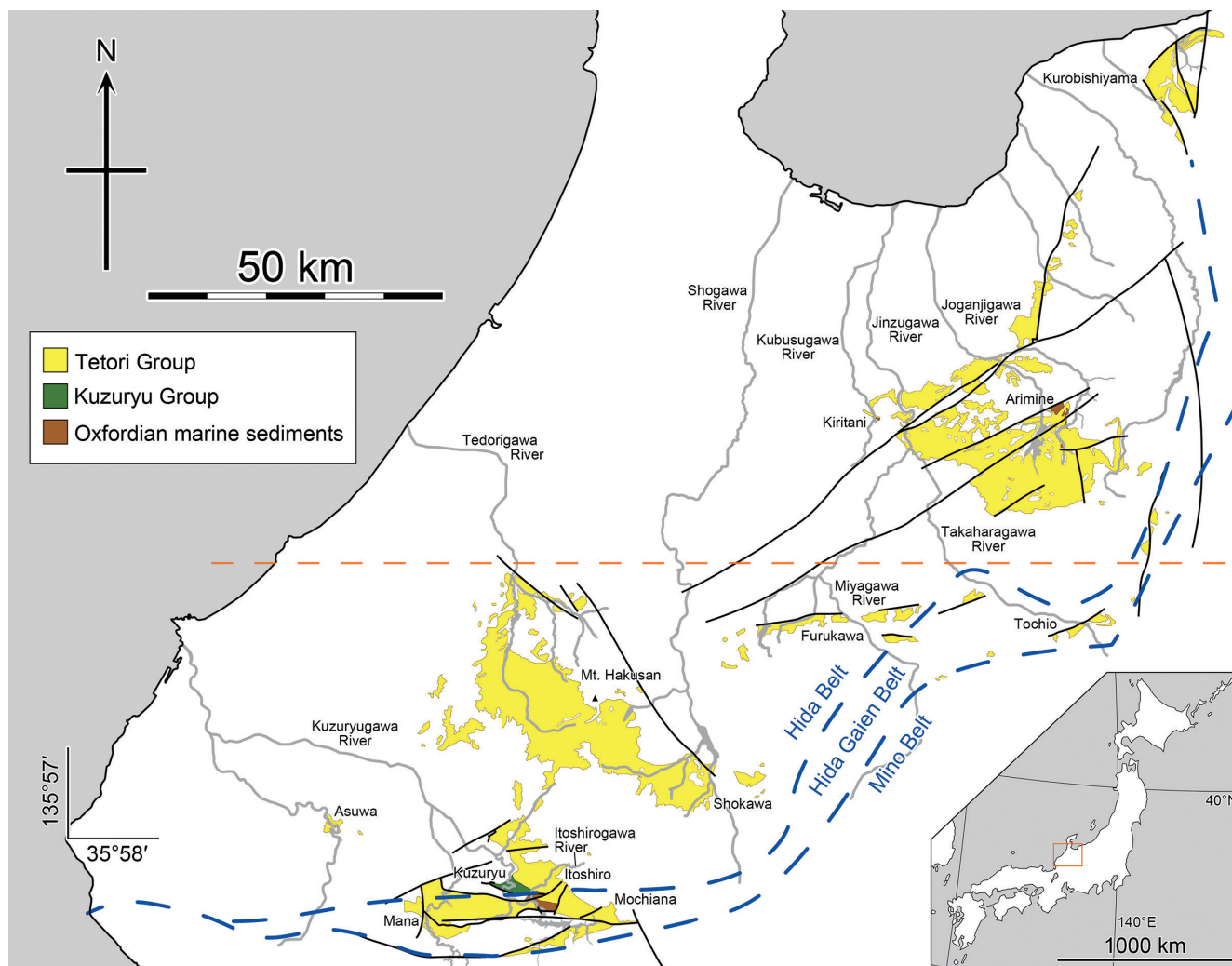


FIGURE 1. Distribution of the Kuzuryu and Tetori Groups, based on Maeda (1961), Yamada K. et al. (1989), Yamada N. et al. (1989), Wakita et al. (1992), Harayama et al. (1996), Kano et al. (1999), Takeuchi et al. (2015), and Sakai et al. (2018). The distribution is largely divided into two Geological Regions, *i.e.*, Hakusan (south of the red dashed line) and Jinzu (north of the red dashed line). The Oxfordian marine sediments (colored brown) were formerly included in the Kuzuryu Subgroup (*sensu* Maeda, 1961), but are excluded from the Kuzuryu Group redefined herein.

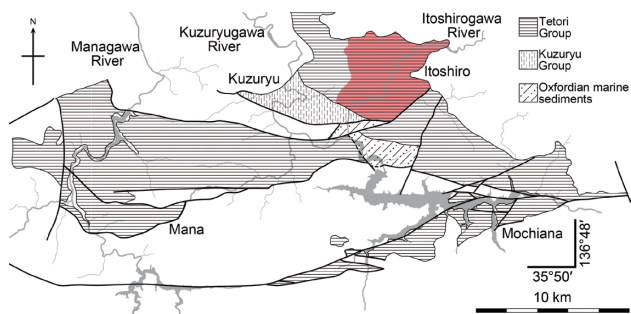


FIGURE 2. Type sections of the Kuzuryu and Tetori Groups. The type area of the Tetori Group is colored red.

ORIGINAL AND CURRENTLY PREVAILED DEFINITIONS OF THE TETORI GROUP (*S.L.*)

Oishi (1933a, b) first used the term “Tetori Group” to name a lithostratigraphic unit. In the original definition of the Tetori Group, Oishi (1933a, b) did not include the marine Kaizara and Kiritani Formations (found in the Itoshiro and Kiritani areas, respectively; Fig. 1), although they belong to the Kuzuryu Subgroup of the Tetori Group (*s.l.*) in Maeda’s (1961) stratigraphy (Fig. 3).

Subsequently, Iwaya (1940) reported on marine sediments containing ammonoids in the Shokawa area (Fig. 1), which are now called the Mitarai Formation (Maeda, 1952a, 1961). The Mitarai Formation is conformably overlain by non-marine sediments that Oishi (1933a, b) included in his Tetori Group. Maeda (1952a, b) considered the Mitarai Formation to be coeval

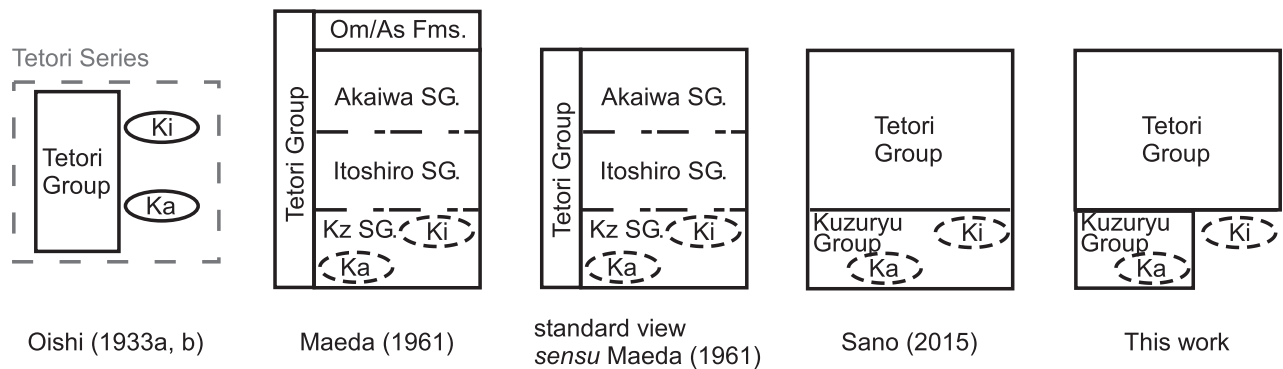


FIGURE 3. Schematic comparison of the stratigraphic interpretations of this study with those of previous studies. Ka, Kaizara Formation; Ki, Kiritani Formation; Om/As Fms, Omichidani/Asuwa Formations; SG, Subgroup.

with the Kaizara Formation (Fig. 3), interpreting the depositional environment as changing from the marine Kuzuryu Subgroup to the non-marine Itoshiro Subgroup with no depositional hiatus, at least in the proximal part of the sedimentary basin (i.e., the Shokawa area), although an unconformable relationship between these two subgroups is recognized in the likely marginal part of the basin (i.e., the Itoshiro area). In other words, Maeda (1952a, b) thought that the Kaizara Formation and Oishi's (1933a, b) Tetori Group were formed in a depositional sequence. Therefore, Maeda (1961) classified the marine Kaizara, Kiritani, and Mitarai Formations as the Kuzuryu Subgroup, which comprises the Tetori Group along with the non-marine Itoshiro and Akaiwa Subgroups.

Recent biostratigraphic studies of ammonoids showed that the Mitarai Formation is Tithonian to Berriasian in age (Sato et al., 2003, 2008), differing from the Bathonian to Callovian age of the Kaizara Formation (Sato and Westermann, 1991). In addition, at least two marine transgressions were recognized in the sediments that Maeda (1961) classified as the Itoshiro Subgroup, which are dated to the Tithonian (Sato and Yamada, 2005) and Hauterivian to Barremian (Goto, 2007) or Barremian to Aptian (Matsukawa et al., 2007), respectively. As the Mitarai Formation could have formed during the earlier marine transgression, it is now included in the Itoshiro Subgroup (Fig. 3; Sato and Yamada, 2005; Yamada and Uemura, 2008).

These biostratigraphic data clearly suggest that a hiatus of at least ca. 5 million years (i.e., the late Oxfordian to early Tithonian) occurred between deposition of the Kuzuryu and Itoshiro Subgroups in all distributional areas of the Tetori Group (*s.l.*) (Sato and Yamada, 2014). Therefore, Kuzuryu Subgroup (i.e., deposits older than the Tithonian) should not be included in the Tetori Group (Sano, 2015; Yamada, 2017), as in Oishi's (1933a, b) original definition. We redefine a part of these excluded sediments as the Kuzuryu Group. As Oishi (1933a, b) did not designate a type section for the Tetori Group, we choose the Itoshiro area in the Kuzuryu region, Fukui Prefecture, as the type section (Fig. 2). The Itoshiro area is suitable as the type section for the following reasons: 1) it is where the boundary between the Kuzuryu Subgroup and the rest of the Tetori Group (*s.l.*) is best observed (Oishi, 1933a; Maeda, 1952b); 2) the Tetori Group

(*s.l.*) stratigraphy is undisputed; and 3) the stratigraphic standard of the Tetori Group (*s.l.*) was originally established there (e.g., Yokoyama, 1895, 1904; Oishi, 1933a, b).

STRATIGRAPHIC NOTES

1. Kuzuryu Group (redefined)

Author—Maeda (1952b)

Type section—Areas along the Itoshirogawa and Kuzuryugawa Rivers (Figs. 1 and 2)

Note—The Kuzuryu Group, as redefined here, includes the Shimoyama [conglomerate, a name used originally in Maeda (1961), as are the following names], Oidani (alternation), Tochimochiyama (sandstone), Kaizara (shale), and Yambarazaka (alternation) Formations of Maeda (1961). However, our Kuzuryu Group does not include the Oxfordian sediments (Sano et al., 2013; Sakai et al., 2018) distributed in the Middle Row of the Kuzuryu region (*sensu* Sano et al., 2013) (Figs. 1 and 2), which were included in the Kaizara Formation by Oishi (1933a, b) and Maeda (1952b, 1961). As Sano et al. (2013) pointed out, the Oxfordian sediments are lithologically and biostratigraphically distinguishable from those of the Kuzuryu Group (redefined herein). We also do not include the Oxfordian Kiritani and Arimine Formations (*sensu* Maeda, 1961) distributed in the Jinzu Geological Region (Fig. 1) in the Kuzuryu Group because we believe that the relationship between the Kuzuryu Group and Kiritani/Arimine Formations needs to be reconsidered in light of basin and tectonic analyses.

2. Tetori Group

Author—Oishi (1933b)

Type section—Areas along the Itoshirogawa River (red area in Fig. 2).

Note—The Tetori Group in the type area consists of the Yambara (conglomerate), Ashidani (shale), Obuchi (conglomerate), Izuki (shale), Akaiwa (sandstone), and Kitadani (alternation) Formations of Maeda (1961). In areas other than the Asuwa, Mochiana, Shokawa, Furukawa, and Kurobishiyama (Tomari) areas, the Tetori

Group corresponds to the Itoshiro and Akaiwa Subgroups of Maeda (1961). In the Asuwa, Mochiana, Shokawa, and Furukawa areas, our Tetori Group is equivalent to Maeda's (1961) Tetori Group (*s.l.*). In the Kurobishiyama area, our Tetori Group follows the Tetori Group of Takeuchi et al. (2015).

Matsukawa et al. (2014) proposed the Jinzu Group for the Itoshiro and Akaiwa Subgroups (*sensu* Maeda, 1961) distributed in the Jinzu Geological Region (Fig. 1). They argued that the Jinzu Group is younger than the Akaiwa Subgroup (*sensu* Maeda, 1961), which occurs in the Hakusan Geological Region (Matsukawa et al., 2014). However, recent re-evaluation of zircon U-Pb ages does not support their interpretation (Nagata et al., 2018).

Use of the Managawa Group (Kobayashi, 1954) is proposed for the Tetori Group (redefined herein) distributed in the Middle Row of the Kuzuryu Region (Sano, 2015). However, we tentatively include the "Managawa Group" in our Tetori Group because Sano's (2015) arguments need to be tested in further biostratigraphic studies.

The term "Subgroup" has been used for the Tetori Group (*s.l.*) (Maeda, 1961), and such a classification seems to facilitate stratigraphic comparison among the distributional areas, although Matsukawa et al. (2006 and subsequent studies) have challenged this stratigraphic opinion. We do not recommend use of the Itoshiro and Akaiwa Subgroups for the Tetori Group redefined here; the boundary between the Itoshiro and Akaiwa Subgroups is marked by thick sandstone at the base of the Akaiwa Subgroup (Maeda, 1961), but thick sandstone could not be compared among the distributional areas in terms of depositional age (Nagata and Otoh, personal comm.).

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* : in Japanese

** : in Japanese with English abstract

APPENDIX 1. Toponyms and geological names appearing in this report.

Names	Names in Japanese	Names	Names in Japanese
Akaiwa Formation	赤岩層	Kurobishiyama	黒菱山
Akaiwa Subgroup	赤岩亜層群	Kuzuryu	九頭龍(竜)
Arimine	有峰	Kuzuryu Group	九頭龍(竜)層群
Arimine Formation	有峰層	Kuzuryu Subgroup	九頭龍(竜)亜層群
Ashidani Formation	葦谷層	Kuzuryugawa River	九頭龍(竜)川
Asuwa	足羽	Mana	真名
Asuwa Formation	足羽層	Managawa Group	真名川層群
Fukui	福井	Managawa River	真名川
Furukawa	古川	Mino Belt	美濃帯
Hakusan Geological Region	白山区	Mitarai Formation	御手洗層
Hida	飛騨	Miyagawa River	宮川
Hida Belt	飛騨帯	Mochiana	持穴
Hida Gaien Belt	飛騨外縁帯	Mt. Hakusan	白山
Hokushinetsu	北信越	Obuchi Formation	大淵層
Itoshiro	石徹白	Omichidani Formation	大道谷層
Itoshiro Subgroup	石徹白亜層群	Shimoyama Formation	下山層
Itoshirogawa River	石徹白川	Shogawa River	庄川
Izuki Formation	伊月層	Shokawa	莊川
Jinzu Geological Region	神通区	Takaharagawa River	高原川
Jinzu Group	神通層群	Tedorigawa River	手取川
Jinzugawa River	神通川	Tetori Group	手取
Joganjigawa River	常願寺川	Tochimochiyama Formation	栃餅山層
Kaizara Formation	貝皿層	Tochio	栃尾
Kiritani	桐谷	Tomari	泊
Kiritani Formation	桐谷層	Toyama	富山
Kitadani Formation	北谷層	Yambara Formation	山原層
Kubusugawa River	久婦須川	Yambarazaka Formation	山原坂層