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Stratigraphy of the late Mesozoic Tetori Group in the Hakusan Region, central Japan: an overview

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ABSTRACT

The late Mesozoic Tetori Group is distributed in central Japan. Although the stratigraphy of this Group is thought to be quite important to study the fossil assemblage including various vertebrate remains collected from the Group, it is rather complicated. We review in the present paper the geological studies on the Tetori Group around Mt. Hakusan to give accurate information especially on the stratigraphy of this Group.

The Tetori Group consists of the Kuzuryu, Itoshiro and Akaiwa subgroups in ascending order. The formations compose these subgroups in the reviewed districts are as follows.

Kuzuryu River district, Fukui Prefecture
Kuzuryu Subgroup. Shimoyama, Oidani, Tochimochiyama, Kaizara and Yambarazaka formations.
Itoshiro Subgroup. Yambara, Ashidani, Obuchi and Itsuki formations.
Akaiwa Subgroup. Akaiwa and Kitadani formations.
Tedori River district, Ishikawa Prefecture
Itoshiro Subgroup. Gomijima and Kuwajima formations.
Akaiwa Subgroup. Akaiwa and Myodani formations.
Shokawa district, Gifu Prefecture
Kuzuryu Subgroup. Ushimaru, Akahoke and Mitarai formations.
Itoshiro Subgroup. Otaniyama, Okurodani and Amagodani formations.
Akaiwa Subgroup. Okura and Bessandani formations.

Following formations are thought to be almost the same horizon: the upper part of the Kaizara Formation and the lower part of the Mitarai Formation; the Kuwajima, Itsuki and Okurodani formations; the lower part of the Akaiwa Formation along the Tedori and Kuzuryu rivers and the Okura Formation.

Only five formations are correlated to the geologic time units based on the index fossils: the Kaizara (Bathonian to Oxfordian), Yambarazaka (Oxfordian), Mitarai (Callovian to ?Tithonian), Kitadani and Myodani (upper Barremian to lower Aptian) formations. To summarize, the Kuzuryu, Itoshiro and Akaiwa subgroups in these districts are roughly correlated to the Middle to Upper Jurassic, Upper Jurassic to lower Lower Cretaceous and Lower Cretaceous, respectively.

The formations from which vertebrate remains have been collected are: the Otaniyama, Itsuki, Kuwajima, Okurodani and Amagodani formations of the Itoshiro Subgroup, and the Akaiwa and Kitadani formations of the Akaiwa Subgroup.

INTRODUCTION

The Middle Jurassic to Lower Cretaceous Tetori Group is distributed in central Japan. This Group is composed of the Middle to Upper Jurassic Kuzuryu Subgroup, Upper Jurassic to Lower Cretaceous Itoshiro Subgroup and Lower Cretaceous Akaiwa Subgroup in ascending order (Maeda, 1952a, 1961e). A number of fossils such as plants, invertebrates and vertebrates have been discovered

from the Group, and particularly, the fossils from the Neocomian part of this Group compose one of the most diverse assemblages of the world. The Group, therefore, is important to understand the Jurassic to Cretaceous biota in Asia of that period. Moreover, the Tetori Group is unique since it is composed of both marine and non-marine deposits of this period. It thus provides significant paleontological informations upon correlation between marine and non-marine faunas of the late Mesozoic.

However, the stratigraphy of the Group is complicated, especially for the foreign researchers, because distribution of the Tetori Group is broad, and, since the mountains are quite precipitous, the formations composing this Group are given different names regionally (Maeda, 1961e). In the present paper, we review the geological studies on the Tetori Group, especially around Mt. Hakusan to settle the complication and give accurate information on the geology and paleontology of this Group.

PREVIOUS STUDIES

It was more than one hundred years ago that studies about the Tetori Group were started. Geyler (1877) reported the fossil plants that had been collected from Shiramine Village, Ishikawa Prefecture, where the Group is distributed, and proposed that they can be correlated to the Middle Jurassic flora in Siberia. The studies after that are mentioned in detail in Maeda (1961e), Matsuo and Omura (1966) and Ishikawa Prefecture Board of Education (1978). The outline of the previous studies is simply described here.

After the Geyler's report, many authors have paleontologically worked mainly on fossil plants from this Group (e.g. Yokoyama, 1889; 1894; Nathorst, 1890; Seward, 1907; Yabe, 1922; Tanaka, 1926; Kobayashi, 1927, 1939; Oishi, 1933a, b, 1936, 1940; Shimakura, 1934; Ogura et al., 1951; Amano and Endo, 1952; Maeda, 1952b, 1954, 1955b, c, d; Kimura, 1953, 1957, 1958, 1961, 1975a, b; Matsuo and Kida, 1953; Matsuo, 1954a, b, 1989; Matsuo and Omura, 1968; Kimura and Sekido, 1971, 1975, 1976a, b, 1978; Kimura and Asama, 1975; Masuda and Watanabe, 1979; Suzuki and Terada, 1989; Ge et al., 1993; Ohana and Kimura, 1994; Chiba and Oura, 1995; Kimura and Ohana, 1997). Yokoyama (1889) reported many fossil plants and suggested that they are of Middle Jurassic. Then Yokoyama (1894) named the Mesozoic formations, which are distributed in this area and are abundant in Middle Jurassic fossil plants, the Tetori Series. The flora collected from the Tetori Group indicates temperate and moderately humid climate (e.g. Ohana and Kimura, 1995).

In addition to the plants, invertebrate fossils such as ammonites and bivalves have been found from the Group (e.g. Yokoyama, 1904; Kobayashi, 1927; Oishi, 1933a, b; Kobayashi and Suzuki, 1937; Maeda, 1949a, 1955b, 1959c, 1962a, b, c, 1963a, b; Hayami, 1959a, b, 1960; Kobayashi et al., 1959; Sato, 1962; Maeda and Kawabe, 1963; Sato and Kanie, 1963; Fujiyama, 1978; Ido and Matsukawa, 1989; Tamura, 1989; Isaji and Hasegawa, 1990; Isaji, 1993; Matsukawa and Ito, 1995; Matsukawa et al., 1997; Fujita et al., 1998; Nakada et al., 1998; Ito et al., 1999; Kumon and Umezawa, 2001). Several formations are correlated to the geologic time units by some of these ammonites and bivalves.

As studies on the Tetori Group were advanced, discoveries of many vertebrate remains including dinosaur footprints have become reported and they have been studied intensively (e.g. Shikama, 1969; Azuma et al., 1987; Azuma and Hasegawa, 1987, 1989; Azuma et al., 1988; Azuma, 1990, 1991a, b; Kondo et al., 1990; Takeyama et al., 1990; Azuma et al., 1992; Goto, 1992; Kojima et al., 1992; Takeyama et al, 1992; Azuma et al., 1994; Hasegawa et al., 1995; Hirayama, 1996a, b, 1997, 1999a, b, 2000; Hirayama and Azuma, 1996; Hirayama et al., 1996; Manabe and Evans, 1996; Matsukawa et al., 1996, 1997; Unwin, Manabe et al., 1996; Unwin, Shimizu et al., 1996; Evans and Manabe, 1997a, b, 1998; Yabumoto, 1997, 2000; Cook et al., 1998; Gifu-ken Dinosaur Fossil Excavation Party, 1999b; Kobayashi, 1999; Manabe, 1999; Azuma and Currie, 2000; Hirayama et al., 2000; Isaji and Okazaki, 2000; Manabe, Barrett et al., 2000; Matsuoka, Isaji et al., 2001; Shikano et al., 2001). In the last few years, tritylodontids (Setoguchi et al., 1998; Matsuoka et al., 1999; Setoguchi et al., 1999; Matsuoka, 2000a, 2000c; Matsuoka and Setoguchi, 2000) and fossil mammals (Manabe, Rougier et al., 2000; Rougier et al., 1999; Takada and Matsuoka, 2001; Takada et al. 2001) have been found, and it has become clear

that the vertebrate fossil assemblage collected from the Tetori Group contains diverse taxa.

Other geological studies have also been progressed (e.g. Fujimoto, 1930; Imamura, 1933; Ijiri, 1936; Iwaya, 1940; Suzuki, 1943; Ueda and Matsuo, 1950; Kobayashi, 1954; Hirayama et al., 1955; Kawai, 1955, 1959, 1961a, b; Obara, 1961; Omura, 1964, 1965, 1967, 1973; Bessho and Fuji, 1967; Kano, 1986; Matsuo, 1989a; Yamada, Niwa et al., 1989; Takeuchi and Takizawa, 1990; Takeuchi et al, 1991; Koido and Harayama, 1992; Soma et al., 1992; Gifu-ken Dinosaur Research Committee, 1993; Matsukawa et al., 1993; Ishimoto, 1994; Kumon et al., 1994; Suzuki et al., 1994; Fujita et al., 1995; Tsujimori, 1995; Kusunoki, 1997; Takizawa, 1998; Hasegawa and Yoshida, 1999; Matsukawa and Nakada, 1999; Matsukawa and Takahashi, 1999). These studies provided important informations about the Tetori Group, for example: the Tetori Group has deposited in the strike-slip basin (Masuda et al., 1991; Otoh, 1998); the Group had provenances except for the Hida Belt (Obayashi et al., 1992; Obayashi, 1995; Sugimoto et al., 1997; Sugimoto et al., 1998). Dr. Shiro Maeda energetically studied about the Tetori Group, and disclosed the great aspects such as stratigraphy and geological structures of this Group (e.g. Maeda, 1949b, 1950a, b, 1951a, b, 1952a, c, 1953, 1955a, 1956, 1957a, b, c, d, e, f, 1958a, b, c, 1959a, b, d, 1960a, b, 1961a, b, c, d, e; Maeda et al., 1954; Maeda and Takenami, 1957a, b; Takenami and Maeda, 1957, 1959; Maeda and Fukui, 1960; Maeda and Nagasaki, 1964). Recently, several sedimentological investigations were conducted as well (e.g. Takizawa and Takeuchi, 1990; Kumon and Kano, 1991; Masuda et al., 1991; Takeuchi and Takizawa, 1991; Fujita et al., 1994; Fujita, 1996, 1997; Umezawa, 1997; Gifu-ken Dinosaur Fossil Excavation Party, 1999a; Okazaki and Isaji, 1999; Kumon and Umezawa, 2001), and the sedimentary environments of this Group have been revealed increasingly.

STRATIGRAPHY OF THE TETORI GROUP

The Middle Jurassic to Lower Cretaceous Tetori Group is distributed in Ishikawa, Gifu, Fukui, Toyama and Nagano prefectures of the Inner Zone of central Japan (Fig. 1). It unconformably overlies the Paleozoic metamorphic rocks and the Triassic to Early Jurassic granites, Hida Gneiss and Granites, in the northern area, and the Paleozoic sedimentary rocks and the Sangun Schists in the southern area (Maeda, 1961e).

The name "Tetori Group" has been used without being clearly defined. The Tetori Series (Yokoyama, 1894) became to be called afterward as the Tetori Group (e.g. Oishi, 1933a; Maeda, 1949a) or the Tetori Supergroup (e.g. Maeda, 1951b; Kawai, 1961a, b). Maeda (1961e) used the "Tetori Group" and completed the stratigraphy of the Group, and after then it became generally defined as the Group. We use the name Tetori Group of Maeda (1961e).

The Tetori Group is composed of three subgroups: the Kuzuryu, Itoshiro and Akaiwa subgroups in ascending order (Maeda, 1952a, 1961e). These subgroups were primarily defined as groups (Maeda, 1951b, 1952a) but later they became called as subgroups (e.g. Maeda, 1955d, 1957a, b, 1961e).

Maeda (1961e) divided the distribution of the Tetori Group into the Hakusan and Jinzu regions (Fig. 1). In the present paper, we review the stratigraphy of the Tetori Group in the Hakusan region, especially in the Kuzuryu River, Tedori River and Shokawa districts (Fig. 2), because these districts are typical of the Group.

As for the stratigraphy of the Tetori Group in these districts, we mostly follow Maeda (1961e) and Ishikawa Prefecture Board of Education (1978). References cited in lithofacies sections are mentioned at the end of each section.

1. HAKUSAN REGION

The Hakusan region is the typical wide distribution of the Tetori Group. Stratigraphy of the Group along the Kuzuryu River, Tedori River, and in the Shokawa district (Fig. 2) is reviewed here. The geological correlation is shown in Fig. 3. A number of important Mesozoic fossil records including plants and vertebrates have been reported from these districts (Fig. 4).

1. 1 Along the Kuzuryu River, with Itoshiro and Takinami Rivers

The Kuzuryu, Itoshiro and Akaiwa subgroups are

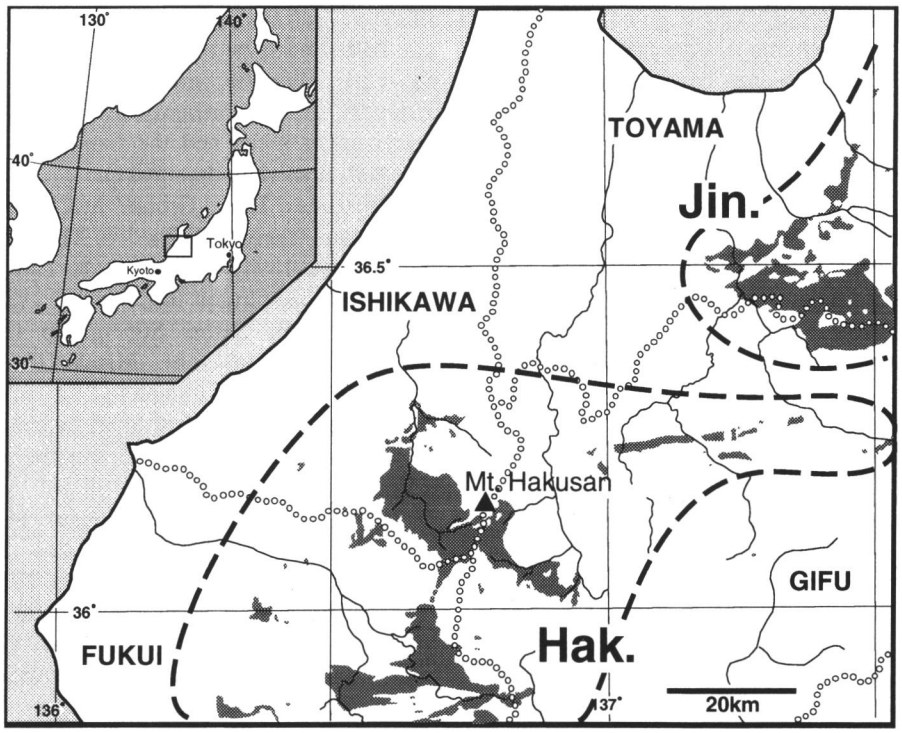

Fig. 1. Main distribution of the Tetori Group (modified from Maeda, 1961e). Hak., Hakusan region; Jin., Jinzu region.

distributed along the Kuzuryu, Itoshiro and Takinami rivers (Maeda, 1961e). The upper part of the Akaiwa Subgroup is typically distributed along the Takinami River. The Tetori Group in this district contacts with faults or unconformably overlies the Hida Gneiss, Permian, Carboniferous, Silurian-Devonian and schists, and is overlain by the Upper Cretaceous or Tertiary volcanic and plutonic rocks (Yamada, Niwa et al., 1989). The Kuzuryu Subgroup in this district is composed of the Shimoyama, Oidani, Tochimochiyama, Kaizara and Yambarazaka formations, Itoshiro Subgroup is of Yambara, Ashidani, Obuchi and Itsuki formations, and Akaiwa Subgroup is of Akaiwa and Kitadani formations, in ascending order (Maeda, 1952c, 1961e). The standard division of the Kuzuryu and Itoshiro subgroups was defined in this district (Maeda, 1961e).

Kuzuryu Subgroup

The Kuzuryu Subgroup (Maeda, 1951b, 1952a, 1961e) in this district consists of conglomerates, pebbly sandstones, sandstones and shales. The lowermost part of the Subgroup is composed of basal conglomerate, and upper part is of marine deposits (Maeda, 1961e). In this district, the total thickness of this Subgroup is about 1000 m (Maeda, 1961e).

Shimoyama Formation

Author. Maeda (1950a, 1952c).

Other names. 'Shimoyama Conglomerate' (Maeda, 1961e); 'Lowest Formation' (Yamada, Niwa et al., 1989).

Type section. Shimoyama, Izumi Village, Fukui Prefecture (type section of the 'Shimoyama Conglomerate' of Maeda, 1961e).

Thickness. 200 to 300 m (Maeda, 1961e).

Lithofacies. The Shimoyama Formation is the basal conglomerate of the Tetori Group, and consists of conglomerates (dominant) and coarse-grained or pebbly sandstones. Conglomerates are composed mainly of rounded or subrounded pebbles and cobbles of clastic rocks such as granite, gneiss, limestone, chert, sandstone and shale.

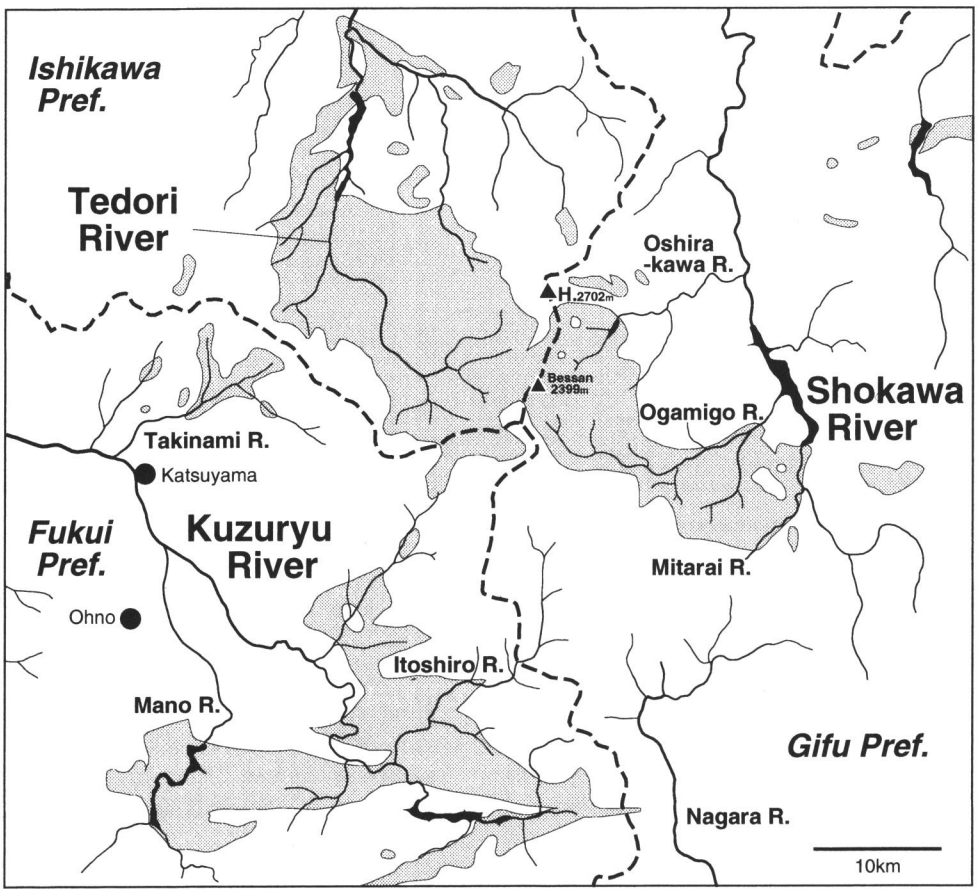

Fig. 2. Main distribution of the Tetori Group in the Hakusan region (modified from Yamada, Nozawa et al., 1989; Yamada et al., 1990; Wakita et al., 1992; Kano et al., 1999).

(Maeda, 1952c, 1961e; Yamada, Niwa et al., 1989).

Fossils. Few fossils (Maeda, 1952c; Yamada, Niwa et al., 1989).

Age. Middle Jurassic?

Oidani Formation

Author. Maeda (1952c).

Other names. 'Shimowakogo Sandstone and Shale' (Kobayashi, 1954); 'Oidani Alternation' (Maeda, 1961e); lower part of the 'Lower Formation' (Yamada, Niwa et al., 1989).

Type section. North part of Tandoguchi, Izumi, Fukui (type section of the 'Oidani Alternation' of Maeda, 1961e).

Thickness. 300 m in north of Tandoguchi and 200 to 650 m in Mana River area (Maeda, 1961e).

Lithofacies. The Oidani Formation consists of alternations of coarse-grained sandstones and blackish shales. Upper part of this Formation is interpreted as marine deposits. It conformably overlies or partly interfingers with the Shimoyama Formation. (Kobayashi, 1954; Maeda, 1961e; Yamada, Niwa et al., 1989).

Fossils. Plants and belemnites (e.g. Maeda, 1952c, 1961e; Kobayashi, 1954).

Age. Middle Jurassic?

Tochimochiyama Formation

Author. Maeda (1950a, 1952c).

Other names. 'Dosaiyama Conglomerate and Sandstone' (Maeda, 1961b); 'Tochimochiyama Sandstone' (Maeda, 1961e); upper part of the 'Lower Formation' (Yamada, Niwa et al., 1989).

Type section. Oidani to Horadani, Izumi, Fukui

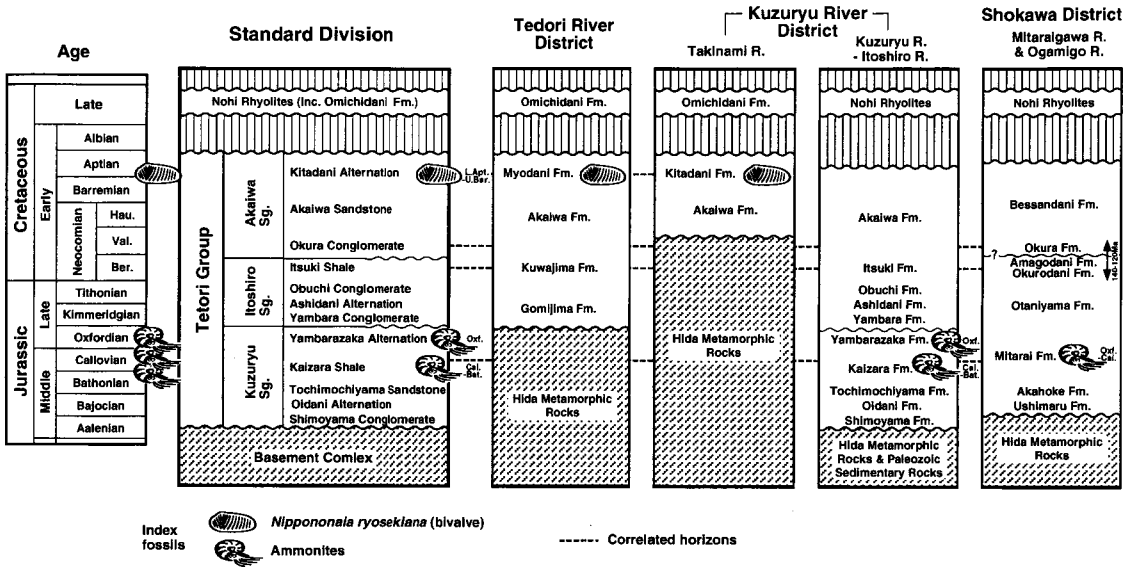

Fig. 3. Schematic stratigraphy of the Tetori Group in the Hakusan region. Stratigraphy is modified after Maeda (1961e). Index fossil records are from Maeda (1961e); Sato (1962); Sato et al. (1963); Sato and Kanie (1963); Isaji (1993). Radiometric ages are from Gifu-ken Dinosaur Research Committee (1993).

(type section of the 'Tochimochiyama Sandstone' of Maeda, 1961e).

Thickness. 200 m in Itoshiro River area, 650 m in Ono River and 1800 m in Mana River (Maeda, 1961e).

Lithofacies. In the type section, the Tochimochiyama Formation is composed of alternation of pebbly sandstones and fine-grained sandstones, and rare shales are intercalated. Conglomerates come to be dominant to the westward, and are major along the Mana River. Sandstones are arkosic and light gray to light blue. Conglomerates consist of pebbles and cobbles of gneiss, granite, quartz porphyry, chert and sandstone. This Formation is thought to be fan-delta front to slope deposits. It overlies the Oidani Formation with conformity. (Maeda, 1952c, 1961b, e; Masuda et al., 1991).

Fossils. Plants and belemnites (e.g. Maeda, 1950a, 1952c, 1961b, e).

Age. Middle Jurassic?

Kaizara Formation

Author. Oishi (1933a); Maeda (1950a, 1952c).

Other names. 'Nagano (Shale) Formation' (Ijiri, 1936); 'Kurotodo Shale' (Kobayashi, 1954); 'Kaizara Shale' (Maeda, 1961e); 'Middle Formation' (Yamada, Niwa et al., 1989).

Type section. Horadani, Izumi, Fukui (type section of the 'Kaizara Shale' of Maeda, 1961e).

Thickness. 195 to 230 m in Itoshiro River area and 200 to 500 m in Ono River area (Maeda, 1961e).

Lithofacies. The Kaizara Formation consists mainly of massive or laminated blackish shales containing nodules, and alternations of sandstones and shales are frequently intercalated. The alternations are seen relatively more often in the western side. Lenticular fine to coarse-grained sandstones are occasionally observed, and light yellowish acid tuff is intercalated. This Formation is thought to consist of fan-delta slope deposits. It conformably overlies the Tochimochiyama Formation, and partly contacts the basement with fault or unconformity. (Maeda, 1952c, 1961c, e; Yamada, Niwa et al., 1989; Masuda et al., 1991).

Fossils. Marine mollusks such as ammonites, belemnites and *Inoceramus* (e.g. Yokoyama 1904; Oishi, 1933a; Ijiri, 1936; Kobayashi, 1947; Kobayashi and Fukada, 1947; Maeda, 1950a, 1952c, 1961e; Hayami, 1960; Sato, 1962; Sato et al., 1963; Yamada, Niwa et al., 1989).

Age. This Formation is correlated to the Bathonian to Oxfordian on the basis of ammonites (e.g. Kobayashi, 1947; Maeda, 1952c, 1961e; Sato et

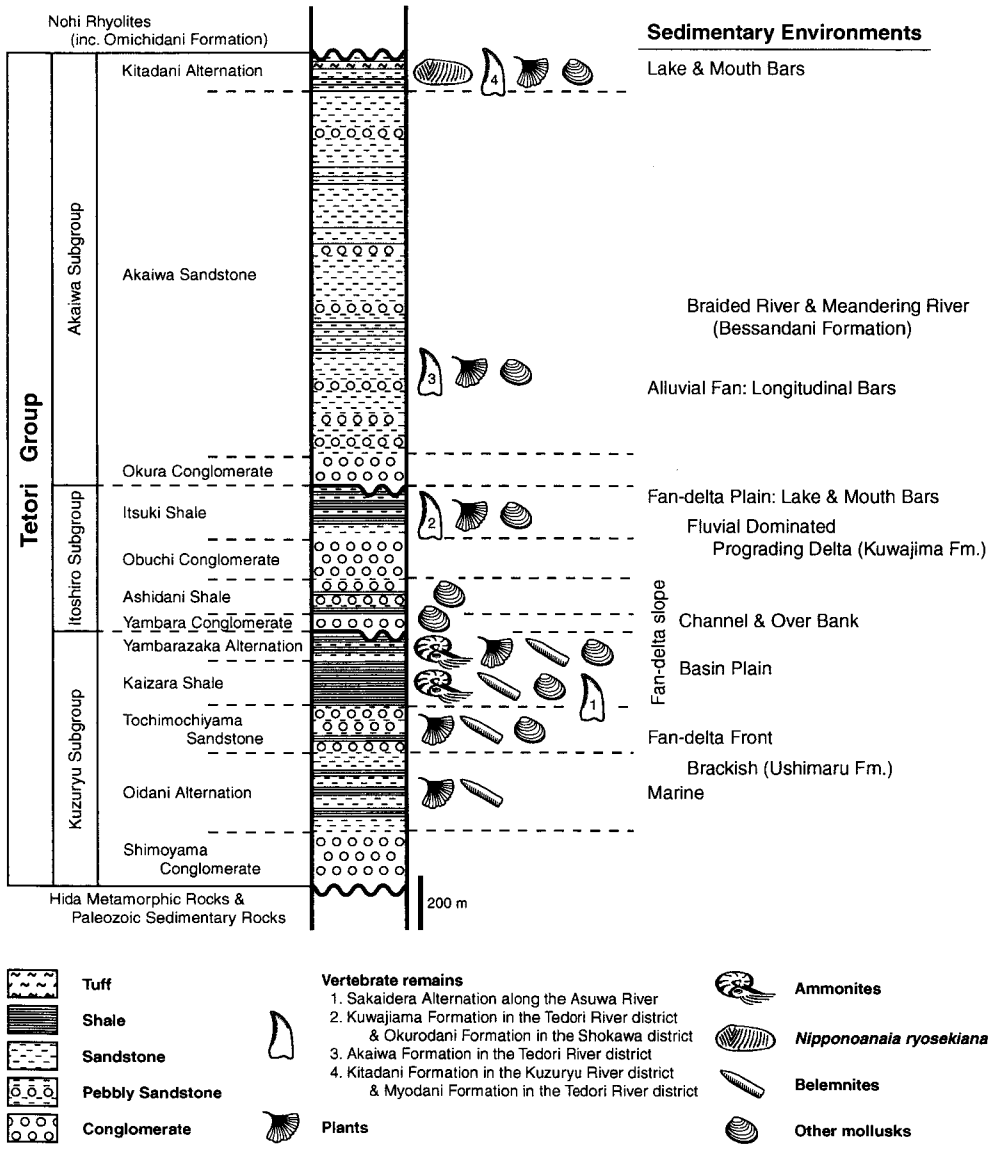

Fig. 4. Schematic columnar section of the standard division of the Tetori Group (modified after Maeda, 1961e), and fossil records of the Group in the Hakusan region. Sedimentary environments are cited mostly from Masuda et al. (1991).

al., 1963).

Yambarazaka Formation

Author. Maeda (1950a, 1952c).

Other names. 'Yambarazaka Alternation' (Maeda, 1961e); a part of the 'Upper Formation' (Yamada, Niwa et al., 1989).

Type section. Yambarazaka area in the left side of the Itoshiro River, Fukui Prefecture (type section of the 'Yambarazaka Alternation' of Maeda, 1961e).

Thickness. 70 to 120 m (Maeda, 1961e).

Lithofacies. The Yambarazaka Formation consists of alternations of conglomerates, sandstones and shales. Angular patches of shale are frequently contained as gravel. This Formation is

interpreted as fan-delta slope deposits. It conformably overlies the Kaizara Formation, and in the western side, lower part of this Formation is contemporaneous with the Kaizara Formation. (Maeda, 1952c, 1961e; Yamada, Niwa et al., 1989; Masuda et al., 1991).

Fossils. Plants, mollusks such as ammonites, belemnites and bivalves, and brachiopods (e.g. Kobayashi, 1957; Maeda, 1950a, 1952c, 1961e, 1963a; Sato, 1962).

Age. This Formation is correlated to the Oxfordian on the basis of ammonites (Maeda, 1952c, 1961e; Sato, 1962).

ITOSHIRO SUBGROUP

The Itoshiro Subgroup (Maeda, 1951b, 1952a, 1961e) in this district consists of conglomerates, pebbly sandstones, sandstones and shales, and unconformably overlies the Kuzuryu Subgroup. The lowermost part of the Subgroup is composed of marine deposits, and the other part is of non-marine deposits (Maeda, 1961e). In this district, the total thickness of this Subgroup is about 580 m (Maeda, 1961e).

Yambara Formation

Author. Maeda (1950a, 1952c).

Other names. 'Yambara Conglomerate' (Oishi, 1933a; Maeda, 1961e); 'Itsuki Conglomerate' (Ijiri, 1936); 'Nakajima Conglomerate' (Kobayashi, 1954); lower part of the 'Lower Formation' (Yamada, Niwa et al., 1989).

Type section. Bank of the Itoshiro River, Yambara, Izumi, Fukui (type section of the 'Yambara Conglomerate' of Maeda, 1961e).

Thickness. 50 to 53 m in the type section, and 300 m in south of Kurotodo (Maeda, 1961e).

Lithofacies. The Yambara Formation consists mainly of conglomerates composed of rounded pebbles to boulders of gneiss, limestone, granite, quartz porphyry, sandstone, slate and shale. Staurolite-bearing sillimanite schist cobbles are also reported. Boulders, one or two meters in diameter, including reworked clasts of the Kuzuryu Subgroup are sometimes observed. This Formation is composed of fan-delta slope deposits. It unconformably overlies the Yambarazaka Formation of Kuzuryu Subgroup. (Maeda, 1950b, 1952c, 1961e; Ueda and Matsuo, 1950; Yamada, Niwa et al., 1989; Masuda et al., 1991; Tsujimori, 1995).

Fossils. Marine mollusks such as bivalves (Maeda, 1952c, 1961e).

Age. Late Jurassic?

Ashidani Formation

Author. Maeda (1950a, 1952c).

Other names. 'Ashidani Alternation' (Maeda, 1961e); middle part of the 'Lower Formation' (Yamada, Niwa et al., 1989).

Type section. Along the Itoshiro River, near Yambara, Izumi, Fukui (type section of the 'Ashidani Alternation' of Maeda, 1961e).

Thickness. 178 m (Maeda, 1961e).

Lithofacies. The Ashidani Formation consists of alternations of pebbly sandstones, blackish shales, and intercalated thin coal beds. This Formation is thought to be deposits that are formed in brackish waters. It conformably overlies the Yambara Formation. (Maeda, 1952c, 1961e).

Fossils. Plants and brackish-water bivalve, *Ostrea* (Maeda, 1952c, 1961e).

Age. Late Jurassic?

Obuchi Formation

Author. Maeda (1950a, 1952c).

Other names. 'Obuchi Conglomerate' (Maeda, 1961e); upper part of the 'Lower Formation' (Yamada, Niwa et al., 1989).

Type section. Along the Itoshiro River, north of Yambara, Izumi, Fukui (type section of the 'Obuchi Conglomerate' of Maeda, 1961e).

Thickness. 150 m.

Lithofacies. The Obuchi Formation is composed of conglomerates of rounded pebble to cobble of gneiss, granite, quartz porphyry, sandstone and no limestone. The size of clasts is much smaller than in the Yambara Formation. This Formation conformably overlies the Ashidani Formation. (Maeda, 1952c, 1961e).

Fossils. Almost no fossil (Maeda, 1952c, 1961e).

Age. Late Jurassic to Early Cretaceous?

Itsuki Formation

Author. Oishi (1933a); Maeda (1950a, 1952c).

Other names. 'Itsuki (Izuki) Shale' (Maeda, 1961e); 'Upper Formation' (Yamada, Niwa et al., 1989).

Type section. Along the Itoshiro River, Itsuki,

Izumi, Fukui (type section of the 'Itsuki Shale' of Maeda, 1961e).

Thickness. 50 m in the type section and 200 to 250 m in the other distributions (Maeda, 1961e).

Lithofacies. The Itsuki Formation is composed mainly of blackish shales, and thin sandstones and arkoses are intercalated. This Formation is interpreted as fan-delta plain deposits. Lacustrine and mouth bar deposits are observed in the Formation. It conformably overlies the Obuchi Formation. (Maeda, 1952c, 1961e; Masuda et al., 1991).

Fossils. Brackish water mollusks such as *Ostrea*, marine mollusks such as *Inoceramus*, and brachiopods (e.g. Maeda, 1952c, 1961e; Fujita et al., 1998). Besides, the footprints of bird and dinosaurs (Azuma et al., 1988; Takeyama et al., 1990), and the dinosaur remain (Manabe, 1999) were discovered. Upper part of the Formation yields plant stem, *Xenoxylon latiporosum* (Maeda, 1961c).

Age. Early Cretaceous?

Comment. The 'Jobu Formation', from which Manabe (1999) reported a tyrannosaurid tooth, means the 'Upper Formation' of Yamada, Niwa et al. (1989) that is invalid name of this Formation.

AKAIWA SUBGROUP

The Akaiwa Subgroup (Maeda, 1951b, 1952a, 1961e) in this district consists mainly of sandstones, shales and tuffs, and conformably overlies the Itoshiro Subgroup. In this district, the total thickness of this Subgroup is about 600 m (Maeda, 1961e).

Akaiwa Formation

Author. Kawai (1961a); Ishikawa Prefecture Board of Education (1978).

Other names. 'Nochino Sandstone' (Oishi, 1933a); 'Akaiwa Sandstone' (Maeda, 1961e).

Type section. Byakudan and Oarashidani, Shiramine Village, Ishikawa Prefecture (Ishikawa Prefecture Board of Education, 1978).

Thickness. 500 to 600 m (Maeda, 1961e).

Lithofacies. The Akaiwa Formation in this district is composed of coarse-grained arkoses containing rounded gravels. Lithofacies of the Formation in this district is similar to that in the type section (along the Tedori River). This Formation is interpreted as braided delta and alluvial fan deposits. It conformably overlies the Itsuki Formation. (Maeda, 1961e; Masuda et al., 1991).

Fossils. Plants (rare) (Maeda, 1961e, 1962c).

Age. Early Cretaceous?

Kitadani Formation

Author. Unknown.

Other names. 'Lower part of the Omichidani Formation' (Maeda, 1953); 'Chinaboradani Alternation of Tuff, Shale and Sandstone' (Maeda, 1957b); 'Kitadani Alternation of Sandstone, Shale and Tuff' (Maeda, 1958b); 'Kitadani Alternation' (Maeda, 1961e).

Type section. Nakanomatadani (branch of the Takinami River), Katsuyama City, Fukui Prefecture (type section of the 'Kitadani Alternation' of Maeda, 1961e).

Thickness. 100 m (Maeda, 1961e).

Lithofacies. The Kitadani Formation in this district consists of alternations of red-brownish tuffs, blackish shales and sandstones. Sandstones are fine to coarse-grained and are generally light grayish to deep greenish. Thin coal beds are intercalated. This Formation is interpreted as lacustrine deposits. It conformably overlies the Akaiwa Formation. (Maeda, 1957b, 1958b, 1961e; Masuda et al., 1991).

Fossils. Bivalves such as *Plicatounio* and *Trigonioides*, and plants (e.g. Maeda, 1957b, 1958b, 1961e). Vertebrate remains including dinosaurs (Azuma, 1990; Isaji and Hasegawa, 1990; Takeyama et al., 1992; Hirayama and Azuma, 1996; Azuma and Currie, 2000) and fresh-water bivalve *Nippononaia ryosekiana* (Isaji, 1993).

Age. Occurrence of *Nippononaia ryosekiana* indicates that the Kitadani Formation in this area is correlated to the upper Barremian to lower Aptian (Isaji, 1993).

Comment. This Formation (originally 'Kitadani Alternation') is defined as a part of the standard division by Maeda (1961e) in the Takinami River area.

1.2 Along The Tedori River

The Itoshiro and Akaiwa subgroups are distributed along the Tedori River (Maeda, 1961e). The Group contacts the Hida Gneiss with faults, and is unconformably overlain by the Upper Cretaceous Omichidani Formation (Ishikawa Prefecture Board of Education, 1978). The Itoshiro Subgroup in this

district is composed of Gomijima and Kuwajima formations, and the Akaiwa Subgroup is of Akaiwa and Myodani formations, in ascending order (Ishikawa Prefecture Board of Education, 1978). The "Akaiwa Sandstone" (Akaiwa Formation) of the standard division by Maeda (1961e) was defined in this district. Though Maeda (1961e) and Ishikawa Prefecture Board of Education (1978) interpreted the Omichidani Formation as a part of the Tetori Group, here we exclude it from the Group following Kawai (1961a) and Omura (1973).

The provenance of the Tetori Group in the Shiramine area was analyzed on the basis of chemical composition of detrital garnet, and as a result, it was suggested that the present Hida Gneiss and Granite were only minor sources for the clastic rocks of the Tetori Group in the Shiramine area (Obayashi, 1995).

By the way, the Tetori Series (Yokoyama, 1894) named undoubtedly after this Tedori River. In old days, Japanese people had a custom to write down the unvoiced consonant even for the voiced pronunciation.

ITOSHIRO SUBGROUP

The Itoshiro Subgroup in this district consists of conglomerates, sandstones and shales. The lowermost part of the Subgroup is composed of basal conglomerate, and upper part is of non-marine deposits (Maeda, 1961e). In this district, the total thickness of this Subgroup is about 300 m (Ishikawa Prefecture Board of Education, 1978).

Gomijima Formation

Author. Ishikawa Prefecture Board of Education (1978).

Other names. 'Gomijima Conglomerate' (Oishi, 1933a; Kawai, 1961a; Maeda, 1961e); 'Gomijima (Conglomerate) Formation' (Omura, 1964).

Type section. Gomijima to Onabara area of the Tedori River, Okuchi Village, Ishikawa (type section of the 'Gomijima Conglomerate' of Maeda, 1961e).

Thickness. 50 to 350 m (Maeda, 1961e).

Lithofacies. The Gomijima Formation is the basal conglomerate of the Tetori Group in this district. Conglomerates are composed of the clasts of aplite, granite, quartz porphyry, gneiss, basic green schist, biotite schist, hornfels, sandstone, slate and chert. Subangular boulders that reach to two meters in diameter are often observed. This Formation contacts with faults or unconformably overlies the Hida Gneiss. It is not distributed in the Shiramine area. (Maeda, 1961e; Omura, 1964; Ishikawa Prefecture Board of Education, 1978).

Fossils. A few non-marine mollusks (Maeda, 1961e).

Age. Late Jurassic to Early Cretaceous?

Kuwajima Formation

Author. Oishi (1933a); Ishikawa Prefecture Board of Education (1978).

Other names. The 'Kuwajima Alternation' (Kawai, 1961a; Maeda, 1961e); 'Kuwajima (Alternation) Formation' (Omura, 1964).

Type section. From Nishijima to south of the Kuwajima "Kaseki-kabe" that is the famous fossil locality, along right side of the Tedori River, Kuwajima, Shiramine Village, Ishikawa (Ishikawa Prefecture Board of Education, 1978).

Thickness. 100 to 150 m (Ishikawa Prefecture Board of Education, 1978); 350 to 450 m (Maeda, 1961e).

Lithofacies. The Kuwajima Formation in this district consists of alternations of grayish sandstone and blackish coaly shales. Sandstones contain an amount of biotites. This Formation is thought to be fresh-water deposits of fluvial dominated prograding delta system. It conformably overlies the Gomijima Formation, and contacts the basement with faults in the Shiramine area. (Maeda, 1961e; Ishikawa Prefecture Board of Education, 1978; Okazaki and Isaji, 1999; Morikiyo and Sato, 2002).

Fossils. Abundant plants including standing stem *Xenoxylon latiporosum*, mollusks, insects and vertebrates (e.g. Maeda, 1961e; Omura, 1967; Fujiyama, 1978; Hirayama, 1996b; Matsuoka, Hasegawa et al., 2001; Matsuoka, Isaji et al., 2001). Especially the "Kaseki-kabe" in the Shiramine area is a famous locality of plant fossils (Maeda, 1961e), and recently it has also become known to yield vertebrate fossil assemblage including various taxa (e.g. Hirayama, 1999a; Matsuoka, 2000b).

Age. Early Neocomian (Early Cretaceous)?

AKAIWA SUBGROUP

The Akaiwa Subgroup in this district consists mainly of arkoses, sandstones and mudstones, and conformably overlies the Itoshiro Subgroup. In this district, the total thickness of this Subgroup is about 1350 m (Ishikawa Prefecture Board of Education, 1978).

Akaiwa Formation

Author. Kawai (1961a); Ishikawa Prefecture Board of Education (1978).

Other names. 'Akaiwa Sandstone' (Oishi, 1933a; Maeda, 1961e).

Type section. Byakudan and Oarashidani, near Kuwajima, Shiramine, Ishikawa (Ishikawa Prefecture Board of Education, 1978).

Thickness. 1000 m (Ishikawa Prefecture Board of Education, 1978); 1400 m (Maeda, 1961e).

Lithofacies. The Akaiwa Formation in this district is composed of coarse-grained arkoses (dominant) and alternations of muddy sandstones and reddish gray to blackish gray mudstones. Arkoses contain rounded clasts of siliceous sandstone and few of gneiss. This Formation in this district is subdivided into lower conglomerates dominant part and upper part that consists of thick and massive coarse-grained sandstones. The Formation is interpreted as delta deposits. It conformably overlies or interfingers with the Kuwajima Formation. (Maeda, 1958b, 1960a, 1961e; Omura, 1965; Ishikawa Prefecture Board of Education, 1978).

Fossils. Plants, mollusks and vertebrates remains (e.g. Maeda, 1958b, 1961e; Kimura and Sekido, 1976b, 1978; Kondo et al., 1990; Hirayama, 1996b; Matsuura et al., 1998; Matsuura, 2001).

Age. Lower Cretaceous?

Comment. The 'Akaiwa Sandstone' (Akaiwa Formation) of the standard division of Maeda (1961e) was defined in this district.

Myodani Formation

Author. Kawai (1961a); Ishikawa Prefecture Board of Education (1978).

Other names. 'Kitadani Alternation' (Maeda, 1961e).

Type section. Around Otadani to Omichidani, Shiramine, Ishikawa (Ishikawa Prefecture Board of Education, 1978).

Thickness. 350 m (Ishikawa Prefecture Board of Education, 1978)

Lithofacies. The Myodani Formation consists of alternations of arkoses, tuffaceous sandstones and mudstones. Arkoses of this Formation resemble that of the Akaiwa Formation. This Formation conformably overlies or interfingers with the Akaiwa Formation. (Kawai, 1961a; Maeda, 1961e; Omura, 1965; Ishikawa Prefecture Board of Education, 1978).

Fossils. Plants (Kawai, 1961a), mollusks such as *Nippononaia ryosekiana* (Maeda, 1961e; Isaji, 1993), vertebrates (e.g. Hirayama, 1996b).

Age. Occurrence of *Nippononaia ryosekiana* indicates late Barremian to early Aptian (Isaji, 1993).

1.3 Shokawa District (Along the Mitarai and Ogamigo Rivers)

The Kuzuryu, Itoshiro and Akaiwa subgroups are distributed in the Shokawa district (Maeda, 1961e). The basement is seldom exposed in this district, but partly the Group unconformably overlies the Funatsu Granitic Rocks, and it is unconformably overlain by the volcanic rocks (Kamiya and Harayama, 1982; Gifu-ken Dinosaur Research Committee, 1993). The Kuzuryu Subgroup in this district is composed of the Ushimaru, Akahoke and Mitarai formations, Itoshiro Subgroup is of Otaniyama, Okurodani and Amagodani formations, Akaiwa Subgroup is of Okura and Bessandani formations, in ascending order (Maeda, 1952a, 1961e).

Along the upper reaches of the Oshirakawa River near the Shokawa district, the Itoshiro and Akaiwa subgroups are distributed (Maeda, 1958b, 1961e; Gifu-ken Dinosaur Research Committee, 1993). From the Tetori Group of the Oshirakawa district, dinosaur footprints have been reported (Kunimitsu et al., 1990; Shikano et al., 2001).

KUZURYU SUBGROUP

The Kuzuryu Subgroup in this district consists of conglomerates, arkoses, sandstones and shales. The upper part of the Subgroup is composed of marine deposits (Maeda, 1961e). In this district, the total thickness of this Subgroup is about 600 m (Maeda, 1961e).

Ushimaru Formation

Author. Maeda (1952a); Iwaya (1940) called this Formation as 'Ushimaru Formation' only in the figures ('Ushimaru Lower Corbicula and Plant Formation' in the text).

Other names. 'Ushimaru Alternation' (Maeda, 1961e); lower part of the "Ushimaru Formation" (Mtsukawa and Nakada, 1999).

Type section. Riverbeds of Shokawa and Nonomata rivers from Ushimaru to north of Nonomata, Shokawa Village, Gifu Prefecture (type section of the 'Ushimaru Alternation' of Maeda, 1961e).

Thickness. 320 m (Maeda, 1961e).

Lithofacies. The Ushimaru Formation is composed mainly of alternations of sandstones and blackish shales. Gravels are fine pebbles of sandstone, slate, granite and diorite. This Formation is interpreted as deposits formed in brackish water. (Maeda, 1952a, 1961e).

Fossils. Plants and non-marine mollusks (Maeda, 1952a, 1961e).

Age. Middle Jurassic?

Akahoke Formation

Author. Maeda (1952a).

Other names. 'Akahoke Sandstone' (Maeda, 1961e); middle to upper part of the "Ushimaru Formation" (Matsukawa and Nakada, 1999).

Type section. Nonomata and Akahoke rivers, Shokawa, Gifu (type section of the 'Akahoke Sandstone' of Maeda, 1961e).

Thickness. 200 m (Maeda, 1961e).

Lithofacies. The Akahoke Formation consists of sandstone-dominant alternations. Sandstones are coarse-grained and arkosic. Coal beds that is five to ten centimeters thick and dark greenish to yellow-brownish tuffs are intercalated. Deposits formed in inner shelf to shoreface associated with delta progradation are observed in the upper part. This Formation conformably overlies the Ushimaru Formation. (Maeda, 1952a, 1961e; Kumon and Umezawa, 2001).

Fossils. Plants and non-marine mollusks (Maeda, 1952a, 1961e).

Age. Middle Jurassic?

Mitarai Formation

Author. Maeda (1952a); Iwaya (1940) called this Formation as 'Mitarashi (Mitarai) Formation' only in the figures ('Mitarashi Middle Corbicula and Plant Formation' in the text).

Other names. 'Mitarai Shale' (Maeda, 1961e); uppermost part of the "Ushimaru Formation" and the "Mitarai Formation" (Matsukawa and Nakada, 1999).

Type section. Matsuyamadani of west to Mitarai, Kaijodani and Mitarai, Shokawa, Gifu (type section of the 'Mitarai Shale' of Maeda, 1961e).

Thickness. 90 m (Maeda, 1961e).

Lithofacies. The Mitarai Formation consists mainly of pebbly or coarse-grained sandstones in the lower part, and of blackish shales in the middle to upper part. In the middle part, acid tuffs and tuffaceous shales are intercalated. The Formation is composed of inner and outer shelf deposits. It conformably overlies the Akahoke Formation. (Iwaya, 1940; Maeda, 1952a, 1961e; Ito et al., 1999; Komatsu et al., 2001; Kumon and Umezawa, 2001).

Fossils. Marine mollusks such as ammonites, belemnites and bivalves (e.g. Iwaya, 1940; Maeda, 1952a, 1961e; Sato and Kanie, 1963; Komatsu et al., 2001).

Age. This Formation is correlated to the Callovian to ?Tithonian on the basis of ammonites and inoceramids (Hayami, 1960; Maeda, 1961e; Sato and Kanie, 1963).

ITOSHIRO SUBGROUP

The Itoshiro Subgroup in this district consists of conglomerates, arkoses, sandstones and shales, and conformably overlies the Kuzuryu Subgroup. In this district, the total thickness of this Subgroup is about 1250 m (Maeda, 1961e).

Otaniyama Formation

Author. Maeda (1952a); Matsukawa and Nakada (1999).

Other names. 'Otaniyama Sandstone' (Maeda, 1961e); 'Okurayam', 'Jigokudani' and 'Otaniyama' formations (Gifu-ken Dinosaur Research Committee, 1993); almost equal with the 'Okurodani (Sandstone and Conglomerate) Formation' (Iwaya, 1940).

Type section. Mt. Otaniyama of west to Mitarai, and Okurodani, Shokawa, Gifu (type section of the 'Otaniyama Sandstone' of Maeda, 1961e).

Thickness. 720 m (Maeda, 1961e).

Lithofacies. The Otaniyama Formation consists mainly of coarse-grained arkoses, and conglomerates, as well as intercalated pebbly sandstones. Conglomerates are composed of well-sorted fine pebbles of quartz, chert and sandstone. The lithofacies of the Formation resembles that of the Akaiwa Formation. This Formation is interpreted as deposits formed in shoreface to delta. It conformably overlies the Mitarai Formation. (Maeda, 1952a, 1961e).

Fossils. Mollusks such as *Ostrea* and belemnites (e.g. Maeda, 1952a; Kumon and Umezawa, 2001). In the Oshirakawa district, dinosaur footprints have been reported from the strata that are correlated to the upper part of this Formation (Kunimitsu et al., 1990; Shikano et al., 2001).

Age. Late Jurassic?

Okurodani Formation

Author. Maeda (1952a); Gifu-ken Dinosaur Research Committee (1993); Matsukawa and Nakada (1999).

Other names. 'Okurodani Alternation' (Maeda, 1961e); almost equal with the 'Ogamigo (Corbicula and Plant) Formation' (Iwaya, 1940).

Type section. Okurodani (branch of the Ogamigo River), Shokawa, Gifu (type section of the 'Okurodani Alternation' of Maeda, 1961e).

Thickness. 250 m (Maeda, 1961e).

Lithofacies. In the Okurodani Formation, blackish shales are dominant and fine arkoses are intercalated. The lithofacies of this Formation resemble that of the Itsuki Formation in Itoshiro River area and of the Mitarai Formation in this district. The Otaniyama Formation grades into this Formation. (Maeda, 1952a, 1961e).

Fossils. Plants and mollusks (e.g. Yokoyama, 1889; Maeda, 1952a, 1954, 1961e). Abundant vertebrate remains have also been reported from this Formation (e.g. Hirayama, 1996b; Manabe and Evans, 1996; Evans and Manabe, 1997a, b, 1998; Yabumoto, 1997; Evans et al., 1998; Hirayama et al., 2000).

Age. Radiometric ages indicating 161 to 81 Ma were obtained by FT and K-Ar dating from tuffs of the Okurodani Formation in this district, and the age of the Formation was estimated to be approximately 140 to 120 Ma (Neocomian), considering the age of the upper igneous rocks (Gifu-ken Dinosaur Research Committee, 1993). But this estimation is based on poor foundations.

Amagodani Formation

Author. Maeda (1952a); Matsukawa and Nakada (1999), but they interpreted this Formation to be included in the Akaiwa Subgroup.

Other names. 'Amagodani Sandstone' (Maeda, 1961e); 'Amagodani Formation' and lower part of the 'Bessandani Formation' (Gifu-ken Dinosaur Research Committee, 1993); almost equal with 'Ogamigo (Corbicula and Plant) Formation' (Iwaya, 1940).

Type section. Amagodani and Ichigodani (branches of the Ogamigo River), Shokawa, Gifu (type section of the 'Amagodani Sandstone' of Maeda, 1961e).

Thickness. 300 m (Maeda, 1961e).

Lithofacies. The Amagodani Formation is composed mainly of coarse-grained sandstones, and the lower part of this Formation is of alternations of conglomerates and fine-graded sandstones. Conglomerates consist of pebbles of quartz, sandstones and slates. This Formation is thought to be lacustrine deposits. It conformably overlies the Okurodani Formation. (Maeda, 1952a, 1961e).

Fossils. Plants, mollusks and vertebrates (Maeda, 1952a, 1961e; Gifu-ken Dinosaur Research Committee, 1993; Hasegawa et al., 1995; Unwin, Manabe et al., 1996).

Age. Neocomian?

AKAIWA SUBGROUP

The Akaiwa Subgroup in this district consists mainly of conglomerates and sandstones, and conformably overlies the Itoshiro Subgroup. In this district, the total thickness of this Subgroup is more than 720 m (Maeda, 1961e; Matsukawa and Nakada, 1999).

Okura Formation

Author. Maeda (1952a); Matsukawa and Nakada (1999).

Other names. 'Okura(dani) Conglomerate' (Maeda, 1961e); lower part of the 'Bessandani Formation' (Gifu-ken Dinosaur Research Committee, 1993).

Type section. Okura along the Ogamigo River, Shokawa, Gifu (type section of the 'Okura(dani)

Conglomerate' of Maeda, 1961e).

Thickness. 120 m (Maeda, 1961e).

Lithofacies. In the Okura Formation, conglomerates that consist mainly of pebbles to cobbles of orthoquartzite are dominant, and thin sandstones are intercalated. Though the relationship with the Amagodani Formation was suggested to be unconformity (Maeda, 1952a) or disconformity (Maeda, 1961e), Gifu-ken Dinosaur Research Committee (1993) and Matsukawa and Nakada (1999) pointed out that it is conformity. (Maeda, 1952a, 1961e; Matsukawa and Nakada, 1999)

Fossils. Few fossils (Maeda, 1952a, 1961e; Gifu-ken Dinosaur Research Committee, 1993).

Age. Early Cretaceous?

Comment. The 'Okura Conglomerate' (Okura Formation) of the standard division by Maeda (1961e) was defined in this district.

Bessandani Formation

Author. Maeda (1952a); Matsukawa and Nakada (1999).

Other names. 'Akaiwa(dani) Sandstone' (Maeda, 1961e); upper part of the 'Bessandani Formation' (Gifu-ken Dinosaur Research Committee, 1993).

Type section. Bessandani in the upper reaches of the Ogamigo River, Shokawa, Gifu (Maeda, 1952a).

Thickness. More than 600 m (Matsukawa and Nakada, 1999).

Lithofacies. The Bessandani Formation is composed mainly of coarse-grained sandstones, and conglomerates are partly intercalated. The lithofacies of this Formation resembles that of the Akaiwa Formation along the upper reaches of the Tedori River. This Formation is interpreted as braided and meandering river deposits. It conformably overlies the Okura Formation. (Maeda, 1952a, 1961e; Matsukawa and Nakada, 1999).

Fossils. Plants (Gifu-ken Dinosaur Research Committee, 1993).

Age. Early Cretaceous?

Note on the chronology of the Tetori Group in the Shokawa district: the radiometric ages indicating 150 to 85 Ma were obtained by FT and K-Ar dating from the tuffs of the 'Bessandani Formation' of Gifu-ken Dinosaur Research Committee (1993). The tuffs are thought to be of the Amagodani or Okura Formation, and the age was estimated to be approximately 140 to 120 Ma, considering the age of the upper igneous rocks (Gifu-ken Dinosaur Research Committee, 1993), but, as mentioned above, this estimation is based on poor foundations.

1.4 Other Distributions

The Tetori Group is distributed some other districts in the Hakusan region: the Kuzuryu and Itoshiro subgroups along the Asuwa River, Fukui Prefecture; the Akaiwa Subgroup in the Itoshiro district, Fukui; the Kuzuryu Subgroup in the Mochiana district, Fukui; the Kuzuryu and Itoshiro subgroups in the Furukawa district, Gifu Prefectrue (Maeda, 1961e). A fossil reptile, *Tedorosaurus asuwaensis*, was reported from the middle part of the Kuzuryu Subgroup in the Asuwa River area (Shikama, 1967, 1969). This is the first vertebrate remain reported from the Tetori Group.

1.5 Correlation and Age of the Formations

Maeda (1961e) correlated the formations of the Tetori Group each other based on the stratigraphic sequence, fossils and geologic trends of the Tetori Group and the neighboring Mesozoic formations (Fig. 3). In these districts, following formations are thought to be almost the same horizon: the upper part of the Kaizara Formation and the lower part of the Mitarai Formation; the Kuwajima, Itsuki and Okurodani formations; the lower part of the Akaiwa Formation along the Tedori and Kuzuryu rivers and the Okura Formation (Maeda, 1961e). Hayami (1960) suggested that the Mitarai Formation is more or less younger than the Kaizara Formation, based on the pelecypod and inoceramid faunas.

Some formations in the districts are correlated to the geologic time unit by index fossils: the Kaizara (Bathonian to Oxfordian), Yambarazaka (Oxfordian) and Mitarai (Callovian to ?Tithonian) formations based on the ammonites and inoceramids (e.g. Kobayashi, 1947; Maeda, 1952c, 1961e; Hayami, 1960; Sato, 1962; Sato et al., 1963; Sato and Kanie, 1963), and the Kitadani and Myodani formations (upper Barremian to lower Aptian) by *Nippononaia ryosekiana* (Isaji, 1993). Matsumoto et al. (1982) discussed the age of some formations of the Group based on fossil mollusks and stratigraphic relations: the Gomijima and Kuwajima

formations (lower Neocomian), and the Kitadani Formation (Hauterivian to lower Aptian). Besides, the quite rough radiometric age indicating 140 to 120 Ma was obtained from the Okurodani Formation (Gifu-ken Dinosaur Research Committee, 1993), and the formation is thought to be correlated to the Neocomian. To summarize, the Kuzuryu, Itoshiro and Akaiwa subgroups are correlated to the Middle to Upper Jurassic, Upper Jurassic to lower Lower Cretaceous (lower? Neocomian) and Lower Cretaceous (upper Neocomian to Aptian), respectively.

2. JINZU REGION

The Jinzu region is another distribution of the Tetori Group. Though the Kuzuryu, Itoshiro and Akaiwa subgroups are also distributed in this region, it is difficult to distinguish the non-marine Itoshiro and Akaiwa formations (Maeda, 1961e).

Fossil plants and mollusks are collected from the Tetori Group distributed in this region and some formations are correlated to the geologic time units by index fossils. The Kuzuryu Subgroup in the Kiridani district is correlated to the upper Oxfordian to Kimmeridgian on the basis of ammonites and trigoniids (Maeda and Takenami, 1957a; Maeda, 1958c). The Kuzuryu Subgroup in the Arimine district yields trigoniids and ammonites that indicate Late Jurassic (Maeda and Takenami, 1957a; Takenami and Maeda, 1957). The Itoshiro and Akaiwa subgroups of this region are correlated to the Lower Cretaceous with fossil plants (Maeda, 1956). In this region, Hasegawa and Yoshida (1999) correlated the Itoshiro Subgroup to the Kimmeridgian and the lowest part of the Akaiwa Formation to the Kimmeridgian to lower Tithonian, estimating from the compound-specific carbon isotope stratigraphy.

CONCLUDING REMARKS

Among the wide distributions of the Tetori Group, stratigraphy of the Group in the Kuzuryu River, Tedori River and Shokawa districts (Hakusan region), where abundant fossil plants and vertebrate remains have been reported, is reviewed. In these districts, following formations are thought to be almost the same horizon: the upper part of the Kaizara Formation and the lower part of the Mitarai Formation; the Kuwajima, Itsuki and Okurodani formations; the lower part of the Akaiwa Formation along the Tedori and Kuzuryu rivers and the Okura Formation. Only five formations of the Tetori Group are correlated to the geologic time units based on the index fossils in these districts: the Kaizara (Bathonian to Oxfordian), Yambarazaka (Oxfordian), Mitarai (Callovian to ?Tithonian), Kitadani and Myodani (upper Barremian to lower Aptian) formations. To summarize, the Kuzuryu, Itoshiro and Akaiwa subgroups in these districts are roughly correlated to the Middle to Upper Jurassic, Upper Jurassic to lower Lower Cretaceous and Lower Cretaceous, respectively. Reliable radiometric age has never been obtained from the Group. The formations from which vertebrate remains have been collected are: the Otaniyama, Itsuki, Kuwajima, Okurodani and Amagodani formations of the Itoshiro Subgroup, and the Akaiwa and Kitadani formations of the Akaiwa Subgroup. The Tetori Group is thick and there are a lot of strata of which sedimentary environments resemble each other, thus we have a good chance to collect fossil vertebrates from other localities.

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* in Japanese
** in Japanese with English abstract or summary
ü in German
ç in French
я in Russian and English

Note: The titles put between double quotation marks are translated into English on authors' responsibility.

APPENDIX

Correspondent Japanese characters of the proper nouns. Most of the proper nouns are appeared in the text of this contribution. In alphabetical order.

Akahoke 赤歩危, **Akahoke River** 赤歩危川
Akaiwa 赤岩
Amagodani アマゴ谷
Arimine 有峰
Ashidani 葦谷
Asuwa River 足羽川
Bessandani 別山谷
Byakudan 百合谷
Chinaboradani 知那洞谷
Dosaiyama 道斎山
Fukui 福井
Funatsu 船津
Furukawa 古川
Gifu 岐阜
Gomijima 五味島
Hakusan, Mt. Hakusan 白山,
Hakusan region 白山区
Hida 飛騨
Horadani ホラ谷
Ichigodani イチゴ谷
Ishikawa 石川
Itoshiro 石徹白, **Itoshiro River** 石徹白川
Itsuki, Izuki 伊月
Izumi 和泉
Jigokudani 地獄谷
Jinzu 神通, **Jinzu region** 神通区
Kaijodani 海上谷
Kaizara 貝皿
Katsuyama 勝山
Kiridani, Kiritani 桐谷
Kitadani 北谷
Kurotodo 黒当戸
Kuwajima 桑島
Kuwajima "Kaseki-kabe" 桑島化石壁,
"Kaseki-kabe" 化石壁
Kuzuryu 九頭竜, **Kuzuryu River** 九頭竜川
Mana River 真名川
Matsuyamadani 松山谷
Mekkodani, Mekko-dani ravine 目附谷(目付谷)
Mitarai 御手洗, **Mitarai River** 御手洗川
Mochiana 持穴
Myodani 明谷
Nagano 長野
Nakajima 中島
Nakanomatadani 中ノ俣谷
Nishijima 西島
Nochino 後野
Nonomata 野々俣, **Nonomata River** 野々俣川
Oarashidani 大嵐谷
Obuchi, Ofuchi 大淵
Ogamigo River 尾上郷川
Oidani 大井谷
Okuchi 尾口
Okura 大倉
Okurayama 大倉山
Okurodani 大黒谷
Omichidani 大道谷
Onabara 女原
Ono River 大納川
Oshirakawa 大白川, **Oshirakawa River** 大白川
Otadani 大田谷
Otaniyama, Mt. Otaniyama 大谷山
Sangun 三郡
Shimowakogo 下若生子
Shimoyama 下山
Shiramine 白峰
Shokawa 荘川, **Shokawa River** 庄川
Takinami River 滝波川
Tandoguchi 谷戸口
Tetori 手取, **Tedori River** 手取川
Tochimochiyama 栃餅山
Togatani 鴇ヶ谷
Toyama 富山
Ushikubi-gawa, Ushikubi River 牛首川
Ushimaru 牛丸
Yambara 山原
Yambarazaka 山原坂