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Additional mammalian fossils from the Upper Cretaceous Mifune Group, Kumamoto, western Japan

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Introduction

The Upper Cretaceous Mifune Group (originally the Mihune Group in Matsumoto, 1939) distributed in Mifune Town district, Kumamoto Prefecture, western Japan, yields a number of fossil vertebrates (e.g., Mifune Town Dinosaur Fossils Research Committee, 1998; Ikegami *et al.*, 2000; Ikegami, 2003). From the "Upper Formation" of this group, a eutherian mammal "*Sorlestes*" *mifunensis* ("Zhelestidae") was reported by Setoguchi *et al.* (1999).

Cretaceous mammalian remains have been found in Japan only from three formations, including the "Upper Formation" of the Mifune Group in Japan. The other two are the Lower Cretaceous Kuwajima and Kitadani formations of the Tetori Group in central Japan (Takada *et al.*, 2001; Tsubamoto *et al.*, 2004; Rougier *et al.*, 2007). Moreover, the Mifune Group is, up to now, the only locality that has yielded a Cretaceous eutherian fossil in Japan, and also the only locality containing Late Cretaceous mammals in the eastern part of East Asia. There are some Early Cretaceous localities in the eastern part of East Asia, such as northeastern China and Japan (e.g., Wang *et al.*, 1995; Takada *et al.*, 2001; Tsubamoto *et al.*, 2004; Wang *et al.*, 2006; Rougier *et al.*, 2007), and abundant mammalian fossil records exist for them, whereas most of the Late Cretaceous localities are located inland, for example, in Mongolia and Central Asia (e.g., Nessov *et al.*, 1994; Nessov *et al.*, 1998; Kielan-Jaworowska *et al.*, 2004). Knowledge about Late Cretaceous mammals in the eastern part of East Asia is, therefore, still quite restricted.

The age estimation of the Mifune Group is relatively well established by biostratigraphical correlations and fission track datings. The "Lower Formation" of the group, which underlies the "Upper Formation," is correlated to the Cenomanian based on an ammonoid, *Eucalycoceras* sp. cf. *E. spathi*, and an inoceramid, *Birostrina tamurai* (Tamura *et al.*, 1974; Matsumoto *et al.*, 1982; Matsumoto and Noda, 1986). Zircon fission track ages have also been reported from tuff beds within the group: 93.1±4.4 and 89.8±4.0 (both 1 SD) Ma from the lower part of the "Lower Formation"; and 83.6±3.1, 82.1±11.1 (both 1 SD), and 86.4±7.8 (2 SD) Ma from the "Upper Formation" (Tsubamoto, 2001; Ikegami *et al.*, 2007). The "Upper Formation" is correlated to the Coniacian to Campanian (Gradstein *et al.*, 2004) on the basis of these data. This indicates that mammals from the formation can be correlated with fertile records from the Bissekty Formation of Uzbekistan (Nessov *et al.*, 1998).

There has been only one mammalian fossil described from the group, the type specimen of "*Sorlestes*" *mifunensis*. The discovery of additional mammalian fossil specimens improves the potential of the "Upper Formation" of the Mifune Group as a Late Cretaceous mammalian fossil locality. In this short paper, we describe two additional fragmentary fossils of mammals from the "Upper Formation" of the Mifune Group. The specimens were found from the type locality of "*Sorlestes*" *mifunensis* (Setoguchi *et al.*, 1999, fig. 1). One of the specimens was provisionally reported by Ikegami *et al.* (1997) as a lower premolar of a primitive "insectivore." The identification is, however, corrected in this paper that it is a lower molar of a "zhelestid" eutherian. Another specimen is an edentulous eutherian mandible.

Abbreviations.—MDM, Mifune Dinosaur Museum (Mifune, Kumamoto, Japan). KUJM, Kyoto University, Japan, Mesozoic (Kyoto University Museum, Kyoto, Japan).

Description and discussion

Specimen 1: "zhelestid" lower molar (Figure 1, Table 1.1)

Material.—MDM 130, an isolated right m1 or m2.

Description.—MDM 130 is a tribosphenic molar preserving most of the trigonid and talonid. The trigonid is much taller than the talonid, and two trigonid cusps are preserved: protoconid and metaconid. The protoconid is larger and slightly higher than the metaconid, and the apices of both cusps have wear facets along the protocristid. A weak paracristid extends mesiolingually from the tip to the base of the protoconid. The paraconid region has been badly broken, and there is no evidence to show the position of the paraconid. The posterior trigonid wall is nearly vertical.

The talonid is at least as wide as the trigonid (Table 1.1). The talonid basin has a flat surface, but it is not obvious whether this situation is the result of wear or secondary erosion. The talonid cusps are badly damaged but the base of the hypoconid is situated in the posterolabial corner of the talonid. Posterior and lingual sides of the talonid are broken, thus the positions of the hypoconulid and entoconid are not apparent. The cristid obliqua extends to the posterior trigonid wall, slightly labially below the notch between protoconid and metaconid.

The posterior root is preserved but it is badly damaged. It is situated just beneath the talonid basin.

Discussion.—In 1997, when MDM 130 was first reported by Ikegami *et al.*, they concluded that it probably was a right lower premolar of a primitive insectivore, based on evidence such as: the talonid is anteroposteriorly shorter than the trigonid; the talonid is simple and has a flat basin; the tooth is smaller than the type specimen of "*Sorlestes*" *mifunensis* (KUJM 95002). Our observation, however, revealed that some of these observations were not correct. The talonid of MDM 130 is well developed, not shorter than the trigonid (Table 1.1). Its original size is estimated not to be evidently smaller than but to be as large as KUJM 95002 (Table 1.1). These facts indicate that MDM 130 is not a premolar but a eutherian molar.

Because the talonid does not extend distally and is at least as wide as the trigonid, MDM 130 seems to be a right lower m1 or m2. When MDM 130 was unearthed, the twinned entoconid and hypoconulid were preserved on the distolingual part of the talonid, which unfortunately disappeared during preparation. The entoconid-hypoconulid twinning is one of the diagnostic features of the "Zhelestidae," and thus MDM 130 seems to be a molar of a "zhelestid" species.

The characteristics of both the paraconid region of the trigonid and the talonid are poorly preserved, hence it is difficult to precisely compare MDM 130 with "zhelestids." The preserved portion of the trigonid in MDM 130 implies that the paraconid was probably small, and that the trigonid is relatively constricted. MDM 130 is distinguished from North American and European "zhelestids" in its crown morphology: it differs from *Gallolestes*, *Labes*, and *Lainodon* in the constricted trigonid (Lillegraven, 1976; Pol *et al.*, 1992; Gheerbrant and Astibia, 1994; Kielan-Jaworowska *et al.*, 2004); from *Avitotherium*, *Gallolestes*, and *Lainodon* in the protoconid, which is not greatly larger than the metaconid (Lillegraven, 1976; Cifelli, 1990; Gheerbrant and Astibia, 1994; Kielan-Jaworowska *et al.*, 2004); and from *Alostera*, *Gallolestes*, and *Labes* in the entoconid-hypoconulid twinning (Lillegraven, 1976; Fox, 1989;

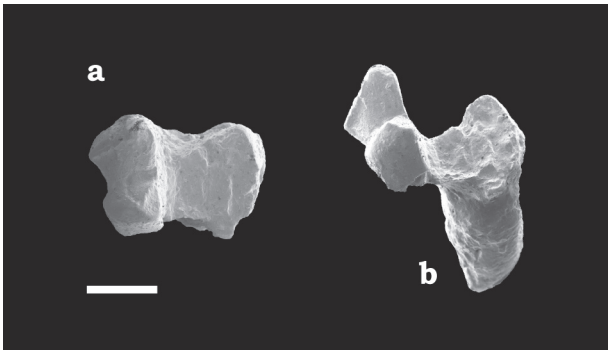

Figure 1. SEM photographs of a "zhelestid" right lower molar (MDM 130, resin cast). Scale bar is 1 mm. Left to anterior. **a**, in occlusal view; **b**, in slightly antero-lingual view.

Table 1. Measurements (mm) of specimens. **1.** MDM 130 and the holotype of "*Sorlestes*" *mifunensis* (KUJM 95002). Data of KUJM 95002 are after Setoguchi *et al.* (1999). L, crown length; TRL, trigonid length; TAL, talonid length; TRW, trigonid width; TAW, talonid width. **2.** MDM 725. L, length of the specimen; D, dorso-ventral depth of the specimen; HRD, depth of the horizontal ramus below m1; HRW, transverse width of the horizontal ramus at position of m1.

	L	TRL	TAL	TRW	TAW
MDM 130	2.4	1.1	1.3	1.6	1.5
KUJM 95002	2.60	1.15	1.45	1.75	1.70

Table 2. MDM 725. L, length of the specimen; D, dorsoventral depth of the specimen; HRD, depth of the horizontal ramus below m1; HRW, transverse width of the horizontal ramus at position of m1.

	L	D	HRD	HRW
MDM 750	16.7	6.2	3.8	2.0

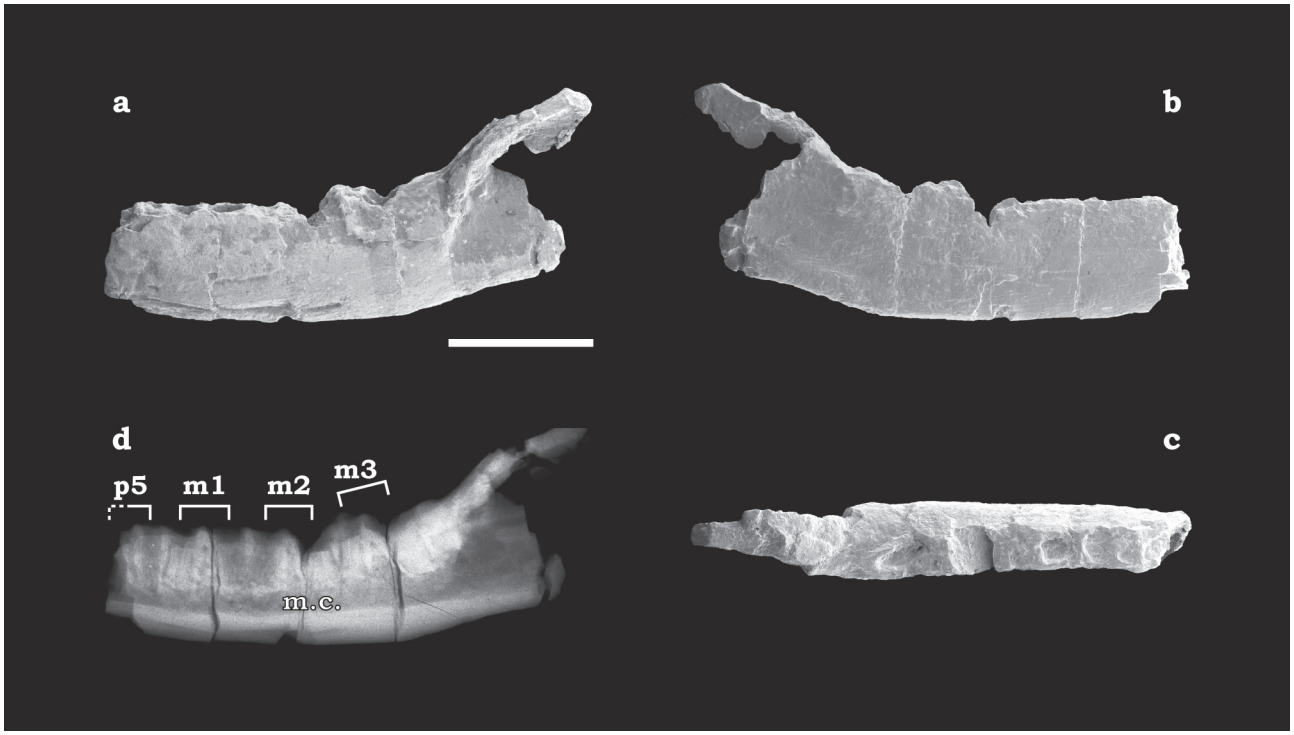

Figure 2. A fragment of eutherian left mandible (MDM 725). Scale bar is 5 mm. **a**, SEM photograph of MDM 725 (resin cast) in labial view; **b**, same in lingual view; **c**, same in occlusal view; **d**, SOFTEX photograph of MDM 725, p5 to m3 indicate alveolus for each tooth; m.c., mandibular canal.

Pol *et al.*, 1992; Kielan-Jaworowska *et al.*, 2004). Compared with Asian "zhelestids," MDM 130 is larger than some species such as *Sheikhdzheilia rezvyii*, *Aspanlestes aptap*, and "*Sorlestes*" *kara*, and is smaller than cf. *Eoungulatum kudukensis* (Nessov *et al.*, 1998; Averianov and Archibald, 2005). The size of MDM 130 is probably in the range of "*Sorlestes*" *budan* and "*S.*" *mifunensis* (Nessov *et al.*, 1998; Setoguchi *et al.*, 1999; Table 1.1). MDM 130 resembles the type specimen of "*S.*" *mifunensis* from the same outcrop (KUJM 95002) in the proportions of the trigonid cusps (Setoguchi *et al.*, 1999), suggesting that MDM 130 might be referable to "*S.*" *mifunensis*.

Specimen 2: eutherian mandible (Figure 2, Table 1.2)

Material.—MDM 725, a left dentary fragment.

Description.—MDM 725 is a fragment of an edentulous left dentary. The anterior part of the horizontal ramus is missing. In the distal part of the specimen, the mesial part of the coronoid process is preserved. From a SOFTEX photograph, subequally sized alveoli for four double-rooted teeth are present (Figure 2d). The posteriormost alveolus is anteroposteriorly longer than the others. The anteriormost alveolus is broken and only the posterior root of a double root tooth is preserved, which is the shortest of all the preserved alveoli. The anterior end of the masseteric fossa reaches just below the mesial base of the coronoid process. The angular process is not preserved on MDM 725. There is no trace of an inflected angular process on the posteriormost part of the specimen. Neither a trace of postdentary elements nor a distinct Meckel's groove is observable.

Discussion.—MDM 725 consists of a dentary. There are no tooth crowns preserved on MDM 725, thus it is difficult to decide to which taxon the specimen belongs. MDM 725 is distinguished from the mandible of multituberculates in having neither a rodentlike deep mandibular corpus (Kielan-Jaworowska *et al.*, 2004) nor the very large alveolus of unique p4, which is the third tooth from the posterior end. MDM 725 is probably a eutherian dentary. It does not appear to be referable to most primitive Mesozoic mammals such as eutriconodontans and "symmetrodontans" in lacking Meckel's groove and any trace of postdentary elements. Because any trace of an inflected angular process is not observed on MDM 725, even at the posteriormost part of the specimen, it is not referable to a metatherian dentary. An anteroposteriorly longer alveolus for the posterior root of m3 is common among Mesozoic eutherians. It is also probable that the anteriormost shorter alveolus is for the last premolar,

and that this specimen had only three molars. MDM 130 resembles the type specimen of "*Sorlestes*" *mifunensis* in the size (depth and width) of the horizontal ramus (Setoguchi *et al.*, 1999; Table 1.2).

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References

Averianov, A. and Archibald, J. D., 2005: Mammals from the mid-Cretaceous Khodzhakul Formation, Kyzylkum Desert, Uzbekistan. *Cretaceous Research*, vol. 26, p. 593–608.

Cifelli, R. L., 1990: Cretaceous mammals of southern Utah. IV. Eutherian mammals from the Wahweap (Aquilan) and Kaiparowits (Judithian) formations. *Journal of Vertebrate Paleontology*, vol. 10, p. 346–360.

Fox, R. C., 1989: The Wounded Knee local fauna and mammalian evolution near the Cretaceous-Tertiary boundary, Saskatchewan, Canada. *Palaeontographica, Abteilung A*, vol. 208, p. 11–59.

Gheerbrant, E. and Astibia, H., 1994: Un nouveau mammifère du Maastrichtien de Laño (Pays Basque espagnol). *Comptes Rendus de l'Académie des Sciences*, *Paris*, *Série II*, vol. 318, p. 1125–1131.

Gradstein, F., Ogg, J. and Smith, A., 2004: *A Geologic Time Scale*. 589p, Cambridge University Press, Cambridge.

Ikegami, N., 2003: A therizinosauroid braincase from the Upper Cretaceous Mifune Group, Kumamoto Prefecture, Japan. *Abstracts with Programs of the 2003 Annual Meeting of the Palaeontological Society of Japan*, p. 38. (*in Japanese*)

Ikegami, N., Hachiya, K., Setoguchi, T. and Hanamura, H., 1997: "A lower premolar of a Cretaceous mammal newly found from the Mifune Group". *Abstracts with Programs of the 146th Regular Meeting of the Palaeontological Society of Japan*, p. 38. (*in Japanese*)

Ikegami, N., Iwano, H., Danhara, T. and Sakai, H., 2007: Fission-track ages of tuff beds from the Upper Cretaceous Mifune Group in Kyushu, Japan. *Journal of the Geological Society of Japan*, vol. 113, p. 127–130. (*in Japanese with English abstract*)

Ikegami, N., Kellner, A. W. K. and Tomida, Y., 2000: The presence of an azhdarchid pterosaur in the Cretaceous of Japan. *Paleontological Research*, vol. 4, p. 165–170.

Kielan-Jaworowska, Z., Cifelli, R. L. and Luo, Z.-X., 2004: *Mammals from the Age of Dinosaurs: Origins, Evolution, and Structure*, 630 p. Columbia University Press, New York.

Lillegraven, J. A., 1976: A new genus of therian mammal from the Late Cretaceous "El Gallo Formation," Baja California, Mexico. *Journal of Paleontology*, vol. 50, p. 437–443.

Matsumoto [as Matumoto], T., 1939: Geology of Mihune district, Kumamoto Prefecture, Kyûsyû (with special reference to the Cretaceous System). *Journal of the Geological Society of Japan*, vol. 46, p. 1–12. (*in Japanese with English résumé*)

Matsumoto, T. and Noda, M., 1986: Some inoceramids (Bivalvia) from the Cenomanian (Cretaceous) of Japan. I. New or little known four species from Hokkaido and Kyushu. *Transactions and Proceedings of the Palaeontological Society of Japan*, *New Series*, no. 143, p. 409–421.

Matsumoto, T., Obata, I., Tashiro, M., Ohta, Y., Tamura, M., Matsukawa, M. and Tanaka, H., 1982: Correlation of marine and nonmarine formations in the Cretaceous of Japan. *Fossils (Kaseki)*, no. 31, p. 1–26. (*in Japanese with English abstract*)

Mifune Town Dinosaur Fossils Research Committee ed., 1998: *Report of the Research on the Distribution of Important Fossils in Kumamoto Prefecture: Dinosaurs from the Mifune Group, Kumamoto Prefecture, Japan*, 95 p. Mifune Town Board of Education, Mifune. (*in Japanese*)

Nessov, L. A., Archibald, J. D. and Kielan-Jaworowska, Z., 1998: Ungulate-like mammals from the Late Cretaceous of Uzbekistan and a phylogenetic analysis of Ungulatomorpha. *Bulletin of Carnegie Museum of Natural History*, vol. 34, p. 40–88.

Nessov, L. A., Sigogneau-Russell, D. and Russell, D. E., 1994: A survey of Cretaceous tribosphenic mammals from Middle Asia (Uzbekistan, Kazakhstan and Tajikistan), of their geological setting, age and faunal environment. *Palaeovertebrata*, vol. 23, p. 51–92.

Pol, C., Buscalioni, A. D., Carballiera, J., Francés, V., Martinez, N. L., Marandat, B., Moratalla, J. J., Sanz, J. L., Sigé, B. and Villatte, J., 1992: Reptiles and mammals from the Late Cretaceous new locality Quintanilla del Coco (Burgos Province, Spain). *Neues Jahrbuch für Geologie und Palaontologie*, *Abhandlungen*, vol. 184, p. 279–314.

Rougier, G. W., Isaji, S. and Manabe, M., 2007: An Early Cretaceous mammal from the Kuwajima Formation (Tetori Group), Japan, and a reassessment of triconodont phylogeny. *Annals of Carnegie Museum*, vol. 76, p. 73–115.

Setoguchi, T., Tsubamoto, T., Hanamura, H. and Hachiya, K., 1999: An early Late Cretaceous mammal from Japan, with reconsideration of the evolution of tribosphenic molars. *Paleontological Research*, vol. 3, p. 18–28.

Takada, T., Matsuoka, H. and Setoguchi, T., 2001: The first multituberculate from Japan. *In*, Deng, T. and Wang, Y. *eds.*, *Proceedings of the Eighth Annual Meeting of the Chinese Society of Vertebrate Paleontology*, p. 55–58. China Ocean Press, Beijing.

Tamura, M., Matsumura, M. and Matsumoto, T., 1974: On the age of the Mifune Group, Central Kyushu, Japan, with a description of ammonite from the Group. *Memoirs of the Faculty of Education, Kumamoto University, Section 1 (Natural Science)*, no. 23, p. 47–56.

Tsubamoto, T., 2001: Fission-track zircon age of the "Upper Formation" of the Mifune Group, Mifune Town, Kumamoto Prefecture, Japan. *Annual Report of the Mifune Dinosaur Museum*, no. 1, p. 12–16. (*in Japanese with English abstract*)

Tsubamoto, T., Rougier, G. W., Isaji, S., Manabe, M. and Forasiepi, A. M., 2004: New Early Cretaceous spalacotheriid "symmetrodont" mammal from Japan. *Acta Palaeontologica Polonica*, vol. 49, 329

–346.
Wang, Y.-Q., Hu, Y.-M. and Li, C.-K., 2006, Review of recent advances on study of Mesozoic mammals in China. *Vertebrata PalAsiatica*, vol. 44, 193–204.
Wang, Y.-Q., Hu, Y.-M., Zhou, M.-Z. and Li, C.-K., 1995: Mesozoic mammal localities in western Liaoning, northeast China. *In*, Sun, A.-L. and Wang, Y.-Q. *eds.*, *Sixth Symposium on Mesozoic Terrestrial Ecosystem and Biota, Short Papers*, p. 221–227. China Ocean Press, Beijing.