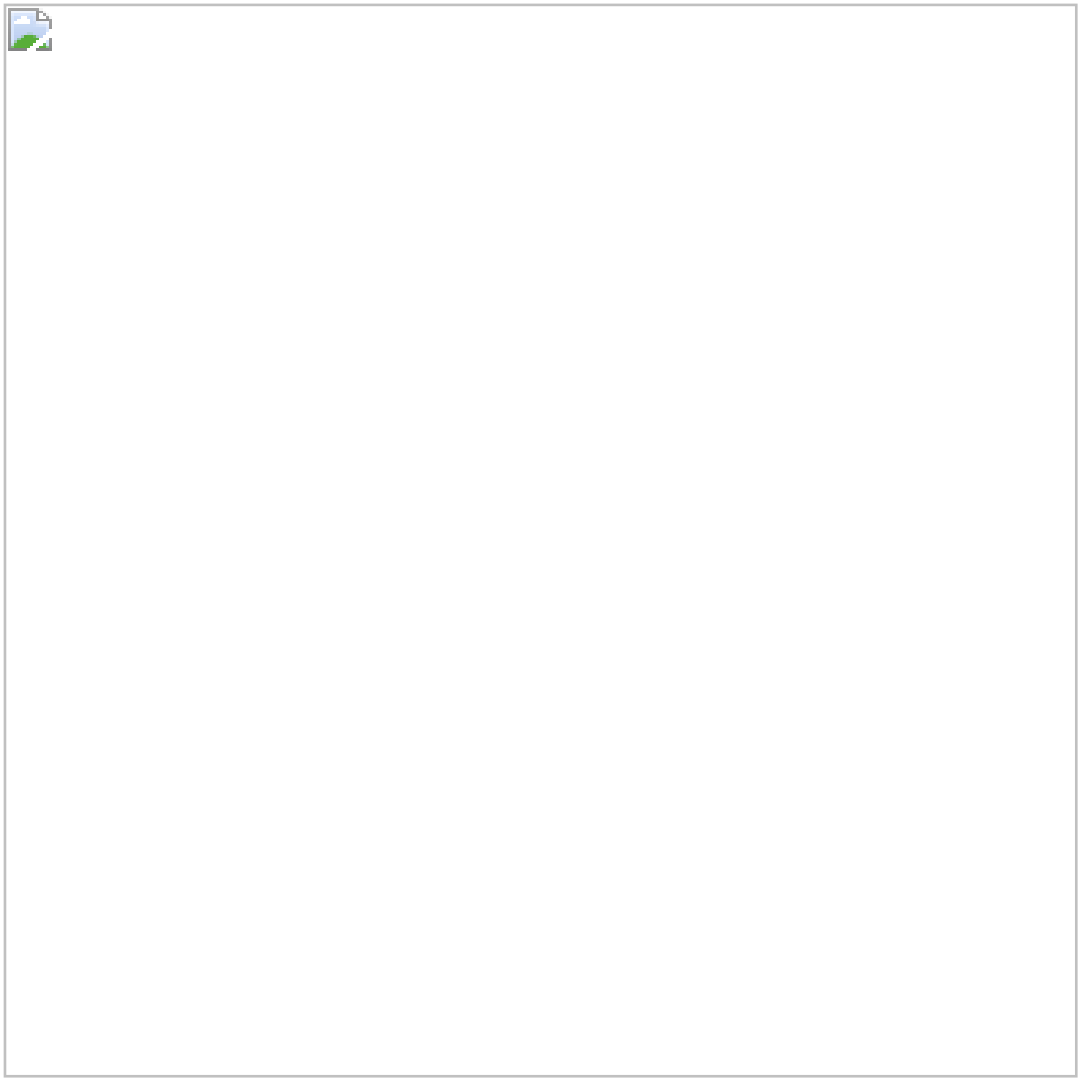

# A Pleistocene Rhinocerotid (Mammalia, Perissodactyla) from Yage, Shizuoka Prefecture, central Japan

Author: Handa, Naoto

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# A Pleistocene rhinocerotid (Mammalia, Perissodactyla) from Yage, Shizuoka Prefecture, central Japan

NAOTO HANDA

*Shinshushinmachi Fossil Museum, 88-3 Kamijo, Shinshushinmachi, Nagano 381-2404, Japan (e-mail: k1552325@kadai.jp)*

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**Abstract. A fossil rhinocerotid tooth from the Yage Formation (Middle to Late Pleistocene), Yage in Shizuoka Prefecture, is described. The present specimen shows the following characteristics of the second lower incisor: tusk-like shape, enamel on the labial side, a teardrop-shaped cross section of the tooth crown, and an oval cross section of the root. The specimen is similar to the genus *Rhinoceros* in having a large and robust shape. However, owing to a lack of other elements, generic and specific identification are not possible. Previously, several large mammal fossils had been reported from the Yage area, but there were no rhinocerotids among them. Thus, this report is the first record of a rhinocerotid from the area. The Yage specimen suggests rhinocerotids were widely distributed during the Pleistocene of Far East Asia.**

**Key words: Japan, lower incisor, Pleistocene, Rhinocerotidae, Shizuoka Prefecture, Yage**

## Introduction

In this study, I describe a lower incisor of a rhinocerotid. According to the specimen label, it was collected by Takeshi Nishizawa in the Yage area in Inasa Town (a part of present-day Hamamatsu City) Shizuoka Prefecture, central Japan (Figure 1). Nishizawa (1972) further noted that it was found in “Yage mine”.

The Pleistocene Yage Formation is distributed in this area. Tomida (1978) subdivided the Yage Formation into the Lower and Upper Yage formations (Tomida, 1978). The lower part of the Yage Formation, which is composed of lacustrine deposits, has yielded fossils of freshwater fish, crocodiles, turtles, and a river otter (e.g. Tomida, 1978; Nakajima and Hasegawa, 1982; Nojima, 2002). The geological age of the lower part is estimated as Middle Pleistocene by sedimentological and paleontological correlation with neighboring areas (Tomida, 1978; Nojima, 2002). The upper part of the Yage Formation, on the other hand, which consists of fissure deposits, has yielded various terrestrial mammal fossils (Takai *et al.*, 1958; Tomida, 1978; Nojima, 2002). Based on these vertebrate fossils, the upper part has been correlated to the upper part of the Kuzuu Formation (Upper Pleistocene) in Kuzuu, Tochigi Prefecture, and the upper part of the Isa Formation (Upper Pleistocene) in Isa, Yamaguchi Prefecture, Japan (Tomida, 1978; Nojima, 2002). Several mammal bones from the upper part of the Yage Formation have also been dated to 18,040 ± 990 yrs BP by $^{14}C$ dating (Kawamura and Matsuhashi, 1989).

*Abbreviations*.—KPM: Kanagawa Prefectural Museum of Natural History, Kanagawa Prefecture, Japan, GMNH: Gunma Museum of Natural History, Gunma Prefecture, Japan.

## Systematic Paleontology

Order Perissodactyla Owen, 1848
Family Rhinocerotidae Owen, 1845
Subfamily Rhinocerotinae Owen, 1845
Genus and species indeterminate

Figure 2

*Specimen*.—SFM04-11306, a left lower second incisor.

*Repository*.—Shinshushinmachi Fossil Museum (SFM), Nagano Prefecture, Japan.

*Locality and horizon*.—Yage area, Inasa Town, Hamamatsu City, Shizuoka Prefecture, central Japan (Figure 1B). The specimen was collected from the lower or upper Yage Formation (Middle to Late Pleistocene: Tomida, 1978). Its precise locality and horizon is uncertain because this information was not provided on the label and literature.

*Description*.—The specimen described here represents

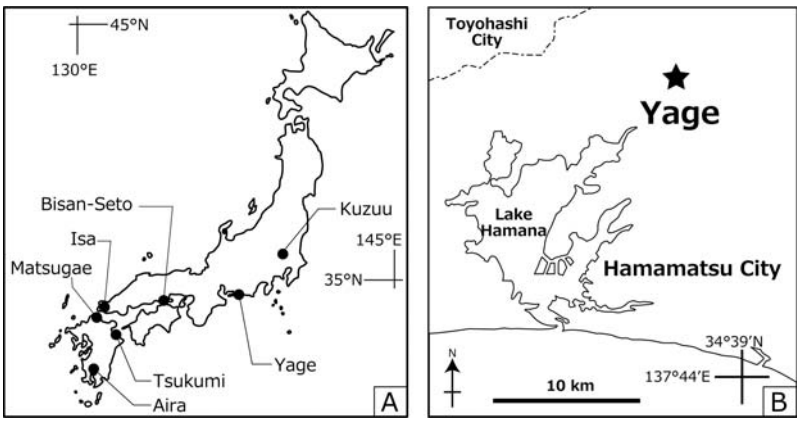


**Figure 1.** A, Map showing the fossil localities of the Pleistocene rhinocerotids in Japan. B, Map showing the Yage area, Hamamatsu City, Shizuoka Prefecture (modified from Tomida, 1978).

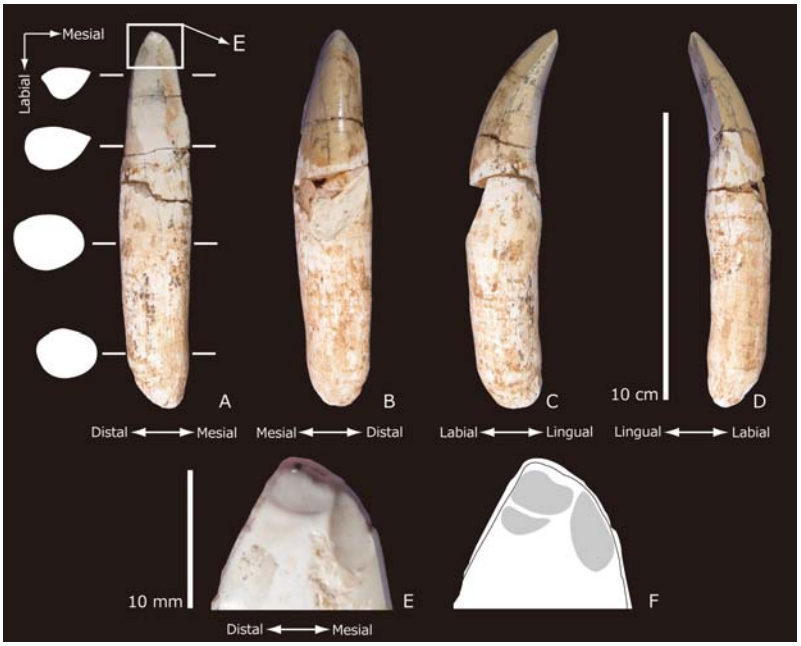


**Figure 2.** A lower second incisor of Rhinocerotinae genus and species indeterminate from the Yage area, Shizuoka Prefecture, central Japan (SFM04-11306). **A,** lingual view; **B,** labial view; **C,** distal view; **D,** mesial view; **E,** occlusal facets of Rhinocerotinae genus and species indeterminate; **F,** schematic drawing. White shaded areas represent cross sections. Gray shaded areas represent occlusal facets.

a left lower second incisor (i2) (Figure 2), the labial part of which is partially lacking. The specimen was coated with reddish-brown-colored very fine sandstone. Relatively long and robust in size, the apex is slightly curved lingually, while the mid-part is slightly swollen labio-lingually. It has a maximum longitudinal length of 129.2 mm, a maximum labio-lingual width of 19.5 mm, and a maximum mesio-distal width of 26.0 mm. Several occlusal facets are observed on the apex of the tooth crown (Figure 2E, 2F). The cross section of the crown part is teardrop-shaped, with an acutely angled mesial margin, and a rounded distal margin. In contrast, the cross section of the root is labio-lingually compressed into an oval shape. Light brown enamel covers the labial side of the tooth crown, while the lingual side of the tooth crown is smooth and lacking in enamel. The root end of the specimen is tapered with dense rings on the root surface.

*Comparisons and discussion*.—The specimen described here shows the following characteristics of the i2 of Rhinocerotidae: tusk-like shape, enamel on the labial side, a teardrop-shaped cross section of the tooth crown, and an oval cross section of the root (Mermier, 1895; Osborn, 1898; Prothero *et al*., 1986; Prothero, 2005).

Several taxa of the Subfamily Rhinocerotinae (including

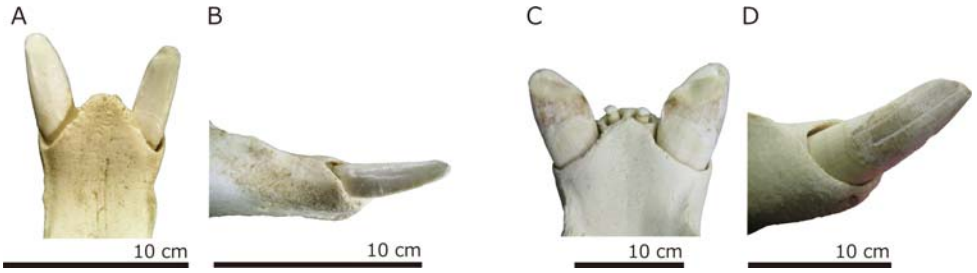


**Figure 3.** The lower second incisors of *Dicerorhinus* and *Rhinoceros*. **A, B,** *Dicerorhinus sumatrensis* (GMNH-VM-562: recent, adult individual, cast); **C, D,** *Rhinoceros unicornis* (KPM-NF1002747: Recent, adult individual). A and C, lingual view; B and D; right distal view.

**Table 1.** Measurements of the incisors of the present specimen, *Rhinoceros* and *Dicerorhinus* (in mm).

| Taxon | Specimen number | Labio-lingual width | Mesio-distal width |
|---|---|---|---|
| Present specimen | SFM04-11306 | 19.5 | 26.0 |
| *Rhinoceros unicornis* | KPM-NF1002747 | 28.4 | 41.9 |
| *Rhinoceros sinensis hayasakai* | Specimens No. 5 (Otsuka and Lin, 1984) | – | 17.4 |
| *Dicerorhinus sumatrensis* | GMNH-VM-562 | 12.6 | 18.3 |

*Dicerorhinus*, *Rhinoceros*, *Coelodonta* and *Elasmotherium*), have been reported from the Pleistocene in East Asia (e.g. Tong and Moigne, 2000). Of these, *Dicerorhinus* and *Rhinoceros* have tusk-like i2 (Otsuka and Lin, 1984; Tong and Guérin, 2009; Schepartz and Miller-Antonio, 2010). Several species of *Dicerorhinus* (*D. choukoutiensis*, *D. yunchuensis*, *D. sumatrensis*, *D. nipponicus*) have been discovered in East Asia (Shikama *et al*., 1967; Tong and Moigne, 2000; Tong and Guérin, 2009; Tong, 2012), and of these, *D. sumatrensis* is known to have i2. *Dicerorhinus sumatrensis* was discovered from Early to Late Pleistocene localities of China (Tong and Guérin, 2009; Tong, 2012 and references therein), such as Liucheng *Gigantopithecus* Cave, Guangxi; Xiawanggang, Henan; Yuyao, Zhejiang and Yunxian, Hubei. Tong and Guérin (2009) reported mandibles of *D. sumatrensis* from Liucheng *Gigantopithecus* Cave, Guangxi. Although these specimens lacked the lower incisors, they estimated that these mandibles had short and small lower incisors. The shape of the i2 of extant *D. sumatrensis* is short and slender and smaller in size (Table 1), unlike that of the specimen described here (Figure 3).

Some species of *Rhinoceros* (*R. sinensis*, *R. sivalensis*, *R. unicornis*) have been reported from Pleistocene localities of China (Tong and Moigne, 2000). *Rhinoceros sinensis* was discovered from many lower to Upper Pleistocene localities in South China (Tong and Moigne, 2000). *Rhinoceros sinensis hayasakai* was also reported from the lower Pleistocene T'ouk'oushan Group in Taiwan (Otsuka and Lin, 1984). *Rhinoceros sivalensis* was found in the Middle Pleistocene of South China (e.g. Tong and Moigne, 2000). An isolated upper deciduous premolar, which is closer to *R. unicornis*, was discovered from the Late Pleistocene locality of Lijiang Basin, Yunnan (Li, 1961; Tong and Moigne, 2000). The i2 of *Rhinoceros* is large and robust (e.g. Otsuka and Lin, 1984; Tong and Guérin, 2009; Schepartz and Miller-Antonio, 2010) (Figure 3). Although the size of the specimen described here is smaller than that of extant *Rhinoceros* (Table 1), its morphology is similar to that of *Rhinoceros*. However, owing to a lack of other elements (e.g. skull, mandible, and cheek teeth), generic and specific identification are not possible.

The i2 of female individuals is less curved than that of males (Prothero, 2005). The specimen described here is almost straight, and is therefore from a female.

Previously, several large mammal fossils, such as *Ursus arctos*, *Panthera tigris*, *Nipponiceros* (*Nipponicervus*) *praenipponicus*, and *Palaeoloxodon naumanni* (Takai *et al*., 1958; Tomida, 1978; Nojima, 2002), have been reported from the Yage area. However, rhinocerotid fossils have not been previously discovered from this area. Thus, this report is the first record of a rhinocerotid from the area.

In Japan, *Dicerorhinus* and *Rhinoceros* have been discovered in Pleistocene deposits (Figure 1A). A skull and mandibular fragments of *Dicerorhinus nipponicus* were discovered from the Middle Pleistocene of Isa, Yamaguchi Prefecture (Shikama *et al*., 1967). Isolated upper milk teeth and mandibles of *Dicerorhinus* cf. *nipponicus* (Okazaki, 2007), and isolated cheek teeth of *Dicerorhinus* sp. (Ogino *et al*., 2009) were reported from the Middle Pleistocene deposits of Matsugae in Fukuoka Prefecture, respectively. Upper and lower jaws with cheek teeth of *Rhinoceros* sp. and an undescribed juvenile rhinocerotid skeleton were discovered from the Pleistocene deposits in Kuzuu in Tochigi Prefecture (e.g. Nagasawa, 1961; Okazaki, 2007 and references therein). *Rhinoceros* aff. *sinensis* was reported from the Lower Pleistocene deposit in Aira in Kagoshima Prefecture (Shikama, 1967). A lower jaw of an indeterminate rhinocerotid was reported from the Middle Pleistocene of Tsukumi in Oita Prefecture

(Kawamura *et al*., 1977). Limb bones of an indeterminate rhinocerotid were also recovered from the seabed of Bisan-seto (Taruno, 1988). These Japanese Pleistocene rhinocerotid specimens, however, did not include any i2 specimens. Thus, direct comparisons of the specimen described here with other Pleistocene rhinocerotids in Japan are not possible. Nevertheless, the Pleistocene rhinocerotid specimens described previously and the specimen described here indicate the wide distribution of rhinocerotids during the Pleistocene in Far East Asia.

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