148. *Eocene Mammals from the Ube and Hósan Coal-fields in Nippon**.

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I. *The Ube Fossil Mammal.*

The Ube coal-field in Yamaguchi Prefecture is situated at the western extremity of Honsyû and the coal-bearing formation has been surveyed by Shigeyasu Tokunaga and Minoru Iizuka¹⁾. Its geological age was considered to be the Miocene epoch, and this opinion has been accepted for years by most geologists in Nippon. The Ube coal-bearing formation is rather thin, its thickness being less than 180 metres. Five workable coal-seams called the "Hitoe (一重)", "Hutae (二重)", Oha (大派)", "Itudan (五段)", and "Sanzyaku (三尺)" in descending order are interbedded with several coaly layers of little economic value or sometimes with layers almost barren of coal, from which two specimens of rhinoceros, a soft-shelled turtle, and several marine molluscs were collected. The soft-shelled turtle named *Trionyx ubeensis* Chitani²⁾ were found from the two coal-seams of "Hitoe" and "Oha", but yields no clue for the determination of geological age. Though the mammalian remains are generally believed to be more useful in this respect, the two specimens of rhinoceros—the one "? *Aceratherium watanabei* Tokunaga³⁾" from the "Itudan" coal-seam and the other "? *Rhinoceros* sp. of Tokunaga⁴⁾" from the "Hitoe" coal-seam—are too fragmentary to be of much help in determining exact geological ages. Several years ago the writer⁵⁾ wrote that when a well-preserved upper jaw with teeth should be unearthed some day the two might be discriminated from *Chilotherium pugnator* (Matsumoto)⁶⁾ which was

* Contribution from the Geological Institute, Faculty of Science, Imperial University of Tokyo.

1) S. Tokunaga and M. Iizuka: Geological Studies on the Ube Coal-field. Mem. Fac. Sci. Eng., Waseda Univ., no. 6. pp. 1-151, pls. 1-7, geol. map. 1, figs. 1-11, tables 1-36, 1930 (in Japanese).

2) Y. Chitani: On a New Fossil *Trionyx* from Yamaguchi Prefecture. Journ. Geol. Soc. Tokyo, vol. 32, no. 380, pp. 28-33 (English part), 1925.

3) S. Tokunaga: Fossils of Rhinocerotidae found in Japan. Proc. 2 (1926), 289-291.

4) S. Tokunaga: Ancient Rhinocerotids lived in the Main Island of Japan, Korea, and Manchuria. Dobutsugaku Zasshi (Zool. Mag.), vol. 41, nos. 490-491, pp. 377, 378, 1929 (in Japanese).

5) F. Takai: Cenozoic Mammalian Fauna of the Japanese Empire (A Preliminary Note). Journ. Geol. Soc. Japan, vol. 45, no. 541, pp. 747, 748, 1938 (in Japanese).

F. Takai: The Mammalian Faunas of the Hiramakian and Togarian Stages in the Japanese Miocene. Jubilee Publ. Comm. Prof. H. Yabe's 60th Birthday, vol. 1, pp. 192, 193, 1939.

6) H. Matsumoto: Descriptions of Some New Fossil Mammals from Kani District, Prov. of Mino, with Revisions of Some Asiatic Fossil Rhinocerotids. Sci. Rep., Tôhoku Imp. Univ., 2nd. ser. (geol.), vol. 5, no. 3, pp. 80-82, pl. 14, 1921.

described from the Burdigalian Hiramaki stage of the Togari-Kani districts, Gihu Prefecture, in the central part of Honsyû. At that time, he provisionally referred them to the Hiramakian species. Accordingly the geological age of the formation might be considered to belong to the Hiramakian—Burdigalian age. When the new palaeontological data described below are taken into consideration, it must be admitted that “? *Aceratherium watanabei*” and “? *Rhinoceros* sp.” should be compared with the Hôsanian species of *Coenolophus makii* Takai¹⁾ and the Ardynobian species of *Cadurcotherium ardynese* Osborn²⁾, but the whereabouts of this material is at present unknown. The former was a fragmental lower left and right jaw with M1-M3, and the latter was a fragment of a right upper molar. They seem to belong to the same species. The generic and specific determination of Rhinoceroidea on teeth, especially on lower teeth, is a very difficult task for even the specialists, but the laterally compressed and extremely hypsodont crown of the lower molars, M1-M3, of “? *Aceratherium watanabei*” resembles the generic characters of *Cadurcotherium*³⁾ much more than those of *Caenolophus*⁴⁾. The writer will therefore provisionally call them by the name of ? *Cadurcotherium watanabei* (Tokunaga) and discuss the difference with the Ardynobian species, pending the occurrence of more complete specimens.

Fortunately Hisakatsu Yabe recently came into possession of three right lower teeth which were embedded in the “Hitoe” coal-seam of the Okinoyama (沖ノ山) Colliery. Prof. Yabe kindly gave the writer the opportunity to study this new material. The writer was convinced that they were identical specifically with *Desmatotherium grangeri* Tokunaga⁵⁾ originally described from the Uppermost Eocene Hôsan formation of Kôkai-dô in the central part of Tyôsen. As Yabe⁶⁾ states, on the other hand, an external mould of the abactinal surface of an echinoid, *Clypeaster* sp. identified by Syôzô Nisiyama and three specimens of an interesting gastropod, *Athleta japonica* Nagao⁷⁾ occur from the “Itudan” coal-seam of the Motoyama (本山) and Okinoyama Col-

1) F. Takai: Eocene Mammals found from the Hôsan Coal-field, Tyôsen. Journ. Fac. Sci., Imp. Univ. Tokyo, sec. 2, vol. 5, pt. 6, pp. 214, 215, pl. 5, 1939.

2) H. F. Osborn: *Cadurcotherium* from Mongolia. Amer. Mus. Novit., no. 92, pp. 1, 2, 1923.

3) P. Gervais: Mammifères dont les Ossements accompagnent les Dépôts de Chaux phosphatée des Départements de Tarn-et-Garonne et de Lot. 2me mémoire. Journ. Zool., tome 2, p. 362, pl. 14, 1873 (Type—*Rhinoceros cayluxi* Gervais, 1873).

4) W. D. Matthew and W. Granger: New Mammals from the Shara Murun Eocene of Mongolia. Amer. Mus. Novit., no. 196, p. 6, 1925. (Type—*Caenolophus promissus* Matthew and Granger, 1925).

5) S. Tokunaga: On the Geological Age of Hozan Coal Field, Chosen. Journ. Geol. Soc. Tôkyô, vol. 40, no. 475, pp. 181, 182, pl. 8, fig. 6, 1933-a (in Japanese).

S. Tokunaga: A List of the Fossil Land Mammals of Japan and Korea with Description of New Eocene Forms. Amer. Mus. Novit., no. 627, pp. 6, 7, fig. 2, 1933-b.

6) H. Yabe: Palaeogene Age of the Coal Formation of the Ube Coal field, Yamaguchi Prefecture. Proc. 20 (1944), 725-731.

7) T. Nagao: Palaeogene Fossils of the Island of Kyûshû, Japan. Sci. Rep., Tôhoku Imp. Univ., 2nd ser. (geol.), vol. 12, no. 1, pp. 120, 121, pl. 16, figs. 6-10, 12-19, 1928.

lieries respectively. Furthermore, two important fossil plants, namely *Sabalites nipponicus* (Kryshstofovich) and *Nelumbo* cf. *nipponica* Endo, are examined by Seidô Endô and the former was collected from the "Itudan" coal-seam of the Okinoyama Colliery but the exact horizon of the latter is not known. Takumi Nagao¹⁾ recorded the occurrence of *Athleta japonica* from the Uppermost Eocene Otuzi group or the Upper Eocene Iozima beds in the various coal-fields of the northern part of Kyûsyû. Both *Sabalites nipponicus*²⁾ and *Nelumbo nipponica*³⁾ occur from the Palaeogene or Basal Neogene series in Hokkaidô and Karahutô including the Russian Sakhalin.

Synthesizing all these new palaeontological data, the formation can be, on the one hand, correlated with the Hôsan formation and on the other hand also with the Otuzi group. Therefore its geological age must be Uppermost Eocene. The description of the new material is given below.

Desmatotherium grangeri Tokunaga, 1933.

Figs. 1-5.

- 1933 *Desmatotherium grangeri* Tokunaga, Journ. Geol. Soc. Tôkyô, vol. 40, no. 475, pp. 181, 182, pl. 8, fig. 6.
 1933 *Desmatotherium grangeri* Tokunaga, Amer. Mus. Novit., no. 627, pp. 6, 7, fig. 2.
 1939 *Desmatotherium grangeri*, Takai, Journ. Fac. Sci., Imp. Univ. Tokyo, sec. 2, vol. 5, pt. 6, pp. 211, 212, pl. 4, figs. 5, 6, 8, 9.

Material:—Right second and fourth lower premolars and a fragment of right first lower molar embedded in the "Hitoe" coal-seam of the Okinoyama Colliery at their natural arrangement; all stored in the Museum of the Institute of Geology and Palaeontology, Faculty of Science, Tôhoku Imperial University; Reg. No. 66319.

Description:—"Size approximately that of *D. mongoliense* from the Irдин Manha beds of Mongolia but differing from both that species and from *D. fissum*, also from the Irдин Manha beds, by the greater simplicity and less quadrate character of the premolars. P2 and P3 with a single interior cusp and triangular in outline. P4 with two inner cusps placed close together and separated by shallow groove on the lingual face of the tooth: subquadrate in outline. Enamel crown relatively low, 5mm. in the present species and 6mm. in *D. mongoliense*, measured on the lingual face of the teeth (Tokunaga, 1933-b)" P2

1) T. Nagao: A Summary of the Palaeogene Stratigraphy of Kyûshû, Japan, with Some Accounts on the Fossiliferous Zones. Sci. Rep., Tôhoku Imp. Univ., 2nd ser. (geol.), vol. 12, no. 1, pp. 1-10, pl. 1, table 1, 1928.

2) A. N. Kryshstofovich: Occurrence of the Palm, *Sabal nipponica*, n. sp., in the Tertiary Rocks of Hokkaidô and Kyûshû. Journ. Geol. Soc. Tokyo, vol. 25, no. 303, pp. 59-66 (English part), pl. 41, 1918.

S. Endo: Two New Early Tertiary Plants from Japan. Johns Hopkins Univ. Stud. Geol., vol. 11, pp. 263, 269, pl. 18, 1934-b.

3) S. Endo: A New Species of *Nelumbo* from the Palaeogene of Japan. Japan. Journ. Geol. Geogr., vol. 11, nos. 3-4, pp. 255-258, pls. 36-38, 1934-a.

S. Endo: Op. cit., 1934-b, pp. 269, 270, pls. 19, 20.

Desmatotherium grangeri: Tokunaga, 1933.

- Text-fig. 1a Buccal view of right second lower premolar. $\times 3$.
 1b Lingual view of same. $\times 3$.
 2a Buccal view of right fourth lower premolar. $\times 3$.
 2b Lingual view of same. $\times 3$.
 2c Crown view of same. $\times 3$.
 3a Buccal view of right first lower molar. $\times 3$.
 3b Lingual view of same. $\times 3$.
 3c Crown view of same. $\times 3$.
 4 Buccal views of right fourth lower premolar and right first lower molar at their natural arrangement. $\times 1.5$.
 5a Crown views of casts of right fourth lower premolar and right first and second lower molars. $\times 1.5$.
 5b Buccal view of same. $\times 1.5$.

simple-crowned, laterally compressed, and two rooted. $\overline{P4}$ fully molari-form with moderately developed connecting ridge and two-rooted, anterior part of which damaged. $M1$ also bilobed connecting ridge moderately developed but posterior lobe and both anterior and posterior roots already lost.

Measurements in mm.

$\overline{P2}$	{ antero-postero.....	7.5
	{ transverse	5.5

$\overline{P4}$	{ antero-postero.....	10.0
	{ transverse	8.5
$\overline{M1}$	{ antero-postero.....	—
	{ transverse	8.5

Remarks:—The present material is exactly identifiable with the Hôsanian species by their molar pattern and size. As Tokunaga has already stated, the present species must be clearly discriminated from the Irдинmanhian species¹⁾ of *D. mongoliense* Osborn and *D. fissum* Matthew and Granger by the three cusped character of $\overline{P2}$ and $\overline{P3}$. It is also different from the Bridgerian species of *D. guyotii* Scott²⁾ in its smaller size.

II. The Hôsan Fossil Mammal.

In 1926 Shintarô Nakamura³⁾ took up the subject of the occurrences of mammalian remains from the Hôsan coal-field in the central part of Kôkai-dô, Northwest Tyôsen (Korea). Later Tokunaga⁴⁾ and the writer⁵⁾ described the fauna comprising five species as listed belows:—

Desmatotherium grangeri Tokunaga, 1933
Lophialetes tokunagai, Takai, 1939
Colodon hodosimai Takai, 1939
Caenolophus makii Takai, 1939
Protitanotherium koreanicum Takai, 1939

Subsequently Tokio Shikama⁶⁾ added a new species of creodont, *Harpagolestes koreanicus* to them. The fauna is believed to show the Uppermost Eocene age.

The writer found that an isolated right third lower molar identified with *Desmatotherium grangeri* belonged to the genus *Cristidentinus*.⁷⁾ Its description is as follows:

1) H. F. Osborn: Titanotheres and Lophiodonts in Mongolia. Amer. Mus. Novit., no. 91, pp. 2, 3, 1923.

W. D. Matthew and W. Granger: The Smaller Perissodactyls of the Irдин Manha Formation, Eocene of Mongolia. Ibid., no. 199, pp. 1-3, figs. 1-3, 1925.

2) W. B. Scott: On *Desmatotherium* and *Diplophodon*, Two New Eocene Lophiodonts. Contrib. Mus. Geol. Arch., Princeton Coll., Bull. no. 3, p. 46, pl. 8, 1883.

3) S. Nakamura: Geology of the Hôsan Coal Mine, Hôsan-gun, Kôkai-dô, Korea. Chikyû—The Globe, vol. 5, no. 1, pp. 97, 98, 1926 (in Japanese).

4) S. Tokunaga: Op. cit., 1926, pp. 289-291.

——: Op. cit., 1929, pp. 377, 378.

——: Op. cit., 1933-a, pp. 179-182, pl. 8.

——: Op. cit., 1933-b, pp. 4-7, figs. 1, 2.

5) F. Takai: Op. cit., 1939, pp. 199-217, pls. 1-5.

6) T. Shikama: A New Eocene Creodont from the Hôsan Coal Mine, Tyôsen. Bull. Biogeogr. Soc. Japan, vol. 13, no. 2, pp. 7-11, figs. 1, 2, 1943.

7) O. Zdansky: Die alttertiären Säugetiere Chinas nebst stratigraphischen Bemerkungen. Palaeont. Sinica, ser. C, vol. 6, fasc. 2, pp. 32-34, pl. 2, figs. 1, 2, 1930 (Type—*Cristidentinus depereti* Zdansky, 1930).

Cristidentinus sp.

Fig. 6.

1939 *Desmatotherium grangeri*, Takai, Journ. Fac. Sci., Imp. Univ. Tokyo, sec. 2, vol. 5, pt. 6, pp. 211, 212, pl. 4, fig. 7.

Material:—An isolated lower premolar in Tosisaburô Hodosima's private collection: its position is unknown.

Description:—"Rather wide, sharp. transverse crests, no connecting ridge; a low, transverse, crested cingula before and behind the tooth. Both lingual and buccal basal cingula absent. (Takai, 1939)."

Measurements in mm.

{ antero-postero.....	14.0
{ transverse	10.0

Remarks:—The characters of tooth closely related with those of *Cristidentinus*, but the tooth is too fragmental to be identified as *Cristidentinus depereti* Zdansky monotypically described from the Uppermost Eocene Kuanchuang series of Shantung Province, China. With the exception of that genus, the writer knows of none other which could be compared with the material.

This paper embodies the result of one of the studies made under the Science Research Fund from the Department of Education. The writer wishes to express his many thanks to the Department as well as to Prof. H. Yabe for placing new material at his disposal. To Prof. Yabe he is indebted also for communicating this paper to the Imperial Academy. Prof. T. Kobayashi has kindly gone over the whole paper.

6a

6b

Cristidentinus. sp.

Text-fig. 6a Side view of
lower premolar.
×3.
6b Crown view of
same. ×3.