63. A New Anthracothere from the Shiramizu Group in the Joban Coal-Field, Japan, with Notes on its Geological Age

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On November 26, 1957 an isolated mammalian molar has been collected by Sukeji Tsuchiya from a coarse grained sandstone of the Iwaki coal-bearing formation of the Shiramizu group, in the Joban coal-field along the eastern foot of the Abukuma Mountains, which unconformably rests on the Futaba Cretaceous and older rocks. The fossil was found at a place 454 meters below sea-level, situated 14 meters above the upper coal seam, and at 255 meters distant from the entrance to the south incline of the Iwasaki Colliery, Joban Coal Mining Co. The fossil apparently belongs to a Palaeogenic archaic ungulate mammal, that is, Anthracotheriidae.

According to G. G. Simpson, geologic occurrence and geographical distribution of Anthracotheriidae are middle Eocene to lower Miocene of Europe, upper Eocene to Pleistocene of Asia, and lower Oligocene to lower Miocene of Africa and North America. Among 23 genera of the family approved by Simpson, the following 15 genera have been recorded from Asia and Africa.

Rhagatherium Pictet and Humbert, 1855-1857. lower Pliocene (Asia); lower Oligocene (Africa)

Anthracobune Pilgrim, 1940. middle Eocene (Asia)

Anthracohyus Pilgrim and Cotter, 1916. upper Eocene (Asia)

Anthracokeryx Pilgrim and Cotter, 1916. upper Eocene (Asia)

Anthracotherium Pilgrim, 1928. upper Eocene (Asia)

Anthracosenez Zdansky, 1930. upper Eocene (Asia)

Anthracotherium Cuvier, 1822. upper Eocene, lower Miocene, and ? lower Pliocene (Asia)

Bothriodon Aymard, 1846. upper Eocene (Asia)

Brachyodus Depéret, 1895. upper Oligocene to middle Miocene (Asia); lower Oligocene (Africa)

Hemimeryx Lydekker, 1883. lower Miocene to lower Pliocene (Asia)

Hyoboops Trouessart, 1904. lower Miocene to lower Pliocene (Asia); lower Miocene (Africa)

Telmatodon Pilgrim, 1907. lower Miocene to lower Pliocene (Asia)

Parabrachyodus Forster Cooper, 1915. lower Miocene (Asia)

Choeomeryx Pomel, 1848. lower to middle Pliocene (Asia)

Judging from its 5 cuspidate, bunodont molar pattern, and outline, the fossil is the second left upper molar. Although any reliable generic identification is now impossible, but it can be safely said that the fossil is related at least to some Eocene anthracotheriids, such as Anthracobune, Anthracohyus, Anthracokeryx, Anthracothema, Anthracosenex, Anthracotherium, and Bothriodon. From the viewpoint of the configuration of primary and peripheral cusps, the development of cingula, and the size, the fossil bears a fairly strong resemblance to Anthracothema.

Therefore, the fossil shall be called provisionally by the new name of "Anthracothema" tsuchiyai Takai (MS) referring to its discoverer. Its detailed description shall be given in future after the precise comparison of related genera.

In Asia the majority of Eocene anthracotheriids\(^2\) has been reported from the Eocene Pondaung sandstone of Burma together with

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No. 5] A New Anthracothere from the Shiramizu Group 257

Pondaungia, Amphipithecus, Sivatitanops, Metatelmatherium, Paramynodon, Indolophus, Deperetella, and Indomeryx. The Pondaung mammalian fauna indicates the late Eocene (Auversian) age. A few of them are also known from the Lower Yüanch'ü series of Shansi and Honan provinces and the Lunan series of Yunnan province, China, along with Ictopodium, Adapidium, Hoanghonius, Cricetodon, Hyaeodon, Eomoropus, Protitanotherium, Cristidentinus, Lophioides, Deperetella, Diplolophodon, Teleolophus, Caenolophus, Amynodon, Cadurotherium, Gobiohyus, etc. These Yüanch'ü—Lunan mammalian faunae show the late Eocene (Bartonian) age. Accordingly it is probable that “Anthracothema” tsuchiyai (MS) has migrated from the Asiatic continent through Korea (the Hōsan formation of Kōkaidō) together with Desmatotherium grangeri and Amynodon watanabei. Then the Iwaki coal-bearing formation must be correlated with the lowest horizon of the Numata formation or the uppermost horizon of the Tachibets formation of the Eocene Uryu group in the central part of Hokkaido on one hand, and the Ube coal-bearing formation in the western extremity of Honshu on the other. The latter two have yielded Amynodon watanabei in common.

Brachyodus, one of the transitional genera between the archaic and modern anthracotheriids in Asia and Africa, has been reported from the Nakazato formation of the Sasebo group in the northwestern part of Kyushu, and the Sasebo group has been once considered to be of Oligocene age. But as stated in 1939, Brachyodus japonicus from the Sasebo group is a member of the Burdigalian Hiramaki mammalian fauna which consists of Bunolophodon annectens, Anchitherium hypohippoides, Palaeotapirus yagii, Rhinoceros (Chilotherium) pugnator, Palaeochoerus japonicus, and Amphitragulus minoensis. Besides Brachyodus japonicus, this formation yields, according to A. Mizuno, some species of the so-called Kadonosawa

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molluscan fauna, such as *Batillaria takeharai*, *Glycymeris cisshuensis*, *G. matsumoriensis*, *Pitar itoi*, *Cyclina japonica*, *Protothaca tateiwai*, *Venerupis siratoriensis*, *V. nagahamai*, etc. From these palaeontological evidences, the Sasebo group should not be Oligocene in age as was previously believed.

In the species of *Brachyodus* the selenodont condition of the cusp on the buccal side of the upper molar is completely established. On the contrary, this character is not yet accomplished in some anthracotheiids of Eocene age, and the bunodont condition remains unchanged in the greater part of them. “Anthracothema” *tsuchiyai* (MS) must not be an exceptional case, and there is no possibility of synchronous occurrence of “Anthracothema” *tsuchiyai* (MS) and *Brachyodus japonicus*.

K. Sugai et al.⁹ and I. Imai et al.¹⁰ divided the Tertiary system of the Joban coal-field into seven groups, namely, Shiramizu, Yunagaya, Shirado, Takaku, Taga, Hitachi, and Hatsuzaki groups in ascending order. The lowest Shiramizu and the succeeding six groups are respectively assigned to the Oligocene and the Neogene. Especially most reliable for the age-determination are *Desmostylus cf. mirabilis* from the Kamenooo shale of the Miocene Yunagaya group and *Stegodon elephantoides* from the Hanareyama tuff of the Pliocene Hitachi group. Accordingly it can be generally accepted that the Neogenic sediments have been deposited during the Miocene and Pliocene. This is supported also by the occurrences of many mega-fossils.

The so-called Oligocene Shiramizu group is subdivided into three formations, namely, the Iwaki coal-bearing formation (100–350 meters thick), the Asagai formation (50–120 meters), and the Shirasaka formation (100–250 meters) in ascending order, all conformable to each other. The Shiramizu group is unconformably overlain by the Taki coal-bearing formation the lowest member of the Miocene Yunagaya group.

The Iwaki coal-bearing formation, with one of the workable coal seams of the Joban coal-field, is chiefly composed of sandstone with conglomerate, shale, and thin coal seams. It yields marine molluscs such as *Glycymeris nakosoensis*, *Spisula (Macromeris) nagakoensis*, etc., and plants such as *Equisetum arcticum*, *Metasequoia langsdorfi*, *Glyptostrobus europaeus*, *Juglans acuminata*, *Corylus Mac quarriii*, *Betula prisca*, *Diospyros brachysepala*, *Acer arcticum*, *A. trilobatum*,

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etc. T. Tanai\(^{11}\) stated that the fossil flora is early Oligocene in age and closely resembles the Yubetsu or Shakubetsu flora of the Urahoro group in the Kushiro coal-field and seems to be younger than the *Woodwardia* flora in the Ikushumbetsu formation of the Eocene Ishikari group in Ishikari coal-field.

The Asagai formation, generally consisting of fine-grained sandstone, contains rich marine molluscs as "*Margarites* makiyamai, *Turritella tokunagai*, *T. importuna*, *Boreoscala oyamadensis*, *Am- pullina asagaiensis*, *Colus asagaiensis*, *Molopophorus watanabei*, *Yoldia (Yoldia) laudabilis*, *Acila (Truncacila) oyamadensis*, *Venericardia (Cyclocardia) laxata*, *V. (C.) tokunagai*, *Thyasira (Conchocele)*, *bisecta*, *Nemocardium iwakiense*, *Clinocardium asagaiense*, *Paryridea harrimani*, *Liocyma furtiva*, *Macoma asagaiensis*, *M. sejugata*, *Spisula (Mactromeris) nagakoensis*, *Mya grewingki*, *Periploma besshoense*, etc., and foraminifers as *Trochammina asagaiensis*, *Cyclammina cfr. incisa*, *Elphidium asagaiense*, *E. yumotoense*, etc. After a discussion of the molluscan fauna, J. Makiyama\(^{12}\) correlated the Asagai formation with the Marie formation near Matchgar in Schmidt peninsula, North Sakhalin and settled the Aquitanian age of them. Lately, K. Asano,\(^{13}\) on his foraminiferal study correlated the Asagai formation with the Vaqueros of the Pacific coast of North America and attributed it to the Zemorian (Rupelian) or Saucesian (Aquitanian).

The Shirasaka formation overlying the Asagai, consists of gray mudstone and contains in its lower part some representatives of the Asagai molluscan fauna such as *Turritella tokunagai*, *T. importuna*, *Molopophorus watanabei*, *Yoldia (Yoldia) laudabilis*, *Venericardia (Cyclocardia) laxata*, *Clinocardium asagaiense*, *Liocyma furtiva*, *Macoma asagaiensis*, *Mya grewingki*, *Periploma besshoense*, etc.

In his letter nomination of the Japanese Cenozoic, N. Ikebe\(^{14}\) selected the Asagai formation (including the Asagai sandstone and the Shiramizu shale), as the type of his division E (upper Oligocene or lowest Miocene) characterized by the Asagai molluscan fauna.

Makiyama's opinion on the geological age of the Asagai formation has for a long time been accepted by almost all Japanese geologists; however, its revision seems now necessary.

\(^{13}\) Asano, K. (1949): Foraminifera from the Asagai formation (Tertiary) of Fuku- shima prefecture, Japan, Jour. Paleont., 23, no. 5, 473-478, figs. 1, 2.
In conclusion, an isolated second left upper molar from the Iwaki coal-bearing formation is here provisionally assigned to the genus *Anthracothema* under the new name “*Anthracothema*” tsuchiyai (MS). But this generic identification requires future study. The tooth bearing a late Eocene (Priabonian) feature is considered to be a new member of the Ube mammalian fauna, and not of the Hiramaki. Accordingly, the Shiramizu group must be regarded Eocene in geological age, in good coincidence with that of the Noda coal-bearing group\(^{15}\) at the eastern foot of the northern Kitakami Mountains, which unconformably overlies the upper Cretaceous Kuzi group and has hitherto been thought Eocene. The fossil flora of the Noda group, called Minato flora by T. Tanai,\(^{16}\) is correlated by him with the *Woodwardia* flora of the Eocene Ishikari group, on floral composition. The Abukuma Mountains and the northern Kitakami Mountains have the Tertiary history in common.

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