CENTRAL ASIATIC EXPEDITIONS

AMERICAN MUSEUM OF NATURAL HISTORY

美國博物館

中亞調查記

PRELIMINARY REPORTS VOL. I 1918-1925

CENTRAL ASIATIC EXPEDITIONS OF THE AMERICAN MUSEUM OF NATURAL HISTORY, UNDER THE LEADERSHIP OF ROY CHAPMAN ANDREWS

PRELIMINARY CONTRIBUTIONS IN GEOLOGY, PALÆONTOLOGY AND ZOOLOGY

1918-1925

By R. C. Andrews

J. T. Nichols
Outram Bangs
H. W. Fowler
W. Granger
C. P. Berkey
W. K. Gregory
H. F. Osborn
G. M. Allen
C. C. Mook
W. D. Matthew
F. K. Morris
G. K. Noble
T. D. A. Cockerell
K. P. Schmidt
V. Van Straelen
G. G. Simpson

Reprints from the *American Museum Bulletin* and *Novitates*, also one from the *Proceedings of the Biological Society of Washington*, of the years 1918–1925

VOLUME I
Nos. 1 to 63

List of additional articles, 1916-1925, not included in this volume

TO THE BENEFACTORS OF THE CENTRAL ASIATIC EXPEDITIONS

The Central Asiatic Expeditions of the American Museum of Natural History, under the leadership of Roy Chapman Andrews, actually began in the year 1916 with the first collecting tour of the Leader accompanied by Mrs. Andrews, into the western Chinese Province of Yun-nan.

The exploration continued under Doctor Andrews' leadership in the First, Second and Third Asiatic Expeditions, and all the scientific results are now embraced under the general title of CENTRAL ASIATIC EXPEDITIONS.

Beginning in 1916, Doctor Andrews has contributed to *Asia* Magazine and other periodicals, as listed in the bibliography included in this volume, a series of articles on the organization, personnel, narrative and discoveries of the Expeditions, which will be comprised in Volume I, 'Narrative of the Expeditions,' of the series of twelve volumes in which the scientific results of the Expedition will be republished in permanent form. Volume II of the series, 'Geological Reconnaissance in Mongolia,' covers the work of Messrs. Berkey and Morris to the end of the year 1925, and will appear during the present year.

Meanwhile, sixty-three preliminary scientific papers, as listed in the bibliography of this volume, have been published, chiefly in the American Museum *Bulletin* and *Novitates*, reprints of which are collected and bound together in the present volume. This volume is issued especially for the convenience of specialists and investigators actually engaged in present researches in the same fields of Geology, Palæontology and Zoology. While designed for personal use, the volumes are addressed and donated to the institutions to which the recipients are attached, to become part of the permanent libraries of these institutions.

A special branch of the AMERICAN MUSEUM LIBRARY is to be devoted to Central Asiatic exploration, especially in the regions covered by our expeditions, and libraries and individuals are invited to contribute in return for the present volume, which is sent out in the spirit of international exchange and coöperation.

HENRY FAIRFIELD OSBORN,
President.

AMERICAN MUSEUM OF NATURAL HISTORY,
April 8, 1926.

ARTICLES INCLUDED IN THIS VOLUME

22. **New Insectivores and Ruminants from the Tertiary of Mongolia, with Remarks on the Correlation. 1924.** By W. D. Matthew and Walter Granger.

23. **A New Crocodilian from Mongolia. 1924.** By Charles C. Mook.

24. **The Great Bathylith of Central Mongolia. 1924.** By Charles P. Berkey and Frederick K. Morris.

25. **Psittacosaurus and Protiguanodon: Two Lower Cretaceous Iguanodonts from Mongolia. 1924.** By Henry Fairfield Osborn.

26. **Sauropoda and Theropoda of the Lower Cretaceous of Mongolia. 1924.** By Henry Fairfield Osborn.

27. **A New Spadefoot Toad from the Oligocene of Mongolia with a Summary of the Evolution of the Pelobatidæ. 1924.** By G. K. Noble.

28. **Microtines Collected by the Asiatic Expeditions. 1924.** By Glover M. Allen.

29. **Basin Structures in Mongolia. 1924.** By Charles P. Berkey and Frederick K. Morris.

30. **Structural Elements of the Oldrock Floor of the Gobi Region. 1924.** By Charles P. Berkey and Frederick K. Morris.

31. **The Peneplanes of Mongolia. 1924.** By Charles P. Berkey and Frederick K. Morris.

32. **Three New Theropoda, Protoceratops Zone, Central Mongolia. 1924.** By Henry Fairfield Osborn.

33. **Eudinoceras, Upper Eocene Amblypod of Mongolia. 1924.** By Henry Fairfield Osborn.

34. **Andrewsarchus, Giant Mesonychid of Mongolia. 1924.** By Henry Fairfield Osborn.

35. **Cadurcotherium ardynense, Oligocene, Mongolia. 1924.** By Henry Fairfield Osborn.

36. **Serridentinus and Baluchitherium, Loh Formation, Mongolia. 1924.** By Henry Fairfield Osborn.

37. **Fossils in the Ondai Sair Formation, Mongolia. 1924.** By T. D. A. Cockerell.

38. **Some Fishes Collected by the Third Asiatic Expedition in China. 1924.** By Henry W. Fowler.

39. **The Affinities of the Fish Lycoptera middendorffi. 1925.** By T. D. A. Cockerell.

40. **On Protoceratops, a Primitive Ceratopsian Dinosaur from the Lower Cretaceous of Mongolia. 1925.** By William K. Gregory and Charles C. Mook.

41. **New Reptiles and a New Salamander from China. 1925.** By Karl Patterson Schmidt.

42. **Jerboas from Mongolia. 1925.** By Glover M. Allen.
43. **Squirrels Collected by the American Museum Asiatic Expeditions. 1925.** By Glover M. Allen.
44. **A New Homalopterin Loach from Fukien. 1925.** By J. T. Nichols.
45. **An Analysis of Chinese Loaches of the Genus Misgurnus. 1925.** By J. T. Nichols.
46. **The Two Chinese Loaches of the Genus Cobitis. 1925.** By J. T. Nichols.
47. **Nemacheilus and Related Loaches in China. 1925.** By J. T. Nichols.
48. **Homaloptera caldwelli, a New Chinese Loach. 1925.** By J. T. Nichols.
49. **The Microstructure of the Dinosaurian Egg-Shells from the Cretaceous Beds of Mongolia. 1925.** By Victor Van Straelen.
50. **New Chinese Amphibians and Reptiles. 1925.** By Karl Patterson Schmidt.
51. **Some Chinese Fresh-Water Fishes. 1925.** By J. T. Nichols.
52. **Hamsters Collected by the American Museum Asiatic Expeditions. 1925.** By Glover M. Allen.
53. **Some Chinese Fresh-Water Fishes. 1925.** By J. T. Nichols.
54. **Some Chinese Fresh-Water Fishes. 1925.** By J. T. Nichols.
55. **Some Chinese Fresh-Water Fishes. 1925.** By J. T. Nichols.
56. **Fauna and Correlation of the Gashato Formation of Mongolia. 1925.** By W. D. Matthew and Walter Granger.
57. **New Creodonts and Rodents from the Ardyn Obo Formation of Mongolia. 1925.** By W. D. Matthew and Walter Granger.
58. **New Ungulates from the Ardyn Obo Formation of Mongolia. 1925.** By W. D. Matthew and Walter Granger.
59. **New Mammals from the Shara Murun Eocene of Mongolia. 1925.** By W. D. Matthew and Walter Granger.
60. **New Mammals from the Irdin Manha Eocene of Mongolia. 1925.** By W. D. Matthew and Walter Granger.
61. **The Smaller Perissodactyls of the Irdin Manha Formation, Eocene of Mongolia. 1925.** By W. D. Matthew and Walter Granger.
62. **A Mesozoic Mammal Skull from Mongolia. 1925.** By George Gaylord Simpson.
63. **Upper Eocene and Lower Oligocene Titanotheres of Mongolia. 1925.** By Henry Fairfield Osborn.

A List of Articles (1916–1925) Relating to the Asiatic Expeditions of The American Museum of Natural History Not Included in This Volume

1916

The Asiatic Zoölogical Expedition of the American Museum of Natural History. By Roy Chapman Andrews. *The American Museum Journal*, Vol. XVI, No. 2, pp. 105–106.

Reproductions in Duotone of Asiatic Photographs, taken by Roy Chapman Andrews. *The American Museum Journal*, Vol. XVI, No. 2, pp. 107–114.

Note—The American Museum's Asiatic Zoölogical Expedition secures the services of Mr. Edmund Heller. *The American Museum Journal*, Vol. XVI, No. 3, p. 208.

Note—Advices from Mr. Andrews dated Shanghai, China, May 18, 1916. *The American Museum Journal*, Vol. XVI, No. 5, p. 334.

Note—Mr. Roy Chapman Andrews reports on the progress of the Museum's Asiatic Zoölogical Expedition. *The American Museum Journal*, Vol. XVI, No. 6, p. 411.

Note—Mr. Roy Chapman Andrews writes from Li-kiang-fu, Yunnan Province, China, October 7, 1916, on activities of the Museum's Asiatic Zoölogical Expedition. *The American Museum Journal*, Vol. XVI, No. 8, p. 547.

1917

Report from the Asiatic Zoölogical Expedition. By J. A. Allen. *The American Museum Journal*, Vol. XVII, No. 2, pp. 144–145.

Note—Mr. Andrews reports to the American Museum that the Asiatic Zoölogical Expedition will return about the end of September, 1917. *The American Museum Journal*, Vol. XVII, No. 6, p. 422.

Chinese Pagoda, near Tali-fu, Yunnan, Photographed by Yvette Borup Andrews on the American Museum's Asiatic Zoölogical Expedition. *The American Museum Journal*, Vol. XVII, No. 8 (Cover).

Frontispiece, A Typical Goral Cliff in the Province of Yunnan, China. *The American Museum Journal*, Vol. XVII, No. 8, p. 508.

Little-known Mammals from China. By Roy Chapman Andrews. *The American Museum Journal*, Vol. XVII, No. 8, pp. 509–524.

Picturesque Yunnan. Reproduction in Duotone from Photographs taken by Yvette Borup Andrews. *The American Museum Journal*, Vol. XVII, No. 8, p. 525.

1918

Whaling Off Asian Shores. By Roy Chapman Andrews. *Asia* Magazine, Vol. XVIII, pp. 227–232.

Tracking the Chinese Chamois. By Roy Chapman Andrews. *Asia* Magazine, Vol. XVIII, pp. 473–479.

Note—Reverend Harry R. Caldwell and Professor C. R. Kellogg elected to life membership in appreciation of assistance rendered to the Asiatic Zoölogical Expedition in Yunnan. *The American Museum Journal*, Vol. XVIII, No. 1, p. 69.

China's Ancient Monuments. By Roy Chapman Andrews. *The American Museum Journal*, Vol. XVIII, No. 4, pp. 251–262.

Letter from Rev. A. Kok, of Li-kiang-fu, Yunnan, China, to President Osborn tells of cordial relations that exist between members of Asiatic Expedition and Chinese people where Expedition worked. *The American Museum Journal*, Vol. XVIII, No. 4, p. 314.

The Blue Tiger. By Roy Chapman Andrews. Illustrations by Yvette Borup Andrews. *The American Museum Journal*, Vol. XVIII, No. 5, pp. 372–380.

Note—Roy Chapman Andrews writes September 18, 1918, to President Osborn describing journey to Urga. *The American Museum Journal*, Vol. XVIII, No. 7, p. 621.

Note—Second Asiatic Zoölogical Expedition to continue for another year. *The American Museum Journal*, Vol. XVIII, No. 8, p. 727.

Camps and Trails in China. By Roy Chapman Andrews and Yvette Borup Andrews. D. Appleton & Co., New York.

Traveling toward Tibet. By Roy Chapman Andrews. *Harper's Magazine*, Vol. 136, pp. 617–32.

Frontier of the Forbidden Land. By Roy Chapman Andrews. *Harper's Magazine*, Vol. 136, pp. 894–905.

Camps in China's Tropics. By Roy Chapman Andrews. *Harper's Magazine*, Vol. 137, pp. 124–37.

1919

Across Mongolia by Motor-Car. By Roy Chapman Andrews. *Harper's Magazine*, Vol. 139, pp. 1–16.

Photographs by Roy Chapman Andrews, depicting scenes in Peking on the signing of the Armistice at Close of World War. *Natural History*, Vol. XIX, No. 2, pp. 229–232.

Note—Roy Chapman Andrews discusses with Mr. Kungpah T.

King ways and means of coöperation. *Natural History*, Vol. XIX, No. 2, p. 229.

Note—Roy Chapman Andrews writes to the Museum regarding the speed of antelopes. *Natural History*, Vol. XIX, No. 3, p. 355.

Shooting Whales in the Far East. By Roy Chapman Andrews. *Asia* Magazine, Vol. XIX, pp. 592–596.

Exploring Unknown Corners of the "Hermit Kingdom." By Roy Chapman Andrews. *National Geographic Magazine*, Vol. XXXVI, pp. 25–48, 30 ills., 1 page map.

1920

Note—By invitation of the American Asiatic Association, Mr. Andrews delivers two lectures at Carnegie Hall upon the American Museum's Asiatic Expeditions. *Natural History*, Vol. XX, No. 2, p. 222.

Note—Mr. Andrews returns from China after an absence of two years where he had been in charge of the Second Asiatic Zoölogical Expedition. *Natural History*, Vol. XX, No. 1, p. 110.

Note—Pending publication of extensive article in *Natural History* describing work of the American Museum's Second Asiatic Expedition to North China and Mongolia, Mr. Andrews gives notes regarding the material obtained. *Natural History*, Vol. XX, No. 3, pp. 340–341.

Frontispiece, Where the Mongolian Bighorn Sheep are found. From a photograph by Yvette Borup Andrews. *Natural History*, Vol. XX, No. 4, p. 348.

New Expedition to Central Asia. By Roy Chapman Andrews. *Natural History*, Vol. XX, No. 4, pp. 349–355.

In Mongolia and North China. By Roy Chapman Andrews. *Natural History*, Vol. XX, No. 4, pp. 356–373.

Big Game Hunting at the Eastern Tombs. By Roy Chapman Andrews. *Asia* Magazine, Vol. XX, No. 8, pp. 795–799.

A New Search for the Oldest Man. By Roy Chapman Andrews. *Asia* Magazine, Vol. XX, No. 10, pp. 945–949.

Urga, the Sacred City of the Living Buddha. By Roy Chapman Andrews. *Harper's Magazine*, Vol. 141, pp. 145–156.

Lure of the Mongolian Plains. By Roy Chapman Andrews. *Harper's Magazine*, Vol. 141, pp. 430–441.

1921

The Motor Truck in Central Asia. By Roy Chapman Andrews. *Natural History*, Vol. XXI, No. 1, pp. 69–70.

Note—Regarding scientific staff of the Expedition during first and second years. *Natural History*, Vol. XXI, No. 1, p. 100.

Note—Assistance rendered to Mr. Andrews by Rev. Harry R. Caldwell on First and Second Asiatic Expeditions. Mr. Caldwell sends to American Museum collection of mammals, including exceptionally fine tiger skin. *Natural History*, Vol. XXI, No. 2, p. 211.

Digging for the Roots of our Family Tree. By Roy Chapman Andrews. *Asia* Magazine, Vol. XXI, No. 5, pp. 439–444.

Walter Granger and the Third Asiatic Expedition. *Natural History*, Vol. XXI, No. 3, pp. 320–321.

Note—Prof. C. P. Berkey prepares to join Third Asiatic Expedition in the spring of 1922. *Natural History*, Vol. XXI, No. 3, p. 326.

Note—Mr. Clifford Pope sails from San Francisco, Calif., May 31, 1921, with Mr. Walter Granger, to join the Third Asiatic Expedition. *Natural History*, Vol. XXI, No. 3, p. 326.

Note—The Third Asiatic Expedition begins important work in China with every promise of success. Cordial interest manifested by Dr. Yen and other members of the Cabinet in Peking. Dr. V. K. Ting and Dr. J. G. Andersson have given invaluable aid. *Natural History*, Vol. XXI, No. 5, pp. 545–546.

Note—Report of the Third Asiatic Expedition. Letters from Roy Chapman Andrews and Walter Granger to President Osborn. *Natural History*, Vol. XXI, No. 6, pp. 649, 650.

Across Mongolian Plains. By Roy Chapman Andrews. Photographs by Yvette Borup Andrews. D. Appleton & Co., New York.

Hunting the Great Ram of Mongolia. By Roy Chapman Andrews. *Harper's Magazine*, Vol. 142, pp. 328–338.

1922

Note—Mr. Roy Chapman Andrews prepares a full account of activities in China to be featured in early number of *Natural History* Mr. Andrews' letter of December 20, 1921, quoted. *Natural History* Vol. XXII, No. 1, p. 85.

Note—Mr. Roy Chapman Andrews sends to President Osborn a series of water color sketches of Chinese reptiles and amphibians made from living specimens secured by the Expedition. *Natural History*, Vol. XXII, No. 2, pp. 181–182.

Note—Mr. Walter Granger, palæontologist of Expedition, has been engaged for some months in explorations on the Upper Yangtze-kiang. Extracts from letter. *Natural History*, Vol. XXII, No. 2, pp. 184, 185.

Politics and Palæontology. By Roy Chapman Andrews. *Asia* Magazine, Vol. XXII, No. 5, pp. 360–364; 400–401.

Scientific Work in Unsettled China. By Roy Chapman Andrews. *Natural History*, Vol. XXII, No. 3, pp. 213–223.

Note—Inaugural Meeting of the Geological Society of China held in Peking, March 23, 1922. *Natural History*, Vol. XXII, No. 3, p. 286.

Note—April 16, Message from Roy Chapman Andrews, announces departure of Expedition for Mongolia. Discovery of important Cretaceous and Tertiary beds with fragmentary fossils of mammals and dinosaurs. *Natural History*, Vol. XXII, No. 3, pp. 276–277.

The Third Asiatic Expedition of the American Museum of Natural History. By Roy Chapman Andrews. *Science*, N.S., Vol. LV, No. 1431, pp. 584–587.

The Quest of the Golden Fleece. I. The Wilds of Shensi. By Roy Chapman Andrews. *Asia* Magazine, Vol. XXII, No. 6, pp. 440–446.

The Quest of the Golden Fleece. II. Takin on Their Rugged Peaks. By Roy Chapman Andrews. *Asia* Magazine, Vol. XXII, No. 7, pp. 515–520; 568.

Hunting Takin in the Mountains of Shensi. By Roy Chapman Andrews. *Natural History*, Vol. XXII, No. 4, pp. 292–300.

Note—Progress of the Expedition. Letter to President Osborn from Roy Chapman Andrews from Urga, quoted. *Natural History*, Vol. XXII, No. 4, pp. 374–375.

Discovery of Cretaceous and Older Tertiary Strata in Mongolia. By Henry Fairfield Osborn. (Abstract.) *Science*, N. S., Vol. LVI, No. 1446, pp. 291–293.

Note—Professor Osborn to visit the Far East. *Natural History*, Vol. XXII, No. 5, p. 471.

Proving Asia the Mother of Continents. By Henry Fairfield Osborn. *Asia* Magazine, Vol. XXII, No. 9, pp. 721–724.

Note—Discoveries in Mongolia—Expedition reports extraordinary success from summer's explorations in Mongolia. Mr. Granger, palæontologist of the Expedition, secured complete skeletons of small Cretaceous dinosaurs, a skull of the giant hornless rhinoceros *Baluchitherium* and numerous other important specimens. *Natural History*, Vol. XXII, No. 6, pp. 569–570.

Gobi—A Desert "Wonder-House." By Roy C. Andrews and W. D. Matthew. *Asia* Magazine, Vol. XXII, No. 12, pp. 959–962; 1000–1002; 1005.

Current Palæontological Research in China. By J. G. Andersson.

Bulletin of the American Museum of Natural History, Vol. XLVI, Art. 13, pp. 727–737.

China as a Field for Scientific Research. By Roy Chapman Andrews. *Bulletin of the Geological Society of China*, Vol. 1, No. 1–4, p. 8.

The Wider Significance of Palæontological Research in China. By Walter Granger. *Bulletin of the Geological Society of China*, Vol. 1, No. 1–4, p. 8.

Some Points of Interest in the First Three Weeks' Work of the Third Asiatic Expedition. By Davidson Black, *Bulletin of the Geological Society of China*, Vol. 1, No. 1–4, p. 37.

1923

Note—What the Gobi Desert has Yielded. In a cable sent by Roy Chapman Andrews to *Asia* Magazine and published in the December issue, Mr. Andrews summarizes the remarkable results obtained from five months' work in the Gobi Desert. *Natural History*, Vol. XXIII, No. 1, pp. 90–91.

Note—Vertebrate Fossils—A Forerunner of the Horned Dinosaurs. A skull casually discovered by J. B. Shackelford, photographer of the Expedition, while on a trip to Mongolia, proves to be a type ancestral to the ceratopsians known only from Upper Cretaceous. Dr. Gregory and Mr. Granger prepare paper to be published in *Novitates*. *Natural History*, Vol. XXIII, No. 2, p. 192.

Note—Motion pictures of the Expedition to Mongolia. Preliminary demonstration in the American Museum of the pictures secured during the trip. *Natural History*, Vol. XXIII, No. 2, p. 193.

Fossil Bones of the *Baluchitherium*. (Frontispiece). *Asia* Magazine, Vol. XXIII, No. 4, p. 240.

Setting Out for the Buried Treasure of Mongolia. By Roy Chapman Andrews. *Asia* Magazine, Vol. XXIII, No. 4, pp. 241–245; 288.

A Paradise for Dinosaurs. By Roy Chapman Andrews. *Asia* Magazine, Vol. XXIII, No. 5, pp. 336–340.

The Extinct Giant Rhinoceros *Baluchitherium* of Western and Central Asia. By Henry Fairfield Osborn. *Natural History*, Vol. XXIII, No. 3, pp. 209–228.

Untying Red Tape in Urga. By Roy Chapman Andrews. *Asia* Magazine, Vol. XXIII, No. 6, pp. 420–424; 459–460.

Field Explorations of the American Museum during the Year 1922. By Henry Fairfield Osborn. *Science*, N.S., Vol. LVII, No. 1485, pp. 681–683.

Ancient Fauna of Mongolia Discovered by the Third Asiatic Expedition of the American Museum of Natural History. By Henry Fairfield Osborn. (Address to the New York Academy of Sciences at a special meeting, May 21, 1923). *Science*, N.S., Vol. LVII, No. 1487, pp. 729–732.

Note—The Third Asiatic Expedition Resumes Work in Mongolia. *Natural History*, Vol. XXIII, No. 4, pp. 406–408.

Tenting in Lama Land. By Roy Chapman Andrews. *Asia* Magazine, Vol. XXIII, No. 7, pp. 516–520.

A Kentucky Derby in the Gobi Desert. By Roy Chapman Andrews. *Asia* Magazine, Vol. XXIII, No. 8, pp. 547–552; 598–600.

Baluchitherium, Largest Known Land Mammal. (Frontispiece). Fourth Restoration painted under the direction of Henry Fairfield Osborn by Charles R. Knight. *Asia* Magazine, Vol. XXIII, No. 9, p. 624.

Giant Beasts of Three Million Years Ago. By Henry Fairfield Osborn. *Asia* Magazine, Vol. XXIII, No. 9, pp. 625–630; 676.

Baluchitheres browsing in the fertile savanna uplands of Mongolia, three million years ago. Third restoration drawn under direction of Henry Fairfield Osborn by Elizabeth M. Fulda. *Asia* Magazine, Vol. XXIII, No. 9, p. 629.

Speech delivered by Dr. V. K. Ting at dinner given by Geological Society of China, September 27, in honor of Professor Henry Fairfield Osborn. *The Peking Leader*, September 29.

The Broader Aspects of the Third Asiatic Expedition. By Henry Fairfield Osborn. *The Peking Leader*, September 29, p. 4. Reprinted, *Bulletin of the Geological Society of China*, Vol. 2, pp. 100-103.

Note—The Palæontology of China. Dr. A. W. Grabau, Geological Survey of China, engaged in the description of all collections of invertebrate fossils brought back to Peking by the Third Asiatic Expedition. Dr. Berkey, under date of June 9, pays tribute to Dr. Grabau's work in the field. *Natural History*, Vol. XXIII, No. 5, pp. 521–522.

Note—Mr. Roy Chapman Andrews' letter written in Camp Erhlien (Iren Dabasu), May 15, 1923, quoted. *Natural History*, Vol. XXIII, No. 5, pp. 525–527.

Note—Dinosaur Eggs Discovered—Cable report reaches the American Museum of remarkable find of no less than seventy skulls and ten skeletons of primitive horned Ceratopsian dinosaurs. *Natural History*, Vol. XXIII, No. 5, p. 536.

A Fossil-Hunter's Dream Come True. By Roy Chapman Andrews. *Asia* Magazine, Vol. XXIII, No. 10, pp. 746–751; 770.

Why Mongolia may be the Home of Primitive Man. An Address (to the Wen Yu Hui). By Henry Fairfield Osborn. *The Peking Leader*, October 10, pp. 2, 4: Reprinted, *Columbia Alumni News*, Vol. XV, No. 16, pp. 254–256 (February 1, 1924).

The Explorations of the American Museum of Natural History in China and Mongolia. By Henry Fairfield Osborn. *Proceedings of the American Philosophical Society*, Vol. LXII, No. 3, pp. 90–94.

Winter-Cooled Ardor for Fossils. By Roy Chapman Andrews. *Asia* Magazine, Vol. XXIII, No. 11, pp. 838–843; 867–869.

Mongolia May Yield the Secret of Man's Origin. Reported by James C. Young, *The New York Times*, November 11.

Note—President Osborn's Trip to Asia. President Osborn, accompanied by Mrs. Osborn, sailed from Seattle on S.S. *Madison*, August 18, 1923, for Shanghai. While in Asia took prominent part in activities of Expedition. Made trip to the Gobi. *Natural History*, Vol. XXIII, No. 6, p. 622.

The Second Year Work of the Third Asiatic Expedition. By Roy C. Andrews. (Abstract.) *Bulletin of the Geological Society of China*, Vol. 2, No. 3–4, pp. 103–105.

Palæontological Discoveries of the Third Asiatic Expedition. By Walter Granger. (Abstract.) *Bulletin of the Geological Society of China*, Vol. 2, No. 3–4, pp. 105–108.

Physiography of Mongolia. By F. K. Morris. (Abstract.) *Bulletin of the Geological Society of China*, Vol. 2, No. 3–4, p. 109.

1924

The Significance of Recent Discoveries in Mongolia. By Henry Fairfield Osborn. *The China Journal of Science and Arts*, Vol. II, No. 1, pp. 39–43.

Where the Dinosaur Hid Its Eggs. By Roy Chapman Andrews. *Asia* Magazine, Vol. XXIV, No. 1, pp. 9–15; 82–83.

Discoveries during the Season of 1923 by the Third Asiatic Expedition in Mongolia. By Henry Fairfield Osborn. *Proceedings of the National Academy of Sciences*, Vol. 10, pp. 23, 24.

Notes—Welcome by the Geological Society of China. An Estimate of the Mongolian Discoveries. The Geological Survey of China. Welcomed Home by a Dinosaur. Replicas of *Baluchitherium* distributed. *Natural History*, Vol. XXIV, No. 1, pp. 112–114; 118, 119.

Along the Trail with the Editor. *Asia* Magazine, Vol. XXIV, No. 2, p. 89.

The Lure of Mongolia. By Roy Chapman Andrews. *Asia* Magazine, Vol. XXIV, No. 2, pp. 137–144.

Recent Explorations in China and Neighbouring Regions. By Arthur De C. Sowerby. *The China Journal of Science and Arts*, Vol. II, Pt. I, No. 2, pp. 131–132.

Basin Structures in Mongolia. By Charles P. Berkey and Frederick K. Morris. (Abstract.) *Bulletin of the Geological Society of America*, Vol. 35, No. 1, pp. 59, 60.

Physiography of Mongolia. By Frederick K. Morris. (Abstract.) *Bulletin of the Geological Society of America*, Vol. 35, No. 1, pp. 87, 88.

Fossils Mark Mongolian Waste as Cradle of the Human Race. By Henry Fairfield Osborn. *The New York Herald*, March 30, Section II, p. 4.

Where Did Man Originate? By Henry Fairfield Osborn. *Asia* Magazine, Vol. XXIV, No. 6, pp. 427–431; 498, 499.

"Wind-Devils" and Warriors of the Gobi. By Roy Chapman Andrews. *Asia* Magazine, Vol. XXIV, No. 7, pp. 528–531.

Andrews of Mongolia. By Louis D. Froelick. *Asia* Magazine, Vol. XXIV, No. 8, pp. 638–640.

The Discovery of an Unknown Continent. By Henry Fairfield Osborn. *Natural History*, Vol. XXIV, No. 2, pp. 132–149.

Living Animals of the Gobi Desert. By Roy Chapman Andrews. *Natural History*, Vol. XXIV, No. 2, pp. 150–159.

Geological Reconnaissance in Central Mongolia. By Charles P. Berkey. *Natural History*, Vol. XXIV, No. 2, pp. 160–173.

Hainan. By Clifford H. Pope. *Natural History*, Vol. XXIV, No. 2, pp. 215–223.

Through the Yangtze Gorges to Wan Hsien. By Anna G. Granger. *Natural History*, Vol. XXIV, No. 2, pp. 224–235.

Exploration for Fossil Remains in Mongolia. (Abstract.) By W. D. Matthew. *Bulletin of the Geological Society of America*, Vol. 35, No. 1, pp. 187, 188.

The Coming Five Years, 1924–1928, of the Third Asiatic Expedition. By Roy Chapman Andrews. *Natural History*, Vol. XXIV, No. 2, pp. 256–257.

Note—Addresses by Prof. Henry Fairfield Osborn in Peking, September 21 to October 11, 1923. *Natural History*, Vol. XXIV, No. 2, pp. 260–265.

Notes on the Mapping Program of the Third Asiatic Expedition in Mongolia. By Frederick K. Morris. *The Geographical Review*, Vol. XIV, No. 2, pp. 287–293.

Explorations in the Desert Region of Central Asia. By Charles P. Berkey. *Proceedings American Society of Civil Engineers*, pp. 606–615.

Geologic Explorations in the Gobi Desert. By Charles P. Berkey. *Columbia Alumni News*, issue of May 23.

Eggs at $60,000 a Dozen. By Roy Chapman Andrews. *The Saturday Evening Post*, May 24.

American Men of the Dragon Bones. By Henry Fairfield Osborn. *Natural History*, Vol. XXIV, No. 3, pp. 350–365.

Wintering over a Fire Basket in Szechuan Province. By Anna G. Granger. *Natural History*, Vol. XXIV, No. 3, pp. 366–380.

Note on the Third Asiatic Expedition. Editorial Comments. *The China Journal of Science and Arts*, Vol. II, No. 5, p. 428.

Asiatic Expeditions of the American Museum of Natural History. By Henry Fairfield Osborn. *Nature*, Vol. 114, No. 2866, pp. 504–507.

Danger? (With illustrations). By Roy Chapman Andrews. *Cosmopolitan*, pp. 42, 43; 180, 181, December.

Flying Feet on Mongolian Hill and Plain. By Roy Chapman Andrews. *Asia* Magazine, Vol. XXIV, No. 12, pp. 975–979; 1018.

Note—Roy Chapman Andrews returned in September to Peking from Urga, where he completed preliminary arrangements for the 1925 phase of work. Other members of the Expedition will follow by motor in the spring. *Asia* Magazine, Vol. XXIV, No. 12, p. 937.

1925

Note—Extract from letter of Roy Chapman Andrews: Things were lively in Urga when he was there in September. But he had no trouble and has arranged satisfactorily for work of the Expedition in the spring. *Asia* Magazine, Vol. XXV, No. 2, p. 97.

Note—On March 7, Walter Granger and several members of the Asiatic Expedition sail from San Francisco, to meet Roy Chapman Andrews for work of the Expedition in Mongolia, starting from Peking, April 15, returning to Peking about September 20. *Asia* Magazine, Vol. XXV, No. 3, p. 187.

Note—Archæological Research in Asia. By N. C. Nelson. *Natural History*, Vol. XXV, No. 3, p. 314.

Note—The Structure of the Dinosaur Egg Shell. *Natural History*, Vol. XXV, No. 4, p. 422.

Note—Letter from Mr. Clifford H. Pope, April 25, 1925. *Natural History*, Vol. XXV, No. 4, pp. 426–427.

Note—Excerpts from letter of Roy Chapman Andrews, *Asia* Magazine, Vol. XXV, No. 10, p. 821.

Note on Third Asiatic Expedition. *Natural History*, Vol. XXV, No. 6, pp. 622–623.

Structural Nature and Origin of the Eastern Altai. By Charles P. Berkey and Frederick K. Morris. (Abstract.) *Bulletin of the Geological Society of America*, Vol. 36, No. 1, p. 133.

Tectonic History of Central Asia. By Charles P. Berkey and Frederick K. Morris. (Abstract.) *Bulletin of the Geological Society of America*, Vol. 36, No. 1, p. 134.

Central Asia in Cretaceous Time. By Charles P. Berkey and Frederick K. Morris. (Abstract.) *Bulletin of the Geological Society of America*, Vol. 36, No. 1, pp. 158, 159.

Origin of Desert Depressions. By Charles P. Berkey and Frederick K. Morris. (Abstract.) *Bulletin of the Geological Society of America*, Vol. 36, No. 1, pp. 169–170.

Protoceratops, a primitive Ceratopsian from the Lower Cretaceous of Mongolia. By W. K. Gregory and C. C. Mook. (Abstract.) *Bulletin of the Geological Society of America*, Vol. 36, No. 1, p. 228.

Stratigraphy of China. By A. W. Grabau. Geological Survey of China. Peking.

Palæogeographical Maps of Asia. By A. W. Grabau. Geological Survey of China. Peking.

Vol. 31, pp. 15–20 May 16, 1918

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

NEW CHINESE FISHES.

BY JOHN TREADWELL NICHOLS.

The American Museum of Natural History has recently accumulated a small collection of fresh-water fishes from China. These have come from two widely separated sources, firstly from Yunnan-fu, Yunnan Province, collected by Mr. John Graham, secondly from Futsing, Fu-kien Province, collected by the Museum's Asiatic Zoological Expedition of 1916–17, about July 25, 1916.

Only one species is common to the two lots, the Goldfish, *Carassius auratus* (Linnaeus).

Owing largely to small collections sent to the British Museum by Mr. Graham over a period of years, the fishes of Yunnan are comparatively well known. It will suffice merely to mention those species in the Yunnan lot already known from that locality: namely (Catfish) *Silurus mento* Regan, *Macrones medianalis* Regan, *Liobagrus nigricauda* Regan; (Carps) *Misgurnus anguillicaudatus* (Cantor), *Nemachilus nigromaculatus* Regan, *Cyprinus carpio* Linn., 2 barbelled form, *Cyprinus micristius* Regan, *Barbus grahami* Regan; (others) *Ophiocephalus argus* Cantor. *Monopterus* sp. (see beyond).

Five species in the Fu-kien lot are well known fishes, namely (Carps) *Acanthogobia maculatus* (Bleeker), *Zacco platypus* (T. & S.), known from Japan, *Opsariichthys bidens* Günther; (others) *Anguilla japonica* T. & S. *Channa ocellata* Peters. Mr. H. R. Caldwell contributes interesting data on *Channa*. This fish is abundant near sea level in the vicinity of Fu-chau, and also occurs, though in less numbers, at Yen-ping. It prefers stagnant water and will travel across country to get from one pool

to another or to invade the rice fields. Natives call it *nguok-la*, "Moon-pike," differentiating it from *chau-la*, "Grass-pike"—*Ophiocephalus*. The reference is to the moon-like markings at the caudal base. It is a good food-fish.

There remain to be considered at greater length two carps from Yunnan (a *Hemiculter* and *Acanthorhodeus*) apparently undescribed; two from Fu-kien, a *Cobitis*, and a fish allied to *Leuciscus* but with peculiar jaw,—and symbranch eels of the genus *Monopterus* from each locality. *Monopterus* from various parts of China is now referred to *M. javanensis* Lacépède, but I find the material from Yunnan and Fu-kien separable, and see no reason why either form should be identical with that in Java, with the description of which neither agrees well.

Cobitis dolichorhynchus, sp. nov.

Resembles the striped loach, *Cobitis taenia*, which ranges from Europe to Japan, but is more elongate, especially the snout. The type and only specimen No. 7026, American Museum of Natural History, was collected at Futsing, Fu-kien Province, China, by the Museum's Asiatic Expedition. It is 66 mm. long to base of caudal. Head 4.0 in this length, depth 5.8. Snout 2.0 in head, pectoral 1.5, ventral 1.7, longest dorsal ray 2.0, longest anal ray 1.9, caudal 1.5, depth of peduncle 2.0. Eye 3 in snout. Interorbital 1.5 in eye.

A strong, unequally forked spine recumbent in an elongate pit which extends forward from below the front of the eye. Body compressed, head and snout strongly compressed. Interorbital flat. Mouth small, well under the projecting snout, the gape reaching to below a point midway between tip of snout and nostril. A pair of barbels near the tip of snout, another at the end of the maxillaries, and a third in an intermediate position. Besides these six, a short barbel at the nostril. A broad, fleshy, weakly three-lobed membrane under the chin. Dorsal origin equidistant from chin and caudal base. Ventral slightly in advance of middle of dorsal. Pectoral reaching slightly more than half way to ventral, ventral slightly more than half way to anal, anal not reaching caudal by a distance equal to a third of head. Caudal rounded. Body covered with very small scales. Dorsal 9. Anal 7.

Color in spirits pale, darker on top of head, a dark streak from eye to snout, dark specks on the cheek. Irregular dark cross blotches occupying most of the back. Below these a narrow dark stripe extends backward from the nape, broken and mixed with the dorsal blotches behind the dorsal fin. A row of more or less oval dark blotches from the center of the side behind the gill cover to the lower caudal base, a faint dusky shade connecting them. Between the blotches and the stripe above, a ragged dark streak extends backward, terminating in widely spaced

specks under the dorsal. A narrow oblique vertical inky-black blotch at the upper base of the caudal. Dorsal and caudal with dark bars.

Georgichthys, gen. nov.

Type, Georgichthys scaphignathus, sp. nov.

A cyprinid fish with superficial resemblance to certain species of *Leuciscus.* Mouth small, slightly inferior. Rami parallel and fused, the lower jaw rather broad and rounded at its end, flat above, covered in front and above with a longitudinally fluted membrane. Lips rather thick, confined to the sides of the lower jaw. No barbels. Scales moderate. Lateral line complete, in the center of the peduncle. Dorsal without spinous ray, its origin slightly in advance of ventral. Dorsal and anal fins short. Teeth in a single row, five, hooked. This interesting minnow is named for George Borup Andrews.

Georgichthys scaphignathus, sp. nov.

The type and only specimen, No. 7038, American Museum of Natural History, collected at Futsing, Fu-kien Province, by the Museum's Asiatic Expedition, is 70 mm. long to base of caudal. Head 4.0 in this measure, depth 3.5. Snout 3.3 in head, eye 4.0, interorbital 3.1, maxillary 4.0, not reaching eye, pectoral 1.3, vental 1.4, longest dorsal ray 1.3, longest anal ray 1.5, caudal 1.0.

Body moderately compressed, peduncle 1.4 times as long as broad. Ventral not reaching anal, anal not reaching caudal, which is moderately forked. Scales normal on the rounded belly and elsewhere, with conspicuous radiating and concentric marking, 39, 4½ between lateral line and dorsal, 3 between lateral line and ventral. Dorsal 9. Anal 8.

Color in spirits dark on the back, the sides with extensive irregular dark blotches, front of dorsal and center of caudal lobes blackish, under surface of body, and fins otherwise pale. (*scaphignathus*—spade-jaw.)

Hemiculter andrewsi, sp. nov.

Scales smaller than in others of the genus (see monograph by Warpachowski. Bull. Ak. Sci. St. Petersb. 32, 1888, pp. 15 to 23, and Nikolski Annre. Mus. St. Petersb. 8, 1903, p. 359, for an additional species.) Teeth in 3 rows, compressed, and slightly hooked, 4–4–2.

The type, No. 7038, American Museum of Natural History, was collected at Yunnan-fu, Yunnan, China, by Mr. John Graham. It is 137 mm. long to base of caudal. Head 3.8 in this length, depth 4.2. Eye 4.2 in head, snout 4.0, interorbital 3.5, maxillary 3.4, depth of peduncle 2.8, pectoral 1.5, ventral 2.0, longest dorsal ray 1.9, longest anal ray 2.9, caudal 1.4.

Elongate, moderately compressed, peduncle twice as long as deep. Mouth moderate, rather oblique, lower jaw distinctly projecting, maxillary not quite to under front of eye, no barbels. Gill-rakers numerous and slender (the longest ½ eye), about 45 on the first arch, backed by a

second row of shorter ones. Dorsal without a spine, its second ray soft and segmented though not divided, its origin a little behind ventral base, equidistant from base of caudal and front of eye. Pectoral pointed, reaching ⅔ to ventral, ventral a little more than half way to anal, anal not reaching caudal by a distance equal to half head, caudal deeply forked. Apparently a low keel on belly behind ventrals and none in front of them (all three specimens are so cut as to make this difficult of determination). Lateral line complete, dropping to the lower part of the side with an abrupt flexure over end of pectoral, rising gradually on the peduncle to terminate in the center of same. Scales of moderate size on the body becoming smaller posteriorly, about 75, 11 between lateral line and dorsal, 3 between lateral line and ventrals. Dorsal 9. Anal 15.

Brownish along the back, silvery elsewhere. Named for Mr. and Mrs. Roy Chapman Andrews in recognition of their recent zoological explorations in Yunnan. Besides the type we have two smaller specimens of 114 and 116 mm. with the same data. The type is a female with eggs.

Acanthorhodeus grahami, sp. nov.

Close to *Acanthorhodeus atranalis* Günther, but more slender. Depth 3.0 to 3.3 (instead of 2.5); 4½ scales between lateral line and vent (instead of 5½). Dorsal soft rays 11 to 13, anal 10 to 11. Scales 37 to 39. Teeth in one row, 5, slender, hooked, denticulate.

The type, No. 7029, American Museum of Natural History, was collected at Yunnan-fu, Yunnan, China, by Mr. John Graham. It is 54 mm. long to base of caudal. Head 4.0 in this length, depth 3.1. Eye 2.7 in head, snout 4.1, interorbital 3.4, maxillary 3.5, depth of peduncle 2.5, dorsal spine 1.6, longest ray 1.4, anal spine 1.7, longest ray 1.6, pectoral 1.3, ventral 1.5, caudal about 1.0.

Body compressed. Mouth oblique, lower jaw slightly projecting, maxillary not quite reaching front of eye, upper jaw strongly protractile, angle of mandible under front of eye, no barbels. Upper profile straight to nape, thence convex to dorsal, thence concave to caudal; lower profile oblique to angle of mandible, thence horizontal to gill opening, thence gently convex to anal, thence slightly concave to caudal; peduncle tapering, 2⅓ times as long as deep. Vent just behind base of ventrals with a conspicuous papilla. Pectoral narrow and pointed, just reaching ventral, ventral just not reaching anal, dorsal and anal slightly concave above, caudal forked. Dorsal origin behind ventrals, midway between snout and base of caudal; anal origin under middle of dorsal. Second dorsal and anal rays developed as strong sharp spines, but not serrate. Scales loosely attached, lateral line complete, below the center of the front of the peduncle. Scales 38, 4½ between lateral line and vent, 6½ between it and dorsal. Dorsal II 12. Anal II 10.

Color pale. Sides silvery, the silvery forming an ill-defined stripe posteriorly, with a faint dark central streak. Most of the anal occupied by a large black semi-oval terminal blotch, which does not extend on the spines or posterior rays.

Besides the type, a male, we have 4 males and 3 females of about the same size with the same data. Females lack the black anal blotch, have the ventral papilla more prominent, and a long vermiform oviduct.

Monopterus cinereus Richardson.

Ichthyology Voyage of the *Sulphur*, 1844, p. 117, plate 52. Woosung. Not *Pneumabranchus cinereus* McClelland. See Richardson, Ichthyology of China. Rept. Brit. Assoc. Adv. Sci. 1845 (1846), p. 315.

Measurements of Yunnan specimens are as follows:

Total length.	Head in length.	Tail from vent in length.	Eye in snout.
420 mm.	12.4	3.7	2.0
338	12.1	3.6	1.7
336	12.0	3.6	1.5

The two smaller specimens (and a third with imperfect tail of about the same size) agree with Richardson's excellent figure in Voyage of the *Sulphur*. The larger specimen is pale colored with occasional blackish blotches. They lack evident fins.

Monopterus xanthognathus Richardson.

Voyage of the *Sulphur*, 1844, p. 118, plate 52. Canton.

Measurements of Fu-kien specimens are as follows:

Total length.	Head in length.	Tail from vent in length.	Eye in snout.
284 mm.	13.5	4.2	2.3
173	13.8	3.6	2.0

These specimens differ from *cinereus* just as does Reeves' figure on which Richardson bases his description, in a shorter tail, smaller eye, and a high gibbous nape.

AMERICAN MUSEUM NOVITATES

No. 6

DESCRIPTION OF A NEW SPECIES OF SEROW FROM YÜN-NAN PROVINCE, CHINA

By Roy Chapman Andrews

Issued March 24, 1921

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AMERICAN MUSEUM NOVITATES

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DESCRIPTION OF A NEW SPECIES OF SEROW FROM YÜN-NAN PROVINCE, CHINA

By Roy Chapman Andrews

Although it is not the purpose to publish extensively upon the collections obtained by the Asiatic Expeditions of the American Museum until the field work has been completed, it is desirable to describe such new species as may come to light from time to time in the preliminary examination of certain groups.

The splendid serow which I shot near Teng-yüeh, China, not far from the Burma frontier, is the first animal to be described from the Asiatic collections, and I take pleasure in proposing for it the name *Capricornis osborni*, in honor of the distinguished President of The American Museum of Natural History, Professor Henry Fairfield Osborn.

Capricornis osborni, new species

Type No. 43042, ♀ juv., Hui-yao (20 miles from Teng-yüeh), Yün-nan Province, China, May 9, 1917; Roy Chapman Andrews.

Forehead, cheeks, neck, breast, and body coal black. The white basal parts of the hairs show through to a certain extent but the general effect is jet black. A narrow margin of white 6 mm. wide on upper lips from middle of snout to corner of mouth. Above this white band but below and behind the nostril on each side, is a triangular tawny patch. The lower lip is margined with white which occupies all except the central half of the chin and extends behind the corner of the mouth in a long, gradually narrowing streak; this almost reaches the white throat-patch which is about 40 mm. in width.

The proximal part of each ear in front is strongly tinged with tawny but on the back this is less pronounced and the ear is largely black. The short mane is intense black like the body, stiff, erect and crest-like; the hairs are about 120 mm. in length. From the mane to the tail, the hair of the mid-dorsal line forms a well-defined ridge. The tail is black in the center with an admixture of tawny hairs; the tip is all black.

Inside of fore legs to hoofs, tawny; externally, black to the knees; front of "cannon bones" black except at the knees where the black is indistinct and suffused with tawny. Just above the hoofs, the blackish area is thinly sprinkled with light buff and posteriorly, between the dew claws and the hoof, it is all light buff. Buttocks tinged with tawny. Thighs almost to hocks, black with slight admixture of tawny. Inner side of hind legs to hoofs tawny. From hocks to opposite dew claws, anteriorly, the legs are tawny but with a suggestion of blackish, due to the hairs which are black on the basal half and tawny on the tips. From opposite the dew claws to the hoofs the black is pronounced and thinly interspersed with buff-tipped hairs. The area between the dew claws and the hoofs, posteriorly, is all buff.

There is no underfur present on any part of the body.

Skull badly broken. Measurements of skull: condylo-basal length, 257 mm.; least orbital width, 68; width of palate between first premolars, 37; length of horn on curve, 117; circumference of horn at base, 95. External measurements of type: head and body, 1350; tail, 180; hind foot, 390; ear, 175; height at shoulder, 950.

Capricornis osborni is undoubtedly allied to our specimens from Li-chiang, Yün-nan Province, which I have identified as *C. milne-edwardsi*. Its chief distinguishing characters are its coal-black body and head, its short black mane and the greater amount of black on the lower part of the legs. Our four specimens of *C. milne-edwardsi* all have brownish-black bodies and heads, long whitish manes, and little or no black upon the lower legs. In the very heavy mat-like gray mane, my two specimens of *C. argyrochætes* from Fukien Province, China, differ strikingly from *osborni*, although in the amount and disposition of the black on the lower legs the two somewhat resemble each other. *C. swettenhami* of the Malay Peninsula is distinguished from *osborni* by the black legs and the mane, which is a mixture of whitish, black and reddish hairs.

In discussing *C. milne-edwardsi* Mr. R. I. Pocock[1] has remarked: "A closely allied form apparently resembling typical *milne-edwardsi* in color except that the fronts of the cannon bones appear to be black has been recorded by Mr. H. Shaw Dunn from Kyonklongyi and other localities in the North Shan States of Upper Burma where it lives mostly in evergreen forests at altitudes of from 4,500 to 6,000 feet (Field, Jan. 9, 1909.)."

I have not been able to discover Mr. Dunn's communication in the 'Field' but I have no doubt that the race I am now describing is the one to which he refers.

The serow which Lieut. R. C. Beavan[2] described as inhabiting the vicinity of Moul-mein, Burma, and which Mr. Pocock referred provisionally to *milne-edwardsi* may be this new form. While the affinities of *osborni* are toward *milne-edwardsi*, it is interesting as showing an approach toward *swettenhami* of the Malay Peninsula in the considerable amount of black on the legs and the short black mane.

Near Genkang, Yün-nan Province, we purchased from a native a flat serow skin which lacks the head and lower legs. This specimen was said to have come from the mountains of Keng-ma about 200 miles southeast of Teng-yüeh and not far from the Burma frontier. It is brownish black

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[1] 'The Serows, Gorals and Takins of British India and the Straits Settlements.' By R. I. Pocock. Part II. Journal, Bombay Natural History Society, XXII, pp. 307–308.

[2] 1866, Proc. Zool. Soc. London, p. 4.

in general color, has a short crest-like, brownish-black mane, similar in character to that of *osborni*, and what remains of the skin shows that both the fore and hind legs were whitish or light buff below the knees and hocks.

This specimen may possibly represent the male of *C. osborni*, for the differences are somewhat similar to those between the male and female of our *C. argyrochætes* from Fukien.

I shot *C. osborni* near the village of Hui-yao while hunting monkeys on the precipitous bank of the river. The cliff was almost perpendicular and was covered with a tangled jungle growth. Now and then the rock wall would become less precipitous and the thick cover give place to an open grassy slope. It was when I was about to cross such an opening that the serow dashed out of the bushes where it had evidently been feeding. I fired just before it disappeared over the rim of the gorge and it sank in its tracks, gave a convulsive twist, and plunged into the canyon. It was recovered with considerable difficulty.

Although the natives knew that serows lived in this part of the gorge, few of them had ever seen one and it was an object of great curiosity in the village.

There is little change in the country between Hui-yao and the Burma frontier and no reason why *C. osborni* should not have an unrestricted range into Burma.

The Birds of the American Museum of Natural History's Asiatic Zoological Expedition of 1916-1917

By Outram Bangs

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BULLETIN AND MEMOIRS

OF

The American Museum of Natural History

FRANK E. LUTZ, EDITOR

The following are the more recent papers on MAMMALOGY AND ORNITHOLOGY. Orders should be addressed, Library, The American Museum of Natural History, 77th St. and Central Park West, New York City.

MAMMALOGY

201. Mammals Collected on the Roosevelt Brazilian Expedition, with Field Notes by Leo E. Miller. By J. A. Allen, 1916, Bulletin, XXXV, Art. 30, pp. 559–610. 50c.
202. Shrews Collected by the Congo Expedition of the American Museum. By N. Hollister, 1916, Bulletin, XXXV, Art. 35, pp. 663–680, Pls. VII–XI. 60c.
203. The Sei Whale (*Balænoptera borealis* Lesson). By Roy C. Andrews and Hermann von W. Schulte, 1916, Memoirs, N. S., I, part 6, pp. 289–502, Pls. XXIX–LVII, 48 text figures. $6.00
204. A New Rabbit and a New Bat from Neotropical Regions. By H. E. Anthony, 1917, Bulletin, XXXVII, Art. 13, pp. 335–337, Pl. XXXIV. 15c.
205. The Skull of *Kogia breviceps* Blainville. By H. von W. Schulte. 1917, Bulletin, XXXVII, Art. 17, pp. 361–404, Pls. XXXV–XLIII, 2 text figures. $1.00
206. The American Museum Congo Expedition Collection of Bats. By J. A. Allen, Herbert Lang, and James P. Chapin, 1917, Bulletin, XXXVII, Art. 18, pp. 405–563, Pls. XLIV–LV, 26 text figures, 1 map. $1.50
207. The Skeletal Characters of *Scutisorex* Thomas. By J. A. Allen, with Field Notes by H. Lang. 1917, Bulletin, XXXVII, Art. 28, pp. 769–784, Pls. LXXXIX–XCII, 8 text figures. 30c.
208. A Note on the Lumbar Vertebræ of *Scutisorex* Thomas. By H. von W Schulte, 1917, Bulletin, XXXVII, Art. 29, pp. 785–792. 10c.
209. The External Characters, Skeletal Muscles, and Peripheral Nerves of *Kogia breviceps* (Blainville). By H. von W. Schulte and M. de Forest Smith, 1918, Bulletin, XXXVIII, Art. 2, pp. 7–72, 21 text figures. 60c.
210. Memoranda Upon the Anatomy of the Respiratory Tract, Foregut, and Thoracic Viscera of a Fœtal *Kogia breviceps*. By John D. Kernan, Jr. and H. von W. Schulte, 1918, Bulletin, XXXVIII, Art. 8, pp. 231–267, 16 text figures. 50c.
211. The Skull of *Ziphius cavirostris*. By John D. Kernan, 1918, Bulletin, XXXVIII, Art. 11, pp. 349–394, Pls. XX–XXXII. 85c.
212. The Indigenous Land Mammals of Porto Rico, Living and Extinct. By H. E. Anthony. 1918, Memoirs, N. S., II, part 2, pp. 331–435, Pls. LV–LXXIV, 55 text figures. $5.00
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59.82(5)

Article XX.—THE BIRDS OF THE AMERICAN MUSEUM OF NATURAL HISTORY'S ASIATIC ZOOLOGICAL EXPEDITION OF 1916–1917

By Outram Bangs

The birds collected by Roy Chapman Andrews and Edmund Heller in Burma, Yunnan and Fokien during the course of The American Museum of Natural History's Asiatic Zoological Expedition of 1916–1917, were very kindly placed in my hands for identification by Dr. Frank M. Chapman, and I now take pleasure in submitting the following annotated list.

The collecting of mammals was the primary object of the expedition and birds were to some extent a secondary consideration, which accounts for the short series, many of the species being represented by only a single specimen. The shortness of the series renders subspecific identification in a few instances a matter of some uncertainty.

The Expedition traveled along the border of Burma and Yunnan, and in western Yunnan to the Snow Mountains, and made one trip eastward to Yunnan Fu. An interesting detailed account of the wanderings and experience of the members of the party, with descriptions of all stations at which specimens were collected, and illustrated by many photographs and a sketch map of the route, has been published by Mr. Andrews.[1]

The collection of birds made in Fokien was supplemented by a series of skins received on the spot from Rev. Harry R. Caldwell. This collection is included here with the others.

I have kept the birds from Fokien apart from those of Burma and Yunnan, giving two separate lists. This has caused very little repetition of names and has made no faunal confusion, which would have been the case had all been listed together.

Long after this paper was originally written Lord Rothschild published an article (Novitates Zoologicæ, XXVIII, pp. 14–67, May 1921) on a collection of birds numbering 1442, made in 1918 and 1919 by George Forrest in west-central and north-western Yunnan.

Many changes in current names occur in this article and, as might be expected, much that I had said in my original MS. is anticipated. All this has now been rewritten and so far as the material in the Andrews Collection will allow I follow Lord Rothschild's opinions.

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[1] 'Camps and Trails in China.' Appleton & Co. New York, 1918.

Birds from the Burma Border and Yunnan

Phasianidæ

Francolinus pintadeanus phayrei (Blyth)

Two males: Malipa, Burma, March 13, 1917; and Namting River, Burma border, March 4, 1917. These skins agree with one from Mengtsz, Yunnan, and one from Siam in the Museum of Comparative Zoology in being much smaller in all dimensions than specimens from southern China (Fokien, etc.). The wing ranges from 138 to 143 mm., with all other measurements proportionately small. I cannot detect any constant differences in color in the two races. Blyth's type was from Arakan, and his description reads: "Closely resembling in plumage the Pintado Partridge of the Mauritius, *Francolinus perlatus*, but of a less robust form and the male armed with well-developed spurs." The measurements given lately by Robinson and Kloss (1919, Ibis, (11) I, July, p. 408) for birds from South Annam are also small.

Arboricola torqueola (Valenc.)

One adult female: No-mu-shu Pass, Yunnan, 8000 feet altitude, April 7, 1917. The oviduct contained eggs nearly ready for laying.

Arboricola brunneipectus brunneipectus Tickell

One adult male: Namting River, Burma border, March 2, 1917.

Coturnix coturnix japonica Temminck and Schlegel

One adult female: Malipa, Burma, March 13, 1917.

Bambusicola fytchei fytchei Anderson

Two adult females: Mu-cheng, Salwin drainage, February 10, 1917; Teng-Yueh, Yunnan, April 22, 1917.

These skins like Rothschild's are wholly referable to *Bambusicola fytchei fytchei* Anderson, type locality Pouse, western Yunnan, and differ from *B. f. hopkinsoni* Godwin-Austen of Assam, etc., as pointed out by Rothschild.

I am loath, however, to throw the Mengtsz bird *B. f. oleaginea* Bangs and Phillips into the synonymy of true *fytchei* as Rothschild was inclined to do. The type, to be sure, is the only individual I have seen, but it differs more from *fytchei* than does *fytchei* from *hopkinsoni*. The spots on the upper parts are much blacker, these black spots extending even all over the hind neck; the ground color of the upper parts is darker olive

and the top of the head much darker; all the wing coverts, the scapulars and the back are much more uniform in color, hardly at all varied with paler, grayish cross markings and vermiculations; the chest is darker and very uniform—but little spotted.

Until a series from Mengtsz, which might, of course, prove the type to be an exceptional specimen, is available, I prefer to recognize three forms.

Tragopan temmincki (J. E. Gray)

One adult male: Ho-mu-shu Pass, Yunnan, 8000 feet altitude, April 8, 1917.

Gennaeus nycthemerus ripponi Sharpe

One fine adult, male: Ho-mu-shu Pass, Yunnan, 8000 feet altitude, April 7, 1917.

Phasianus colchicus elegans Elliot

Three adult males: Li-chiang Fu, Yunnan, 9000 feet altitude, October 25 and November 4, 1916.

Rothschild regretted his inability to compare Szechwan and Yunnan adults of this species and so be sure that *P. elegans* and *P. sladeni* (*nomen nudum*) were identical. This I have done, comparing four adult males from Szechwan with four adult males from Yunnan, and can find no constant differences either in size or in color.

Calophasis humiæ Hume

One female: Teńg-yueh Ting, Yunnan, April 22, 1917.

Chrysolophus amherstiæ (Leadbeater)

Four adult males: Wan-tien, 7000 feet; Pei-ti-ping, Mekong River drainage, 9000 feet; and Li-chiang Fu, 11,000 feet altitude, November and December 1916 and May 14, 1917.

Gallus gallus ferrugineus (Gmelin)

Five specimens, three adult males, two adult females; Chang-lung, Salwin River, Yunnan; Namtung River, Burma border; and Malipa, Burma, February and March 1917. The distinction Stuart Baker (1917, Journ. Nat. Hist. Soc. of Bombay, XXV, p. 18) makes between the Indian and the Chino-Malayan Jungle Fowls is shown to a certain extent in the series of birds I have examined, though I find it very difficult to distinguish some specimens.

Pavo muticus Linnæus

One adult female: Chang-lung, Salwin River, Yunnan, 2000 feet altitude, March 21, 1917. The oviduct contained partly formed eggs.

TURNICIDÆ

Turnix pugnax rostrata Swinhoe

One adult female: Chu-tung, Yung-ping Ho, Yunnan, 5000 feet altitude, January 17, 1917.

COLUMBIDÆ

Columba hodgsonii Vigors

Three males: Chang-lung, Yunnan, 2000 feet altitude, and Malipa, Burma, March 1917.

Streptopelia orientalis orientalis (Latham)

Three specimens, two males and a female: Ho-mu-shu Pass, Yunnan, 8000 feet altitude, April 8, 1917, and Malipa, Burma border, 3000 feet, March 10 and 14, 1917.

Rothschild referred his one specimen to this form without comment. Our three skins show a decided approach to *S. o. agricola* (Tickell); No. 143299 from Ho-mu-shu Pass in particular. This specimen, I think, might almost as well be referred to one form as to the other.

Streptopelia chinensis tigrina (Temminck and Knip)

One adult female: Namting River, Burma border, February 28, 1917. This example is perfectly typical.

RALLIDÆ

Amaurornis phoenicura chinensis (Boddaert)

Three adults, two males and a female: Namting River, Burma border, March 4, 1917; Malipa, Burma, March 14, 1917; and Meng-peng, Salwin drainage, March 17, 1917.

CHARADRIIDÆ

Hoplopterus ventralis (Wagler)

Two adult females: Meng-ting, Yunnan, February 16 and 17, 1917.

Scolopax rusticola rusticola Linnæus

One male: Namting River, Burma border, March 1, 1917.

ARDEIDÆ

Bubulcus ibis coromandus (Boddaert)

One immature female: Lung-ling, Yunnan, March 28, 1917.

FALCONIDÆ

Lophospiza trivirgatus rufitinctus (McClellan)

One male, Namting River, Burma border, February 24, 1917. This specimen has a wing of 230 mm.

Spilornis cheela ricketti Sclater

One adult male: Malipa, Burma border, March 14, 1917. This is a large bird with a wing of 455 mm. and without much doubt belongs to this race lately described by Sclater.

Cerchneis tinnunculus saturatus (Blyth)

One "male" (female): Hung-chang, Yunnan, January 28, 1917.

BUBONIDÆ

Glaucidium cuculoides cuculoides (Gould)

One adult female: Namting River, Burma border, March 1, 1917.

CORACIIDÆ

Coracias affinis McClellan

Three specimens, two males and a female: Hsiao, Meng-ting and Cheng-kang, Salwin drainage, February 3 and 6; and Shui-chai, Mekong River, Yunnan, January 19, 1917. All three are large birds like those from the eastern Himalayas, with wings ranging from 193 to 196 mm. Specimens in the Museum of Comparative Zoology from Cochin China are smaller, as also is one listed by Kloss from Siam. The smaller form of Cochin China and Siam, if really separable, should be known as *C. affinis theresiæ* Parrot. It, however, was not recognized by Kloss (1918, Ibis, (10) VI, January, p. 91), nor by Robinson and Kloss (1919, Ibis, (11) I, July, p. 421).

ALCEDINIDÆ

Halcyon smyrnensis fusca (Boddaert)

One adult female, Meng-ting, Burma border, February 18, 1917.

BUCEROTIDÆ

Anthracoceros malabaricus affinis (Blyth)

Two specimens, an adult male and an immature (sex not determined): Namting River, Burma border, February 28, 1917. These birds belong to the large Himalayan form, the adult male having a wing of 308 mm.

UPUPIDÆ

Upupa epops saturata Lönnberg

One adult male: Yung-chang Fu, Yunnan, January 28, 1917. This is a large bird, with a wing of 154 mm. In size, as well as in other respects, it is an extreme example of the northern *saturata*.

MEROPIDÆ

Melittophagus leschenaulti swinehoei (Hume)

Three adults, a male and two females: Chang-lung, Salwin River, Yunnan, March 18, 19, and 21, 1917.

TROGONIDÆ

Pyrotrogon erythrocephalus erythrocephalus (Gould)

One adult male: Namting River, Burma border, March 30, 1917.

Rothschild referred a male and a female from Shweli-Salwin Divide to *P. e. yamakanensis* (Rickett) of Fokien. Our specimen certainly does not represent that form, of which I have seen one fully adult male. I have no hesitation in calling it true *erythrocephalus*.

CUCULIDÆ

Cuculus canorus bakeri Hartert

Two adult males: Teng-yueh Ting and Wa-hui, Yunnan, April 22 and May 16, 1917. On the label of one (killed April 22 at Teng-yueh Ting) is written: "Note *ku-ku*-calling throughout the day." These two specimens seem to me to be *bakeri*. They are quite as heavily barred below as in *C. canorus canorus*, and the color of the upper parts is as dark as in *C. optatus*. They have small bills, smaller than in *C. optatus*.

Centropus sinensis intermedius (Hume)

Five specimens, both sexes: Namting River, Burma border; Chang-lung, Salwin River; Meng-ting, Yunnan; February 18, 22, and 28, and March 2 and 22, 1917. These specimens undoubtedly belong to the smaller form; the wing in the four females ranges from 205 to 216 mm. In the single male it is 200 mm.

Rhopodytes tristis tristis (Lesson)

One adult male: Chang-lung, Salwin River, Yunnan, March 20, 1917. This specimen, with a wing of 163 mm., I refer to the larger northern form.

CAPITONIDÆ

Cyanops asiatica Latham

Two specimens, male and female: Chang-lung, Salwin River, Yunnan, March 20 and 21, 1917.

Cyanops franklini franklini (Blyth)

One adult male: Tai-ping-pu, Yunnan, April 12, 1917.

Xantholaema hæmacephala indica (Latham)

One adult male: Namting River, Burma border, February 28, 1917.

PICIDÆ

Picus canus sordidior (Rippon)

Three adults, two males and a female: Hui-yao, Yunnan, 5000 and 5500 feet altitude, May 7, 1917; and Malipa, Burma border, 3200 feet altitude, March 14, 1917.

Hypopicus hyperythrus subrufinus (Cabanis and Heine)

Two adult males: Li-chiang Fu, Snow Mountains, Yunnan, 10,000 feet altitude, November 16, 1916.

Dryobates pernyi pernyi (Verreaux)

One adult male: Li-chiang Fu, Snow Mountains, Yunnan, 10,000 feet altitude, November 16, 1916.

Chrysocolaptes guttacristatus sultaneus Hodgson

Two adult males: Malipa, Burma border, February 22, 1917. These are large birds, with the wings 176 and 178 mm. respectively and with heavy bills, and must, therefore, I suppose, be referred to this form.

Thriponax javensis feddeni (Blanford)

One adult male: Malipa, Burma border, March 15, 1917.

Jynx torquilla japonica Bonaparte

One adult female: Yung-chang Fu, Yunnan, January 28, 1917.

EURYLAIMIDÆ

Serilophus lunatus lunatus Gould

One male: Meng-ting, Burma border, February 19, 1917. Apparently referable to this form.

HIRUNDINIDÆ

Hirundo rustica gutturalis Scopoli

One adult male: Meng-ting, Burma border, February 18, 1917.

Hirundo daurica nipalensis Hodgson

One adult, sex not determined: Meng-ting, Salwin drainage, Yunnan, February 19, 1917.

Ptyonoprogne rupestris (Scopoli)

One female: Chen-kang, Salwin drainage, Yunnan, February 6, 1917.

MUSCICAPIDÆ

Cyornis tickelliæ whitei Harington

One adult male: Chang-lung, Salwin River, Yunnan, 2000 feet altitude, March 21, 1917.

Niltava sundara denotata Bangs and Phillips

Three adult males: Chang-lung, Salwin River and Tai-ping-pu, Yunnan, March 18 and 20, and April 9, 1917. These skins exactly match the type of the subspecies and differ from true *N. sundara* in having the back blacker, less purplish, and the under parts much paler and yellower and in longer wing.

Rothschild hesitates to recognize *denotata*, but again going over all material available to me I am still inclined to do so.

Muscicapula melanoleuca melanoleuca (Blyth)

Four specimens: Tai-ping-pu, Yunnan, April 12 and 13, 1917.

Rhipidura albicollis albicollis (Vieillot)

Three adults, two males and a female: Namting River, Burma border, and Mu-cheng, Salwin drainage, Yunnan, February 25 and March 5, 1917.

As well as I can determine these skins with the limited Indian material available to me, which does not include an example from the region assigned by Baker to his form, *stanleyi*, they do not belong to the northern and north-eastern race, characterized by Baker (1913, Records of the Indian Museum, VIII, part 3, September, p. 275) as *Rhipidura albicollis kempi*, new subspecies. The specimens recorded by Phillips and myself from Mengtsz are quite the same in color as those in the present collection.

The name *kempi* given by Baker was preoccupied by *Rhipidura rufifrons kempi* Mathews (1912, Nov. Zool., XVIII, January, p. 320) and was changed later by Baker to *stanleyi*. It was, however, again used for still another bird, *Rhipidura flabellifera kempi* Mathews and Iredale of North Island, New Zealand (Ibis, 1913, p. 441), which may be called **Rhipidura flabellifera placabilis**, new name.

Culicicapa ceylonensis ceylonensis (Swainson)

Three adults, two male and a female; Namting River and Malipa, Burma border, and Tai-ping-pu, Yunnan, February 22, March 16, and April 12, 1917.

Stoparola thalassina thalassina (Swainson)[1]

One adult male: Mu-cheng, Salwin drainage, Yunnan, 5000 feet altitude, February 15, 1917.

CAMPEPHAGIDÆ

Pericrocotus speciosus speciosus (Latham)

One adult male: Ta-shui-tang, Salwin drainage, Yunnan, 6000 feet altitude, February 2, 1917.

Pericrocotus yvettæ,[2] new species

Two specimens, an adult male and an adult female: Malipa, Burma border, and Taiping-pu, Yunnan, March 10 and April 12, 1917.

TYPE.—Amer. Mus. of Nat. Hist. No. 143365; adult male; Malipa, Burma border, 3000 feet altitude, March 10, 1917; R. C. Andrews and E. Heller.

CHARACTERS.—Adult male similar to the adult male of *P. xanthogaster xanthogaster* (Raffles) and with the four outer primaries without red but slightly larger, and red on secondaries continuous from base to near tip on outer webs of feathers

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[1]For change in the specific name from *melanops* Vig. to *thalassina* (Swainson), see Oberholzer, 1919, Proc. Biol. Soc. Wash., XXXII, p. 240, December 31.

[2]Named in honor of Mrs. Andrews.

(in *P. xanthogaster* the red on the secondaries is arranged in spots near the tips of the feathers which are separated from the red bases by black); red of under parts nearly scarlet-red (nearly scarlet in *P. xanthogaster*). Adult female similar to the female of *P. xanthogaster*.

MEASUREMENTS

A. M. N. H. No.	Sex	Wing	Tail	Tarsus	Culmen
143365	♂ ad.	94 mm.	105 mm.	14.5 mm.	11 mm.
143367	♀ ad.	87	94	14.0	11

I feel a little hesitation in describing this form on the strength of one adult male, still I have been unable to match this specimen at all nearly, nor can I find the description of a Minivet which could apply to this one. The female, which I refer to this species because it certainly is not the female of *brevirostris* or *speciosus*, I cannot distinguish from females of *P. xantogaster* from Sumatra in color or markings, except that in this one example there is no yellow on the secondaries except at the base.

The red markings in the wing of the male are very striking, giving two broad red stripes down the closed wing, with black between them, one along the primaries, the other along the secondaries.

Pericrocotus brevirostris ethologus Bangs and Phillips

One adult male: Tai-ping-pu, Yunnan, April 12, 1917. This is an intensely colored individual not extremely typical of this form. When Phillips and I (1914, Bull. Mus. Comp. Zool., LVIII, No. 6, pp. 282–283) divided this species into three subspecies we allowed a typographical error to creep into one of our new names, which we did not detect till long afterward, probably because the printed *fl* and *f* look so alike. The name we gave the more western subspecies should be *Pericrocotus brevirostris favillaceus* (favillaceus, like glowing ashes or embers) not "flavillaceus," as it appeared, which has no meaning. I believe even at this late date the rules of nomenclature allow such a correction to be made.

PYCNONOTIDÆ

Ægithina tiphia tiphia Linnæus

One male in green plumage: Chang-lung, Yunnan, March 19, 1917.

Chloropsis hardwickii (Jardin and Selby)

Four adults, both sexes: Chang-lung and Mu-cheng, Salwin River, Yunnan, February 15 and March 18 and 21, 1917.

Chloropsis icterocephala chlorocephala (Walden)

Two males: Namting River, Burma border, February 21 and 28, 1917.

Hypsipetes leucocephalus (Gmelin)

Two adults, male and female: Namting River, Burma border, and Yoakuan, Yunnan, January 21 and February 21, 1917.

The male of this pair has a pure white head, neck, and chest; the rest of the under parts are clear ashy gray with no black intermixed. Such a condition of plumage is apparently rare. Most birds with pure white heads have the under parts black or much mixed with black. One or two, however, in a long series from other parts of China match this one.

The female I at first inclined to refer to some other species. Like the male, it has no black on the under parts, which are wholly gray, but there is no white at all on its head. I have seen some skins, however, from Hupeh and Mengtsz, Yunnan, that have hardly any white on the head and that almost match it. It has no black on the cheek and therefore cannot be referred to *H. concolor* Blyth.

The extraordinary range of variation in color in this species seems to be individual rather than due to age. I have before me black-breasted birds with wholly white heads and others with only a few white feathers in the head, and gray-breasted birds with and without white heads, and all sorts and kinds of intermediates.

Hemixus flavala flavala (Hodgson)

One male: Chang-lung, Salwin River, Yunnan, March 19, 1917.

Iole maclellandi similis Rothschild

One male: Ta-shiu-tang, Salwin drainage, Yunnan, February 3, 1917.

Alcurus striatus (Blyth)

One adult female: Tai-ping-pu, Yunnan, April 9, 1917.

Molpastes cafer burmanicus (Sharpe)

Three adults, two males, one with sex not determined: Yung-chang Fu, Yunnan, January 24, 27, and 28, 1917.

Pycnonotus xanthorrhous xanthorrhous J. Anderson

Four adults, both sexes: Wan-tien, Li-chiang Fu, Chang-lung, and Hui-yao, Yunnan, November 11, 1916, March 19, and May 1, 16 and 17, 1917. These are, of course, true *xanthorrhous* of Anderson. A large series collected by Zappey in Hupeh represents quite a different form, distinguished by being slightly larger, paler brown above, and with the brown band across the chest much paler and less sharply contrasted. This is *Pycnonotus xanthorrhous andersoni* (Swinhoe); type locality, Ichang.

Otocompsa emeria emeria (Linnæus)

Six adults, both sexes: Malipa, Burma; Chang-lung and Meng-ting Yunnan, February 17, March 12 and 21, 1917.

Otocompsa flaviventris flaviventris (Tickell)

One adult male: Chang-lung, Yunnan, March 19, 1917.

Spizixos canifrons Blyth

Five aults, both sexes: Tai-ping-pu and Chen-kang, Yunnan, February 7 and April 8, 9, and 12, 1917.

TIMELIIDÆ

Ianthocincla lanceolata lanceolata J. Verreaux

One adult male: Mu-cheng, Salwin drainage, Yunnan, February 13, 1917. I cannot distinguish this skin in any way from specimens from the mountains of Hupeh.

Ianthocincla lanceolata bonvaloti (Oustalet)

One adult male: Li-chiang, Snow Mountains, Yunnan, 10,000 feet altitude, November 16, 1916. This specimen is indistinguishable from examples taken by Zappey in the high mountains, 9000 to 14,000 feet altitude, of extreme western Szechwan.

These two specimens are both in unworn, fresh plumage and I have had ample material, collected by Zappey in Hupeh and Szechwan, with which to compare them.

It is interesting to get both forms in Yunnan, and there as in south-western China to find the small paler form, *lanceolata*, at lower and the large darker form, *bonvaloti*, at higher altitudes.

In the series now before me, in 7 adults of *lanceolata* the wing ranges from 91 to 98 mm.; in 4 adults of *bonvaloti* from 106–113. In fresh plumage *bonvaloti* is darker than *lanceolata* with the browns of the head and back deeper and richer, and the stripes on the under parts both heavier and darker in color.

Ianthocincla erythrocephala woodi (Stuart Baker)

One adult male: Mu-cheng, Salwin drainage, Yunnan, February 14, 1917; "caught in a steel trap set in the forest." This skin agrees very well with Stuart Baker's description and undoubtedly represents the very distinct form recently described by him. It, No. 143413 Amer. Mus. of Nat. Hist., affords the following measurements: Wing, 104; tail, 119; tarsus, 41.5; exposed culmen, 20 mm.

Ianthocincla ellioti (Verreaux)

One adult male: Li-chiang, Snow mountains, Yunnan, 10,000 feet altitude, November 9, 1916. After a very careful comparison of this skin with the long series collected by Zappey in Hupeh and Szechwan, I can detect not the slightest difference.

Rothschild reached the same conclusions from a study of his material, but hesitated to throw *I. ellioti honoripeta* Hartert, the supposedly darker Yunnan form into synonymy, thinking it might be a form that reached the province only on migration. I think there is little doubt that the name is a pure synonym.

Ianthocincla cinereiceps styani (Oustalet)

One adult male: Malipa, Burma border, 3600 feet altitude, March 16, 1917. This specimen represents true *styani* with a black cap and yellowish-brown ear-coverts. The one skin taken February 6 and probably a migrant, recorded by Phillips and myself from near Mengtsz, Yunnan, under the name *styani* proves on comparison to be *I. c. cinereiceps* (Styan). The black cap, I have lately been told by La Touche, is only a sign of maturity, and is acquired by old birds of both forms. The two subspecies can, however, be distinguished easily by the colors of the ear-coverts and of the under parts.

Pomatorhinus macclellandi odicus Bangs and Phillips

Two adults, male and female: Mu-cheng, Salwin drainage, Yunnan, February 10 and 13, 1917. These agree exactly with the Mengtsze specimens upon which the subspecies was based.

Garrulax leucolophus leucolophus (Hardwick)

Two males: Malipa, Burma, March 14, 1917. These seem to be quite typical, showing no characters even approaching those of *G. l. belangeri* Lesson.

Garrulax pectoralis pectoralis (Gould)

One adult female: Malipa, Burma, March 14, 1917. This specimen appears to be nearer the bird of the Himalayas than it is to the southern *G. p. meridionalis* Stuart-Baker.

Dryonastes chinensis chinensis (Scopoli)

Two adults, male and female: Chang-lung, Salwin River, Yunnan, 2000 feet altitude, March 18 and 21, 1917.

Dryonastes sannio albosuperciliaris (Godwin-Austen)

Two adult females: Wan-tien and Mu-cheng, Yunnan, February 13 and May 14, 1917. With ample material I now have no hesitation in recognizing two forms of *D. sannio: D. sannio sannio* (Swinhoe), central and southeastern China, more reddish olive above with more rusty tail, and *D. s. albosuperciliaris* (Godwin-Austen), Manipur to Yunnan, olive above with much less rusty tail.

Pellorneum ruficeps minus Hume

Two adults, male and female: Chang-lung, Salwin River, Yunnan, and Malipa, Burma border, March 15 and 23, 1917. These two skins are, I think, best called *minus*, though they appear to be somewhat intermediate between that form and *P. r. mandellii* Blanford.

Drymocataphus tickelli tickelli (Blyth)

One male: Namting River, Burma border, 1700 feet altitude, February 25, 1917; "caught in a rat trap set in the forest." I have seen no other skins of this species and have identified the specimen as best I can by Harington's 'Notes on the Indian Timelliides and their Allies' (1915, Journ. Bomb. Nat. Hist. Soc., XXIII, p. 435). He thinks true *tickelli* and *assamensis* Sharpe will prove to be one and the same. Certainly this skin is not "rufescent" olive-brown above.

Alcippe phæocephala magnirostris Walden

One adult male: Namting River, Burma border, 1700 feet altitude, February 21, 1917. This specimen, with no whitish eye-ring and very well-marked black stripes on the side of the head, I refer without much doubt to this form, of which, however, I have seen no other examples.

Shoeniparus genestieri (Oustalet)

Three specimens, two males and a female: Ho-mu-shu Pass, 8000 feet altitude, and Mu-cheng, Salwin drainage, 7000 feet altitude, Yunnan, February 10 and April 4, 1917.

Mixornis rubricapilla sulphurea (Rippon)

Two adults, male and female: Meng-ting, Burma border, and Chang-lung Salwin drainage, Yunnan, February 18 and March 18, 1917.

Myiophoneus eugenei eugenei Hume

Four adults, both sexes: Namting River, Burma border, and Yung-chang, Yunnan, January 28, February 18 and 28, and March 2, 1917.

Rothschild is wholly right in his suspicion that *M. eugenei* and *M. tibetanus* Madarász are in reality one and the same. The skins of the so-called *tibetanus* collected by Zappey in high western Szechwan are in every way like Yunnan specimens of *eugenei*. This I detected long ago, when we first received a series of *eugenei*.

Lioptila annectens annectens Blyth

One adult male: Mu-cheng, Salwin drainage, Yunnan, 5000 feet altitude. February 15, 1917. The flanks and undertail coverts in this specimen are rather paler, otherwise it agrees with birds in the Museum of Comparative Zoölogy from Manipur with the back Sanford's brown. *L. annectens saturatus*, which I have not seen, is said to have the back "rich, deep chestnut."

Lioptila desgodinsi (David and Oustalet)

Two adults, male and female: Tai-ping-pu and Yao-kuan, Yunnan, 6000 to 7000 feet altitude, January 31 and April 12, 1917.

Staphidia striata (Blyth)

One adult male: Chang-lung, Salwin River, Yunnan, 2000 feet altitude, March 20, 1917.

Siva cyanuroptera wingatei Ogilvie-Grant

Two adults, male and female: Hui-yao and My-cheng, Yunnan, February 10 and May 1, 1917.

Yuhina diademata ampelina Rippon

Two adults, male and female: Li-chiang, Snow Mountains, 10,000 feet altitude, November 11 and 12, 1917. These specimens are no darker than examples from Hupeh and Szechwan—in fact, one of them is lighter in color than true *diademata*. I might add that, in comparing examples of this species, it is well to compare only those taken at approximately the same season of the year, spring and summer specimens being much lighter in color than autumn and winter ones.

I follow Rothschild in the name used for the bird of western Yunnan, as I am afraid I do not know the real characters of *ampelina*.

Yuhina occipitalis obscurior Rothschild

Two adults, male and female: Lung-ling, Yunnan, March 27, 1917.

Ixulus flavicollis rouxi Oustalet

One adult male: Tai-ping-pu, Yunnan, April 2, 1917.

Cutia nepalensis nepalensis Hodgson

One adult male: Ho-mu-shu Pass, Yunnan, 8000 feet altitude, April 5, 1917.

Pterythius æralatus ricketti Ogilvie Grant

One adult female: Ho-mu-shu Pass, Yunnan, 8000 feet altitude, April 7, 1917. There is a note on the label of this specimen reading "contained eggs."

Mesia argentauris argentauris Hodgson

One adult male: 20 miles south of Chen-kang, Salwin drainage, Yunnan, February 7, 1917.

TROGLODYTIDÆ

Spelæornis souliei Oustalet

One male: Tai-ping-pu, Yunnan, 7000 feet altitude, April 12, 1917; "caught in a rat trap set in the forest." I have compared this skin with Oustalet's description and believe it to belong to the species he described as *souliei*. It is, however, the only specimen of the species that I have seen.

Pnoepyga pusilla pusilla Hodgson

Two specimens, male and female: Ho-mu-shu Pass, Yunnan, 7000 feet altitude, and Namting River, Burma border, 1700 feet altitude, February 25 and April 8, 1917. Both examples were caught in traps set for small mammals in the forest.

TURDIDÆ

Turdus merula mandarinus Bonaparte

Two adults, male and female: Yung-chang, Yunnan, January 24 and 29, 1917.

Turdus castaneus gouldi (Verreaux)

Four specimens, three adults, both sexes, and an immature female: Li-chiang, Snow Mountains, 10,000 feet altitude, Yoa-kuan, and Tai-ping-pu, Yunnan, November 10 and 14, 1916, January 31 and April 10, 1917.

Turdus dissimilis Blyth

Two adults, male and female: Chang-lung, Salwin River, Yunnan, March 18, 1917.

Turdus auritus conquisitus, new subspecies

TYPE and only specimen.—No. 143452, Amer. Mus. of Nat. Hist.; adult female; Li-chiang, Snow Mountains, 10,000 feet, Yunnan; November 16, 1916; R. C. Andrews and E. Heller.

CHARACTERS.—Similar to *Turdus auritus auritus* Verreaux, but under parts much more heavily spotted with black, especially on sides and flanks, all the spots larger and more intensely black less brownish black. Wing, 124 mm.; tail, 91 mm.; tarsus, 36 mm.; culmen, to base of forehead, 23.

When I first compared the Yunnan skin with one adult of *T. a. auritus*, collected by Zappey in western Szechwan, both killed in November, I was at once struck by the great difference in the spotting of the under parts and made a note to that effect but did not name the Yunnan bird having only one skin from each region. Since then Rothschild has called attention to exactly the same difference shown by his one adult from Yunnan, compared with his one adult from the Tsin Ling Mountains, and now no reason remains for not giving the Yunnan form a name.

Turdus mollissimus Blyth

One adult female: Li-chiang, Snow Mountains, Yunnan, 10,000 feet altitude, November 9, 1916; "caught in a steel trap."

Monticola solitarius pandoo (Sykes)

One adult male: Tung-chang Fu, Yunnan, January 26, 1917.

Monticola erythrogaster Vigors

One adult male: Ho-mu-shu Pass, Yunnan, 8000 feet altitude, April 9, 1917.

Enicurus schistaceus Hodgson

One female: Namting River, Burma border, February 25, 1917.

Chimarrhornis leucocephala (Vigors)

Two adults, male and female: Mu-cheng, Salwin drainage, and Yuan-chiang-Chou, Yunnan, January 26 and February 16, 1917.

Phœnicurus hodgsoni (Moore)

Two specimens, male and female: Yung-chiang-chou, Yunnan, January 27, 1917.

Calliope calliope calliope (Pallas)

Two adults, male and female: Namting River, Burma border and Chang-lung, Yunnan, March 2 and 21, 1917.

Ianthia rufilata practica Bangs and Phillips

Two specimens, male and female: Mu-cheng, Yunnan, February 10 and 14, 1917. The male, a fine adult in full plumage, has the blue parts of its plumage a little deeper and slightly more purplish than in the type of *practica*. There is also some slight white at the bases of the superciliaries.

Notodela leucura (Hodgson)

Two adult males: Namting River, Burma border, 1700 feet altitude, February 20 and 21, 1917. These two specimens show a wing measurement of 95 mm. in one and 97 mm. in the other.

Copsychus saularis saularis (Linnæus)

One female: Meng-ting, Burma border, February 18, 1917.

Saxicola torquata przewalskii Pleske

Three specimens, two males and a female: Yung-chang Fu, Yunnan, January 27 and 28, 1917.

Oreicola jerdoni Blyth

One adult male: Namting River, Burma border, February 22, 1917.

Oreicola ferrea haringtoni Hartert

Three specimens, a male and two females: Malipa, Burma border, and Wan-tien, Yunnan, March 14 and May 14, 1917.

SYLVIIDÆ

Megalurus palustris andrewsi,[1] new subspecies

Two adult males: Malipa, Burma, and Meng-ting, Burma border, February 18 and March 14, 1917.

TYPE.—No. 143478, Amer. Mus. of Nat. Hist.; adult male; Meng-ting, Burma border; February 18, 1917; R. C. Andrews and E. Heller.

CHARACTERS.—Similar to *M. palustris palustris* Horsford from Java and of about the same size, differing in the black striping of the upper parts being wider and more intensely black: the brown of upper parts deeper, brighter, more reddish brown, especially on the crown. The general color of upper parts in *M. palustris palustris* is clay-color to buck-thorn brown; general color of upper parts in the new form is ochraceous tawny, almost tawny on the crown.

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[1]Named in honor of Roy Chapman Andrews.

MEASUREMENTS

	Sex	Locality	Wing	Tail	Tarsus	Exposed Culmen
A. M. N. H. No. 143478	♂	Burma border Meng-ting	107 mm.	135 mm.	41 mm.	17.5 mm.
A. M. N. H. No. 143477	♂	Burma Malipa	106	133	42	18.0
M. C. Z. No. 34207	♀	India Buxa Doars	94	124	37	16.0

I cannot find that the Indian and Burmese form has ever been separated from the typical Javanese bird. Gray (1848, 'Gen. Birds,' I, p. 169, Pl. XLVIII) figured a young bird in the very yellowish plumage and named it *Megalurus citrinus*. He did not state where his specimen was from, and Sharpe in Vol. VII of the catalogue of birds does not claim the type in the British Museum. I believe the young as figured by Gray could not be positively identified as that of either one or the other subspecies.

Both the Javanese and Burmese forms are much browner, less grayish, than the Philippine bird, *M. palustris forbesi* Bangs.

Phylloscopus fuscatus (Blyth)

One female: Yuan-chiang-Chou, Yunnan, January 27, 1917.

Phylloscopus davisoni (Oates)

One male: Wan-tien, Yunnan, May 15, 1917.

Phylloscopus proregulus forresti Rothschild

One male: Yung-chang Fu, Yunnan, January 27, 1917.

This specimen, in winter plumage, fits the description of the lately described *forresti* well, except that it has the extreme base of the lower mandible of a pale color.

Phylloscopus humei præmium Mathews and Iredale

One male: Chang-lung, Salwin River, Yunnan, March 21, 1917. This is, of course, the bird we used to know as *P. superciliosus superciliosus* (Gmelin).

Phylloscopus lugubris (Blyth)

One male: Wan-tien, Yunnan, May 15, 1917.

Horornis canturians (Swinhoe)

Two males: Yung-chang Fu, Yunnan, January 28, 1917.

Prinia inornata exter Thayer and Bangs

Two females: Yung-chang Fu, Yunnan, January 27, 1917.

PRIONOPIDÆ

Hemipus picatus capitalis (McClellan)

One male: Chang-lung, Salwin River, Yunnan, March 20, 1917.

LANIIDÆ

Lanius schach tephronotus (Vigors)

Two specimens, adult male and immature male: Yung-chang Fu, Yunnan, January 27 and 28, 1917.

Lanius nigriceps nigriceps Franklin

One adult female: Meng-ting, Burma border, February 18, 1917.

Lanius colluroides Lesson

Two adult females: Chang-lung and Yung-chang Fu, Yunnan, January 28 and March 21, 1917.

PARIDÆ

Parus major commixtus Swinhoe

Two males: Yung-chang Fu, Yunnan, 5500 feet altitude, January 27 and 28, 1917. These skins, like many taken by Zappey in parts of western Szechwan, are not extreme *commixtus* but are nearer to it than they are to any of the other races. The wing measures 70 mm. in one of these and 74 mm. in the other.

SITTIDÆ

Sitta europea nagaensis Godwin Austen

One adult female: Ho-mu-shu Pass, Yunnan, 8000 feet altitude, April 4, 1917. This specimen is much grayer, less rusty below, than in any of our skins of *S. europea montium* LaTouche and, if the two are distinct, should, I believe, be referred to *magænsis*.

Sitta frontalis corallina Hodgson

Three adult females: Malipa, Burma and Namting River, Burma border and Chang-lung, Salwin River, Yunnan, February 23 and March 13 and 20, 1917.

Indian and Burmese birds are slightly different from true *S. frontalis* of Java. They are somewhat paler below with a vinaceous rather than a lilaceous tinge and have a more extended white throat-patch.

I follow Hellmayr and unite all the true nuthatches in one genus, being loath to accept the excessive subdivision of the genus proposed by Buturlin in his recent (1911) review.

CERTHIIDÆ

Certhia discolor discolor Blyth

One adult male: Tai-ping-pu, Yunnan, 7000 feet altitude, April 9, 1917.

ZOSTEROPIDÆ

Zosterops palpebrosa simplex Swinhoe

Two adults, male and female: Chang-lung, Salwin River, Yunnan, and Malipa, Burma border, March 15 and 21, 1917.

DICÆIDÆ

Dicæum minullum olivaceum Walden

One female: Chang-lung, Salwin River, Yunnan, March 20, 1917.

NECTARINIIDÆ

Æthopyga ignicauda (Hodgson)

One immature male (in change from young to adult plumage): Yoakuan, Yunnan, 6000 feet altitude, January 31, 1917.

Æthopyga nipalensis (Hodgson)

Two adults, male and female: Mu-cheng and Chang-lung, Yunnan, February 16 and March 18, 1917.

Æthopyga dabryi (J. Verreaux)

Four adult males: Wan-tien, Ta-shui-tang and Mu-cheng, Yunnan, February 2, 3 and 16, and May 14, 1917.

MOTACILLIDÆ

Motacilla alba hodgsoni Blyth

One adult female: Yung-chang Fu, Yunnan, January 27, 1917.

Motacilla alba ocularis Swinhoe

One adult male: Yung-chang Fu, Yunnan, January 27, 1917.

Motacilla cinerea melanope Pallas

One immature male: Yung-chang Fu, Yunnan, January 27, 1917.

Anthus hodgsoni Richmond

Two specimens, male and female: Yung-chang Fu, Yunnan, January 27 and 28, 1917.

Lately Uchida and Kuroda (1916, Annotationes Zoologicæ Japonenses, IX, p. 134) have named a form from Yunnan *Anthus maculatus yunnanensis*, apparently based upon migrant birds. The only character ascribed to the new form is a smaller bill than in the typical bird. The two specimens listed above have rather small bills, but five winter birds from Mengtsz are quite like examples from anywhere else in this respect. In a good series of breeding birds from the high mountains of Hupeh and Szechwan I find a good deal of individual variation in the size of the bill, as also in breeding birds from Sachalin Island, and I do not believe *yunnanensis* is a recognizable form.

Sarundy, in 1909, named the breeding bird of south-western Kansu *Anthus maculatus berzowskii*, on the character of a grayer back with blacker shaft markings. I have seen no specimens from Kansu, but all mid-summer examples that I have examined show these two characteristics to a marked degree when compared with winter or spring killed individuals from the same regions.

I am inclined to believe that Rothschild, in using *berezowskii* as the name of the species, overlooked the fact that *A. hodgsoni* Richmond, as a substitute for the preoccupied *Anthus maculatus* Jerdon, dates from 1907, and *A. berezowskii* Sarundy dates from 1909; but perhaps he did not and meant to treat *berezowskii* as a species distinct from *hodgsoni*.

FRINGILLIDÆ

Eophona migratoria migratoria[1] Hartert

One female: Yung-chang Fu, Yunnan, January 28, 1917.

Spinus ambiguus Oustalet

Two males: Yung-chang Fu, Yunnan, 5500 feet altitude, January 28, 1917.

Passer montanus montanus (Linnæus)

One adult male: Yung-chang Fu, Yunnan, January 28, 1917. I cannot distinguish this specimen from European birds. It apparently does not approach *P. montanus malaccensis* Dubois of tropical India, Malaya, etc.

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[1]For the change of the specific name from *melanura* to *migratoria*, see Penard, 1919, Proc. New Eng. Zool. Club, VII, p. 22, October 31.

Passer rutilans cinnamomea (Gould)

One adult male: Lung-ling, Yunnan, 5000 feet altitude, March 27, 1917.

Rothschild records the specimens taken by Forrest as *Passer rutilans assimilis* Walden. I cannot reconcile any Yunnan skin examined by me with Walden's description which calls for a bird with "the cheeks and sides of the neck pure white, and the breast, flanks and ventral region ashy grey." All specimens from Yunnan as well as those from western Szechwan that I have seen have yellow cheeks and sides of the neck, and are strongly washed with yellow all over the under parts, and appear to me indistinguishable from birds from the eastern Himalayas.

Zappey, however, took in Hupeh and eastern Szechwan seven sparrows that Thayer and I referred to *P. rutilans rutilans* (Temminck). These skins agree well with Walden's description, but I cannot see much difference between them and Japanese birds, except that some, not all, of them are intermediate between *rutilans* and *cinnamomea*.

Carpodacus edwardsii Verreaux

One male in plumage similar to that of the female: Tai-ping-pu, Yunnan, April 9, 1917.

Pyrrhula erythaca altera Rippon

One adult male: Li-chiang, Snow Mountains, Yunnan, 10,000 feet altitude, November 11, 1916.

Emberiza pusilla Pallas

Three specimens, two males and a female: Malipa, Burma and Yung-chang Fu, Yunnan, January 28 and March 13, 1917.

Emberiza spodocephala melanops Blyth

Two males: Chang-lung, Salwin River, Yunnan, March 21 and 24, 1917.

Melophus melanicterus (Gmelin)

One immature male: Namting River, Burma border, February 23, 1917.

PLOCEIDÆ

Munia punctata topela Swinhoe

One immature female: Namting River, Burma border, February 28, 1917.

STURNIDÆ

Sturnia nemoricola Jerdon

Two females: Namting River, Burma border, and Chang-lung, Salwin River, Yunnan, February 25 and March 20, 1917.

Gracupica nigricollis (Paykull)

Three adults, two males and a female: Meng-ting, Burma border, February 28, 1917.

Acridotheres tristis (Linnæus)

Two adults, male and female: Shih-tien, Yunnan, January 30, 1917.

Æthiopsar cristatellus cristatellus (Gmelin)

Seven adults, both sexes: Malipa, Burma, Yoa-kuan and Hsiao,[1] Salwin drainage, Yunnan, January 30, February 3, March 12 and 13, 1917; "often seen feeding on the backs of buffalo."

Æthiopsar albocinctus Godwin-Austen and Walden

One adult female: Malipa, Burma, March 13, 1917.

ORIOLIDÆ

Oriolus indicus tenuirostris Blyth

One specimen (marked "♂," apparently a female): Yung-chang, Yunnan, January 26, 1917.

DICRURIDÆ

Chibia hottentotta hottentotta (Linnæus)

One adult male: Chang-lung Salwin River, Yunnan, March 21, 1917. This is a large billed bird; the bill measured as Stuart Baker (1919, Nov. Zool., XXVI, p. 44) measures his series gives 29 mm.

Dicrurus leucophæus nigrescens Oates

Three adult males: Yung-chang and Chang-lung, Salwin River, Yunnan, January 27 and 28, March 22, 1917. These are all large birds (wing: 145, 146, and 140 mm.)

CORVIDÆ

Corvus coronoides levaillantii Lesson

One adult female: Li-chiang, Snow Mountains, Yunnan, 10,000 feet altitude, November 12, 1916.

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[1] "Hsiao" means in English "small, little."

Corvus insolens Hume

One adult male: Meng-ting, Burma border, February 18, 1917.

Nucifraga caryocatactes macella Thayer and Bangs

One adult male: Li-chiang, Snow Mountains, Yunnan, 10,000 feet altitude, November 6, 1916. On comparing this skin with the type of *macella* from the mountains of Hupeh and with one skin from Tachienlu, I can detect no differences that would seem to be subspecific. The type is a little paler brown than in either the Tachienlu or Yunnan specimens, but I cannot believe that this slight difference would prove to be constant. Also, the white spotting in the type of *macella* extends quite down the middle of the belly to the vent, whereas in the two other skins the whole belly is unspotted. If long series should show that *Nucifraga yunnanensis* Ingram (1910) is different from *N. macella* (1909) of Hupeh, then the Tachienlu bird must be referred to *yunnanensis*. For the present, I unite the two under the older name.

Pica pica sericea Gould

Two adult females: Yung-chang Fu, Yunnan, January 27, 1917.

Urocissa erythrorhyncha erythrorhyncha (Gmelin)

Four adults, both sexes: Hui-yao, 5500 feet altitude, and Li-chiang, Snow Mountains, 10,000 feet altitude, Yunnan, November 7, 9, and 12, 1916, and May 7, 1917.

Dendrocitta himalayensis Blyth

Two adults, male and female: Wantien and Taipingpu, Yunnan, April 12 and May 14, 1917.

Garrulus leucotis Hume

One adult male: Malipa, Burma, March 14, 1917.

Garrulus bispecularis sinensis Swinhoe

One adult male: Lichiang, Snow Mountains, Yunnan, 10,000 feet altitude, November 11, 1916. This specimen has a grayish back and a whitish throat, wing 195 mm., and thus represents the variant named *rufescens* by Reichenow.

Rothschild has relegated the supposed subspecies *rufescens* to synonymy. I had written a long account of our large series of Chinese jays showing that "*rufescens*" has no region of its own, but occasionally turns up anywhere within the range of the variable *sinensis*. Briefly stated, our material wholly supports what Rothschild has said.

Birds from Fokien

Phasianidæ

Francolinus pintadeanus pintadeanus (Scopoli)[1]

Four specimens, two males, two sex undetermined: Futsing, Fokien, June 1911 and 1912, and July 10, 1916. I think Scopoli's name must be used for the large bird of southern China, probably introduced from thence into Mauritius, with a wing ranging from 153 mm. to 157 mm., and the smaller form of Burma, Cochin China, Siam and Yunnan be known as *F. pintadeanus phayrei* (Blyth).

Arboricola ricketti Ogilvie-Grant

Two specimens: a male, Yenping, Fokien, June 13, 1916; and one, sex undetermined, Futsing, Fokien, 1912.

Bambusicola thoracica (Temminck)

Three adults, a male, and two females: Futsing, Fokien, April 1911 and March 17, 1912.

Columbidæ

Streptopelia orientalis orientalis (Latham)

Three males: Futsing, Fokien, July 25 and August 1, 1916.

Streptopelia chinensis chinensis (Scopoli)

One adult female: Futsing, Fokien, July 27, 1916.

Rallidæ

Porzana pusilla pusilla (Pallas)

Two specimens, male and female: Futsing, Fokien, April and October 1912.

Amaurornis akool coccineipes Slater

Four specimens, male, two females and one with sex not determined: Futsing, Fokien, May 1911, September 1912, and 1912.

Gallicrex cinerea (Latham)

Three specimens, two adult males, one immature, sex not determined: Futsing, Fokien, June 1911.

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[1]For change of name from *Francolinus chinensis* to *F. pintadeanus* cf. Oberholser, 1919, Proc. Biol. Soc. Wash., XXXII, April, p. 21.

LARIDÆ

Sterna albifrons sinensis Gmelin

Two adults, male and female: Futsing, Fokien, May 1911.

Larus argentatus vegæ Palmén

One adult female: Futsing, Fokien, December 1912.

Charadriidæ

Arenaria interpres interpres (Linnæus)

Two specimens in winter plumage, sex undetermined: Futsing, Fokien, 1912.

Vanellus vanellus (Linnæus)

One adult, sex not determined: Futsing, Fokien, 1912.

Pluvialis dominicus fulvus (Gmelin)

One male, in winter plumage: Futsing, Fokien, October 1912.

Charadrius leschenaultii Lesson

One male: Futsing, Fokien, June 1911.

Charadrius alexandrinus dealbatus (Swinhoe)

One specimen, sex not determined: Futsing, Fokien, 1912.

Numenius arquatus lineatus Cuvier

One adult female: Futsing, Fokien, December.

Numenius phæopus variegatus (Scopoli)

Two specimens, one male, one sex not determined: Futsing, Fokien, 1912.

Tringa ochropus Linnæus

One adult female: Futsing, Fokien, July 21, 1916.

Heteractitis brevipes (Vieillot)

One female, in winter plumage: Futsing, Fokien, September 15, 1911.

Erolia ruficollis (Pallas)

Two females: Futsing, Fokien, May and June 1911.

Erolia acuminata (Horsford)

Three adults, male and two females, all in spring plumage: Futsing, Fokien, May 1911.

Erolia alpina sakhalina (Vieillot)

Two specimens, sex not determined, in winter plumage: Futsing, Fokien, 1912.

Gallinago gallinago gallinago (Linnæus)

One female: Futsing, Fokien, May 1911.

Rostratula bengalensis bengalensis (Linnæus)

Two adults, male and female: Futsing, Fokien, May and June 1911.

Glareolidæ

Glareola maldivarum Forster

Three adults, two males and a female: Futsing, Fokien, May and June 1911.

Ardeidæ

Nycticorax nycticorax nycticorax (Linnæus)

One specimen, immature, sex not determined: Futsing, Fokien, 1912.

Ardeola bacchus (Bonaparte)

Two specimens, an adult male and a somewhat immature female: Futsing, Fokien, July 25, 1916.

Ixobrychus sinensis sinensis (Gmelin)

Two females: Futsing, Fokien, May 1911 and 1912.

Ixobrychus cinnamomea (Gmelin)

Two adults, male and female: Futsing, Fokien, July 26 and 31, 1916.

Anatidæ

Melanonyx segetum serrirostris (Swinhoe)

One adult, sex not determined. Futsing, Fokien, 1912.

Mergus serrator Linnæus

Four specimens, adult male and three females: Futsing, Fokien, November and December 19, 1912.

FALCONIDÆ

Astur soloensis (Horsfield)

Two specimens, adult male, and female immature: Futsing, Fokien, August 1913 and June 1914.

Accipiter gularis (Temminck and Schlegel)

One adult male: Futsing, Fokien, May 1911.

Buteo buteo japonicus (Temminck and Schlegel)

One male: Futsing, Fokien, October 1912.

Butastur indicus (Gmelin)

One adult, sex not determined: Futsing, Fokien, 1912.

Falco columbarius insignis (Clark)

One female: Futsing, Fokien, November 1912.

Cerchneis tinnunculus japonicus (Temminck and Schlegel)

Two females: Futsing, Fokien, January 1912 and 1912.

BUBONIDÆ

Otus bakkamœna glabripes (Swinhoe)

One immature female: Futsing, Fokien, July 24, 1916.

Ninox scutulata scutulata (Raffles)

Two adults, sex not determined: Futsing, Fokien, March 1912.

Glaucidium brodiei (Barton)

One adult, sex not determined (=male): Futsing, Fokien, 1912.

Glaucidium cuculoides whitelyi (Swinhoe)

Four specimens, one male, two females and one sex not determined: Futsing, Fokien, July 24 and 28 and August 1, 1916 and 1912.

CORACIIDÆ

Eurystomus orientalis calonyx Sharpe

Three specimens, an adult female, and two young, male and female: Futsing, Fokien, April 1911 and August 1912. See Stresemann, 1913, Nov. Zool., XX, p. 299 for discussion of the geographical races and the points where intergradation takes place.

ALCEDINIDÆ

Ceryle lugubris guttulata Stejneger

Two males: Futsing, Fokien, July 27 and August 1, 1916.

Alcedo atthis bengalensis Gmelin

Three specimens, two males and a female, all immature: Futsing, Fokien, July 12, 27 and 28, 1916.

Halcyon smyrnensis fusca (Boddaert)

Five specimens, both sexes: Futsing, Fokien, July 26 and 28, 1916 and 1912.

Halcyon pileata (Boddaert)

One female: Futsing, Fokien, July 31, 1916.

CAPRIMULGIDÆ

Caprimulgus indicus jotaka Temminck and Schlegel

Two females: Futsing, Fokien, 1912.

MICROPODIDÆ

Micropus pacificus pacificus (Latham)

Four specimens, three males, one with sex not determined: Futsing, Fokien, May and June 1911 and 1912.

TROGONIDÆ

Pyrotrogon erythrocephalus yamakanensis Rickett

One adult male: Yen-ping, Fokien, June 12, 1916.

CUCULIDÆ

Clamator coromandus (Linnæus)

Three adults, two males and a female: Yen-ping and Futsing, Fokien, June 12, 1916 and 1912.

Cuculus optatus Gould

Three females: Futsing, Fokien, May 1911 and March and April 1912.

Eudynamis orientalis chinensis Cabanis and Heine

Two adults, male and female: Futsing, Fokien, 1912.

Centropus bengalensis lignator Swinhoe

Three adults, male and female and one sex not determined: Futsing, Fokien, July 20, 23 and 24, 1916.

CAPITONIDÆ

Megalaema virens virens (Boddaert)

Four adults, both sexes: Futsing, Fokien, July 27, 1916 and March 1912.

PICIDÆ

Picus canus ricketti Stuart-Baker

Two adults, male and female: Futsing, Fokien, July 1916 and August 1912.

Dryobates cabanisi cabanisi (Malherbe)

Two males, one adult, one immature: Futsing, Fokien, October 1912 and July 26, 1916.

Micropternus brachyurus fokiensis (Swinhoe)

One adult male: Yenping, Fokien, June 12, 1916.

Jynx torquilla japonica Bonaparte

Three specimens, male and two with sex not determined: Futsing, Fokien, March 1912 and 1912.

HIRUNDINIDÆ

Hirundo rustica gutturalis Scopoli

One immature male: Futsing, Fokien, July 3, 1916.

MUSCICAPIDÆ

Hemichelidon sibirica sibirica (Gmelin)

One adult, sex not determined and without date of capture: Futsing, Fokien.

Poliomyias mugimaki (Temminck)

Four specimens, both sexes: Futsing, Fokien, 1912.

Cyanoptila cyanomelana Temminck

Seven specimens, both sexes: Futsing, Fokien, March 1912, September 1912, and 1912. The three adult males in this series are all black-throated birds with dark blue backs lined with black, and all be-

long to this form which seems to be specifically distinct from *C. cumatilis* Thayer and Bangs, the breeding bird of Central China.

Hypothymis azurea styani (Hartlaub)

One (female): Futsing, Fokien, 1912.

Tchitrea paradisi incii Gould

Three specimens, two males and a female, all in the brown phase of plumage: Futsing and Ling Sioh, Fokien, March 1912 and August 2, 1916.

Tchitrea princeps princeps (Temminck)

One male: Futsing, Fokien, March 1912.

CAMPEPHAGIDÆ

Volvocivora melanoptora (Rüppell)

Two males: Futsing, Fokien, April 1912.

Pericrocotus griseigularis Gould

Two adult, male and female: Futsing, Fokien, June 1912 and 1912.

Pericrocotus cantonenis Swinhoe

Four specimens, two adult males, an adult female and immature sex not determined: Futsing, Fokien, March 1912 and July 10, 1916. I do not use the genus *Motacilloides* Buturlin for the black, white and gray Minivets, as it does not seem to me worth while to subdivide the group.

PYCNONOTIDÆ

Hypsipetes leucocephalus (Gmelin)

One immature (without white in the head) male: Futsing, Fokien, June 12, 1916.

Hemixos canipennis Seebohm

Four adults, both sexes: Futsing and Ling Sioh, Fokien, July 27, 28, and 29, 1916, and April 1912.

Iole maclellandi holti (Swinhoe)

Three specimens, one male, two females: Futsing and Ling Sioh, Fokien, July 28, 1916, and April 1912.

Pycnonotus sinensis (Gmelin)

Twelve specimens, adult and immature of both sexes: Futsing, Fokien, July 3, 4, 22, 23, 24, 27, 28, and 31, 1916, and March 1912.

Spizixos semitorques Swinhoe

One adult, sex not determined: Futsing, Fokien, 1912.

TIMELIIDÆ

Ianthocincla canora (Linnæus)

Eight specimens, adult and immature, both sexes: Futsing, Fokien, July 10, 24, 27, and 28, 1916, and March 1912.

Pomatorhinus ruficollis stridulus Swinhoe

Eleven specimens, both sexes: Futsing, Fokien, July 1, 24, 26, and 31, 1916, and April 1912. These all have short bills, but the color of the back is variable in this series, some specimens being much less reddish than others.

Pomatorhinus swinhoei David

One adult male: Futsing, Fokien, 1912.

Garrulax picticollis Swinhoe

One male: Yenping, Fokien, June 15, 1916.

Dryonastes perspicillatus perspicillatus (Gmelin)

Four specimens, one adult, three immature: Futsing, Fokien, July 13 and 26, 1916, and March 1912.

Dryonastes sannio sannio Swinhoe)

Four specimens, two adult, two immature: Futsing, Fokien, July 26 and 27, 1916, and April 1912.

Alcippe nipalensis hueti (David)

Seven specimens, adults and immature of both sexes: Futsing, Fokien, July 26 and 31, 1916.

Hartert (Vog. Pal. fauna, p. 616) says he cannot substantiate the differences claimed by Styan to separate his *davidi* of Szechwan from true *hueti* of Fokien. In Harington's review of the genus published in 1915, however, both forms are kept. I have compared the present series with a large one in Mus. Comp. Zool. from Szechwan and find that the Fokien birds are decidedly paler below, the chest more pinkish, less grayish, the sides more buffy, less olivaceous and, therefore, consider *A. nipalensis davidi* Styan of Szechwan a good form.

Stachyrhidopsis ruficeps davidi Oustalet

Six specimens, adults and immature, both sexes: Futsing, Fokien, July 10, 26, and 29, 1916, and January 1912.

Myiophoneus cæruleus (Scopoli)

Four adult males: Futsing, Fokien, July 28, 1916, August and September 1912.

Staphidia torquola Swinhoe

One adult male: Yen-ping, Fokien, June 21, 1916.

TURDIDÆ

Turdus merula mandarinus Bonaparte

Three females: Futsing, Fokien, March 1912.

Turdus cardis lateus Thayer and Bangs

Three adults, two males and a female: Futsing, Fokien, March 1912 and 1912.

Turdus eunomus Temminck

Four specimens, all unmarked as to sex: Futsing, Fokien, 1912.

Turdus hortulorum Sclater

One adult male: Futsing, Fokien, 1912.

Turdus chrysolaus (Temminck)

Two females: Futsing, Fokien, April 1912.

Turdus aureus aureus Holander

Two specimens, a female and one with sex not determined: Futsing, Fokien, February 1912 and 1912.

Monticola solitarius pandoo (Sykes)

One adult male: Futsing, Fokien, March 1912.

Monticola solitarius philippensis (Müller)

Two males: Futsing, Fokien, 1912.

Monticola solitarius magna La Touche

Two specimens a male and a female: Futsing, Fokien, May 1911 and September 1912. These are large birds, apparently migrants of the big race that breeds in Northeast Siberia and Japan. The wing in the male gives 128 and in the female, 120 mm.

Enicurus sinensis Gould

Two males: Futsing and Ling Sioh, Fokien, July 27, 1916, and April 1912.

Enicurus schistaceus Hodgson

Three adults, two males and a female: Futsing and Ling Sioh, Fokien, July 31, 1916, June 21, 1914, and June 1914.

Chimarrhornis fuliginosa fuliginosa (Vigors)

One female: Futsing, Fokien, September 1912.

Phœnicurus auroreus auroreus (Gmelin)

One male: Futsing, Fokien, 1912.

Ianthia cyanura (Pallas)

One male: Futsing, Fokien; no date of capture.

Copsychus saularis saularis (Linnæus)

Eight specimens, adults of both sexes and one immature: Futsing, Fokien, July 4, 10, 23, and 24, 1916, and March 1912.

Saxicola torquata stejnegeri (Parrot)

One female: Futsing, Fokien, 1912.

SYLVIIDÆ

Locustella ochotensis (Middendorff)

One specimen: Futsing, Fokien, May 1911.

Sutoria sutoria phyllorrhaphea Swinhoe

Two males: Ling Sioh, Fokien, July 1 and 30, 1916.

Cisticola cisticola tintinnabulans (Swinhoe)

Two specimens, male and female: Futsing, Fokien, May 1911.

LANIIDÆ

Lanius tigrinus Drapiez

One adult male: Futsing, Fokien, July 10, 1916.

Lanius schach schach (Linnæus)

Six specimens, adults of both sexes and one immature female: Futsing and Ling Sioh, Fokien, July 22, 24, 27, and 28, 1916, and December 1912.

Lanius cristatus lucionensis Linnæus

Three specimens, an adult male and two immature: Futsing, Fokien, May 1911, September 1912, and 1912.

Paridæ

Parus major commixtus Swinhoe

Five specimens, adults and immature: Futsing, Fokien, July 1, 10, 21, 23, and 24, 1916.

Zosteropidæ

Zosterops palpebrosa simplex Swinhoe

Eleven specimens, both sexes: Futsing, Fokien, July 1, 3, 4, and 10, 1916, and October 1911 and 1912.

Dicæidæ

Dicæum ignipectus ignipectus (Hodgson)

Three specimens, a male and two females: Futsing, Fokien, 1911 and 1912.

Motacillidæ

Motacilla alba leucopsis Gould

Two specimens, an adult male and an immature female: Futsing, Fokien, July 24, 1916, and September 1912.

Anthus hodgsoni Richmond

Two males: Futsing, Fokien, January and March 1912.

Alaudidæ

Alauda gulgula cœlivox Swinhoe

One adult male: Futsing, Fokien, April 1912.

Fringillidæ

Eophona migratoria migratoria Hartert

Four adults, three males and a female: Futsing, Fokien, April 1912 and 1912.

Chloris sinica sinica (Linnæus)

Two adult males: Futsing, Fokien, April 1912.

Fringilla montifringilla Linnæus

Two specimens, sex not determined: Futsing, Fokien, 1912.

Possibly there may be an eastern subspecies, *Fringilla montifringilla subcuneolata* Kleinschmidt. But after carefully comparing long series of specimens from the far east with European birds, I find the only char-

acters claimed by Kleinschmidt—the size and distinctness of the paler marking of the outer tail feather—are very variable in both series and, in our material at least, do not indicate the existence of such a race.

Passer montanus taivanensis Hartert

Four specimens, two adult males, two immature males: Futsing and Ling Sioh, Fokien, July 28 and 31, 1916. I can refer these skins to no other form than *taivanensis* originally described from Formosa. The adults have bills much larger than in *P. montanus saturatus* Stejn. of Japan and the Liu Kiu Islands. The culmen affording respectively 12.5 and 13 mm.

Passer rutilans rutilans (Temminck)

Ten specimens, both sexes. Futsing, Fokien, July 1, 3, 4, 10, and 23, 1916, and January 1912.

Emberiza spodocephala spodocephala Pallas

Two females: Futsing, Fokien, May 1911 and March 1912.

Melophus melanicterus (Gmelin)

Three specimens, two males and a female: Futsing, Fokien, April and March 1912.

PLOCEIDÆ

Munia punctata topela Swinhoe

Three adults, male and two females: Futsing and Ling Sioh, Fokien, July 26, 1916, January 20, 1914, and March 1912.

Uroloncha squamicollis Sharpe

Ten adults, both sexes: Futsing and Ling Sioh, Fokien, July 26, 28, 29, 30, and 31, 1916.

STURNIDÆ

Sturnia cineracea (Temminck)

Three specimens, both sexes: Futsing, Fokien, January 21, 1914, and 1912.

Sturnia sinensis (Gmelin)

Two males: Futsing, Fokien, 1912.

Sturnia violacea (Boddaert)

One adult male: Futsing, Fokien, May 1911. This example is a fine adult male in full spring plumage, and the record proves beyond doubt that the species does occasionally, at least, occur in China on migration.

Æthiopsar cristatellus cristatellus (Gmelin)

Five specimens, adults of both sexes and one immature female: Futsing and Ling Sioh, Fokien, July 27 and 31, 1916, and March 1912.

ORIOLIDÆ

Oriolus indicus indicus Jerdon

Seven specimens, both sexes: Futsing, Fokien, July 4, 20, and 24, 1916, and March 1912.

DICRURIDÆ

Chibia hottentotta brevirostris (Cabanis)

One immature male: Ling Sioh, Fokien, August 2, 1916.

Dicrurus leucogenys cerrussatus (Bangs and Phillips)

Four adults, both sexes: Futsing, Fokien, March and April 1912.

CORVIDÆ

Corvus coronoides levaillantii Lesson

One adult male: Futsing, Fokien, April 1912.

Urocissa erythrorhyncha erythrorhyncha (Gmelin)

Nine specimens, adults and young of both sexes: Futsing and Ling Sioh, Fokien, July 24, 27, and 28, August 1, 1916, and March 1912.

Dendrocitta formosæ sinica Stresemann

Two adult males: Futsing, Fokien, April 1912 and June 1914.

Garrulus bispecularis sinensis Swinhoe

Four specimens, three adults, one immature, two marked as males, two without sex mark: Futsing, Fokien, January and April 1912.

AMERICAN MUSEUM NOVITATES

No. 38

DESCRIPTION OF A NEW LOACH FROM NORTH-EASTERN CHINA

By Henry W. Fowler

Issued May 25, 1922

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AMERICAN MUSEUM NOVITATES

Number 38 May 25, 1922

59.7,55L (51.1)

DESCRIPTION OF A NEW LOACH FROM NORTH-EASTERN CHINA

By Henry W. Fowler

Lefua andrewsi,[1] new species

Head $4\frac{3}{5}$; depth 7; D. II, 6; A. II, 6; P. I, 12; V. I, 6; scales about 104 in a median lateral series; head width about $1\frac{3}{4}$ in its length; head depth 2; snout $3\frac{1}{3}$; eye $4\frac{7}{8}$; maxillary $3\frac{1}{4}$; interorbital $3\frac{1}{10}$; depressed dorsal $1\frac{1}{4}$; depressed anal $1\frac{2}{5}$; least depth of caudal peduncle 2; caudal length $1\frac{1}{10}$; pectoral $1\frac{1}{8}$; ventral $1\frac{1}{4}$.

Body elongate, moderately slender, considerably depressed forward and becoming compressed posteriorly, edges all convex except slight keel forward above and below on caudal peduncle by rudimentary caudal rays to caudal base. Caudal peduncle strongly compressed, least depth little less than its length.

Head moderate, robust, broadly depressed, especially behind. Snout broad, obtuse, length $\frac{3}{4}$ its width. Eye small, hind edge about midway in head length. Maxillary small, about half-way to eye. Jaws even. Lips rather thin. Nasal barbel reaches eye center. Maxillary barbel to hind eye edge. Upper lateral barbel to eye center. Interorbital broadly though slightly convex.

Gill-opening lateral, long as snout.

Scales all small, not overlapping, in rather irregular distribution though close-set and with imbedded appearance; marginal radiating striæ 31 to 37; circuli moderately fine. No developed lateral line.

Dorsal origin little nearer that of pectoral than to caudal base, depressed fin slightly less than caudal base. Anal inserted little behind dorsal base, though little before depressed dorsal tip, depressed fin three-fourths to caudal base. Caudal rounded, median rays longest. Pectoral about half-way to ventral. Ventral reaches about three-fourths to anal. Vent close before anal.

Color in alcohol nearly sepia above, dusted very obscurely with darker. Dusky lateral band, rather obscurely defined, from each side of snout tip to eye, though below and over infraorbitals, back to caudal base. Posteriorly band much darker to blackish. Dark vertebral line on predorsal, slightly so behind dorsal. Barbel edges and lip margins dusky. Iris pale slaty. Dorsal and caudal grayish, both finely and obscurely spotted with dull dusky, only a distinct median black blotch on latter, reflected out on median rays basally. Other fins all pale, pectorals with few shadings.

Length, 52 mm.

Type, No. 7974, American Museum of Natural History. Shing Lung Shan, Eastern Tombs, China. August 7, 1921. Collected by The Third Asiatic Expedition of The American Museum of Natural History.

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[1]In recognition of Mr. Roy Chapman Andrews, leader of the Third Asiatic Expedition of The American Museum of Natural History.

This species is closely related to *Lefua costata* (Kessler) and appears to differ only in the color-pattern. Apparently the two forms occur associated, as they were received in the same lot. In *Lefua andrewsi* the broad and well-defined lateral band of dusky to blackish, which is reflected out on the median caudal rays, is diagnostic. In *Lefua costata* the scarcely evident lateral streak is replaced at the caudal base by a definite small rounded black spot, clearly defined and not reflected out on the median fin-rays.

AMERICAN MUSEUM NOVITATES

No. 42

DISCOVERY OF CRETACEOUS AND OLDER TERTIARY STRATA IN MONGOLIA

By Walter Granger and Charles P. Berkey

Issued August 7, 1922

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AMERICAN MUSEUM NOVITATES

Number 42 August 7, 1922

56.(117:51.7)

DISCOVERY OF CRETACEOUS AND OLDER TERTIARY STRATA IN MONGOLIA[1]

By Walter Granger and Charles P. Berkey

The American Museum commenced its natural history explorations in Asia in 1916. The First and Second Asiatic Expeditions, in charge of Roy Chapman Andrews in 1916–1917 and 1918–1919, were engaged in zoölogical exploration and in laying the foundations for broader work. The Third Asiatic Expedition, sent out by The American Museum of Natural History, the American Asiatic Association, and Asia Magazine, has included zoölogy, palæontology, geology, and geography under the leadership of Mr. Andrews, with Walter Granger as palæontologist, Charles P. Berkey as geologist and Frederick K. Morris as topographer, and other cognate lines of research may be taken up when the results of reconnaissance warrant it.

The scientific results of these expeditions will be published in numbered sequence as indicated below. The following reports or contributions have already been published:

(No. 1) 'New Chinese Fishes.' By John Treadwell Nichols. Proc. Biol. Soc. Washington, XXXI, pp. 15–20, May 16, 1918.

(No. 2) 'Description of a New Species of Serow from Yün-nan Province, China.' By Roy Chapman Andrews. American Museum Novitates, No. 6, March 24, 1921.

(No. 3) 'The Birds of The American Museum of Natural History's Asiatic Zoölogical Expedition of 1916–1917.' By Outram Bangs. Bull. Amer. Mus. Nat. Hist., XLIV, Art. 20, pp. 575–612, December 30, 1921.

(No. 4) 'Description of a New Loach from North-eastern China.' By Henry W. Fowler, American Museum Novitates, No. 38, May 25, 1922.

Reconnaissance Expedition in Mongolia

On April 21, 1922, the Third Asiatic Expedition left Kalgan, North China, for its announced reconnaissance trip into Mongolia. It is planned to devote the first three weeks of the season to observations along the regular caravan route between Kalgan and Urga, the capital of Mongolia, and the rest of the season to points scattered far to the west, perhaps even as far west as Ulyosutai and Kobdo and the eastward extension of the Altai mountains.

[1]Contribution No. 5. Asiatic Expeditions of The American Museum of Natural History.

The chief effort of the present season is to be devoted to geology, palæontology, geography, and zoölogy, but other scientific interests will be cared for in subsequent seasons if the reconnaissance warrants such expansion. It is believed that fields inviting more extended and detailed work will be discovered and that the reconnaissance will furnish a basis for final plans and indicate the nature of the problems that promise best results.

At the close of the season President Henry Fairfield Osborn is expected to join the expedition staff at the headquarters in Peking and will take an important part in the conferences in which plans for the next three years will be formulated.

The scientific staff on the present reconnaissance includes Roy Chapman Andrews, zoölogist, Walter Granger, palæontologist, Charles P. Berkey geologist, and Frederick K. Morris, physiographer.

It is hoped that there may be opportunity to send short notes of observations or discoveries of special interest directly from the field but, in any case, a summary of the season's results will be issued with little delay on the return of the Expedition.

Cretaceous Strata in Eastern Asia.—The Third Asiatic Expedition announces, under date of May 3, 1922, that strata of Cretaceous age, overlain by two distinct Tertiary formations, have been discovered in the Gobi region of southeastern Mongolia.

They were found on the outbound trip from Kalgan to Urga at a point about 260 miles northwest of Kalgan. Strata of Cretaceous age are wholly unknown in Eastern Asia, as far as the writers are aware, and because of the apparent importance of the find, it was decided to leave the geologists in camp at this place while the rest of the party moved on. Accordingly Messrs. Berkey, Granger, and Morris spent a week in additional inspection of the ground and furnish the notes for this memorandum.

The best exposures of the Cretaceous formation are in the vicinity of the small salt marsh Iren Dabasu, where a total thickness of about 150 feet of nearly horizontal strata is judged to be of this age. Tertiary beds not older than the Miocene lie on top of the Cretaceous strata and are best exposed about five miles south of Iren. Twenty miles farther south early Tertiary beds were found in essentially the same relation.

In each occurrence of the Tertiary beds only a single horizon has furnished determinative fossils, but in the Cretaceous formation below, there are at least two fossil bone-bearing horizons. Fortunately the faunal evidence is unmistakable. Otherwise the widely different age

relations of the strata would not be suspected, for the corresponding physical breaks are inconspicuous and the beds are almost perfectly conformable.

The structural basin in which these strata lie measures forty miles across from north to south and is floored with ancient slates and limestones of extremely complicated deformation structure. This is only one of six basins of similar form and relation between Kalgan and Iren but it is much the longest one and the only one in which, thus far, the presence of strata of Cretaceous age has been proven.

In the vicinity of the small salt lake Iren Dabasu, the Cretaceous beds lie immediately on the slate floor of the basin and between this base and the first determinable beds of later age, in this case late Tertiary, about 150 feet of strata are exposed. The bottom members are dominantly sands and sandstones, prevailingly thin-bedded, some of which are strongly cross-bedded and well cemented. The middle members become finer grained, more mixed with clay and more variable in color. The upper beds are dominantly clays and sandy clays and very fine sands, varying in color from white to dark red and drab and yellowish green. No less than twenty distinct beds or layers can thus be distinguished, all of which are regarded as belonging to a single geologic formation.

Only the lower members of this formation have been found to be fossiliferous. The list includes:

1.—Predentate dinosaurs, probably of the bipedal type.

2.—Carnivorous dinosaurs of at least two genera, the smaller one being of the *Ornithomimus* type.

3.—Crocodiles.

4.—Turtles of the *Trionyx* type.

5.—A few pelecypod shells.

Obretcheff, the Russian geologist, who gives an account of a reconnaissance trip over this same route from Ude to Kalgan, describes sedimentary beds at many places, always referring to them as representatives of the Gobi formation. His only age determination, however, was made on the basis of a few fragments of *Rhinoceros*, found at the escarpment five miles south of Iren. These remains were judged by Eduard Suess, to whom they were referred, to indicate an age not earlier than the Miocene. The Tertiary age of the rest of the occurrences mentioned by him seems to have been taken for granted and apparently that is in general correct, but it is evident that the Gobi formation cannot properly

include strata of both Tertiary and Cretaceous ages. It is clear also that the term Gobi formation or Gobi series is properly applied to the Tertiary beds instead of to those of Cretaceous age. The finding of a Cretaceous formation below makes a new designation necessary. For this purpose nothing seems to be as appropriate as the name of this locality. We therefore propose the term IREN DABASU FORMATION for these beds.

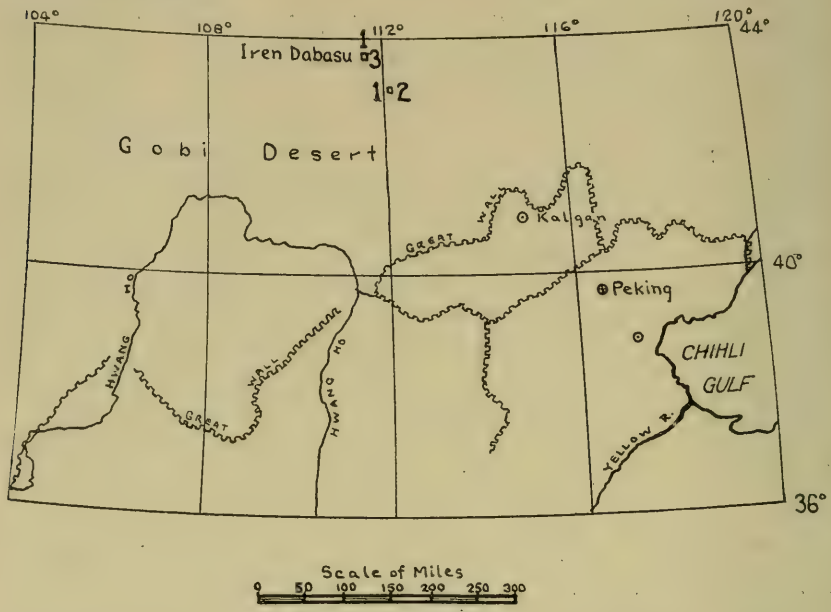

Fig. 1. Sketch map showing location of type sections of Iren Dabasu Formation (Cretaceous) 1; Irdin Manha Formation (Eocene) 2; Houldjin Formation (Miocene) 3.

THE HOULDJIN BEDS (MIDDLE TERTIARY).—For the late Tertiary beds found five miles farther south and belonging to the Gobi Series of Obretcheff we propose the term HOULDJIN BEDS, taken from the local name of the upland formed by these beds. They are characterized by the following fossil content:

1.—A rhinocerid.

2.—A large carnivore.

3.—An artiodactyl of the size of a Virginia deer.

4.—An enormous mammal, probably a perissodactyl and possibly related to or identical with *Baluchitherium*, discovered by Forster Cooper in Baluchistan.

5.—A tortoise of large size.

There is a sharp physical change immediately below this formation and only the coarse sandy conglomeratic member at the very base has been found to be fossiliferous. The fossil remains are unusually fragmentary.

IRDIN MANHA FORMATION (EARLY TERTIARY).—For the early Tertiary beds found twenty-five miles farther south, also assumed properly to belong to Obretcheff's Gobi Series, we propose to use the term IRDIN MANHA FORMATION. It appears to lie immediately on Cretaceous beds, the Iren Dabasu formation, and again there is a sharp change in type of rock. The beds are cross-bedded sandstones, limy sands and pebbly sandstones. Only the lower member has been found to be fossil-bearing. It is characterized by the following forms:

1.—Small Lophiodonta of at least two species in great abundance.
2.—A perissodactyl about the size of the Upper Eocene titanotheres and possibly related to this family.
3.—A small artiodactyl.
4.—A small creodont.
5.—An abundance of turtles of both the hard-shelled and soft-shelled groups.
6.—Teleost fishes.

The geologic column for the Iren Dabasu basin therefore is essentially as in the following table.

Recent	Uplift and Erosion			
	Peneplanation			
Tertiary	Miocene or Later	Upper barren sands Rhinoceros gravels	25′+ 5′	The Houldjin Formation	The Gobi Series
	Oligocene or Eocene	Upper barren sandstones The Lophiodont bed	25′+ 4′	The Irdin Manha Formation	
	Physical and Faunal Break				
Cretaceous	Upper barren members, chiefly clays, marls and fine sands		90′	The Iren Dabasu Formation	
	Lower or Dinosaur beds, chiefly sands and sandstones		60′		
	Great unconformity				
Pre-Cretaceous	The old-rock floor, chiefly slates, limestones and igneous rocks				Probably The Nank'on Series

VERTEBRATE FOSSILS, ADDITIONAL DETAILS.[1]—Remains in all three beds are fragmentary, decidedly so in the Houldjin grave's, but they are of unusual interest apparently and we have taken everything which has any character. Dinosaurs are represented by one complete tibia, ends of femora and humeri, presacral and caudal centra, many good foot bones, including claws of fore and hind feet, portions of a small carnivorous dinosaur skull with two or three teeth, and two teeth of a predentate, as well as two portions of jaw with the alveoli of some teeth, also predentate. Remains of the small *Ornithomimus*-like creature are particularly abundant and the last day at Iren Dabasu we picked up probably fifty good foot bones and centra from two or three knolls. We could find no teeth of the little fellow though—wonder if he was edentatate like *Struthiomimus*? The Cretaceous exposures are very limited so far as we could see but may, of course, outcrop in other basins to the east or west of the road. We did not have time to extend our work in either direction. The outcrops we did see will stand a more careful going over.

The Houldjin gravels are exposed as a rather thin capping to a low bench of Cretaceous which we followed for several miles. Things are badly broken up here—even such massive bones as the heads of femora and humeri were usually cracked into several pieces before deposition. There is one fine bone—a calcaneum of the big beast which would be a match for the astragalus of *Baluchitherium*[2] (?). I can think of nothing else to which it might belong. It is as long as the great *Megatherium* calcaneum from Long Branch, N. J., but is not edentate. A head of a femur is the size of one's head and other limb bone ends correspond. Some enormous rhinoceros teeth (broken) may belong with this animal. Smaller teeth are surely *Rhinoceros*. We did not explore the full length of the exposure and there are possibilities in excavation at one or two points of the bluff where we did explore.

The Irdin Manha beds offer the greatest opportunity for future work. Mammalian remains are abundant though fragmentary and we examined less than two miles of a line of exposures extending many miles both east and west of the trail. A small lophiodont (*Helaletes*-like) is most abundant and we got numerous teeth besides two maxillæ (one with premaxilla and orbital region) and a few lower jaws, also numerous oot bones, limb bones and vertebræ. Next in abundance is a perissodactyl, looking much like our late Eocene titanotheres. We have several premolars, many incomplete molars and one lower jaw with p_3–m_3 in fair condition.

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[1]Communicated in a letter by Mr. Walter Granger, dated May 10, 1922.
[2]A gigantic perissodactyl described by C. Forster Cooper from Baluchistan.

Other forms are curiously rare, a creodont lower jaw and an artiodactyl astragalus or two being the only things noted. Trionychids are common and we saw a complete though badly broken carapace which we were hurrying to get to our car before a storm overtook us the last day we were there. We made three trips down from Iren Dabasu camp but could not do more as our food was getting short and we had to join the rest of the party here.

Much additional detail is in possession of the Expedition which will appear in due course, and it is expected also that further investigation of this area and related ones will be made at a later time.

THE THIRD ASIATIC EXPEDITION.

AMERICAN MUSEUM NOVITATES

Number 72 May 4, 1923

56.81,9P(117:51.7)

PROTOCERATOPS ANDREWSI, A PRE-CERATOPSIAN DINOSAUR FROM MONGOLIA[1]

By Walter Granger and William K. Gregory

With an Appendix on the

STRUCTURAL RELATIONS OF THE *PROTOCERATOPS* BEDS

By Charles P. Berkey

The type of **Protoceratops andrewsi**, new genus, new species, was discovered on September 2, 1922, by Granger and party on the Kwei-wa-ting trail, east of Artsa Bogdo, Mongolia, during a preliminary geological and palæontological survey conducted by the Third Asiatic Expedition of The American Museum of Natural History. The specimen consists of a skull, lacking the occiput. It was found by Mr. Shackelford in exposures of red shale in a formation which has been provisionally referred to the Cretaceous by Professor Berkey.[2]

The skull (A. M. N. H. No. 6251) is hornless and far smaller than that of any known ceratopsian or ankylosaur, being only about 160 mm. in length from the anterior end of the premaxilla to the posterior border of the jugal. As seen from above, it is broadly triangular, with a pointed apex and wide lateral crests, the latter composed chiefly of the backward-and-downwardly expanded jugals. The greatest width of the skull across the posterior borders of the jugals is about 190 mm., while the depth of the jugal below the middle of the orbit is 43 mm. The orbits are very large (50 mm. in anteroposterior length), not surmounted by supraorbital bones or horns. The postorbital-squamosal bar is narrow. Parts of the anterior and lateral borders of the supratemporal fenestra as preserved indicate that the fenestra was large and that the occipital roof was very delicate and not produced as far backward as in later Ceratopsia. The squamosal broadly overlapped the enlarged jugal and was produced posterosuperiorly but was not greatly enlarged. The pineal foramen is small or absent. The single preorbital fossæ are far larger than in other predentates. The premaxillæ were very large and

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Publication No. 6.

[2]See Appendix, p. 7, below.

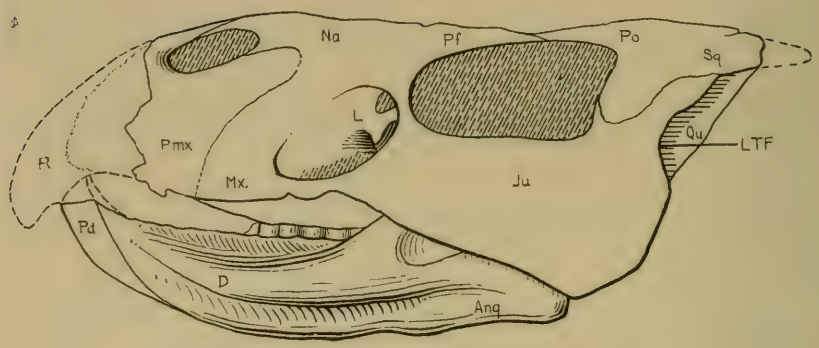

Fig. 1. *Protoceratops andrewsi*, type skull, side view. Position of mandible corrected. ×½

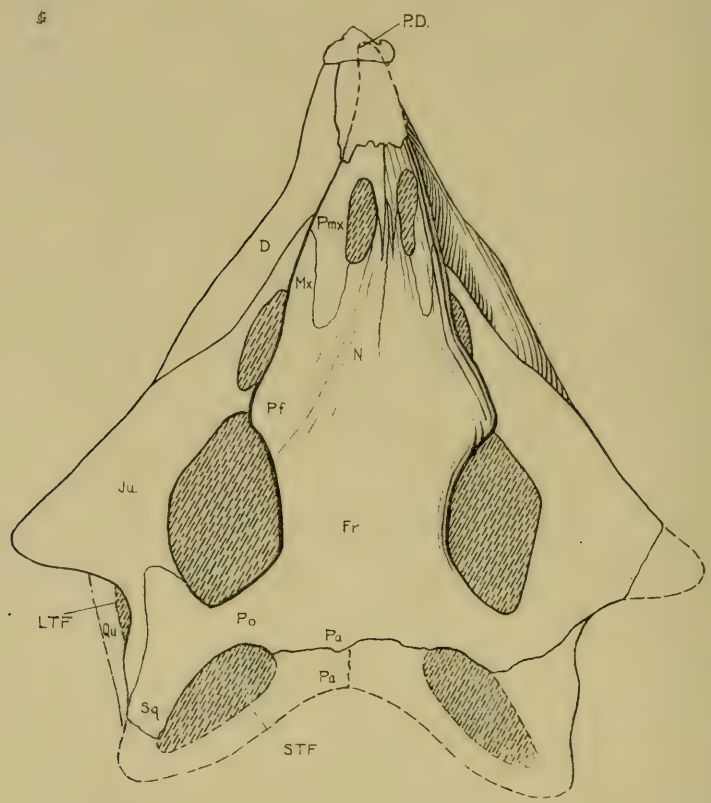

Fig. 2. *Protoceratops andrewsi*, type skull, top view. ×½

probably supported a large rostral bone, which is broken off; the premaxillæ and nasals approach the ceratopsian type and the same is true of the pterygoids, the internal nares, and the quadrates. The quadratojugal lies on the posterior surface of the quadrate.

The mandible has on each side a straight row of about nine relatively large and long-crowned teeth, worn on their buccal sides and set far inward toward the midline. The remains of the lower molar crowns suggest the three-pointed lower molars of ceratopsians, rather than the spatulate, many-cusped teeth of ankylosaurs and of European Acanthopholidæ.[1] The anteroposterior measurement of the four teeth shown in Fig. 1 is 28 mm. The last tooth preserved has its tip about 13 mm. above the alveolus. The first four teeth are represented by their alveoli. The diastema from the first alveolus to the predentary bone was about 14 mm. in length. The strong coronoid process rises from the dentary at a gentle slope. The predentary bone is well developed and has a pair of long inferior processes, one on either side of the midline.

At first sight the specimen suggested the Procolophonia in the very large size and backward prolongation of the orbits and in the presence of a lateral crest below and behind the orbit; but reference to that group is excluded, especially by the absence of a large pineal foramen, by the fact that the lateral crest is composed of the jugal instead of the quadratojugal, by the presence of a predentary bone and by the characters of the dentition. *Meiolania*, *Elginia*, the pariasaurs and other reptiles with flaring lateral crests all differ from *Protoceratops* in fundamental characters.

The presence of a predentary bone and the characters of the mandible and dentition positively determine the specimen as an ornithischian (orthopod) dinosaur. Of the Ornithopoda none of the known skulls have expanded lateral crests and there is a general tendency toward dorsoventral flattening of the beak. The squamosal is reduced and widely separate from the jugal, the latter not greatly expanded posteriorly. The Jurassic *Hypsilophodon* has a relatively short and primitive type of skull (Marsh, 1896, Pl. LXXXIV), which might well be the starting-point for the far more specialized conditions of *Protoceratops*.

Of the Stegosauria the most primitive is the Liassic *Scelidosaurus*, a longer skull, the details of which seem to point toward *Stegosaurus*. In the latter the squamosal is small and widely separated from the small jugal, the coronoid process of the dentary is reduced or wanting and

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[1]For figures of all these see Nopcsa, F. B., 1918, '*Leipsanosaurus*, n. gen. ein neuer Thyreophore aus der Gosau,' Sep. Földstani Közlöny, XLVIII, Taf. III.

the beak is somewhat flattened dorsoventrally. The Acanthopholidæ have small heads and spatulate, many-cusped teeth. The ankylosaurs agree with *Protoceratops*, rather than with *Stegosaurus*, in the characters of the temporal region, but have acquired a heavily armored skull roof and expanded muzzles.

The true Ceratopsia, hitherto unknown below the Upper Cretaceous of America, are all far larger than *Protoceratops;* all of them have horns; the crest is much expanded above and behind the occiput; there are epoccipital and supraorbital bones; and the orbit is small, placed high up and bounded by a wide postorbital bar. The preorbital fossa is reduced to a small slit.

As *Protoceratops* presents the opposite of these characters, it may prove necessary to erect for it a new suborder (Protoceratopsia) but we prefer at present to regard it only as the type of a new and probably primitive family, the **Protoceratopsidæ**, characterized by the lack of horns, the very large size of the orbits, and the narrowness of the post-orbital-squamosal bar.

Protoceratops thus stands far below the Upper Cretaceous ceratopsians and structurally it tends to bridge the long gap between the latter and such primitive Jurassic Ornithopoda as *Hypsilophodon*.

The *Protoceratops* skull tends also to settle the relationships of the ankylosaurs. The latter differ widely from *Stegosaurus* and resemble the Ceratopsia in the temporal region of the skull, in the reduction of the pubis to a vestige and in the outward growth of the dorsal border of the ilium. Abel[1] groups them with the Ceratopsia, and *Protoceratops* may prove to be near the common ancestor of the two groups.

In conclusion, the discovery of *Protoceratops* constitutes one of the foremost items of direct evidence in support of the view advocated especially by Osborn and Matthew, namely that, as, the palæontologic record of Asia is more fully explored, it will fill many gaps in our knowledge of the origin, evolution, and migrations of the late Mesozoic and Tertiary faunæ of western North America and Europe.

We therefore take pleasure in dedicating this important type to Mr. Roy C. Andrews in recognition of his splendid qualities as the organizer and leader of the American Museum Third Asiatic Expedition.

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[1]Abel, O., 1919, 'Die Stämme der Wirbeltiere,' p. 653.

Fig. 3. *Protoceratops andrewsi*, type skull, oblique side view. About two-thirds natural size.

Fig. 4. *Protoceratops andrewsi,* type skull, top view. Two-thirds natural size.

APPENDIX

Structural Relations of the Protoceratops Beds

By Charles P. Berkey

The type *Protoceratops andrewsi*, described by Professor Gregory, was found on the return journey by Mr. Shackleford in making a rapid inspection of some ground a short distance from the trail while waiting for the rest of the party. A few minutes later all came up and joined in a search of the locality. The finds made in the first few minutes of the stop netted some fine specimens, although none surpassed the first one; and all proved to be so unusual in character that it was decided to spend the remaining two hours of daylight in fossil hunting. The next morning the expedition moved on.

The ground would undoubtedly richly reward a more extended investigation. We touched only one spot and each one of the party carried off a load of specimens, leaving behind in our hurry many others either too fragmentary or too heavy or too much imbedded in the rock for recovery.

The spot is on the north side of the Kwei-wa-ting trail, 50 miles east of Artsa Bogdo. The rocks are red, friable sandstones and shaly sandstones which are very well exposed at this point by erosion. Badland cliffs and remnants, more than 200 feet in total relief, form an escarpment here and mark the beginnings of a considerably dissected country extending for many miles northward and eastward, quite in contrast to the smooth peneplane surface over which the trail had led to this point. In fact, at a distance of less than half a mile the escarpment is not noticeable from the upper plain, although one can see that there is a belt of lower ground off to the side.

Beds of the same series and of apparently the same physical relations were crossed by Morris and Berkey on their side trip with camels from Artsa Bogdo to a large mountain group known as the Gurban Saikhan. Several hundred feet of red, sandy beds were seen on the north margin of the Gurban Saikhan, but where the examination was made the beds were barren. The Kwei-wa-ting trail, where the fossils were found, passes north of the Gurban Saikhan at a distance of 20 or 30 miles out on the open plain.

Although there was no time for local side study of the stratigraphic relations in this vicinity, enough of the geology was determined by this earlier trip to the Gurban Saikhan and by the continuous route-cross-section work kept up by the geologic staff to fix these strata structurally

within certain well-prescribed limits. They lie well above the great Jurassic or post-Jurassic unconformity, which is the most marked structural break in central Mongolia. They also lie beneath an early Tertiary or pre-Tertiary unconformity of much less physical prominence, these strata thus partaking of a deformation that antedates all Tertiary sediments.

They are to be regarded, therefore, as belonging to the same series that has been referred to in our reports as of Cretaceous age, using the term in its large sense to cover everything thus far found between the Jurassic strata on one side and Tertiary beds on the other.

This series doubtless does cover a very wide range. Some of the beds may correlate with the Comanchic of America. In Mongolia the series must for the present be kept flexible enough and broad enough to include the dinosaur-bearing beds of Iren Dabasu (already described in Amer. Mus. Novitates No. 42), the Ondai Sair dinosaur-bearing formation of the Hsanda Gol region, and the dinosaur-bearing Ashile formation of the basins north of Artsa Bogdo.

The relative positions in the time scale of these different local developments are yet to be determined, but they probably can be fixed definitely with the material already collected or to be collected this year. A tabulation of locality formational terms, without insistence on the significance of the order, is as follows:

Cenozoic	Tertiary		
		Unconformity	
Later Mesozoic	Cretaceous	Shamo Series	Iren Dabasu Formation Ondai Sair Formation Ashile Formation Dja-doch-ta Formation (*Protoceratops* Beds)
		Great Unconformity	
Earlier Mesozoic	Jurassic		

The beds seen at the Gurban Saikhan, together with these at Dja-doch-ta furnishing the *Protoceratops* remains along the Kwei-wa-ting trail, doubtless are identical with those seen by Chernov, the geologist

of the Kosloff expedition and referred to by him as the Red Khan-Khai beds. Khan-Khai is a well-established term introduced by von Richthofen and has been widely used, apparently rather indiscriminately, for any or all of the later sedimentary beds supposed by the earlier observers to have been formed in the disappearing or evaporating sea. But it is loosely used and undoubtedly has served to cover strata of a large range of age relations. Perhaps it is inadvisable now to attempt any narrower limitation. It is proposed therefore to introduce the term SHAMO SERIES for all of the later Mesozoic strata above the Great Unconformity.

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LATER SEDIMENTS OF THE DESERT BASINS OF CENTRAL MONGOLIA[1]

By Charles P. Berkey and Walter Granger

A preliminary notice of the discovery of Cretaceous and Tertiary strata, based on studies of a small sedimentary basin at Iren Dabasu within the first 265 miles of exploratory travel of the Third Asiatic Expedition, was published as No. 42, American Museum Novitates, August 7, 1922. The expedition subsequently covered approximately 3000 miles of scientifically unknown territory in Mongolia, crossing the Gobi Desert twice, reaching as far north as Urga, the capital, near the Siberian frontier, as far west as Sain Noin Khan and Tsagan Nor, and finally crossing the easterly range of the Altai Mountains with its bordering desert basins, in a side journey, as far south as the Gurban Saikhan. From these advance positions the return course was by a new route to Kalgan, nearly 1000 miles distant from the last general camp at Tsagan Nor. (See accompanying map for itinerary.)

Special and first attention was given to the later sedimentary strata which seemed to promise reptilian and mammalian fossils. But the continuous route study that was conducted by the geologic staff, no matter how rapidly or erratically the expedition moved, has given basis also for an outline both of the older geologic features, the structural and deformational detail of the later fossil-bearing sedimentary formations of the desert basins and of the still later physiographic history.

An advance summary of the stratigraphy of the later sediments is the purpose of this present statement. Other numbers are to be prepared, one for the older geologic features and one for the physiography.

The observations forming the basis of this study were made between April 19 and September 19, 1922 and cover the whole field season, including the work at Iren Dabasu already announced.[2]

I.—GENERAL GEOLOGIC FEATURES

Central Mongolia is structurally a series of later sedimentary basins underlain by a floor of more ancient rocks. These basins of later sedi-

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Publication No. 7. Based on the field observations of Frederick K. Morris, Physiographer, Walter Granger, Paleontologist and Charles P. Berkey, Geologist, of The Third Asiatic Expedition of The American Museum of Natural History.

[2]No. 42, American Museum Novitates, August 7, 1922.

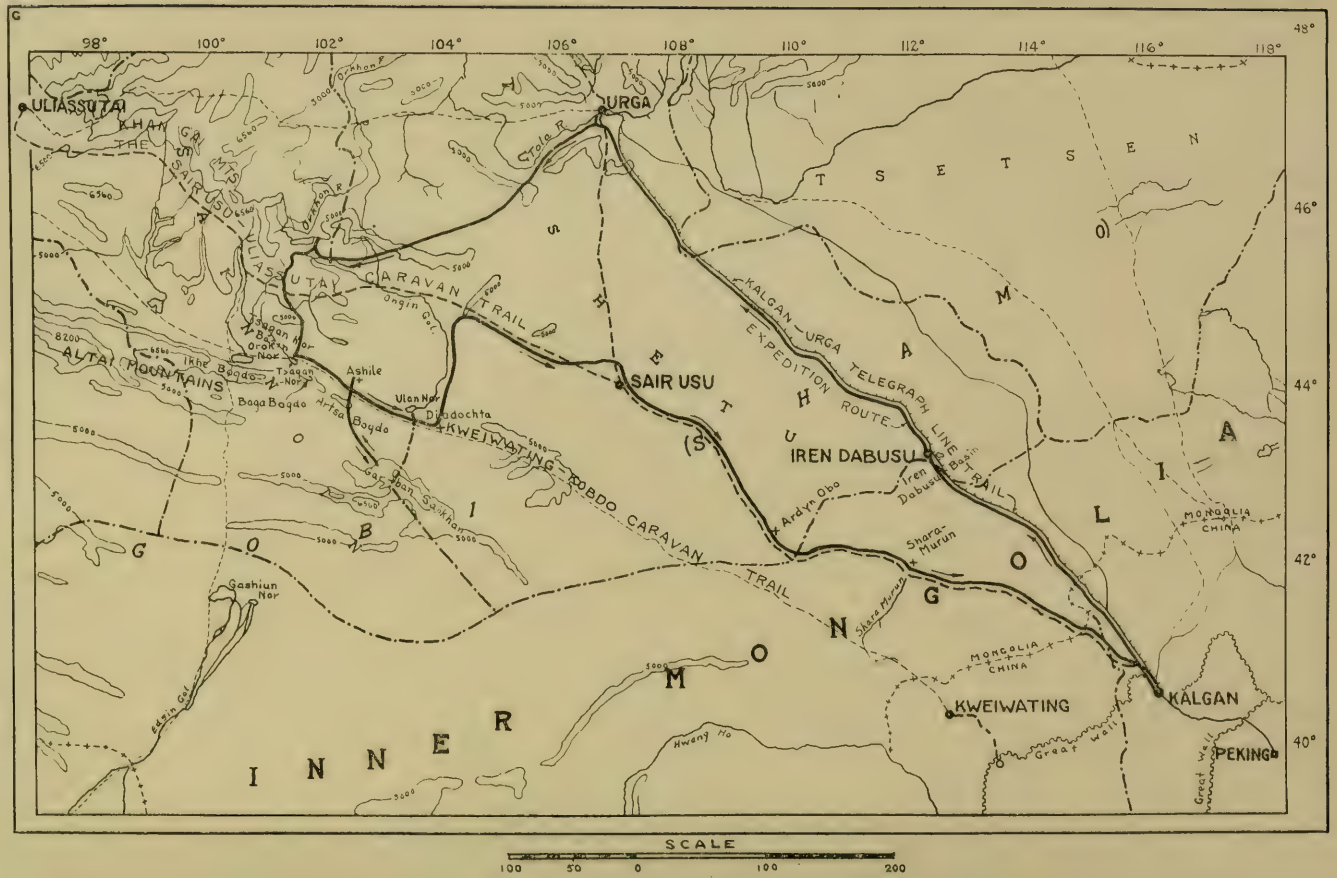

Fig. 1. General Route Map of the Third Asiatic Expedition

This map is a compilation. It covers the itinerary of the expedition which is indicated in solid heavy line beginning at Kalgan. In order to avoid confusion only the major relief features are marked, and only the principal through caravan trails are drawn. All of the localities referred to in the paper as important fossil fields are indicated by appropriate Mongol names.

mentary strata are separated one from another by stretches of open ground where these same ancient floor-rocks form the surface. This floor has a very complicated structure, its members ranging in age from Archæan to Jurassic time. In mid-Mesozoic time, after repeated earlier mountain folding and extensive igneous activity, the region was peneplaned, and it is this old peneplane surface that has been warped and faulted to make the basins which hold the sediments of later age, now proven to be exceptionally good fossil ground.

Since that time the region has never been subjected to mountain folding again, but it has been deformed by warping and faulting more than once, and it is these successive disturbances that give the clearest breaks and the sharpest changes in the several series of later strata. Wherever the deformation is confined to gentle warping the strata lie almost flat. Here and there, however, deformation has been more violent, so that the earlier strata stand steeply tilted and beds of succeeding formations lie on their upturned edges.

In such places the latest beds are formed in part from the waste of the exposed portions of beds still lying immediately beneath, and the break thus made between two physically distinct series helps materially in marking and following important formational limits. Thus there are occasional sharp unconformities within the later series of sediments themselves, but the evidence of it is not general. In the same region there are places that show only obscure disconformity or no apparent stratigraphic break at all, so that one can not readily tell where the dividing line should be. This obscurity is all the more troublesome because a majority of the beds of the later series seem to be almost barren of fossils. Only here and there are fossils abundant or characteristic enough to serve as basis for age discrimination.

Thus, in the very best structural areas, some members of the stratigraphic succession are missing, whereas at the places least disturbed, which ought to exhibit the most complete stratigraphic column, the earlier strata are usually covered so deeply with successive sedimentary accumulations that it is quite impossible to find an exposed section of the underlying beds.

It was found also that sedimentation did not continue to the very present time, but was broken by a deformational epoch judged to be at about the close of the Pliocene. The Pleistocene, therefore, has been a period of erosion in practically all of the region traversed. Denudation processes of that time have not only stripped off all sedimentary cover from large areas of the old floor, but, incidentally, long-continued ero-

sion developed a new peneplane on the later sediments, and, within some of the basins, where deformation still continued, a new and comparatively deep dissection has been accomplished. This has given a typical badland topography in certain areas, where extensive exposures of basin strata can be seen.

After determining these facts about the geologic structure of the region, it was a comparatively simple matter to discriminate between the more promising and the less promising areas. The edges of active basins or the interiors of basins large enough to be affected by internal deformation are particularly suitable places for detailed study. The vicinity of areas of high relief, indicating as they do extensive deformation of the ancient rock floor, are also places with some of the desirable geologic elements. The simpler small warp-basins, not much disturbed, may carry just as important beds, but, unless these beds now form the surface or lie very near to the surface, there is little chance of seeing them, and only a small stratigraphic range is likely to be exposed.

The itinerary of the expedition led across many basins of this sort. These will be indicated in the forthcoming reconnaissance report. Some are only a few miles across from rim to rim and so little deformed that there is no apparent break in the monotonous relief of the slightly rolling country. Some also are not dissected at all. A few large basins, however, were entered, and one nearly a hundred miles across proved to carry later strata several thousand feet in total thickness. This lies just north of Baga Bogdo of the Altai mountain range. It proved to be especially prolific and helpful in both structural and paleontological returns. Here the party spent several weeks in working out critical points in the structure and stratigraphy of the later sediments and in making extensive collections.

In this basin a plainly marked unconformity separates a lower series of dinosaur-bearing sediments from younger, overlying, mammal-bearing strata. In addition to this, the successive warpings and internal deformations of the basins were such as to give most suggestive help in further subdivision and definition of the successive series of associated strata between the mid-Mesozoic peneplanation and Pleistocene conditions. These are represented in the accompanying tabulation. Corresponding or complementary occurrences at other places are included also under their locality designations. There is still too little certainty about their inter-relations to attempt closer correlation at the present time. As the fossil collections are worked over, and especially as larger collections are secured, it will undoubtedly be possible to make much closer correlation of these locality finds.

II.—STRATIGRAPHY OF THE LATER SEDIMENTS

By "later sediments" is meant all of the sedimentary formations that have accumulated in the deformation basins since the post-Jurassic peneplanation. The lower members total at least 2000 feet in thickness and carry fossil remains indicating Mesozoic age.

In certain localities there is above this Mesozoic series a distinct unconformity which separates these formations from overlying ones whose fossil content indicates Tertiary age. The total thickness of this uppermost series is at least 5000 feet in the Tsagan Nor Basin.

Although the Tsagan Nor Basin proved to be the most favorable of all for structural subdivision, altogether five distinct basins have contributed to the general summary of stratigraphic relations. The chief items of this subdivision and structural relation may be briefly indicated as follows:

1.—The Iren Dabasu Basin

As indicated in the first communication, this basin is shallow, the beds lie practically flat, and the breaks between formations whose fossil content indicates wide difference in age are exceedingly obscure.

The geologic column covering this Iren Dabasu relation is as follows:

Uplift and Erosion

Peneplanation

Tertiary	Miocene or later	Upper barren sands Rhinoceros gravels	The Houldjin Formation	The "Gobi Series" of Obruchev
	Pre-Miocene	Upper barren sandstones Lophiodont-bed	Irdin Manha Formation	
	Physical and Faunal Break			
Cretaceous	Upper barren members Dinosaur beds		Iren Dabasu Formation	

Great Unconformity

Pre-Cretaceous	Old-rock floor, deformed, metamorphosed and peneplaned	Probably the Nan-k'ou Series of von Richthofen

The lowest beds furnish abundant dinosaur remains and are certainly Mesozoic in age. Not more than 100 feet above the beds furnishing these dinosaurs lie a series of looser sandy strata and shales, in one member of which rhinoceros remains and the first bones of *Baluchitherium* were found. Twenty miles distant, but still within the same general structural basin, beds are exposed which furnish remains indicating that they are lower and of somewhat greater age than those furnishing *Baluchitherium* and rhinoceros, although they belong also to the Tertiary series.

2.—The Tsagan Nor Basin

North of Baga Bogdo, a very prominent mountain group forming a part of the eastward extension of the Altai mountain range, there is a very extensive sedimentary basin not less than 75 miles across from north to south and of still greater extent east and west. It is in part a downwarped and in part a down-faulted basin which has suffered additional subsequent internal deformation. These later deformations have furnished particularly favorable structural conditions for tracing the major breaks and exposing nearly the whole of the stratigraphic succession.

For example, in the midst of the basin itself there are two smaller mountain blocks that have suffered uplift and have been involved in the distortion since the earliest beds were laid down. One of these is the Mt. Uskuk block, and on its borders a distinct unconformity can be traced between the beds forming the earliest series and all those of later age.

At a still later time, after more than 3000 feet of Tertiary sediments had been laid down on the eroded surface of the preceding series, this interior block suffered another deformation adjustment which turned these beds almost up on end along the chief flexure margins. Deposition continued, however, in the same basin somewhat farther to the south, between Uskuk and the Baga Bogdo border. It appears also that Baga Bogdo itself was raised to its maximum height during this later time, contributing much of itself to these latest sedimentary accumulations.

Subsequent peneplanation beveled off the upturned edges of the strata along the flexure lines and reduced practically the whole basin to a monotonous erosion level, remnants of which are still preserved with residual gravel cover so smooth that one can drive anywhere on them. But, still later, this peneplane was warped enough to cause complete rejuvenation of the streams and initiate a new cycle of erosion, which has extensively developed ravines, gorges, and typical badland topography

in the most favored localities, thus exposing all of these structural features that have been described.

The major formational units distinguished in this basin are typically developed in localities somewhat separated from each other. Thus a certain formation is best exposed in the Ondai Sair, another along the Hsanda Gol, and yet another in the hills of Hung Kureh. For convenience of reference these locality names are attached to the corresponding formational units, the chief characteristics of which are given below:

(*a*). THE ONDAI SAIR FORMATION.—This is a series of thin-bedded, slightly deformed sandstones and black paper shales. The sandstones range in color from white to buff or yellowish, but are rarely red. Although there are variations from this description, they are of little importance, because at every point in this area the rather coarse-grained, moderately indurated, cross-bedded and thin-bedded and plain sandstone beds are very prominent indeed, and alternating with them in much smaller amount are black, carbonaceous shales, some of which are of remarkably fine paper-shale quality. An occasional bed of shale has such a perfect structure that the laminæ split apart almost as true as the leaves of a book and have preserved in them remarkably delicate fossil forms.

The formation, therefore, is to be regarded as a sandstone-paper shale formation. It was noticed that in this locality the basal members are more persistently sandstones and that the uppermost members carry a larger proportion of paper shales. It is not at all certain, however, that these relations would hold for other areas.

Formations believed to belong to the same series, though probably not to the same horizon, found at several other places, were largely reddish sandstones. At one other place, however, nearly a thousand miles distant on the road between Iren Dabasu and Mt. Tuerin, a similar series of sandstones and paper shales was discovered. Although in that case there was not sufficient fossil evidence found to prove their age, they are now believed to belong to the same series and perhaps to the Ondai Sair horizon. Their petrographic similarity, considering the rarity of this type of sediment, is suggestive at least.

The fossil content of the Ondai Sair is as follows: a dinosaur of *Camptosaurus* type; rib of a large dinosaur; insects, including mosquitoes and butterflies; a small form of fish, probably *Lycoptera;* fragments of crustacea; and a thin-walled form of phyllopod crustacean, probably *Estheria.*

This indicates age at least as old as the Cretaceous, perhaps the Lower Cretaceous or Comanchian, rather than the Upper Cretaceous. In

this locality, at Mt. Uskuk, the series is sharply delimited by an unconformity, above which no fossils of this type are to be found; and it is limited also below by a much greater unconformity, beneath which lies folded strata with coal beds, conglomerates, and intrusives, all judged to be of Jurassic age, as well as many still older formations.

(*b*). The Hsanda Gol Formation.—Along the Hsanda Gol, a dry, sandy stream-course leading from Mt. Uskuk through the Ondai Sair locality southward past Loh to the bottom of the basin of Tsagan Nor at the foot of Baga Bogdo, the finest series of Tertiary deposits thus far examined in the whole of Mongolia are exposed. They lie unconformably upon the uneven erosion surface of the Mesozoic Ondai Sair formation just described, and are deeply cut into by recent erosion, which has developed a fine badland topography for several miles along the course of the stream. This stream-course crosses also a strong flexure, along which the basin itself has been deformed, and there the earlier beds are turned up nearly on edge. It is possible, therefore, to examine and measure this formation in detail.

This whole succession of beds along the Hsanda Gol, from the base at Ondai Sair to the topmost beds at Loh, a distance of about fifteen miles, is here included in the Hsanda Gol formation. They are prevailingly yellowish conglomerates and pebbly sands at the base, and vary greatly in quality. This type constitutes at least 800 feet of the lowermost portion of the formation. The succeeding members above include alternating beds of sands, marls, clays and clayey sands of variegated colors, chiefly red, yellow, and white, with no apparent system or uniformity of succession. The high colors are strikingly shown in the middle portion of the formation, where the badland structure is best developed, and where the most clayey and least hardened members occur. The uppermost beds are prevailingly sands and clayey sands inclined to be reddish in color, some beds of which are fairly well indurated.

Altogether, a thickness of approximately 3000 feet has been measured and estimated from measurements, a large proportion of which has been inspected in detail.

The upper portion of the formation carries fossils. In certain layers fossils are abundant with many individuals but not very great range of forms. The middle and lower members are largely barren. In the lower third, the yellowish conglomerates, no fossils whatever were found. Higher in the series an occasional find was made, but only certain of the upper members were found to be prolific, and the age determination is based on them. The formation is judged to be of Miocene age. Whether

the whole thickness of 3000 feet to the very bottom is also Miocene is, of course, not known; but in the failure to find any physical break or any faunal evidence on which to base any other determination, we have chosen to regard the whole succession as a unit.

Thousands of fossil specimens were secured in this ground, particularly in the vicinity of Loh, ten miles downstream from Ondai Sair, and in the vicinity of the so-called Grand Gorge, a corresponding erosion exposure ten miles farther to the west. The forms recognized in the field, taken from these beds, are as follows:

Baluchitherium, a fine skull nearly five feet long, and other rhinocerids; rodents by the hundreds; artiodactyls; insectivores; and carnivores.

(*c.*) The Hung Kureh Formation.—In the very bottom of the basin of Tsagan Nor, between the lake itself and the foot of Baga Bogdo, still younger beds overlie those of the Hsanda Gol. They constitute a series of whitish and yellowish sands and clayey sands at the base, which are overlain by coarser, gravelly sands and conglomerates of great variety and thickness. These beds are not as well exposed as are those of the Hsanda Gol; and, on this account, the complete succession cannot be so well determined. It has been possible, however, to measure more than 1000 feet, and a reasonable estimate would be approximately 2000 feet in the type locality, the hills of Hung Kureh.

These hills stand above the average peneplane level and formed originally a low monadnock group which has been redissected by later erosion. On the extreme margin next to the mountain of Baga Bogdo the upper beds become coarsely conglomeratic. An exposure of 800 feet in total thickness occurs in the hills immediately facing the central canyons of the Baga Bogdo front.

As a whole, this series of beds which we regard as a single formation is almost barren. An occasional bed, however, does carry fossil remains. This is particularly true of the lowermost portion of the formation, within 200 or 300 feet of the base, where yellow, iron-stained sands and white sand beds are the prevailing type. There is apparently no real break in the succession, the conglomerates in this case marking the influence of the adjacent rising mountain mass of Baga Bogdo, which furnished alluvial fan type of materials to the adjacent basin sediments. These uppermost beds, therefore, may be appropriately referred to as alluvial fan conglomerates. They doubtless interlock with the finer sediments washed down from the opposite direction, derived from the erosion of simpler sediments within the deformed basin itself. It is this intermixture that constitutes the Hung Kureh formation.

Although the beds of this formation are not so prolific in fossils as are those of the Hsanda Gol, they are, nevertheless, sufficient to indicate a Pliocene age and include a wide variety of forms. We have, therefore, set off this member as the Hung Kureh formation, limited at the base by a conformable contact with the Miocene Hsanda Gol formation, and at the top by the present erosion surface.

In this region no deposits of consequence are preserved above the Hung Kureh formation. The Pleistocene, or at least the period following the deposition of the Hung Kureh formation, was a period of erosion; and no sediments are preserved except very insignificant accumulations of comparatively recent time along the stream courses, where the disappearing streams drop their load or where newer fans are reaching out from the mountain blocks.

The fossil content of the Hung Kureh, as identified in the field, is as follows: a few fragments of horse; a few bones and egg-shell fragments of a very large bird, probably *Struthiolithus;* a large cervid; mastodon; and rhinoceros.

3.—The Ulan Nor and Neighboring Basins

Eastward from Tsagan Nor for several hundred miles there is no mountain barrier. The Altai mountain range continues along on the south side, and at first glance the whole region to the north appears to be a single basin. If one follows it, however, with enough care to unravel its structural detail, it is found that the basin sediments are not continuous but that the ancient rock floor comes to the surface at several places, separating the region into individual, smaller basins. Thus it happens that on the north side of Artsa Bogdo, a hundred miles east of Tsagan Nor, there is another large sedimentary basin; and, one hundred miles still farther east, yet another. The dividing barriers are scarcely more conspicuous than the monotonous basin surface itself, but the sediments are not continuous. As would be expected from such circumstances, the sediments that do occur in adjacent basins are not necessarily of the same age or type. In the shallower basins there is good chance of finding the earlier formations, representing Mesozoic strata, and in the deeper ones one is almost certain to find both Mesozoic and Tertiary.

(*a*). The Ashile Formation.—Such conditions are found in both of the basins to the east. In that one lying to the north of Artsa Bogdo, at the locality known as Ashile, a series of reddish and buff, fairly well indurated sands and sandstones were found. Certain members of this series carry dinosaur remains, indicating Mesozoic age. This is the Ashile formation of the accompanying table.

(*b*) THE DJA-DOCH-TA FORMATION.—In the vicinity of Ulan Nor, at the locality Dja-doch-ta, along the Kwei-wa-ting Trail, a series of somewhat similar red sands and clayey sands were found, which again carried a rare species of dinosaur and a variety of undetermined fossil material. One entirely new form has been described recently by Granger and Gregory under the name *Protoceratops andrewsi*. Because of the strikingly different fossil content, these beds are also given a separate designation, and because of the very primitive character of the forms it is believed that they may well be lower and older than even those of Ondai Sair. This unit is, therefore, given the locality name, the Dja-doch-ta formation.

In the trip across the desert basin south of the Altais, between Artsa Bogdo and the Gurban Saikhan, a very similar series of reddish sandstones was encountered, and on the northern margin of the Gurban Saikhan uplift itself at least 600 feet of upturned conglomeratic and coarse cross-bedded sands are well exposed. No fossils were found at the Gurban Saikhan locality; and, on this account, there is no way to determine just how these beds may be related to others just described. They may deserve a descriptive name, such as the Gurban Saikhan conglomerates; but there is no way of placing them at any particular horizon in the column. Their physical character and general structural relations indicate close relationship to the Ashile and Dja-doch-ta, and they doubtless belong to the same group of Mesozoic strata referred to in this tabulation as the Shamo Series.

Most of the beds of this whole complicated basin region are barren, but here and there certain ones are prolific and tell essentially the same story. On the basis of these few finds these formations are all regarded as Mesozoic in age; and because of the difference between this material, both as to fossil content and rock quality, they are judged to be the equivalent of neither the Ondai Sair beds encountered to the west, in the Tsagan Nor Basin, nor the Iren Dabasu, farther to the east. The Dja-doch-ta beds at least are probably Lower Cretaceous in age.

In the Ashile formation were found a sauropod of very large size, and a dinosaur of *Camptosaurus* type.

In the Dja-doch-ta formation were found a few fragments of a bird, and an entirely new form of dinosaur, since described under the name *Protoceratops andrewsi*.

There are doubtless higher beds, some of which must be of Tertiary age, in these easterly basins; but at the places crossed by the Expedition none of these is well exposed and no collections could be made from them.

As the Expedition passed northward, keeping on the east side of Ulan Nor, sediments continued for more than seventy-five miles; but in this whole distance, which was covered in less than a day, no specific determinations could be made beyond the fact that the underlying rocks represent the later sedimentary series and must correspond closely with some of those already seen in more favorable localities.

4.—Ardyn Obo

South of Sair Usu, on the main Kalgan-Uliasutai Trail, several basins carry later sediments. The general nature of the formations can generally be seen, but only in two or three localities are there extensive exposures of these later sediments, where exploration would be certain to furnish good fossil evidence. Both the earlier, Mesozoic, and the later, Tertiary, series are represented and a few new forms were found whose significance is not yet determined.

One of the better localities is at Ardyn Obo. Here a great escarpment, surmounted by that inevitable guidepost of the desert, an Obo, stands 300 feet above the general level of the plain over which the trail passes; and for many miles the edges of the flat-lying strata are exposed. They are rather loose and slightly indurated sandstones and clayey sands of considerable variety of texture, quality, and color. In the upper members of this series of beds fossils were secured, the chief items of which are several fine specimens of rhinoceros and numerous fragments of turtles.

This content is judged to indicate mid-Tertiary age, not very different from that of the Miocene beds of Hsanda Gol, or the Houldjin formation of Iren Dabasu. It is not possible with the present evidence, however, to correlate the Ardyn Obo beds with either of the others, and it may very well be, indeed, that they belong to an entirely different horizon in the same series. It seems best, therefore, to preserve the locality name in the Ardyn Obo Formation.

5.—Shara Murun

A hundred miles farther south another basin carries fossiliferous strata. The sedimentary area is very large and the best exposures occur along the borders of a 200-foot escarpment. At this place were found titanothere remains very like those found at Irdin Manha early in the summer, in the Iren Dabasu area. These seem to be, therefore, early Tertiary in age, perhaps as early as Eocene.

Still farther south, on the very borders of Kalgan, a great series of later sedimentary strata furnished a few reptile fragments. Too little work was done at these places to warrant further description or classification of beds. They deserve careful inspection.

Summary

It appears from this listing of the formational units distinguished by locality and structural features that there are at least four formations of locality significance of late Mesozoic age, presumably Upper and Lower Cretaceous, and four formations belonging to the Upper Tertiary, including beds of Miocene and Pliocene age. The early Tertiary is much less fully represented, or else is represented by formations not yet furnishing adequate fossil criteria. Only the Irdin Manha formation, in the Iren Dabasu region, and the beds of Shara Murun, one of the basins on the Uliasutai Trail, have been placed earlier than the Miocene on fossil evidence. It may be, of course, that the lower barren beds of the Hsanda Gol are pre-Miocene also; but for this there is no direct evidence.

This is an additional reason for grouping these scattered formational units into definite series. There are no used or published terms that have suitable limitations for this purpose. Obruchev's "Gobi Series" was used by him to include all sorts of later sedimentary beds, without age distinction. Von Richthofen's term "Khan-Khai Beds" has been used in the same way for all of the later sediments, without more intimate discrimination.

Perhaps it is not advisable to disturb usages of this sort, which have at least the merit of being fixed. But, since these terms were not originally based on fossil evidence and have been used only as a convenient field term for general purposes, it may be permissible to continue to use them as good general terms for all of the later sediments as defined in this communication, and, when referring to smaller groups of formations or specific portions of the later sedimentary column, to make use of more accurately defined and delimited terms.

If this is done, the preference, perhaps, should be given to the term Khan-Khai, which is much the older one. But the error of interpretation involved in the name makes it less appropriate than Obruchev's Gobi Series. Von Richthofen thought that the name Khan Khai meant deposits of an evaporating sea and used it with that significance. None of these sediments, however, have such an origin. All are strictly continental in origin. On this account Obruchev's Gobi Series

is a much better term. Gobi means desert basin, and Gobi Series therefore is a very suitable name for the desert basin deposits.

It would be particularly appropriate if these older terms could be used for the larger divisions, corresponding to systems, leaving all other terms to be used for smaller groups and individual formations. In any case, there will be little cause for confusion if the significance of each is kept clear. With this object in view, the following terms are proposed for the smaller groups:

1.—The Tsagan Nor Series (Upper Tertiary).

2.—An unnamed series (Lower Tertiary).

3.—The Shamo Series (Upper Mesozoic).

The Tsagan Nor Series is intended to include formations of Pliocene and Miocene age, or the Upper Tertiary. To it belong the units already described as the Hung Kureh, Hsanda Gol, Ardyn Obo and Houldjin formations.

Another series ought to include the Lower Tertiary, or the pre-Miocene Tertiary. Thus far, the only formations classified in this series are the Irdin Manha and the beds of another basin, the Shara Murun, farther west. Others, however, are certain to be added as the work proceeds. Perhaps a better name than has yet been proposed for this series will be suggested by the coming season's work.

The Shamo Series is pre-Tertiary. It is intended to include the Cretaceous beds overlying the great unconformity above the folded and eroded Jurassic. The units distinguished in the field are the Iren Dabasu, Ondai Sair, Ashile, and Dja-doch-ta formations.

The geologic column showing these groupings and relations is given in the table, p. 15.

It is entirely likely that some of these separately designated formations overlap in time, so that the sum of all the thicknesses given is not an accurate statement of the total column. Making all due allowance, however, for such probability, it appears that no less than 6000 to 8000 feet of later sedimentary strata are accounted for in the complex series of later sediments lying above the great post-Jurassic unconformity in the Gobi region of Mongolia.

All of the formations named are distinguished by characteristic fossil content, but great thicknesses of strata that are barren are included with them. The region has proved to carry not only a prolific fossil fauna but one that is also of unusual scientific interest and significance; and the field is capable of furnishing immensely greater returns in this direction. All are of strictly continental type. No evidence of marine invasion was found anywhere.

	Quaternary			Uplift and Erosion			
				Peneplanation			
Cenozoic	Tertiary	Upper Tertiary	Pliocene	The Tsagan Nor Series	Hung Kureh Formation (*Mastodon* and *Cervus*)	2000′	The "Khan Khai Beds" of von Richthofen; The "Gobi Series" of Obruchev
			Miocene		Hsanda Gol Formation (*Baluchitherium* and rodents)	3000′	
					Ardyn Obo Formation (*Rhinoceros*)	500′±	
					Houldjin Formation (*Rhinoceros*) and *Baluchitherium*	50′+	
		Lower Tertiary	Oligocene Eocene		Irdin Manha Formation (Lophiodont beds)	50′+	
					Shara Murun Formation (Titanothere beds)		
				Unconformity			
Late Mesozoic	Upper Cretaceous		The Shamo Series		Iren Dabasu Formation (Dinosaurs)	150′±	
					Ondai Sair Formation (Dinosaurs and insects)	500′+	
	Lower Cretaceous				Ashile Formation (Dinosaurs)	1000′±	
					Dja-doch-ta Formation (Dinosaurs)	300′+	
				Great Unconformity			
Early Mesozoic	Jurassic				A great thickness of conglomerates, sandstones and volcanics		

The Expedition has found that later sediments of this general range are abundant in the Gobi region. They all occur in basin-like depressions, but not all are well enough exposed by later erosion to be open to examination. It has been our good fortune, however, to find excellent exposures of certain parts of the series.

The determined formations are so well distributed through the Upper Mesozoic and Tertiary column, and are related to the general

sedimentation and deformation history of the Gobi region in such a way as to promise ultimately a practically complete and continuous succession from Lower Cretaceous to Pleistocene time. Even the Pleistocene, which is an erosion blank in the Northern Gobi, ought to be represented in certain adjacent regions farther south and east, where deposition continued while these northerly basins were being peneplaned and redissected.

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BALUCHITHERIUM GRANGERI, A GIANT HORNLESS RHINOCEROS FROM MONGOLIA

BY HENRY FAIRFIELD OSBORN[1]

In previous communications on the rhinoceroses (Rhinoceros Contributions 1 to 11), Osborn separated six distinct phyla or subfamilies. The remarkable discoveries by Clive Forster Cooper in Baluchistan, by A. Borissiak in north Turkestan, and by Walter Granger of the Third Asiatic Expedition in southeastern and central Mongolia, indicate the existence of a seventh subfamily which we may term **Baluchitheriinæ**, if the generic name proves valid. At present our knowledge rests on the following materials:

BUGTI HILLS, Chur-lando, Baluchistan. Cooper Collection, British Museum.

Paraceratherium bugtiense Cooper, December 1911. Fairly complete skulls and lower jaws of about the size of a large rhinoceros, simple aceratherine molars, abnormal lower incisors.

Thaumastotherium osborni Cooper, October 1913, changed to *Baluchitherium osborni* Cooper, November 1913. Fragmentary skeletal remains found in close proximity to *Paraceratherium*, including neck vertebræ, foot and limb bones of elephantine size.

TURGAI, a province of north Turkestan. Discoveries by A. Borissiak, published 1915–1918.

Indricotherium asiaticum Borissiak, 1916. Teeth, skull, and skeletal remains, occurring *in situ* and resembling both *Paraceratherium* and *Baluchitherium*.

Epiaceratherium turgaicum Borissiak, 1918.[2]

LOH, central Mongolia, Third Asiatic Expedition Collection, 1922. Associated skull and skeletal remains similar in size to the type of *Baluchitherium osborni*.

Baluchitherium grangeri, new species. Type, nearly complete skull and jaws (Amer. Mus. 18650) associated with parts of vertebræ and of limb bones, as described in the present bulletin.

IREN DABASU, southeastern Mongolia. *Baluchitherium* ref., calcaneum and other fragments of skeleton.

DISCOVERY OF SKULL AND SKELETON IN MONGOLIA, 1922

The party left Kalgan on April 21, 1922. (1) The first *Baluchitherium* material was discovered by Dr. Charles P. Berkey on the journey

[1]Contribution No. 8, Asiatic Expeditions of The American Museum of Natural History. Twelfth Contribution on the Evolution of the Rhinoceroses. See Bibliography of H. F. Osborn, 1916, p. 21.

[2]The genus *Epiaceratherium* was founded on the species *Epiaceratherium bolcense*. See Abel, 'Kritische Untersuchungen über die paläogenen Rhinocerotiden Europas,' Abh. k. k. geol. Reichsanst., XX, Heft 3, p. 20.

north towards Urga, near Iren Dabasu; this consists of a large calcaneum and other tarsal or carpal bones, more or less fragmentary, bearing the field number "Third Asiatic Exped. 37," to which has been assigned the catalogue number "Amer. Mus. 18651." (2) The second and most important find was made on August 5, 1922, near Loh, in the Tsagan Nor Basin, Hsanda Gol Beds; this includes a skull, portions of the jaws, and the distal end of a humerus, bearing the field number "Third

Fig. 1. Map of central and southwestern Asia showing the type localities of (1) *Baluchitherium osborni* type, eastern Baluchistan; (2) *Indricotherium asiaticum* type, near Turgai, northern Turkestan; (3) *Baluchitherium grangeri* ref., near Iren Dabasu, southeastern Mongolia; (4) *Baluchitherium grangeri* type, near Loh, central Mongolia.

Asiatic Exped. 90," to which has been assigned the catalogue numbers "Amer. Mus. 18650, 18652." The skull and mandible were about fifty feet apart and probably belong to the same individual. This specimen is made the type of **Baluchitherium grangeri** described below. (3) The

humerus was found a quarter of a mile distant from the type and may or may not belong to the same individual, but probably to another individual. The American Museum catalogue references to the three specimens are as follows:

Amer. Mus. 18651 Third Asiatic Exped. Calcaneum and other fragments of skeleton	Amer. Mus. 18650 Third Asiatic Exped. Type skull and part of mandible	Amer. Mus. 18652 Third Asiatic Exped. Distal end of humerus

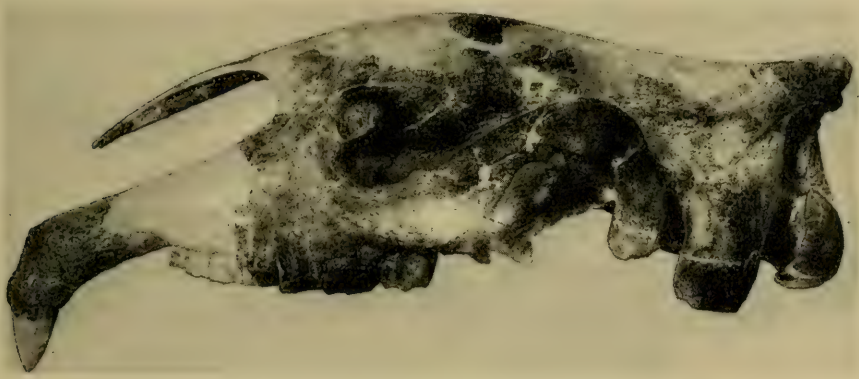

Fig. 2. Type skull of *Baluchitherium grangeri* as restored up to March 16, 1923. A portion of the jaw and of the right side of the skull is now being added for the skull and jaw cast. One-twelfth natural size.

Geologic Age.—The *Baluchitherium* calcaneum (Amer. Mus. 18651, Fig. 8 of this article) is from the Houldjin formation near Iren Dabasu, an upper member of the Gobi series containing at the base rhinoceros gravels five feet in thickness; the Houldjin beds were correlated by Granger and Berkey (Amer. Mus. Novitates No. 42, August 7, 1922, p. 4) as of Miocene or more recent age, more recent than the underlying Irdin Manha formation, which is regarded as of Oligocene age. Of the same age is the equivalent formation in the Tsagan Nor district near Loh, several hundred miles to the west, from which the type of *Baluchitherium grangeri* was obtained. This formation has been named the Hsanda Gol formation. Borissiak placed the *Indricotherium asiaticum* zone as far down as the Middle Oligocene; it is regarded by Granger and Berkey as more probably of middle or late Miocene age, since it contains (*op. cit.*, p. 4) a rhinocerid, a large carnivore, an artiodactyl of the size of a Virginia deer, and a tortoise of large size, in addition to the enormous perissodactyl known as *Baluchitherium*.

Baluchitherium grangeri, new species

This remarkable type specimen, named in honor of Walter Granger, head of the palæontologic division of the Third Asiatic Expedition under Roy Chapman Andrews, was found as indicated in the map (Fig. 1, 4) and described above.

Description of the Type Skull

The skull of *B. grangeri*, while of enormous size, as shown by comparison (Fig. 3) with that of the type of *Aceratherium incisivum* Kaup and the skull of the large white rhinoceros, is relatively primitive in structure; the central portion of the forehead is prominently arched or convex, and the bones preserved (Fig. 3*A*) show that there is absolutely no indication of either a frontal or nasal horn. The proportions are decidedly dolichocephalic, as indicated by the following chief measurements:

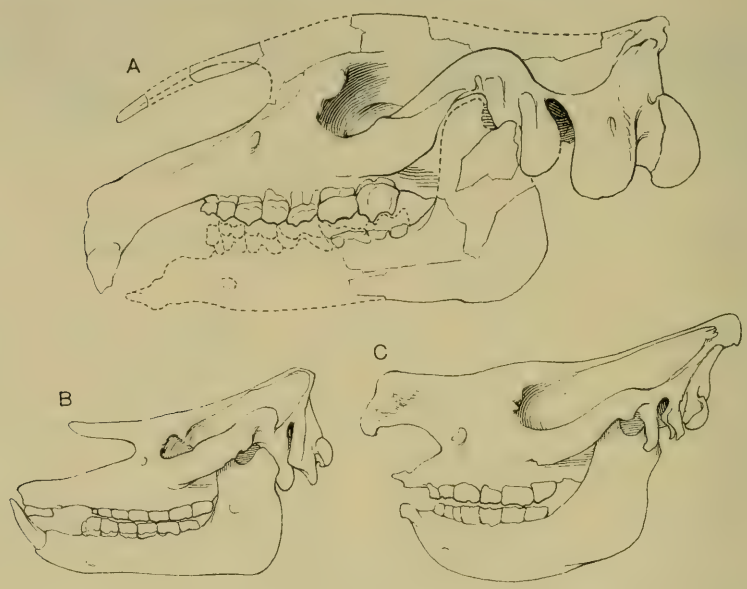

Fig. 3. Comparative view of the skulls of: *A*, *Baluchitherium grangeri* type; *B*, *Aceratherium incisivum* type, from the Darmstadt collection; *C*, *Ceratotherium simum* (Amer. Mus. 1142). One-sixteenth natural size.

Length of *Aceratherium incisivum* type skull, from premaxillaries to condyles	694 mm.
Length of *Ceratotherium simum* skull, from premaxillaries to condyles	728

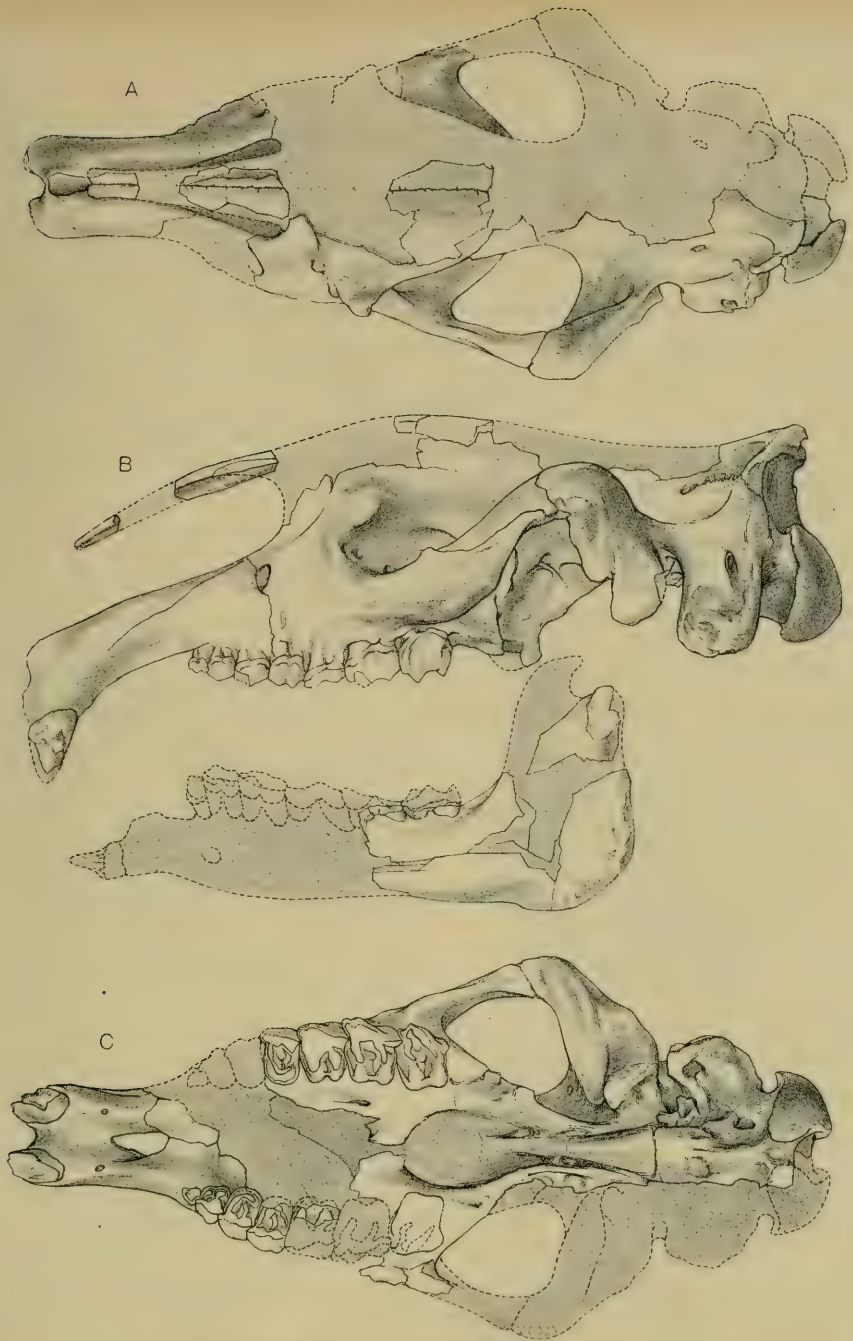

Fig. 4. *A*, Top view of skull of *Baluchitherium grangeri* type, to show the original and restored portions; the original portion including parts of the frontals, the middle portion of the nasals and the tip of the nasals. *B*, Side view of the skull and jaws of the same; part of the fragments of the jaw, reversed from the other side; anterior portion of the jaw restored from *Paraceratherium bugtiense*, after Forster Cooper, Pl. x, fig. 1, highly conjectural. *C*, Palatal view of same showing the simple and primitive characters of the premolar teeth. All figures one-twelfth natural size.

Length over all of *Baluchitherium grangeri* type, from front of premaxillary symphysis to back of occipital condyles..... 1286 (4 ft. 3 in.)
Greatest zygomatic width of *B. grangeri* type, anterior to glenoid fossæ..... 614 (2 ft. ⅛ in.)

Consequently, the zygomatic-cephalic index of the type of *Baluchitherium grangeri* is 47.7; the zygomatic-cephalic index of the much smaller *Aceratherium incisivum* type skull is 54.3; the zygomatic-cephalic index of the massive *Ceratotherium simum* skull is 46.7.

The proportions, length, and breadth of the *B. grangeri* type skull are extremely close to those of the *Cænopus* (*Aceratherium*) *occidentalis* skull of the American Oligocene, namely:

Cænopus occidentalis, zygomatic-cephalic index =48.5
Baluchitherium grangeri, zygomatic-cephalic index =47.7
Rhinoceros indicus, zygomatic-cephalic index =58.0
Ceratotherium simum, zygomatic-cephalic index =46.7
Aceratherium incisivum type, zygomatic-cephalic index =54.3

This is a primitive Eocene and Lower Oligocene form of skull grown large. In profile it nearly resembles the primitive skulls of several Eocene perissodactyls in several independent lines of perissodactyl descent, also of several Lower Oligocene aceratheres. The reasons are obvious: (1) the greatly enlarged second incisor, I^2, functions as a defensive tusk or canine; (2) the animal was completely protected by this as well as by its rapidly increasing height, so that it probably towered over all the mammals of the period; with its very thick rhinocerotic skin, it was safe from attack; (3) with an entire absence of horns there is no secondary cranial modification to support the powerful nasal and frontal horns, as in the ceratorhines and African rhinoceroses.

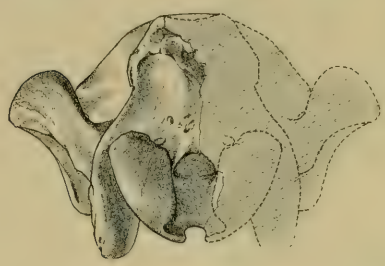

Fig. 5. Occipital view of the skull of *Baluchitherium grangeri* type (Amer. Mus. 18650), to be compared with occipital views of the Oligocene aceratheres. One-twelfth natural size.

The amazing size and power of the skull is none the less manifested in the condyles, which are enormous as compared with those of *C. simum* and as large as in any species of proboscidean. The occipital condyles of *Baluchitherium grangeri* exceed in both diameters the anterior facets of the atlas in Forster Cooper's specimen; it follows that the skull of *B. grangeri* belongs to an animal with even larger and more massive cervicals than those described and figured by Forster Cooper in *B. osborni*. The

seven superior grinding teeth, P^1–M^3, are of the brachyodont, short-crowned, browsing type and parallel, in the very retarded development of the superior crests or metalophs of the premolar teeth, those in the American aceratheres described by Osborn as *Aceratherium platycephalum* (see Osborn, 1898, p. 140, Pl. XIII, figs. 9, 10).

COMPARATIVE MEASUREMENTS IN MILLIMETERS

	Baluchitherium osborni	*Indricotherium asiaticum*	*Baluchitherium* OF IREN DABASU	*Baluchitherium grangeri* OF LOH
SKULL, length condyles to symphysis	....	....	....	1286
Zygomatic width	....	....	....	614
Condylar width	....	....	....	306
HUMERUS, length between articular surfaces	840	930	....	....
Proximal width	376(?)	....	....	....
Distal width	230	....	....	287
ULNA	....	1200	....	....
FEMUR, length between articular surfaces	1200	1230	....	....
Proximal width	300(?)	....	....	....
Distal width	190	....	....	....
TIBIA, length between articular surfaces	790	860	....	....
Proximal width	250	....	....	....
FIBULA	....	....	....	....
CALCANEUM, max. length	....	....	324	....
TUBER CALCIS max. width	....	....	148	....
ASTRAGALUS	....	....	....	....
Max. height	144est.	....	....	....
Max. width	195	212	....	....
METATARSAL III, max. length	....	510	....	....
METACARPAL III, max. length	440	545	....	....
METACARPAL IV, max. length	375	....	....	....
RIB	....	660	....	....
ATLAS (1ST CERVICAL)	....	....	....	....
Max. width	475	....	....	....
Width of ant. condylar surfaces	280	....	....	....
Extreme length of wing	240	....	....	....
3RD CERVICAL	....	....	....	....
Extreme width	400	....	....	....
Extreme length	420	....	....	....
6TH CERVICAL	....	....	....	....
Max. width	460	....	....	....
Max. length	300	....	....	....

Specific Dental Characters of *Baluchitherium grangeri*.—Premolar crests retarded in development: First premolar a small simple tooth. Second premolar, small, protoloph distinct; also with large postero-internal tetartocone and rudimentary metaloph. Third pre-

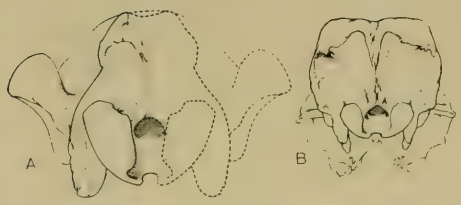

Fig. 6

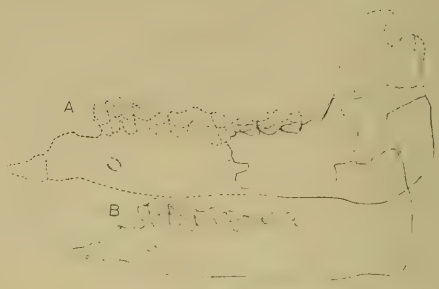

Fig. 7

Fig. 6. Occipital view of: *A*, *Baluchitherium grangeri* type; *B*, *Ceratotherium simum*, an unusually large skull in the American Museum (Amer. Mus. 1142). Both figures one-sixteenth natural size.

The *Baluchitherium* occiput is very similar to that of the Oligocene aceratheres of America, as figured by Osborn, 1898, Pl. xix, namely, *A. trigonodum, copei, occidentale, tridactylum.*

Fig. 7. Lower jaws of: *A*, *Baluchitherium grangeri* type (Amer. Mus. 18650), as compared with *B*, *Paraceratherium bugtiense*, after Forster Cooper. The dotted restoration of the anterior portion of the *Baluchitherium grangeri* jaw is conjectural. Both figures one-sixteenth natural size.

molar with protoloph forming a long hook-like crest continuous with tetartocone; metaloph slender, not connected with tetartocone. Fourth premolar still larger, with very prominent metaloph curving (hook-like) into internal tetartocone; within this a slender metaloph. The premolar transformation in *B. grangeri* is shown in the type specimen (Fig. 4*C*). The fourth premolar is relatively wider than in *I. asiaticum.*

This kind of premolar transformation is different from that observed in the American Oligocene aceratheres, *A. occidentale* and *D. tridactylum;* it approaches *A. platycephalum* (compare Osborn, 1898, Pl. xiii, figs. 9, 10), but is more advanced. As compared with the premolar transformation in the European aceratheres (compare Osborn, 1900, p. 242, Fig. 8, "Evolution of the grinding teeth in the Aceratheriinæ"), it resembles most closely the condition observed in P^3, P^4 in *Aceratherium filholi* type, Lower Oligocene, Phosphorites, Quercy.

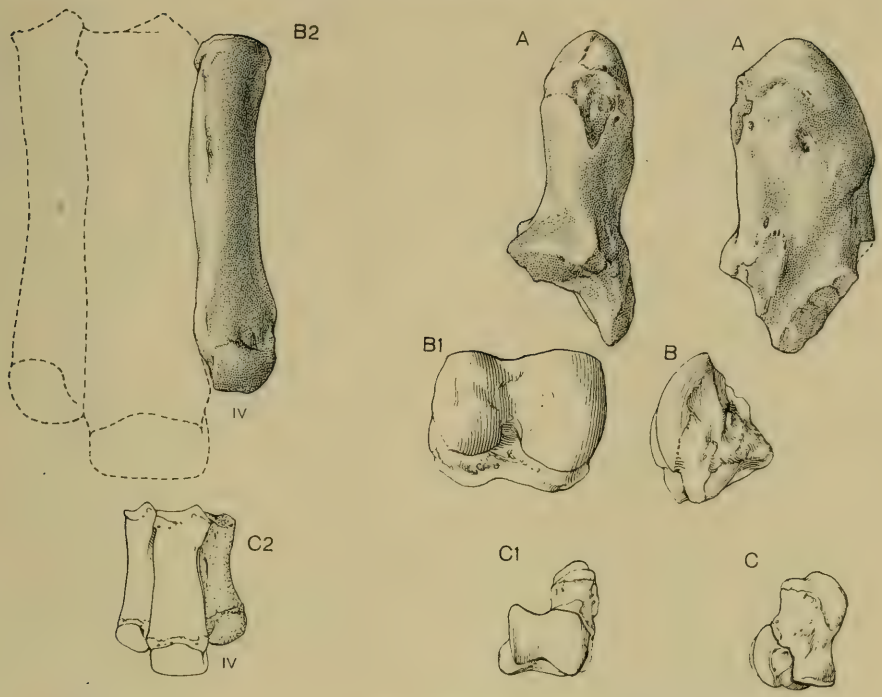

Fig. 8. Foot bones of: *B*, *Baluchitherium osborni*, and *A*, *Baluchitherium grangeri*, as compared with the corresponding foot bones of *C*, *Ceratotherium simum*. *A*, External, and *A*1, anterior views of the left calcaneum (Amer. Mus. 18651) found near Iren Dabasu. *B*, Internal, and *B*1, anterior views of astragalus, also *B*2, metatarsal IV, drawn after casts presented by the British Museum; cast Amer. Mus. 5210 (?metacarpal), and 5209 (astragalus). Corresponding astragalus and calcaneum united of *Ceratotherium simum* (Amer. Mus. 51862). *C*, External view; *C*1, anterior view; *C*2, anterior view of right fore foot. All figures one-eighth natural size.

Second Restoration of *Baluchitherium grangeri*[1]

The skeleton of *Baluchitherium* has been restored through careful comparison of four sets of measurements (p. 7), two given by Forster Cooper (1923) and Borissiak (1918), and two from specimens in the American Museum, one from Iren Dabasu, and one the type from Loh. These measurements are astonishingly uniform and indicate that the

[1]This restoration has been prepared under the direction of the writer with the coöperation of Dr. W. K. Gregory and Mrs. L. M. Sterling. The first restoration was drawn chiefly under the direction of Dr. W. D. Matthew by Mrs. E. Rungius Fulda and has been published in the magazine Asia, April 1923.

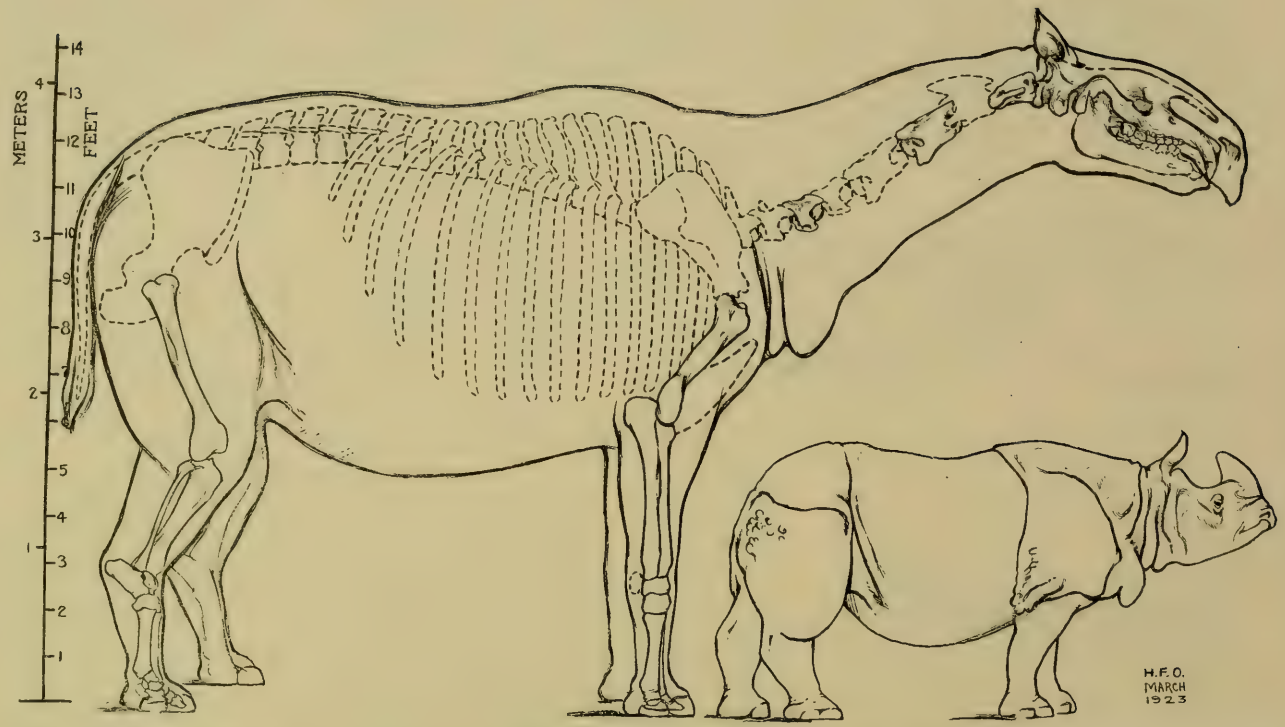

Fig. 9. Partial restoration of skeleton of *Baluchitherium grangeri* and *B. osborni* combined. Body contours, compared with those drawn to full size of the Indian rhinoceros (*R. unicornis*), drawn to the same scale.

specific forms known as *osborni*, *asiaticum*, and *grangeri* are closely similar in size, the differences indicated in the accompanying comparative measurements being partly attributable to age, or growth, and to sex, male or female. The proportions of the skull are fortunately exactly determinable from the superb American Museum type specimen No. 18650. The skull belongs to an animal larger even than the individual which possessed the gigantic neck vertebræ figured by Cooper; yet the skull, gigantic as it is, appears proportionately small. The length of the neck has been ascertained by a comparison of cervical 1 (atlas), cervical 3 and cervical 6, figured and measured by Cooper; the proportions of the neck and head are very similar to those in a giant specimen of the horse from Kansas preserved in the American Museum.

The height of the fore limb has been determined by the humerus, ulna, carpals and metapodials, figured and measured by Cooper, but it is apparent that this fore limb, like the neck, belongs to an individual inferior in size to the American Museum skull. The scapula is restored in dotted lines by careful comparison of the scapulæ of *C. simum*, *R. unicornis*, and especially of the American Oligocene aceratheres *A. occidentale* and *Cænopus tridactylus*. The *Baluchitherium* scapula will probably be found to have: (1) a large glenoid region for the massive head of the humerus; (2) a strong coracoid for attachment of the biceps; (3) a relatively high, narrow blade adapted to the elongate muscles of the elongate limbs; (4) inasmuch as the humerus is very distinctly rhinocerotoid in form (*fide* Cooper), the scapula must have the form of cursorial rhinoceroses; (5) the posterior border is more projecting than in *C. simum*.

The hind limb may be estimated from comparison of the measurements given by Cooper and Borissiak with the proportions of the limbs and calcaneum preserved in the American Museum collection. The pelvis is given a vertical rather than a horizontal character in adaptation to weight; the pelvis and the hind limbs, and especially the abbreviate proportions of the tibia as compared with the femur, correspond with the graviportal quadrupedal type of Osborn, the ratio between tibia and femur being: Tibia, 790×100÷femur, 1200=66. The corresponding ratios in the following quadrupeds are:

	Tibia	Femur	Tibio-femoral Ratio
Indricotherium asiaticum Bor.	860 mm.	1230 mm.	70
Baluchitherium osborni F. C.	790	1200	66
White Rhinoceros (*C. simum*)	343	523	66
Indian Elephant (*E. indicus*)	618	1020	60
Loxodonta africana ("Jumbo")	755	1050	72

Consequently, we infer that the locomotion in the hind limb of *Baluchitherium* was of Osborn's graviportal type, namely, that of the rhinoceroses and elephants. The closest correspondence in the actual length of the femur is with *Loxodonta africana* (in the skeleton of "Jumbo") which measures 1050 mm.; the hind limb of *L. africana* is shorter as a whole than that of *Baluchitherium*, but the tibia is relatively longer in *Loxodonta*.

The radio-humeral ratios, that is, the proportion between length of radius and that of the humerus, are also on the whole rhinocerotine rather than elephantine. The corresponding ratios in the following quadrupeds are:

	Radius	Humerus	Radio-humeral Ratio
Indricotherium asiaticum	976 mm.	930 mm.	105
Indian Rhinoceros (*R. unicornis*)	385	385	100
White Rhinoceros (*C. simum*)	364	381	96
Indian Elephant (*E. indicus*)	685	810	85
African Elephant (*Loxodonta africana*)	870	1000	87

These measurements show that, while the actual combined length of the radius and humerus in *Indricotherium* equals 1906 mm. and that in *Loxodonta africana* equals 1870 mm., the radius is relatively longer in *Indricotherium* (ratio, 105) and resembles the ratio of *Rhinoceros unicornis* (100) more closely than the low radial ratios of the Indian elephant (85) and of the African elephant (87). The radio-humerus is as elevated in *Baluchitherium* as in the elephants, while the metapodials are much more elevated, which accounts for the greater height at the shoulder in *Baluchitherium*.

	Metacarpo-humeral Ratio	Metatarso-femoral Ratio
Baluchitherium osborni	52	
Indricotherium asiaticum	59	41
Rhinoceros unicornis	48	36
Ceratotherium simum	45	31
Elephas indicus	22	13
Loxodonta africana	20	14

The above ratios show that the baluchithere podials (41) are relatively higher than in the two rhinoceroses (36 and 31); they are very much higher than in the two elephants (13 and 14). In other words, the metapodials are relatively three times as tall in the baluchitheres as they are in the elephants; this accounts for the much greater height of the baluchitheres at the shoulder and at the hip.

The astragalus and calcaneum exceed in size and in length those of the Pleistocene mammoths, e.g., *Elephas jeffersonii* type, Amer. Mus. 9950, but the structure of both the astragalus and calcaneum is distinctively rhinocerotoid (*teste* Forster Cooper, 1923).

Relative Body and Limb Proportions.—The height of the *B. grangeri* dorsal spines is nearer 13 feet than 12 feet, as originally estimated. The fore limbs, the trunk and the hind limbs are all within a square 4270 mm. long by 3965 mm. high; the height-length ratio is 92; as compared with a giant horse (*Equus caballus*) in which the same ratio is 94; or with the Indian rhinoceros (*R. unicornis*) in which the same ratio is 82; or with the extremely short-limbed teleocerine rhinoceros which falls within a square 1200 mm. high by 2060 mm. long, the same ratio being only 58.

Characters of the **Baluchitheriinæ**, New Subfamily

There is no doubt that *Baluchitherium*, while most closely parallel to the Aceratheriinæ, belongs in an entirely distinct line of descent or phylum of its own, to which the name **Baluchitheriinæ** may be applied, or **Paraceratheriinæ** in case by any chance this animal proves to be synonymous with *Paraceratherium bugtiense*.

The polyphyletic evolution of the rhinoceroses was pointed out by Osborn in 1898 in his memoir on 'The Extinct Rhinoceroses,' Preface, p. 77; it was carried to a further point in 1900 in his 'Phylogeny of the Rhinoceroses of Europe,' in which the subfamilies (I.) Diceratheriinæ, (II.) Aceratheriinæ, (?II*a*.) Elasmotheriinæ, (III.) Brachypodinæ, (IV.) Ceratorhinæ, (V.) Atelodinæ, and (VI.) Rhinocerotinæ were clearly defined as indicating early separation, absolute distinctness, and great geologic age.

The new subfamily, Baluchitheriinæ, is most clearly distinguished as follows. (1) The caniniform adaptation of the second upper incisor tooth, which will probably be found to be correlated with a second lower incisor tooth quite dissimilar to that in any of the Aceratheriinæ; consequently both the upper and lower second incisors of the Baluchitheriinæ are distinctive. (2) The second feature of great importance is the horse-like elongation of the entire cervical region which is also a unique subfamily character. (3) The third feature, although not quite so distinctive, is the marked elongation and lateral compression into a functional-tridactyl-monodactyl type. (4) A subsidiary subfamily feature is the relatively small size of the head which with the greatly elongated neck we may correlate adaptively with tree-browsing habits, that is,

browsing on the higher branches and leaves of trees, as compared with the shrub-browsing of the *D. bicornis* of Africa or the *R. sondaicus* of India in which the head is carried very low and near to the ground. (5) An additional subfamily character is the peculiar proportions of the head, neck, fore limb, hind limb, and trunk, which, while more rhinocerotine than equine, are nevertheless unique among rhinoceroses.

Habits of Baluchitheres.—The writer anticipates that the baluchitheres will be found to be unique, large animals of the particular geologic period, either Upper Oligocene or Miocene, in which their remains occur; they were typical browsers and probably browsed on the herbage of the lofty branches of trees, as do the elephants and giraffes and to a less extent certain of the chalicotheres. They were amply defended by their powerful tusks. The type skull of *Baluchitherium grangeri* indicates that these animals attained a greater height, when the neck was elevated and stretched, than 14 feet, nearer 15 and possibly 16. The writer further anticipates that, when the complete fore limb and scapula of *B. grangeri* become known, it will be found that the shoulders were elevated above the hips, as in the chalicothere *Moropus*, in the okapi, and in the moose (*Alces*), because it is generally found that the anterior part of the body of tree-browsers is elevated in correlation with the elongation of the neck. It is obvious that tree-browsing animals of increasing height, of length of neck, of height of shoulder, and of stretch of prehensile lips would be constantly selected, as in the giraffes.

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AMERICAN MUSEUM NOVITATES

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59.7.55C(51)

DESCRIPTION OF A NEW CYPRINOID FISH FROM CHINA[1]

By Henry W. Fowler[2]

Recent examination of material sent to The American Museum of Natural History by its Third Asiatic Expedition has brought to light the following new cyprinoid fish with Indian affinities.

Chela nicholsi,[3] new species

Head, 5; depth, 4½; D. III, 7, I; A. III, 25, I; P. I, 14; V. I, 8; scales 64 in lateral line to caudal base, and 4 more on latter; 10 scales above lateral line to dorsal origin, 3 below to anal origin; 52 predorsal scales; head width, 3 in its length; head depth, 1⅔; first branched dorsal ray, 1⅘; first branched anal ray, 2⅓; least depth of caudal peduncle, 2⅔; caudal length, 1; pectoral, 1; ventral, 1¾; snout, 3½ in head measured from upper jaw tip; eye, 4; maxillary, 3 1/10; interorbital, 4.

Body elongately compressed, dorsal and caudal edges convex, abdominal edge strongly trenchant from head to vent with scales not passing over ridge, and greatest depth about tips of depressed pectoral. Caudal peduncle well compressed, least depth 1¼ in its length.

Head attenuate, strongly compressed, flattened sides little more approximated below and profiles nearly alike, except lower little more inclined. Snout conic, long as wide. Eye advanced, little inferior in depth of head, center at first ⅖ in length of head, long as snout, equals interorbital. Moderate adipose eyelid all around eye marginally. Mouth oblique, lower jaw slightly protruding and with slight symphyseal knob fitting into slight cavity in front of upper jaw. Maxillary slips largely below preorbital, reaches opposite eye, and expansion 4½ in eye-diameter. Nostrils together; front one at least ⅖ in snout, simple pore; hind one exposed as narrow crescent close behind. Interorbital convexly elevated. Suborbital chain narrow; preorbital width about 1¼ in eye.

Gill-opening forward midway in head. Gill-rakers 5 + 8, lanceolate, half length of gill-filaments, which 1⅞ in eye. Pseudobranchiæ 1⅕ in gill-filaments. Pharyngeal teeth 4, 4, 2—2, 3, 5, hooked, slender and most of larger at least with slight grinding surfaces.

Scales closely adherent, thin, papery, in even longitudinal series largely parallel with lateral line, little smaller on predorsal and caudal base. Row of medium-sized scales along anal base. Pointed scaly flap in ventral axil about ⅖ length of fin. Head naked. Scales with 9 to 11 basal radiating striæ and 3 or 4 short marginal auxiliaries; apical circuli 55 to 62. Lateral line complete, strongly decurved, passes ventrals about lowest fourth in body depth and ascends midway along side of caudal

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Publication No. 9.

[2]Of the Academy of Natural Sciences of Philadelphia.

[3]Named for Mr. John T. Nichols, of The American Museum of Natural History, in recognition of his paper on Chinese fishes (1918).

peduncle to caudal base. Tubes in lateral line well exposed, slender, simple, extend over first half to $\frac{2}{3}$ of scale exposures and each with slight terminal branch below.

Dorsal origin midway between gill-opening and caudal base, depressed fin reaching $\frac{1}{3}$ to caudal base. Anal begins little before end of depressed dorsal, first branched ray highest and forms apex of slight anterior lobe. Caudal strongly forked, lobes slender and sharply pointed, lower slightly longer. Pectoral long, acuminate, $1\frac{2}{5}$ to ventral. Ventral fin inserted midway between snout tip and caudal base, fin reaching $1\frac{1}{2}$ to anal origin. Vent close before anal.

Color in alcohol, back dull olivaceous, sides and lower surface silvery white. Dorsal and caudal slightly grayish, other fins whitish. Iris silvery white.

Length, 177 mm.

Type.—No. 8254, Amer. Mus. Nat. Hist., Ningkuo, An-hwei Province, China, September 15 to October 15, 1921, collection Third Asiatic Expedition.

Only one Chinese species of *Chela* has been described. Otherwise the genus is confined to the Indian region. The imperfectly known *Chela melanopus* Bleeker, based on a Chinese drawing (evidently a poor drawing), does not seem to be the same as the present species. Its fundamental characters, such as the very large head, posterior position of its dorsal, striate opercle and greatly fewer anal rays (could we accept them as accurate) would clearly define it as distinct. Moreover, the position of the eye and the lips, according to the artist's representation apparently fringed, convey the impression of a fish with an absolutely different physiognomy from the present specimen. Possibly the unusual black basal regions of the ventrals are the result of stain or other accident to the specimen from which the artist made his sketch.

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59.9,4(51)

NEW CHINESE BATS[1]

By Glover M. Allen

Over five hundred bats have been thus far sent back by the Asiatic Expeditions under the leadership of Mr. Roy C. Andrews. These are chiefly from Fukien, Szechwan, southeastern Yunnan, and North China. The series of skins is well supplemented by specimens in alcohol, and in many cases wide-ranging species are represented by a number of skins from the coastal regions as well as by others from the higher or more inland provinces, so that an unusual opportunity is afforded for a comparison of the lowland and the upland members of a species. This is undoubtedly the largest single collection of bats yet obtained by any one expedition in China, and my thanks are due The American Museum of Natural History for the opportunity to study this important series. The following are recognized as new.

Rhinolophidæ

Rhinolophus blythi calidus, new subspecies

? *Rhinolophus cornutus pumilus* Andersen, 1905, Proc. Zool. Soc. London, II, p. 127 (in part, as to specimen from Foo-chow).

Type.—Adult female, skin and skull, No. 44692, American Museum of Natural History, from Yenping, Fukien Province, China. Roy C. Andrews, collector. June 17, 1916.

Description.—Similar to *R. blythi szechwanus* Andersen, but much brighter, more cinnamon throughout. The bases of the hairs above are everywhere whitish, with a faint buffy tint, their tips dull cinnamon, near "sayal brown" of Ridgway (1912); below pale pinkish buff, the hairs becoming whitish near their bases.

Measurements.—The skull is a very little larger than in *szechwanus;* its total length, occiput to front of canine, 16 mm.; palatal bridge, 1.8; maxillary toothrow, 5.7; mandibular toothrow, exclusive of incisors, 6.3. The forearm measures 38 mm.; tibia, 15; foot, 7.

This is a bright-colored lowland representative of *R. blythi* of India, and is very different in color from the series of smoky-gray specimens from Szechwan representing Andersen's *R. b. szechwanus.* The species was included as *Rhinolophus minor* in this author's preliminary revision of the small bats of the *lepidus* (=*pusillus*) group in 1905. A fragmen-

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Publication No. 10.

tary skin from Foo-chow, included by him as possibly representing *R. cornutus pumilus*, may have been the present form. The nose-leaf has the characteristic form of the species, with the sella slightly constricted in the middle, and its rounded tip narrower than its base. The horn on the connecting process is nearly an isosceles triangle in side view. The dark-gray immature pelage is practically alike in both races. Twelve skins from Fukien Province represent this lowland form and fourteen from Szechwan are assumed to be typical of *szechwanus*.

Rhinolophus episcopus, new species

Type.—Adult male, skin and skull, No. 56895, American Museum of Natural History, from Wanhsien, Szechwan Province, China. Third Asiatic Expedition. October 9, 1921.

Description.—A small species of the *macrotis* group. Ears large and broad, with a wide trapezoidal antitragus, about 7 mm. across, well marked off by a deep notch. Horseshoe of the nose-leaf broad, quite covering the muzzle, with a narrow median anterior notch. On each side below the horseshoe is a small supplementary outgrowth extending back nearly to the level of the nostril. Sella parallel-sided, with broadly rounded vertex, its base if anything narrower; the nasal lappets thin, their outer margins continuous with the sides of the sella, and vertically raised, to form a shallow cup at the base of the sella. The connecting process is well developed, commencing about a millimeter below the summit of the sella, prominent and convex. The terminal leaf instead of being pointed is ovate, with convex sides and rounded tip, recalling a bishop's mitre. It is thin and leaf-like, about as high as the sella itself (5 mm.) and stands erect between the ears. Front face of the sella as well as the terminal leaf with numerous minute hairs, smaller than those rising from the connecting process. Two pairs of much longer hairs rise from the sides of the latter and exceed the leaves in height.

Wings from the metatarsus. Third metacarpal shortest, fourth and fifth of equal length. Second phalanx of third finger one and one-half times the first. Tail about as long as combined tibia and hind foot.

Color above, smoke gray, the hairs dull whitish at their bases. Below, the chin, throat and middle of the abdomen are pale, almost white, the hairs at the sides of the body smoky (near "avellaneous"), paler at their bases.

The skull is characteristic of the group, with very low sagittal ridge, prominent globular nasal swellings, narrow zygomata, and a broad palatal bridge, equalling one-half the maxillary toothrow. The small p^2 is fully in the toothrow and the third upper molar has its W-pattern nearly complete, the posterior commissure about half the length of the anterior. In the lower jaw the small premolar is external to the row on one side, and partly so on the other.

Measurements.—Collector's measurements of the type are: head and body, 51 mm.; tail, 24; foot, 10; ear, 26; spread, 275. The forearm measures 47.5 mm.; the third metacarpal, 34.5; fourth and fifth metacarpals, 36; tibia, 18.

The skull measures: occiput to front of canine, 19 mm.; occipital condyle to front of canine, 17; palatal bridge, 3.7; mastoid width, 9.2; zygomatic width, 8.2;

maxillar width, 6.2; width outside canines, 4.4; maxillary toothrow, 7; length of mandible, 12; mandibular toothrow to front of canine, 7.2.

This is a larger species than *macrotis* with a peculiar terminal noseleaf, which is rounded rather than pointed. Like *pearsoni*, it is represented in the low coastal area by a smaller, brighter-colored race which may be named as follows.

Rhinolophus episcopus caldwelli, new subspecies

TYPE.—Adult female, skin and skull, No. 44771, American Museum of Natural History, from Yuki, Fukien Province, China. H. R. Caldwell, collector. October 31, 1916.

DESCRIPTION.—Similar to the typical form but smaller (forearm 43 mm., against 48), the pelage above with a warmer, cinnamon tint, near "sayal brown," instead of smoky. The difference in tint is similar to that separating the upland and lowland races of *R. blythi* in China, and the differences in measurements are obvious from the following. The teeth are strikingly smaller. The small p^2 is full in the toothrow and has a long sharp cusp. The lower premolars are not crowded.

MEASUREMENTS.—Forearm, 43 mm.; tibia, 17; foot, 9; third metacarpal, 31.5; fourth and fifth metacarpals, 33. Skull: occiput to front of canine, 18 mm.; occipital condyle to front of canine, 15.5; palatal bridge, 3; mastoid width, 8.5; zygomatic width, 7.8; maxillar width, 6.7; width outside canines, 3.7; maxillary toothrow, 6; length of mandible, 11.4; mandibular toothrow to front of canine, 6.5.

The single specimen on which this form is based differs so strikingly from the Szechwan series that there can be no doubt of its distinctness. It was found in a cave at the summit of a mountain by Mr. H. R. Caldwell, whose coöperation has resulted in the addition of many interesting species and in whose honor the form is named.

Rhinolophus rex, new species

TYPE.—Adult female, skin and skull, No. 56890, American Museum of Natural History, from Wanhsien, Szechwan Province, China. October 12, 1921.

DESCRIPTION.—A large member of the *macrotis* group, with ears, horseshoe and sella enormously enlarged, but the terminal lancet much reduced.

Ears large, almost funnel-like, the antitragus fully half their height and almost an isosceles triangle with broadly rounded point, marked off by a deep notch from the rest of the conch. Horseshoe very broad extending far (at least 3–4 mm.) beyond the sides of the muzzle, with a deep narrow median cleft anteriorly. There is no accessory outgrowth external to it. The lappets covering the nostrils at the base of the sella are much enlarged, thin and membranous, about the width of the muzzle, their edges slightly raised to form a cup and their posterior wings enclosing the base of the sella. The latter is large, about 9 mm. high in the dried specimen (11 as measured by the collector), tongue-shaped, narrowest at base, and gradually expanding to the broadly rounded summit, which stands upright between the ears. Its front face is thickly beset with microscopic whitish hairs. The connecting process commences

about 4 mm. below the summit and is relatively low with a convex outline. The terminal lancet is very small, almost concealed by the fur of the occiput, and does not quite reach the summit of the connecting process in height. Its summit is broadly rounded instead of pointed.

The wings arise from the metatarsus slightly below the toes. Calcaneum slender, about 1½ times the length of the foot. Tail with its tip projecting. Third metacarpal slightly the shortest, the fourth and fifth practically of equal length. The second phalanx of the third digit barely exceeds 1½ times the first; that of the fourth is less than 1½ times the first phalanx.

Fur rather long, about 16 mm. on the back, 10 mm. on the chest. In color it is light "cinnamon-buff" above, paler below except at the extreme sides under the armpits. A thin fringe of hairs borders the inner edge of the ear conch and the rib parallel to it on the lower three-fifths of the ear.

The skull is peculiar in having the surface of the braincase above the ear cancellar or spongy in appearance with numerous small fenestræ as far forward as the orbit. The nasal swellings are elliptical, with a deep cavity behind, but the sagittal crest is very low. The small p^2 is fully in the toothrow, or even with a hair-space behind it and has a well developed cusp. In the lower jaw the minute middle premolar (p_3) is fully in the row in all four specimens.

Measurements.—The collector's measurements of the type are: head and body, 55 mm.; tail, 38; foot, 10; ear, 33; stretch of wings, 356. The forearm measures 58 mm.; third metacarpal, 41.5; its first phalanx, 17; its second, 26; fourth metacarpal, 43; its first phalanx, 12.7; its second, 17; fifth metacarpal, 43; tibia, 21.

The skull measures: occiput to front of canine, 22 mm.; occipital condyle to front of canine, 19.8; palatal bridge, 4.5; mastoid width, 11; zygomatic width, 10; maxillar width, 7; width outside canines, 4.8; maxillary toothrow, 8; length of mandible, 13.5; mandibular toothrow to front of canine, 8.

This extraordinary bat is a most interesting discovery. The exaggerated development of its anterior nose-leaves is in contrast to its otherwise primitive structure in the unspecialized wing and the unmodified position of the small premolars. The addition of this and the preceding species to the known Asiatic members of the *macrotis* series is of importance as pointing to the origin of the group from the central Asian land mass. The four specimens were captured in the Yen-ching-kao cave, whence also was obtained the Szechwan series of *Rhinolophus episcopus*.

Hipposideridæ

Hipposideros armiger swinhoii (Peters)

Phyllorhina swinhoii Peters, 1870, Proc. Zool. Soc. London, p. 616.

In his review of the horseshoe bats of the *armiger* group, Andersen (1906, Ann. Mag. Nat. Hist., (7) XVII, p. 37), working mostly with alcoholics, placed Peters' name *swinhoii* in the synonymy of this species. The fine series of skins obtained in Fukien Province, Szechwan and

Yunnan seems to show clearly that those from the coast are uniformly more brightly colored, with a strong buffy suffusion. The name may therefore be revived in a subspecific sense for the eastern, lowland form, type locality Amoy, Fukien Province.

Vespertilionidæ

Myotis chinensis luctuosus, new subspecies

Type.—Adult male, skin and skull, No. 56867, American Museum of Natural History, from Wanhsien, Szechwan Province, China. October 12, 1921. Third Asiatic Expedition.

Description.—A large, dark *Myotis*, differing from typical *chinensis* of the lowlands in having the under surface evenly gray, instead of with black sides.

Color above a uniform grayish brown, nearly "buffy brown" of Ridgway (1912), the top of the head a trifle grayer; below uniformly gray, the hairs nearly fuscous at their bases with a minute whitish tip, which gives an evenly frosted appearance, darkened by the bases of the hairs showing through.

The calcar is long and slender, without keel. At the base of the fifth metacarpal a prominent membranous slip extends from the lower side of the carpus to the inner base of the digit.

The skull is obviously larger than that of a specimen of *chinensis* from Yunnan, though the forearm is no longer. In both, the second small upper premolar (p^3) is drawn slightly in from the toothrow. There is no protoconule nor hypocone on the molars.

Measurements.—The collector's measurements of the type are: head and body, 80 mm.; tail, 65; foot, 16; ear, 21; spread of wings, 456. The forearm measures, 65 mm.; third metacarpal, 64; fourth metacarpal, 62; fifth metacarpal, 59.

In the following measurements of the skull, those of a specimen of *chinensis* from Yung-chang, Yunnan Province, are added in parenthesis; greatest length, 24 (22.5); basal length, 22.5 (21); palatal length, 13.4 (12.4); mastoid width, 11.5 (11); zygomatic width, 15.5 (14.9); maxillary width, 9.7 (9.5); upper toothrow, 11.5 (11.3); lower toothrow, 12.2 (11.5).

A series of these large bats was secured in the same cave, Yen-ching-kao, from which the two new Rhinolophi came. They agree closely in the characters given. A specimen of typical *chinensis* from Fukien Province is a much richer brown than any of the Szechwan series, and it is likely that this is a further difference separating the two races. Tomes, in his original description, gave no locality for his specimen beyond "China." It was received from "Mr. Fortune," a botanist who collected in southeastern China, hence undoubtedly came from somewhere along that coast, perhaps from Shanghai, where he obtained other bats. The contrasting black sides are mentioned as a distinguishing character.

Myotis frater, new species

TYPE.—Adult male, alcoholic, No. 48039, American Museum of Natural History, from Yenping, Fukien Province, China. August 10, 1920. H. R. Caldwell, collector.

DESCRIPTION.—A small species, structurally similar to *M. volans*, the long-legged bat of western North America, but differing in details, as follows.

Tail long, as in *volans*, about 50 per cent of total length; tibia very long, exceeding those of *volans;* foot much less than half its length equalling that of *volans*. Like the latter, the calcar has a low but evident keel about the length of the tarsus from the ankle. Wings ample, the metacarpals graduated, that of the third digit nearly reaching the elbow but falling short of it by 1.5 mm. Ears short, barely reaching the muzzle when laid forward, their tips less abruptly rounded off than in *volans*. Tragus similar in both, short, its anterior edge slightly concave, its lower half broad, the posterior upper margin slightly crenulate and abruptly bevelled off to the tip.

Below, the fur extends thinly on the under surface of the wing to a line from the middle of the femur quite to the elbow, as characteristic also of the American species. Its color is not evident in the alcoholic specimens, but is doubtless dark reddish brown as in *volans* of the Pacific coast of California.

The skull resembles closely that of the American species in its short, upturned rostrum, elevated forehead (in profile) and slightly inflated braincase. An important but minute detail of agreement is the conformation of the sagittal crest. Among the American species this is characteristic in that the temporal ridges, after uniting anterior to the occiput are continued back to meet the lambdoid crests not as concave but as convex lines.

The teeth in both are small and weak, but in the Asiatic species the second small upper premolar is much crowded inward from the toothrow instead of standing practically in the row, and it is proportionally as well as absolutely smaller than in the American bat. Similarly in the lower jaw the second premolar is more reduced in size and crowded a very little inward from the row.

MEASUREMENTS.—Total length, 94 mm.; tail, 47; foot, 8; ear from meatus, 11; forearm, 39; tibia, 20; combined length, knee to end of claw, 29. Skull: greatest length, 13.5; basal length, 13.2; palatal length, 6.6; maxillary width, 5.9; zygomatic width, 9.2; mastoid width, 8; maxillary toothrow, 5; mandibular toothrow exclusive of incisors, 5.4.

A most interesting discovery is this Asiatic counterpart of *M. volans* (long known as *M. longicrus*) of western North America, with which it agrees in all important structural details, though with even more elongated tibiæ and more progressive dentition in that the minute premolar 3 in both jaws has gone farther on its way to entire suppression. The more primitive condition of the American species indicates that it was derived from the Asiatic bat. The three specimens were found in holes of live bamboos on mountains at 2500 feet elevation. The bats of this group are distinguished by the combination of short ears, long tibiæ, keeled calcar, fur extending to elbow ventrally, inflated skull with short rostrum, elevated occiput, and convex outline of temporal ridges at occiput.

Nyctalus velutinus, new species

TYPE.—Adult male, skin and skull, No. 44649, American Museum of Natural History, from Futsing, Fukien Province, China. Edmund Heller and R. C. Andrews, collectors. July 29, 1916.

DESCRIPTION.—Color above Prout's brown; below paler, near Dresden brown of Ridgway, slightly grayer on the chest. The bases of the hairs are darker, fuscous, both above and below.

On the dorsal surface, the fur of the body extends out as far as a line joining the proximal half of the humerus and the knee, and back on the interfemoral membrane nearly to a line joining the middle of the tibiæ. Below, the wing membrane is thickly furred from the knee to the basal third of the fifth digit and on the base of the fourth digit, as well as on the propatagium and the under side of the humerus itself. The extent of fur on the interfemoral membrane is much like that on its dorsal side.

MEASUREMENTS.—The collectors' measurements of the type are: head and body, 75; tail, 52; foot, 11; ear, 15. The forearm measures 49 mm.; third metacarpal, 49.5; first phalanx of same, 18; second phalanx, 21.5; fourth metacarpal, 48; first phalanx of same, 18; second phalanx, 8.3; fifth metacarpal, 39.5; first phalanx of same, 9.3; second phalanx, 5.3.

The skull measures: greatest length, 18; basal length, 18.3; palatal length, 9; mastoid width, 11.2; zygomatic width, —; maxillary width, 8.5; upper toothrow to front of canine, 7; mandible, 13; lower toothrow to front of canine, 7.3.

I have been unable to reconcile the characters of this Chinese noctule bat with those of any of the described species. In a previous paper (1912, Mem. Mus. Comp. Zoöl., XL, p. 243), I referred specimens from Ichang and eastern Szechwan to Hodgson's *labiatus*, but this seems to be a larger animal, though the two may eventually prove to be but subspecifically related. Until a more thorough study of their distribution and relationships can be made, the eastern bat may stand as a full species.

Miniopterus schreibersi parvipes, new subspecies

TYPE.—Adult male, skin and skull, No. 44656, American Museum of Natural History, from Yenping, Fukien Province. Roy C. Andrews, collector. June 16, 1916.

DESCRIPTION.—In general similar to *M. schreibersi chinensis* Thomas from Chili Province, but the coloring much richer, a deep brownish instead of smoky gray, and the hind foot shorter and narrower.

Color of the type, a uniform dark cinnamon-brown above, nearly "Verona brown" of Ridgway; below slightly paler, about "snuff brown." On the lower parts the roots of the hairs are darker, but on the back they are nearly uniform, only a shade deeper in color at their bases.

The females, as usual in this genus, are darker than the males, from chestnut-brown to blackish.

MEASUREMENTS.—The forearm and finger measurements are the same as in the more northern form, but the foot is smaller and more slender. The type measures: forearm, 48; third metacarpal, 43.5; first phalanx, 10.5; second phalanx, 39; fourth

metacarpal, 42; first phalanx, 8.5; second phalanx, 19; fifth metacarpal, 39; tibia, 17; foot, 9.5 (10.5 in *chinensis*).

The skull measures: greatest length, 16; basal length, 15.5; palatal length, 8; mastoid width, 8.5; zygomatic width, 8.7; maxillary width, 6.5; upper toothrow (exclusive of incisors), 6; mandible, 12; lower toothrow (exclusive of incisors), 6.8.

A small series of these bats from Fukien Province is obviously different from others obtained in Chili Province, representing the subspecies *chinensis*. They are much browner and lack the dark smoky color of the latter which, in combination with the smaller and slenderer foot, will at once distinguish the more southern race. Its relation to the Indian *Miniopterus* remains to be studied further. In other respects the two seem sufficiently alike to make it probable that the South China form is only subspecifically distinct.

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56.9,72(118:51.7)

TITANOTHERES AND LOPHIODONTS IN MONGOLIA[1]

By Henry Fairfield Osborn

The object of this issue is to describe two of the Upper Eocene mammals first reported by the Third Asiatic Expedition in the Irdin Manha Formation (early Tertiary). It is stated (Granger and Berkey, 1922, p. 5)[2]: "1.—Small Lophiodonta of at least two species in great abundance. 2.—A perissodactyl about the size of the Upper Eocene titanotheres and possibly related to this family."

This constituted the first notice of the existence of the perissodactyl families Lophiodontidæ and Brontotheriidæ in Mongolia. Later there was reported by Berkey and Granger (1923, p. 12)[3] another formation known as the Shara Murun:

"5.—Shara Murun. A hundred miles farther south another basin carries fossiliferous strata. The sedimentary area is very large and the best exposures occur along the borders of a 200-foot escarpment. At this place were found titanothere remains very like those found at Irdin Manha early in the summer, in the Iren Dabasu area. These seem to be, therefore, early Tertiary in age, perhaps as early as Eocene."

The two new species of mammals described herewith appear to indicate that the Irdin Manha formation and the Shara Murun formation are alike of Upper Eocene age and comparable to the Uinta C formation, northern Utah. In 1883 Scott[4] described *Desmatotherium* and *Dilophodon* as two new Eocene lophiodonts; Osborn later united them with the Middle Eocene *Helaletes* of Marsh; Osborn and Matthew in 1909 (U. S. G. S. Bull. 361, pp. 52, 98) and Peterson in 1919, p. 127,[5] separated them, and Troxell, 1922, p. 367,[6] also separated them.

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[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Publication No. 11.

[2]Granger, Walter, and Berkey, Charles P., 1922, 'Discovery of Cretaceous and Older Tertiary Strata in Mongolia,' Amer. Mus. Novitates No. 42, pp. 1–7, 1 text-fig.

[3]Berkey, Charles P., and Granger, Walter, 1923, 'Later Sediments of the Desert Basins of Central Mongolia,' Amer. Mus. Novitates No. 77, pp. 1–16, map.

[4]Scott, W. B., 1883, 'On *Desmatotherium* and *Dilophodon*, Two New Eocene Lophiodonts.' Contrib. E. M. Mus. Geol. and Arch. Prince. Mus., Bull. III, pp. 46, 47, Pls. v–viii.

[5]Peterson, O. A., 1919, 'Report upon the Material Discovered in the Upper Eocene of the Uinta Basin by Earl Douglas in the Years 1908–1909, and by O. A. Peterson in 1912,' Ann. Carnegie Mus., XII, Nos. 2–4, pp. 40–168, 14 plates.

[6]Troxell, Edward L., 1922, '*Helaletes* Redefined' (Contributions from the Paleontological Laboratory, Peabody Museum, Yale University), Amer. Journ. Sci., III, pp. 365–370, text-figs. 1–3.

We find that the Irdin Manha lophiodont, now reported as extremely numerous, is very close to *Desmatotherium guyotii*, a genus and species distinguished by double internal cones in the upper premolars; in *Helaletes* these cones are single.

Desmatotherium mongoliense, new species

Fam. Lophiodontidæ, Subfam. Helaletinæ

In the Irdin Manha beds, twenty-three miles south of Iren Dabasu, there were discovered on April 26, 1922, parts of ten individuals of a small lophiodont which were described in field letters of Granger as representing an animal very similar to *Helaletes* of the Bridger and Uinta beds of Wyoming and Utah. Now that these materials have reached the Museum and been closely compared with the Lower Eocene *Heptodon* and with the Middle Eocene *Helaletes* and *Desmatotherium*, it is found that Granger's identification is entirely correct. These animals certainly belong to the family Lophiodontidæ, subfamily Helaletinæ of Osborn, and the best preserved specimens, namely, a right maxilla (Amer. Mus. 19161) and a left lower jaw (Amer. Mus. 19162) are selected as the type and paratype. The comparative measurements are as follows:

		Indices
Desmatotherium guyotii (Prince. Mus.)	P^1–M^3 = 79 M^{1-3} = 44	
	M^2 diams. a–p. × tr. = 14 × 15	107
" *mongoliense*, Type	P^1–M^3 = 75e M^{1-3} = 37	
	M^2 diams. a–p. × tr. = 15 × 15	100
" " Paratype	P_2–M_3 = 67	
Dilophodon minusculus (Prince. Mus.)	P_2–M_3 = 42	

It thus appears that the species *Desmatotherium mongoliense* is intermediate in size between *D. minusculus* and *D. guyotii* of the Middle Eocene Bridger beds of Wyoming, as described by Scott in 1883. In revising these Eocene species of the Helaletinæ, Osborn (1892.67, p. 131)[1] pointed out that *Desmatotherium* is defined as follows: "Premolars $\frac{4}{3}$. Third and fourth upper premolars with two internal lobes. Third lobe of the last lower molar variable. Paracone conic, and metacone flattened, symmetrical, of equal length."

The new species from Mongolia is defined as follows: Vestigial P^1 indicated by a small alveolus; P^2 and P^3 with duplicate internal cusps, i.e., tritocone and tetartocone; P^4 with single internal tritocone only, and rudimentary conules; M_3 with a third lobe.

[1]Osborn, H. F., and Wortman, J. L., 1892, 'Fossil Mammals of the Wahsatch and Wind River Beds. Collection of 1891,' Bull. Amer. Mus. Nat. Hist., IV, Art. 11, pp. 81–147, 1 plate and 18 text-figs. The definition is under the name of *Helaletes* but is based upon *Desmatotherium*.

Thus this animal is specifically but not generically distinguishable from *Desmatotherium*. Parts of the metapodials, complete calcanea, and complete isolated superior and inferior molar teeth found under the same field numbers support this reference.

Protitanotherium mongoliense, new species

The type (Amer. Mus. 18653) consists of lower jaw with well preserved series of lower grinding teeth, P_2–M_3, of the right side, also foot bones, belonging to an animal superior in size to *Protitanotherium emarginatum* of the Uinta C beds, Utah, and somewhat inferior in size to *P. superbum* the largest and most robust animal thus far found in the Upper Eocene of Utah and of which only the jaw is known, but the skull of which doubtless presented osseous horns of considerable size. The relative size and proportions of the teeth in these three specimens may be indicated by the following comparative measurements.

		Indices
P. superbum (Amer. Mus. 2501)	P_2–M_3=296 $M_{1\text{-}3}$=214	
	M_1 diams. a–p.×tr.=51×31	61
	M_2 " " " =62×32	52
	M_3 " " " =98×42	43
P. mongoliense (Amer. Mus. 18653)	P_2–M_3=293 $M_{1\text{-}3}$=200	
	M_1 diams. a–p.×tr.=50×30	60
	M_2 " " " =61×34	56
	M_3 " " " =92×32	35
P. emarginatum (Prince. Mus.)	P_2–M_3=276 $M_{1\text{-}3}$=199	
	M_1 diams. a–p.×tr.=46×29	63
	M_2 " " " =56×33	59
	M_3 " " " =94×34	36

The above figures support the statement that *Protitanotherium mongoliense* is intermediate in size between the two Utah species in the total length of its grinding series. The grinding teeth are also intermediate in proportions, as shown by the indices of the three inferior molar teeth; this index tends to establish the generic relationship of the species *mongoliense* to *Protitanotherium* rather than to *Diplacodon*, in which the grinding teeth are relatively narrower. The internal and external aspects of the crowns are also closely similar in *P. superbum* and in *P. mongoliense;* the molarization or transformation of the premolars into the molar pattern appears to be somewhat more advanced in *P. mongoliense* than in *P. superbum*. The premolar measurements and indices are as follows.

			Indices
P. superbum	P_2 diams. a–p. × tr.	= 28 × 16	57
	P_3 " " "	= 29.5 × 21	71
	P_4 " " "	= 34 × 22	65
P. mongoliense	P_2 " " "	= 28.5 × 16.5	58
	P_3 " " "	= 31 × 21	68
	P_4 " " "	= 34 × 23	68

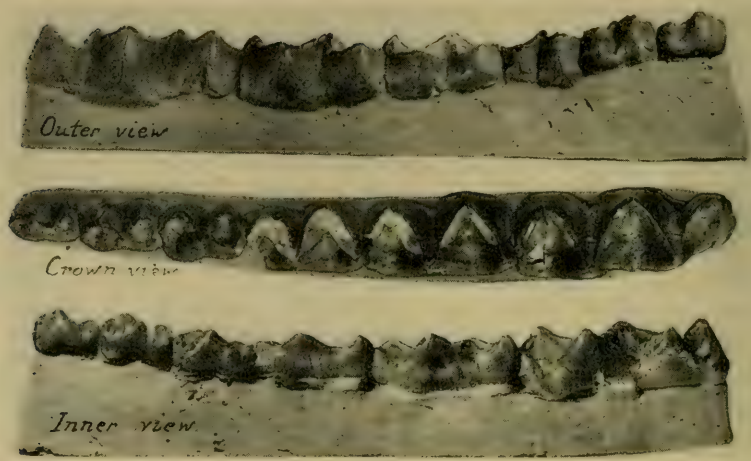

Fig. 1. *Protitanotherium mongoliense*, new species.

Type lower grinding teeth, P_2-M_3, of the right side (Amer. Mus. 18653). After a photograph reduced to one-third natural size. From the Upper Eocene of Iren Dabasu, southeastern Mongolia. Amer. Mus. Exped. 1922.

Fig. 2. Type of *Protitanotherium superbum* (Amer. Mus. 2501).

Lower grinding teeth, P_1-M_3, of the right side. After a photograph reduced to one-third natural size. From the Upper Eocene of Utah, Uinta C formation. Amer. Mus. Exped. 1895.

It remains to be seen whether these two formations are of similar geologic age. The two species above described give a most interesting American aspect to the fauna of this region of Mongolia in Upper Eocene time.

The Expedition of 1923 adds a large number and variety of titanotheres from Mongolia apparently of Upper Eocene and Lower Oligocene age. This material represents three or four species and probably three genera; the animals are very large, medium, and small. The titanotheres must have been exceedingly abundant. These animals will be described by the present writer in a succeeding number of American Museum Novitates.

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CADURCOTHERIUM FROM MONGOLIA[1]

By Henry Fairfield Osborn

Six Tertiary formations have thus far been determined in Mongolia, as follows:

Horizon Names	Field Notes	Museum Notes
Hung Kureh	*Mastodon* and *Cervus*—2000′	*Hipparion, Castor*
Hsanda Gol	*Baluchitherium* and rodents—3000′	*Baluchitherium grangeri* type
Houldjin	Rhinoceros and *Baluchitherium*—50′	
Ardyn Obo	Rhinoceros—500′	*Cadurcotherium, Schizotherium*
Shara Murun	Titanothere beds—50′	*Protitanotherium mongoliense* type
Irdin Manha	Lophiodont beds—50′	*Desmatotherium mongoliense* type

The Ardyn Obo formation was named and defined by Berkey and Granger in American Museum Novitates No. 77, p. 12. The fauna was judged in the field to be of mid-Tertiary age, not very different from the Hsanda Gol and Houldjin formations in other Tertiary basins in Mongolia. The preliminary examination in the Museum of the material collected in 1922 confirms this judgment and likewise confirms the suspicion intimated by Berkey and Granger that they are either of different facies or of somewhat different geologic age. A preliminary list of the fauna follows:

Canidæ, cf. *Cynodictis;* part of lower jaw
Amynodontidæ
  Cadurcotherium ardynense, new species; skulls, jaws, etc.
?Rhinocerotidæ
  New genus and species; upper jaw, etc.
Chalicotheriidæ
  Schizotherium, new species; M_3.
Cervidæ
  New genus and species; lower jaws
Chelonia
  Testudo, large species; parts of shell
  Emydid, gen. indet.; fragments of shell
  Trionychid, gen. indet.; plates of carapace

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Publication No. 12.

The little cervid is the only element in common with the Hsanda Gol fauna except for the doubtful *Cynodictis* and perhaps the chelonians (not yet studied). *Cadurcotherium*, the extreme evolutionary stage in the family Amynodontidæ, appears to be represented by teeth and other fragments in the Houldjin fauna. Larger collections from the three Oligocene formations (Ardyn Obo, Hsanda Gol, and Houldjin) will presumably increase the common elements and means of comparison. At present, while it appears that all three are of Oligocene age, a more exact correlation would be premature.

Cadurcotherium ardynense, new species

Type.—Amer. Mus. 19154; skull with lower jaw, fore and hind limbs and feet probably associated. With this are a young lower jaw and several limb and foot bones of other individuals.

Paratypes.—Amer. Mus. 19155–19158; upper and lower jaw fragments and teeth.

Horizon and Locality.—Ardyn Obo formation, Promontory Bluff, Ardyn Obo basin, about 350 miles west of Kalgan on the Sair Usu caravan trail.

Family and Generic Characters.—Dentition $\frac{3 \cdot 1 \cdot 3 \cdot 3}{1 \cdot 1 \cdot 2 \cdot 3}$ (the incisors are not known in the Mongolian animal). Teeth moderately hypsodont, premolars reduced and crowded, molars compressed transversely, the transverse crests short and strongly oblique. Canines enlarged, vertical, of subcircular cross-section save at the unworn tip, the tips usually worn to a flattened oblique shear, anterior on the upper, posterior on the lower canines. Digits 4–3, the fifth metacarpal only a little smaller than Mc II or IV; the metacarpals considerably longer than the metatarsals.

Distinctions from *Metamynodon*.—(1) Upper premolars with the inner crests completely joined into an inner crescent, the wings extending to the external angles, and enclosing a deep round median fossa at almost all stages of wear. In *Metamynodon* the inner crests are more or less distinct and transverse. In European species of *Cadurcotherium* the condition is more or less intermediate. (2) Lower premolars like those of *Cadurcotherium cayluxi* and *minus;* P_3 very small and simple with two small subparallel crests extending backward from apex of main cusp; P_4 submolariform with obliquely transverse inner crests, anterior, median, and posterior, simulating the transverse lophs of the molars. In *Metamynodon* both P_3 and P_4 are of this submolariform type. (3) Limbs and feet small and slender in comparison with *Metamynodon*, proportioned much as in *Aphelops megalodus* except that the metacarpals are considerably more elongate. The metapodials are both smaller and more slender than in *Amynodon*, and lack the peculiar broad flattening of the shafts that distinguishes both *Amynodon* and *Metamynodon*.

Specific Characters.—About the size of *Cadurcotherium cayluxi*, but the molars appear to be shorter crowned, the upper premolars have the median fossa more fully developed. Other characters may appear when the type is completely prepared. As the skull and feet of *Cadurcotherium* have not hitherto been known, the new species will add materially to what is known of the genus as well as extend its distribution to a region hitherto unknown palæontologically.

Cadurcotherium indicum Pilgrim of the Gaj series of India is of much larger size and different in other particulars enumerated by Doctor Pilgrim.

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56.81,9(117:51.7)

TWO LOWER CRETACEOUS DINOSAURS OF MONGOLIA[1]

By Henry Fairfield Osborn

The Third Asiatic Expedition of 1922 discovered four formations which, from preliminary definition and examination of the fossils they contain, were referred to the Cretaceous, namely:

Fig. 1. Route of Third Asiatic Expedition in Mongolia, 1922, showing the localities of the Cretaceous and Tertiary formations discovered.
*Cretaceous formations; °Tertiary formations.

Iren Dabasu Formation, southeast Mongolia, containing (1) predentate dinosaurs, probably of the bipedal type; (2) carnivorous dinosaurs of at least two genera, the smaller one being of the *Ornithomimus* type; (3) crocodiles; (4) turtles of the *Trionyx* type; (5) a few pelecypod shells.

Ondai Sair Formation, Ussuk, Tsagan Nor basin, western Mongolia, containing skeleton (Amer. Mus. 6253) articulated and nearly complete, except skull which is mostly weathered out.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Publication No. 13.

Ashile Formation, Artsa Bogdo basin, western Mongolia, containing skeleton (Amer. Mus. 6254) in sandstone, tail and pelvis mostly weathered out, skull and jaws, backbone and large part of limbs in block.

Dja-doch-ta Formation, Kwei-wa-ting trail, east of Artsa Bogdo, Mongolia, containing type skull of *Protoceratops andrewsi;* nearly complete skull (Amer. Mus. 6251) and lower jaws, hornless and far smaller than that of any known ceratopsian or ankylosaur, being only about 160 mm. in length, as fully described by Granger and Gregory.

The geographic location of these four Cretaceous formations is shown in the accompanying sketch map (Fig. 1). The relative age of each can only be determined by careful comparison of the fauna found. The only specimens carefully examined up to the present time are the *Protoceratops andrewsi* type and the two new types from the Ondai Sair and Ashile formations to be described in the present bulletin.

Ashile Formation

Psittacosaurus mongoliensis, new genus and species

The type of this new genus and species (Amer. Mus. 6254) is an almost perfect skull and jaws of an adult animal, with the skeleton, including the backbone, tail and pelvis and most of the limbs, in the block. This superb specimen, locally known as the Red Mesa (Ohshih) skeleton, was discovered by the Third Asiatic Expedition in the Artsa Bogdo basin through the bright observation of Wong, the Mongolian chauffeur engaged in Urga. At the time of the present description its characters are not fully known, because the partly exposed teeth (Fig. 2*A*) are not yet worked out and the skeleton still lies in the matrix. On the revelation of these still concealed characters the question of the affinity of *Psittacosaurus* to *Protiguanodon* will be decided.

The proportions of this skull are relatively short, deep, narrow in the facial region, broad in the cranial region. Teeth apparently confined to the maxillaries and dentary, crowns closely compacted; dentition not fully exposed. Functions of edentulous premaxillary and predentary element below suggested by powerful cutting and crushing rostrum or beak, for which the name *Psittacosaurus,* or parrot-beaked saurian, has been suggested by Dr. Gregory.

Left Lateral Aspect (Fig. 2*A*).—Premaxillary distinct, uniting by suture with nasals. Edentulous borders of premaxillary and anterior portion of maxillary. Small narial opening, large orbital, large latero-temporal, small auditory fenestræ. Sutures of premaxillaries, prefrontals, supraorbitals, postorbitals, squamosal, partly separated. Quadrate

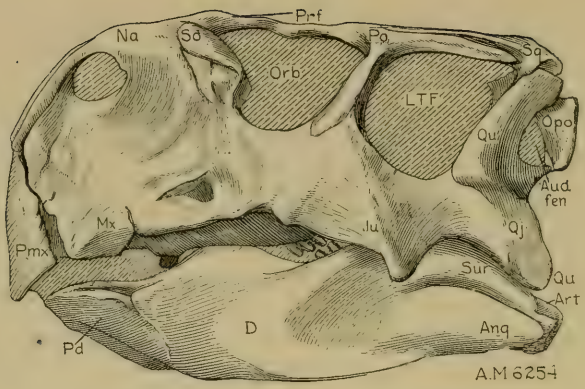
deep, forming anterior border of auditory fenestra, coössified with quadratojugal element below. Prominent osseous horns on sides of jugals. Broad and powerful jugal and infraorbital bar, indicating powerful muscles to control mastication, beak sheathed in horn. In the powerful jaw, surangular, angular, dentary and predentary regions fairly indicated; predentary coalesced with dentary in type.

Right Lateral Aspect (Fig. 2*B*).—In this aspect the tubercular dermal armature of the side of the throat is revealed, consisting of numerous rounded dermal cones, which represent minute ostoses. Whether this armature belongs to the side of the jaw or is a throat armature slipped out of place is difficult to say; it corresponds in general appearance with some of the throat armature observed in the Ankylosauria. Similar rudimentary armature may have extended over the surface of the skull preliminary to the formation of dermal plates, as observed in the armored *Stegoceras* and *Ankylosaurus*. In other features the right lateral aspect agrees with the left, except that the supraorbital is less clearly exposed and the premaxillary is more firmly united with the maxillary.

Superior Aspect (Fig. 2*C*).—In this aspect the general triangular form of the skull, the broadened cranial, the narrow facial and rostral region are clearly shown, reminding us of the *Protoceratops andrewsi* skull. The orbital, laterotemporal and supratemporal fenestræ are clearly shown, placing this skull with the Diapsida group. The nasals, supraorbitals, postorbitals, squamosals and quadrates are shown. Beyond the auditory fenestra lies the paroccipital process of the opisthotic element. The sutures of the mid-cranial region are closed and the boundaries of the cranial bones not clearly defined.

Posterior Aspect (Fig. 2*D*).—In this aspect the skull is seen to be still partially enclosed in matrix. The borders of the occipital foramen, of the auditory and of the post-temporal fenestræ may be seen. The powerful quadrate exhibits its sutural line of union with the quadratojugal. The cranium itself is shallow but is given a depressed aspect by the downward extension of the quadrates and lateral osseous jugal horns.

Anterior Aspect (Fig. 2*E*).—In front aspect the parrot-beaked rostrum of *Psittacosaurus* is well shown, also the relation of the dermal armature of the right side of the skull (left in this figure) to the osseous jugal horns. It is the correlation of these horns with the dermal armature which first led the writer to the opinion that this animal may be ancestral to some member of the armored suborder Ankylosauria. In this front aspect the sutures of the maxillaries, nasals, prefrontals, supraorbitals,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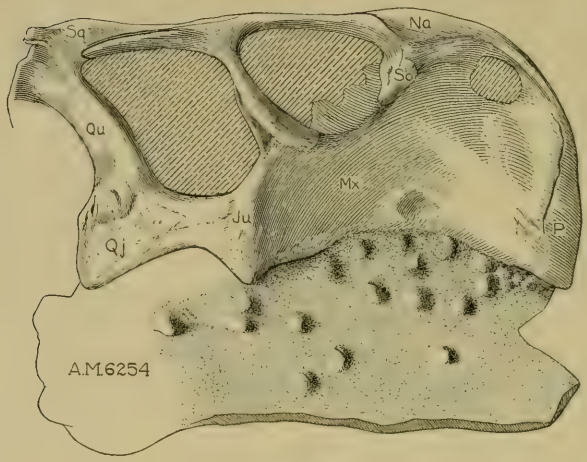
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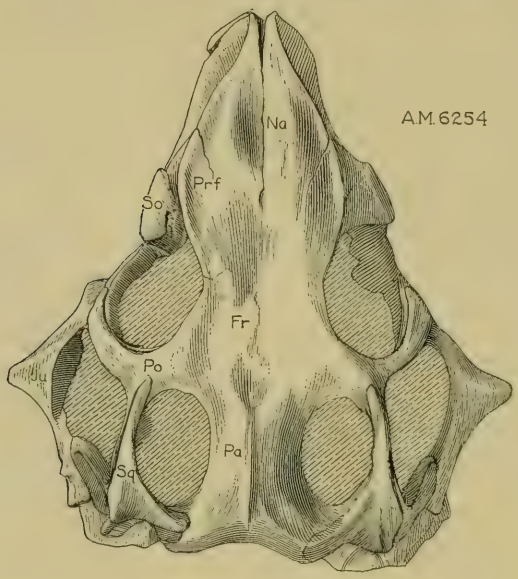
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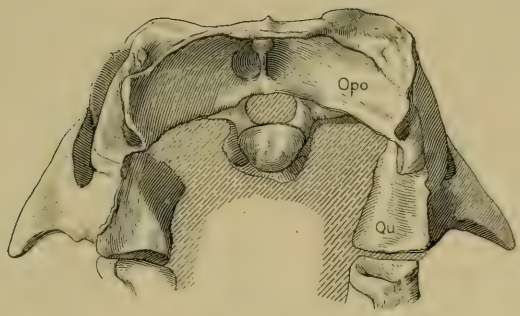

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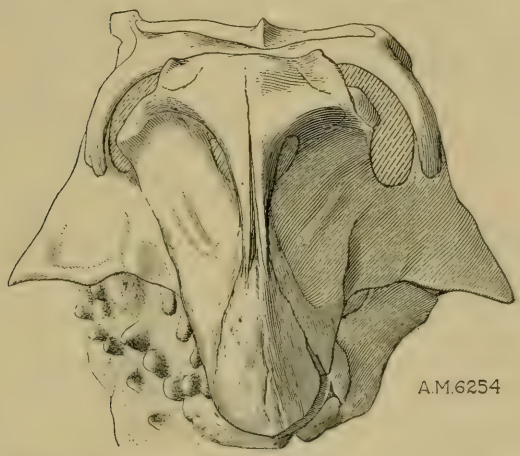

2E

Fig. 2. *Psittacosaurus mongoliensis*, type skull (Amer. Mus. 6254).

A. Left lateral aspect. One-half natural size.
B. Right lateral aspect, showing impressions of dermal armature beneath the osseous jugal horns. One-half natural size.
C. Superior aspect. One-half natural size.
D. Posterior aspect. One-half natural size.
E. Anterior aspect, showing dermal armature of the right side below quadratojugal horns. One-half natural size.

may be partly detected, as indicated in the drawing. It appears that the narial and orbital fenestræ face partly forward.

Psittacosaurus mongoliensis

Herbivorous diapsid reptile with predentary bone and horny beak. Maxillary teeth compressed, not fully known. Skull short and deep, narrow anteriorly, broad posteriorly. Rostrum prominent, parrot-like, edentulous. Nostrils small, orbits large. Infraorbital region and jaw heavy, with attachment for powerful muscles. Primitive dermal armature in head region; lateral osseous horns on jugals.

Genotype of **Psittacosauridæ,** new family. Skeleton and teeth only partly known; supposed primitive armored dinosaurs, possibly related to the fully armored Upper Cretaceous types.

Protiguanodon mongoliense

Probably a diapsid reptile with predentary bone and horny beak. Nine teeth on the dentary, of iguanodont pattern. Rostrum short, jaw very deep but relatively slender. Teeth less compacted than in *Psittacosaurus.* Skull probably deep and short, without rostral prolongation. No evidence of dermal armature. Skeleton of Pro-Iguanodontia type; limbs of prebipedal type. Manus functionally tridactyl with vestigial IV. Pes functionally tetradactyl with vestigial V. Prominent prepubic process. Ilium, scapulæ and limbs of Pro-Iguanodontia type. Osseous tendons and tail indicating bipedal locomotion.

Genotype species of subfamily Protiguanodontinæ.

Ondai Sair Formation

Protiguanodon mongoliense, new genus and species

The type of this new genus and species is a nearly complete, articulated skeleton (Amer. Mus. 6253) lying on its ventral face, with the four limbs prone, the left jaw and portions of the skull weathered out, as represented in the diagram (Fig. 3). This figure, drawn by Mr. John Germann, exhibits only the parts from which the matrix had been removed at the time of writing and serves to supplement this preliminary description.

The animal is 53 inches (1350 mm.) in length; the outstretched fore limb measures about 12 inches (340 mm.); the outstretched hind limb measures about 480 mm., 140 mm. longer than the fore limb. These proportions are of a prebipedal type, in which the fore limb occasionally touches the ground. The balancing tail measures 710 mm. from the center of the ilium to the tip. The thoracic vertebræ measure 340 mm. from the center of the ilium to the base of the scapula. The neck has not yet been exposed and its length cannot now be established.

Peculiar iguanodont features are the ossified tendons lying above the transverse processes of the thoracic vertebræ; another iguanodont

Fig. 3. Type skeleton of *Protiguanodon mongoliense* (Amer. Mus. 6253) from Ondai Sair Formation, as seen from above.

In exposing this skeleton no trace of dermal armature was observed. The jaw and the summit of the skull are placed approximately as found. One-ninth natural size.

character is the presence of 11 stomach-stones opposite the superior border of the scapula.

The contour and proportions of the scapula and of the ilium are well shown in the diagram. Below the anterior border of the ilium is a prepubic extension of the pubis; the postpubis has not yet been exposed from the matrix. The manus is tetradactyl: I, Mtc, short, with two phalanges; II, intermediate, with three phalanges; III, elongate, with four phalanges; IV, vestigial, with single phalanx. Three equal-sized carpals. The pes is pentadactyl: I, Mts, short, with two phalanges; II, elongate, three phalanges; III, most elongate, four phalanges; IV, same length as Mts II, five phalanges; V, vestigial, one phalanx. Manus

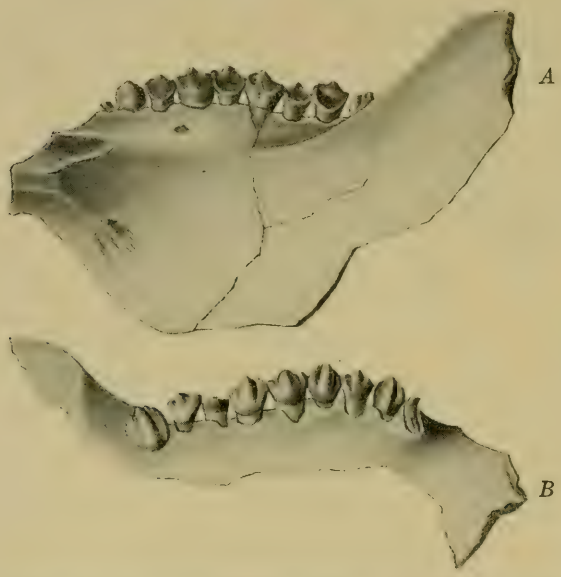

Fig. 4. Type jaw of *Protiguanodon mongoliense* (Amer. Mus. 6253).

A. External view of dentary, showing in the outer aspect the nine dentary teeth. Natural size.
B. Inner aspect of the upper portion of the dentary, showing same nine teeth from the sculptured internal surface.

and pes, although differing in size, are homodynamous. Four tarsals are observed, including an astragalus closely united with the tibia. Both manus and pes are in the same stage of evolution as those of *Hypsilophodon*, except that the Wealden genus has four digits in the manus.

Affinity to the suborder Iguanodontia is revealed in these skeletal characters, which indicate a prebipedal stage. The affinity shows still more clearly in the jaw (Fig. 4) and teeth, as worked out of the matrix by

Mr. Falkenbach and carefully drawn by Mr. R. Weber. Of the nine teeth in the dentary, the unworn ninth tooth of the left side of the mandible shows a most clearly typical structure, consisting of a prominent median ridge, with lesser anterior and posterior ridges serrated along the superior border. Less worn teeth are No. 4 and No. 6; in more advanced wear are the apparently trilobed Nos. 3 and 8; completely worn are Nos. 1 and 7. In external aspect the triserrate interior view of No. 9 appears in front of the anterior border of the coronoid. The jaw itself is short and deep, apparently edentulous anteriorly, a thin border rounding inwards, as shown in Fig. 4. Thus the animal is short-jawed.

Comparing this animal with *Hypsilophodon* of the Wealden, with *Thescelosaurus* of the Lance, with the three genera composing the family Laosauridæ of Marsh (*Nanosaurus*, *Laosaurus*, *Dryosaurus*), and with the families Iguanodontidæ and Trachodontidæ, we may define it as belonging to a new genus, *Protiguanodon*, typified by the genotypic

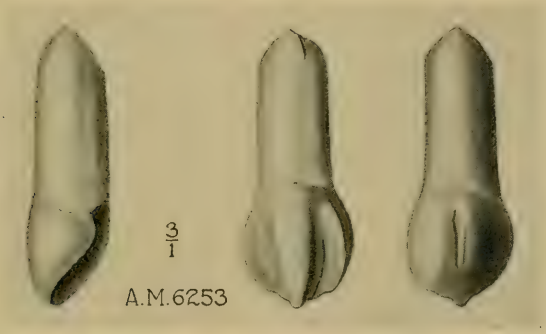

Fig. 5. Greatly enlarged (×3) anterior, exterior and interior aspects of a single tooth, which may belong in the maxillary series.

species *Protiguanodon mongoliense*. When more fully known it may prove to belong to a distinct subfamily of the Iguanodontidæ, for which the subfamily name Protiguanodontinæ would be appropriate.

The writer is of the opinion that this animal is distinct from the reptile above described, but Dr. W. K. Gregory, to whom the writer is deeply indebted for valuable notes and comparative observations, considers that it represents a juvenile stage of an animal similar to the very adult stage which constitutes the type of the genus *Psittacosaurus*. In favor of the view that the animals are the same are (1) close similarity in

size; (2) close resemblances in the parietals of the skull, as far as observed in this type, with that of the skull described above ; (3) general similarity in the quadrate. Against the idea that these animals belong together are the following: (1) absence of dermal armature; (2) comparative unlikeness of the skeleton and skull, as far as observed; (3) wide geologic separation of the two types. The question will be positively settled by the following means: (1) by the complete exposure of the dental series in *Psittacosaurus;* (2) by the exposure of the skeleton in the same; (3) by minute comparison of the tooth structure of the two types. In case the animals prove to be the same, *Psittacosaurus* will have precedence.

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Article XVI.—SKULL CHARACTERS OF *ALLIGATOR SINENSE* FAUVEL[1, 2]

By Charles C. Mook

When the skull characters of the recent species of Crocodilia were described by the writer in 1921[3] no skull of *Alligator sinense* was available for study, in consequence of which this species was dismissed with a brief summary of characters taken from Boulenger's 'Catalogue of the Recent Reptilia in the British Museum.'

In 1922 the American Museum received a number of skins, skulls, and skeletons of the Chinese alligator, collected by the Third Asiatic Expedition. This material sheds light upon previously unknown characters of this species and forms the basis of the present communication. This description is based particularly upon one skull (A. M. N. H. No. 23898) and many of the characters have been verified upon three other skulls (A. M. N. H. Nos. 23899, 23900, 23901).

General Form

The skull is short and broad. It is relatively shorter than that of *A. mississippiensis* and resembles in this respect the Miocene *A. thomsoni*. The height is greater than in the Florida species.

The snout is moderately broad at its anterior end and expands rapidly to the level of the fourth maxillary teeth, then contracts slightly to the level of the sixth maxillary teeth, back of which it expands again. The length of the snout is one and one-sixth times as long as its breadth at the base.

The interorbital plate is situated at a distinctly higher level than the snout and descends abruptly at its anterior end. A pair of prominent ridges extend forward and outward along the anterior borders of the orbits to points slightly in front of the semi-detached supraorbitals and then extend directly forward over the base of the snout. In this character the skull resembles those of the various species of *Jacare* and that of *A. thomsoni* but differs from that of *A. mississippiensis*. The interorbital plate is relatively narrow and is uprolled at its edges. It is also slightly convex in antero-posterior profile.

The cranial table is short antero-posteriorly but rather broad laterally. Its lateral borders converge in the anterior direction at such

[1]Contributions to the Osteology, Affinities and Distribution of the Crocodilia, No. 12.
[2]Publications of the Asiatic Expeditions of The American Museum of Natural History. Publication No. 14.
[3]Bull. Amer. Mus. Nat. Hist., XLIV, Art. 13, pp. 123–268.

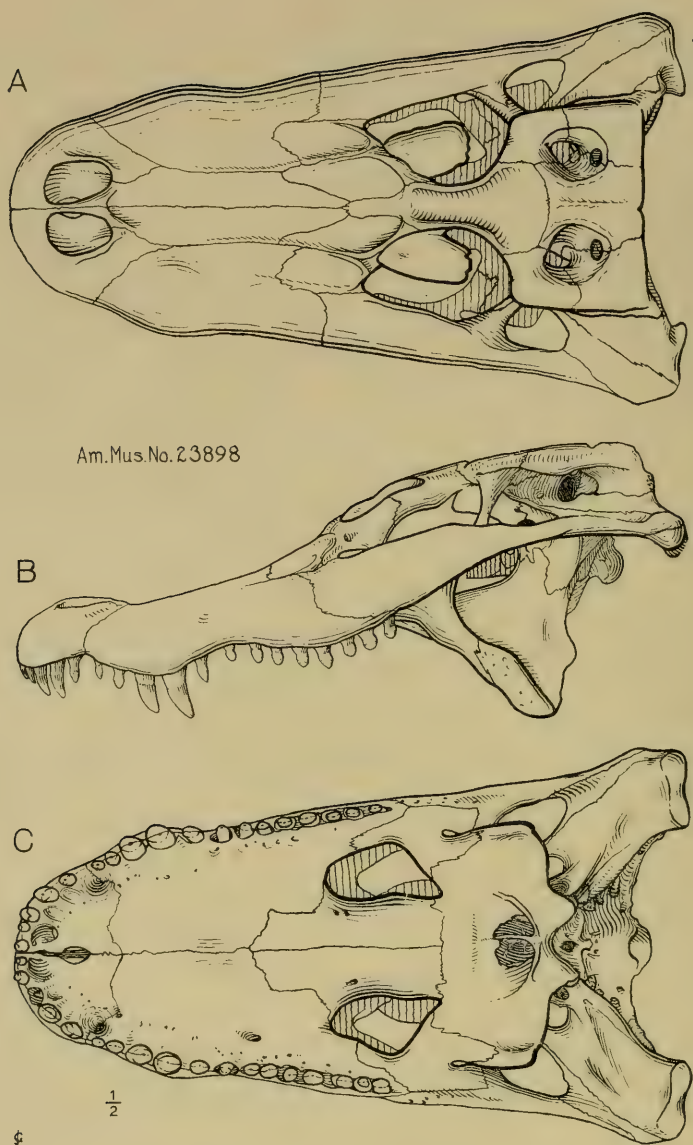

Fig. 1. *Alligator sinense* Fauvel.

Skull (Amer. Mus. No. 23898). One-half natural size. A, superior view; B, lateral view, left side; C, inferior view.

an angle that, if produced forward, they would meet slightly beyond the tip of the snout. The plate between the supratemporal fenestræ is of moderate breadth and is distinctly uprolled at its edges. The lateral borders of the skull are more distinctly wavy than in the southern alligator.

The Cavities of the Skull

Supratemporal Fenestræ.—The supratemporal fenestræ are large at the surface of the cranial table but diminish rapidly in size in depth. Viewed from above, less than half of the area of each fenestra penetrates to the base of the brain-case. The larger part, chiefly posterior, is very shallow and is floored by portions of the parietal and squamosal bones. The small internal cavities which extend from the supratemporal fenestræ to the aural passages are in most crocodilians nearly or quite invisible when the skull is viewed from above; in this species they are entirely visible from above. The edges of the fenestræ are distinctly uprolled, especially on the postero-internal borders. In this character they differ from those of *A. mississippiensis* and *A. thomsoni*. In shape the fenestræ are irregular and not smoothly rounded. Their outlines end posteriorly in rather blunt points and anteriorly, or rather antero-externally, in sharp points. There is a certain amount of variation among the various individuals in regard to this character. The space between the fenestræ is relatively broad.

Infratemporal Fenestræ.—These fenestræ are of moderate size. Their chief point of interest is that their triangular outline is more rounded than in most crocodilians.

Orbits.—The orbits are large. They are irregular in outline; their posterior and postero-internal borders are broadly rounded; their antero-internal borders are nearly straight, as are their external borders. They end anteriorly in rather sharp points, which are nearer their external than their internal boundaries. The length of the orbits is considerably greater than their breadth. The interorbital plate is of moderate breadth; its borders are sharply uprolled. In all of the specimens the anterior ends of the orbits lie over several maxillary teeth. This character indicates immaturity in all of them.

External Nares.—The external narial aperture is broader than it is long. The bony bar which divides it into right and left elements at the surface is moderately stout. It is composed chiefly of the anterior processes of the nasals, but partly of processes of the premaxillaries. In outline the cavity is a somewhat rounded quadrilateral, whose anterior

border is slightly curved and whose lateral borders converge slightly in the posterior direction. The posterior border is very irregular. The lateral borders are distinctly elevated above the general level of the anterior end of the snout. The median bar is also elevated and the posterior border slightly so.

Premaxillary Foramen.—This foramen is very small; on the median line it occupies less than one-third of the distance between the tip of the snout and the premaxillo-maxillary suture. It is acutely pointed at both anterior and posterior ends and its lateral borders are simple curves.

Palatine Fenestræ.—The palatine fenestræ are small and are very irregular in shape. In this the species differs from *A. mississippiensis*. The internal borders are nearly straight parallel lines throughout the posterior two-thirds of their lengths; the anterior thirds diverge rapidly. The external borders are composed of two components of about equal length, which make pronounced angles with each other slightly posterior to the level of the last maxillary teeth. About one-fifth of each external border consists of maxillary bone, the ectopterygoid portion comprising nearly four-fifths, with a minute portion at the posterior end consisting of pterygoid; the entire internal border is composed of palatine. The maximum breadth is considerable in proportion to the maximum length. The anterior end is broadly rounded but the posterior end is acute. The anterior end is situated at the level of the space between the tenth and eleventh maxillary teeth.

Internal Narial Aperture.—This aperture is completely divided by a median vertical plate. On its anterior border at the median line is situated a slight but distinct elevation. Posterior to the aperture is a prominent vertical ridge, approximately semicircular in outline, which completely separates the depression, of which the aperture is the center, from the postero-external elevated flanges of the pterygoid bone.

The Bones of the Skull

Premaxillaries.—The premaxillaries are considerably broader in proportion to their length on their superior surfaces than in the Florida alligator. Their posterior processes are of moderate length, extending backward from the level of the second to that of the fourth maxillary teeth. A small process of both premaxillaries extends backward from the anterior end of the narial aperture to meet the anterior process of the nasals, as in *A. mississippiensis*. The edges of the premaxillaries forming the lateral borders of the aperture are turned sharply upward however,

differing in this character from those of the Florida species. The posterior end of the narial aperture is situated farther back than in the latter species with respect to the level of the premaxillo-maxillary sutures at the lateral borders of the skull.

On the palate the proportion of length to breadth is the same as in the Florida alligator. There are two deep pits on each side, one posterior to the space between the first and second teeth, the other at the premaxillo-maxillary suture. The first of these lodged the first mandibular tooth, the second, the fourth mandibular tooth. On the median line the distance from the anterior end of the premaxillary foramen to the anterior border of the skull is equal to the distance from the posterior end of the foramen to the premaxillo-maxillary suture.

The suture between the premaxillaries and the maxillaries differs from that of *A. mississippiensis.* It extends inward and backward from the external border, across the pit for the fourth mandibular tooth, to a point half-way between the external border and the median line and at the level of the space between the first and second maxillary teeth; from this point it extends inward and slightly forward half-way to the median line, then turns inward and backward and meets the median line at the level of the spaces between the first and second maxillary teeth. From the median line it extends in a symmetrical direction to the opposite border of the skull. The entire suture is therefore wavy in outline.

Each premaxillary contains five teeth, of which the fourth are the largest, the third second in size, the fifth third in size and the first and second very small. The teeth are evenly spaced.

Maxillaries.—These bones are short and broad. They are especially short along the sutures with the nasals; these sutures are less than one-fifth as long as the skull, in contrast to over one-fourth in a Florida alligator of slightly larger size. The sutures with the prefrontals are exceedingly short, being about one-fourth the length of the maxillo-lacrymal sutures. In the Florida alligator they are over one-half the length of the maxillo-lacrymal sutures. The sutures with the jugals are long, especially in their transverse portions. On the palate the maxillaries are especially short and broad. Comparison with a small skull of *Alligator mississippiensis* may be expressed as follows.

	A. sinense A. M. N. H. No. 23898	*A. mississippiensis* A. M. N. H. No. 12572
$\frac{\text{Length maxillaries, median line}}{\text{Length skull}}$	.215	.295
$\frac{\text{Length maxillaries, median line}}{\text{Maximum length, maxillaries}}$	.444	.500
$\frac{\text{Length maxillaries, median line}}{\text{Maximum breadth, maxillaries}}$	.451	.720
$\frac{\text{Length maxillaries, median line}}{\text{Length palatines, median line}}$	.682	.968

Each maxillary contains thirteen teeth, of which the fourth is the largest and the third is second in size. The first and second maxillary teeth are moderately stout and moderately sharp; the crowns of the posterior teeth are all small. The first six teeth are spaced moderately and evenly; the last seven are close together. In the largest skull studied (A. M. N. H. No. 23898) the first six maxillary teeth have separate alveoli and the last seven are lodged in a common alveolar groove. In smaller skulls, however, not at present thoroughly cleaned, the posterior teeth, or at any rate, some of the posterior teeth, appear to have separate alveoli.

Nasals.—These bones are very short; on the median line they occupy considerably less than one-half the length of the skull. The anterior process, extending forward into the narial aperture, is moderately broad at its base and very narrow where it joins the process of the premaxillaries, extending back from the anterior border of the narial aperture. From the posterior border of the narial aperture the nasals broaden rapidly to the posterior extremities of the premaxillaries, which is the point of their greatest breadth. From this point back they narrow gradually to the anterior ends of the naso-prefrontal sutures, back of which they narrow rapidly to their blunt posterior extremities, which are situated slightly forward from the level of the anterior ends of the orbits. The sutures with the maxillaries are relatively short; those with the prefrontals are relatively long.

Prefrontals.—The prefrontals are moderately long. Their anterior ends extend forward as narrow processes, wedging apart the nasals and lacrymals and to a slight extent the nasals and maxillaries. Their contacts with the lacrymals are somewhat elevated into ridges and their orbital borders are greatly elevated, to a slight extent even overhanging. Their posterior processes are short and their contacts with the frontal are moderately so.

Lacrymals.—The lacrymal bones are relatively short and broad. Each suture with the prefrontal extends in a line which is almost parallel with the median line but which is inclined very slightly toward the median line in the anterior direction. The sutures with the maxillaries extend forward and outward irregularly from the anterior ends of the prefronto-lacrymal sutures to points near the external boundaries of the bones, then slightly outward and backward to join the straight lacrymo-jugal sutures. A small but conspicuous oblique ridge extends outward and forward from the postero-internal corner of each lacrymal to the center of the lacrymo-jugal suture, separating a small, low, smooth orbital surface from the more elevated pitted surface. The anterior extremities of the lacrymals are situated farther forward than those of the prefrontals. In this character the species differs from *A. mississippiensis.*

Frontal.—The anterior process of the frontal is smooth and is relatively short. It does not wedge apart the nasals at their posterior extremities but ends abruptly. The interorbital portion is narrow and is decidedly uprolled at the edges. The pitting is arranged in such a manner in this portion of the bone as to leave a distinct but slight median ridge. The posterior portion is relatively broad. The sutures with the postorbitals are very short; the suture with the parietal is a simple curve, the convexity being directed backward. The frontal is entirely removed from the supratemporal fenestræ, thus differing somewhat from that of the Florida alligator.

Postorbitals.—The postorbitals are slightly longer than broad; in *A. mississippiensis* they are considerably longer than broad. They also differ from those of the latter species in occupying a larger proportion of the external border of the cranial table.

Squamosals.—The proportion of the breadth to the length of the squamosals is greater than in the Florida alligator, and the sutures of these bones with the parietal are less symmetrically curved than in the latter species.

Parietal.—This bone occupies a considerable portion of the surface of the cranial table anterior to the supratemporal fenestræ as well as posterior to them. It occupies nearly a third of the posterior border of the cranial table. Its interfenestral plate is relatively broad, compared with *A. mississippiensis.* It is somewhat uprolled at its external, or fenestral, borders. A low median ridge serves to distinguish it readily from that of the American species.

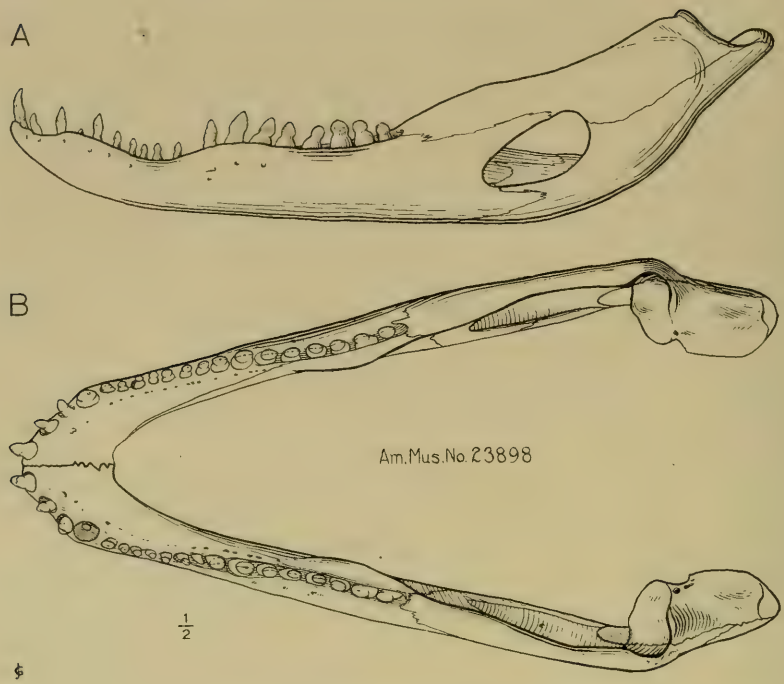

Fig. 2. *Alligator sinense* Fauvel.

Mandible (Amer. Mus. No. 23898). One-half natural size. A, lateral view, left side; B, superior view.

Supraoccipital.—As in *A. mississippiensis* this bone occupies no portion of the border of the cranial table. On the posterior surface of the skull it is narrow laterally and deep vertically. It extends downward to a point about four-fifths of the total distance from the foramen magnum to the cranial table, below the latter.

Exoccipitals.—These bones are relatively deep in the vertical direction. They comprise small portions of the occipital condyle.

Basioccipital.—This bone comprises most of the occipital condyle but not all of it.

Basisphenoid.—This bone is not especially characteristic.

Quadrates.—The quadrates are stout in proportion to their length and their articular surfaces are unusually broad.

Quadrato-jugals.—These bones do not differ from those of *A. mississippiensis* in any characteristic way.

Jugals.—The jugals are relatively larger than in the Florida species and differ from those of the latter in form. Their length is over half the

total length of the skull and they occupy a large portion of the lateral surface of the skull. Their posterior processes are slender, as in the American form, but the anterior processes are much greater than in the latter. The maximum height of each jugal in *A. mississippiensis* is considerably behind the posterior end of the maxillary, near the posterior end of the orbit; in *A. sinense* it is over the posterior process of the maxillary, near the level of the anterior end of the orbit. The suture with the maxillary differs considerably from that in the Florida alligator.

Palatines.—The palatines of this species differ considerably from those of *A. mississippiensis* and in fact of all other crocodilians. Their sutures with the maxillaries extend inward and slightly forward from the anterior ends of the palatine fenestræ about half-way to the median line, then turn directly forward or with a gentle curve whose concavity faces outward to the level of the eighth maxillary teeth, then either directly inward (A. M. N. H. No. 23899) or inward and forward (A. M. N. H. No. 23898) to meet at the median line. The interfenestral portions are very broad and their fenestral borders are nearly parallel. Their pterygoid borders form a nearly straight line.

Pterygoids.—The pterygoids are not especially distinctive. They are considerably arched and the ridge back of the internal narial aperture is unusually high. The aperture is divided, as in the Florida species.

Ectopterygoids.—These bones are very short antero-posteriorly and are very stout.

The Mandible.—The mandible is relatively broader in proportion to its length than in the Florida alligator, the rami diverge at a relatively sharper angle, and the individual elements are all stouter. The symphysis extends back to the level of the fifth mandibular teeth, contrasting with the short symphysis reaching only slightly back of the level of the third in the American species. The splenials do not enter the symphysis but extend forward within a relatively minute distance of it; this is in contrast with the wide spaces between the anterior ends of the splenials and the symphysis in *A. mississippiensis*.

The dental borders occupy about half the length of the mandible, an unusual condition among the living crocodilians, probably approached only by *Jacare latirostris*. There are nineteen teeth in each ramus. The fourth is the largest of these and the thirteenth is second in size. The first teeth are moderately large and are widely separated from the smaller second, which are widely separated from the equal-sized third, which are moderately far from the fourth. Back of the fourth are seven small teeth close together. Back of the thirteenth the short blunt teeth are

all close together. The variation in the size and the arrangement of the teeth is quite different from that in *A. mississippiensis.*

The external mandibular foramen is relatively high in proportion to its length. Its surangular border is longer than in the American form. The internal mandibular foramen is relatively small.

Discussion

This species resembles the living Florida alligator very closely in some respects but differs from it quite markedly in others.

It has certain resemblances to the various species of *Jacare* which are absent in *A. mississippiensis.* These resemblances are offset by other more fundamental characters, however, and there is no evidence of close relationship.

The nearest approach to the structure of this species is to be seen in the Miocene *Alligator thomsoni,* recently described by the writer.[1] The species may therefore be considered more primitive than *A. mississippiensis,* though it has some specializations absent in the latter. *A. thomsoni* approaches *Allognathosuchus polyodon* from the Bridger, which in turn approaches *Allognathosuchus heterodon* of the Wasatch in a number of characters, so that we may consider the following as a logical morphological sequence: *Allognathosuchus heterodon* (Eocene); *Allognathosuchus polyodon* (Eocene); *Alligator thomsoni* (Miocene); *Alligator sinense* (Recent); *A. mississippiensis* (Recent). This does not necessarily indicate a line of descent, but it does indicate that *Alligator sinense* serves partially to bridge the wide structural gap between *A. mississippiensis* and the earlier Tertiary crocodilians. *A. mississippiensis* has been found in Pleistocene deposits. We await the discovery of *A. sinense,* or a very closely related form, in Pleistocene, or even Pliocene, deposits.

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[1]Amer. Mus. Novitates, No. 73.

56.9(1183:51.3)

Article XVII.—NEW FOSSIL MAMMALS FROM THE PLIOCENE OF SZE-CHUAN, CHINA[1]

By W. D. Matthew and Walter Granger

The following is a preliminary notice of a collection secured during the winter of 1920–1921 by Mr. Walter Granger, palæontologist of the Third Asiatic Expedition sent out by the American Museum, the American Asiatic Association, and Asia Magazine, under leadership of Mr. Roy C. Andrews. The locality is a series of pits or fissures at the village of Yen-ching-kao in the vicinity of Wan-hsien, province of Sze-chuan. These pits have been worked by the natives for many years for the Chinese drug trade. Mr. Granger's account of their occurrence and stratigraphic observations and more extended descriptions of the fauna will be published later, this notice serving to place certain interesting novelties upon record.

The age of the fauna is provisionally placed as Upper Pliocene on account of the abundance of *Stegodon* remains and absence of any higher type of Proboscidean, but its final correlation is left open for the present.

The Chinese fossil mammals described by Owen in 1870[2] came from "a cave near the city of Chung-king-foo in the province of Sze-chuan." Chung-king is on the Yang-tse-kiang above Wan-hsien, about one hundred and forty miles distant in an air line. If correctly reported by the finders, Owen's specimens could hardly have come from the Yen-ching-kao pits; but it is apparently the same fauna, or at all events of similar facies and doubtless the same conditions of preservation. Possibly the Chinese informants of Consul Swinhoe, who sent the fossils to Owen, misled him, unintentionally or deliberately, as to the locality. This point will be further discussed at a later date. Owen regarded the fauna as Pliocene and described the following species:

Stegodon orientalis.	Parts of molars.
Rhinoceros sinensis.	Parts of 4 upper and 4 lower molars.
Tapirus sinensis.	Parts of 3 upper and 4 lower teeth.
Chalicotherium sinense.	Part of an upper molar.
Hyæna sinensis.	Canine, 2 premolars.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History, Publication No. 15.

[2]Quar. Journ. Geol. Soc., London, XXVI, pp. 417–436, Pls. xxvii–xxix.

Fig. 1. *Rhinoceros sinensis* Owen. Amer. Mus. No. 18628. Palate of neotype skull. Natural size.

The first three genera are among the most abundant types of large animals in the Yen-ching-kao pits. *Chalicotherium* and *Hyæna* are rare. Owen's descriptions and figures accord very well with some of the species in our collection, so that we have referred them to his species, whether or not later investigation proves them to be exact topotypes.

Koken in 1885[1] described a collection secured by von Richthofen, apparently from the trading junks of the Yang-tse-kiang and understood by him to have come from far up the river in "caves in Yun-nan." Whether this was the real locality remains to be verified; one has the impression from the reading of von Richthofen's letter, quoted by Koken, that the traveller himself suspected that the locality might not have been correctly stated. It is certain at all events that the major part of Koken's collections, like Owen's, represent substantially the same faunal facies, and they seem to agree as to species, in part at least, with our collections. Koken also distinguishes an older fauna of supposed Lower Pliocene age, including *Hipparion*, *Camelopardalis*, *Palæomeryx*, etc., which is more extensively represented in Schlosser's later collections, and is probably substantially the same fauna as the fine collections secured recently by J. G. Andersson[2] and now being studied by Professor Wiman.

Schlosser in 1903[3] described a large collection secured by Dr. Haberer for the Munich museum, and revised the work of Owen, Koken and other previous writers. He concluded that Owen's fauna, except *Stegodon*, and most of Koken's material, was of Pleistocene age. There is no doubt, however, that the *Stegodon* is coeval with the rest of the fauna in Granger's collection, and one may assume that it was probably so in the Owen and Koken collections. Schlosser's material belonged mostly to the older Pliocene fauna distinguished by Koken and came from localities farther to the north.

The collections from Sze-chuan described by Professor Matsumoto in 1915[4] may have come in large part or all from the Yen-ching-kao pits; he does not state any exact localities, but the correspondence of the fauna is evident. Matsumoto divides the material studied by him into two faunas, one found in brown clay and more strongly petrified, the other in cave-loam, feebly fossilized and the teeth strongly colored. The former includes *Stegodon*, *Acerathèrium hipparionum*, *Proboselaphus watasei* and *liodon*, *Bibos geron* and two unnamed species of *Buffelus*. The latter includes *Hyæna ultima*, *Rhinoceros sinensis* and *R. plicidens*.

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[1]Koken, E. 1885. 'Fossile Saügethiere aus Chinas.' Pal. Abh., III, Heft 2.
[2]Andersson, J. G. 1922. Bull Amer. Mus. Nat. Hist., XLVI, pp. 727–737.
[3]Schlosser, Max. 1903. 'Fossile Saügethiere Chinas.' Abh. k. bayer. Akad. Wiss., XXII, Abt. 1
[4]Matsumoto, H. 1915. Science Reports, Tohoku Imp. Univ., Second Ser. (Geol.) III, No. 1, pp 1–28, Pls. I–X.

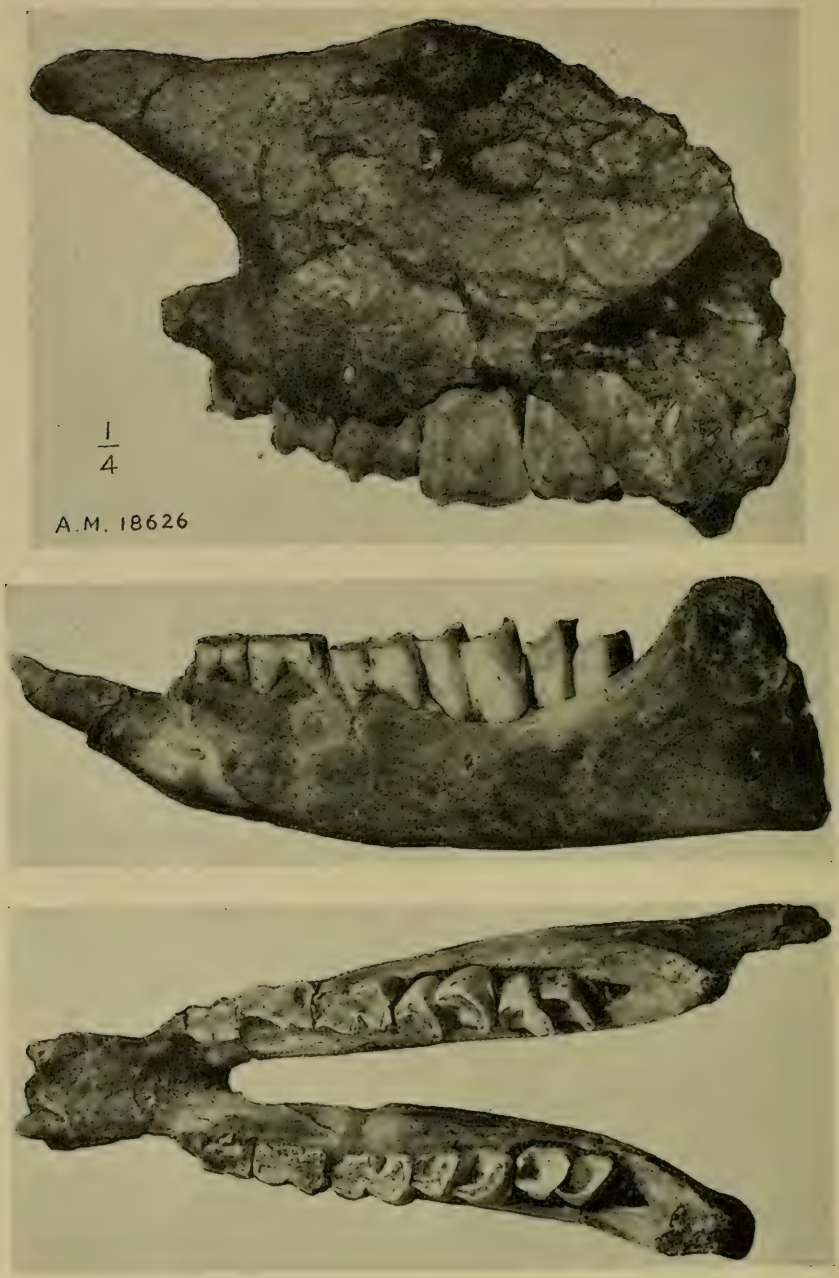

Fig. 2. *Rhinoceros sinensis.* Front of skull and jaws, No. 18626, young individual with milk dentition, the last molar not yet emerged and the second unworn. Natural size.

He regards the first as Upper Pliocene, the second as Lower Pleistocene. In our collections the *Stegodon* material was limited to certain pits occurring low down on the slopes of the mountain valley, and did not occur in pits higher up on the mountain; but we are provisionally disposed to regard this as a matter of limitation of range, and to consider the material from all the pits as of substantially the same geologic age.

Professor Matsumoto's researches[1] upon this and related faunas have been of peculiar value to us as a guide in searching for the probable affinities and identifications of our material.

The Granger collection includes skulls, jaws and numerous parts of jaws of *Stegodon* and *Tapir*, incomplete skulls and many jaws of *Rhinoceros*, a tooth of *Chalicotherium* and a large series of other animals, including a large bovid, smaller antelopes and two or three deer, a pig, various carnivora and a very abundant rodent.

The following notes upon certain described species are a necessary preliminary to the discussion of our new collections.

Stegodon orientalis Owen

Schlosser regards this species as identical with *S. insignis* of India, basing the reference upon the fragmentary teeth described by Owen. Matsumoto regards it as distinct, upon the evidence of the referred material which he describes and figures. The Yen-ching-kao material includes a fairly complete adult skull, two young skulls, a series of palates and lower jaws and many teeth. It should enable us to estimate the affinities of the species more exactly when it has been cleaned up and studied.

Rhinoceros sinensis Owen

Schlosser in his masterly review recognizes this species as valid and considers it most nearly related to *platyrhinus* of the Siwaliks and to the Atelodine group of Pleistocene and modern times. It was, however, practically absent from his Chinese collections at Munich, which seem to have come mostly from the "red clays" of Shan-si, Shen-si and Sze-chuan, but as they were not observed in place the real character and age of the formations remain doubtful. Probably they are chiefly Lower Pliocene. Most of the rhinoceros teeth he refers to *R. habereri*, related in his opinion to *R. palæindicus* and thus to the typical modern *Rhinoceros* of India.

Matsumoto appears disposed to assign *R. sinensis* to the *Teleoceras* group; but if our material be correctly referred, the affinities of Owen's

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[1]Matsumoto, H. 1915, *loc. cit.*; 1921, *idem*, V, No. 3, pp. 75–91, Pls. XIII–XIV.

Fig. 3. *Stegodon orientalis* Owen. No. 18630, adult skull, laterally crushed. One-fifth natural size.

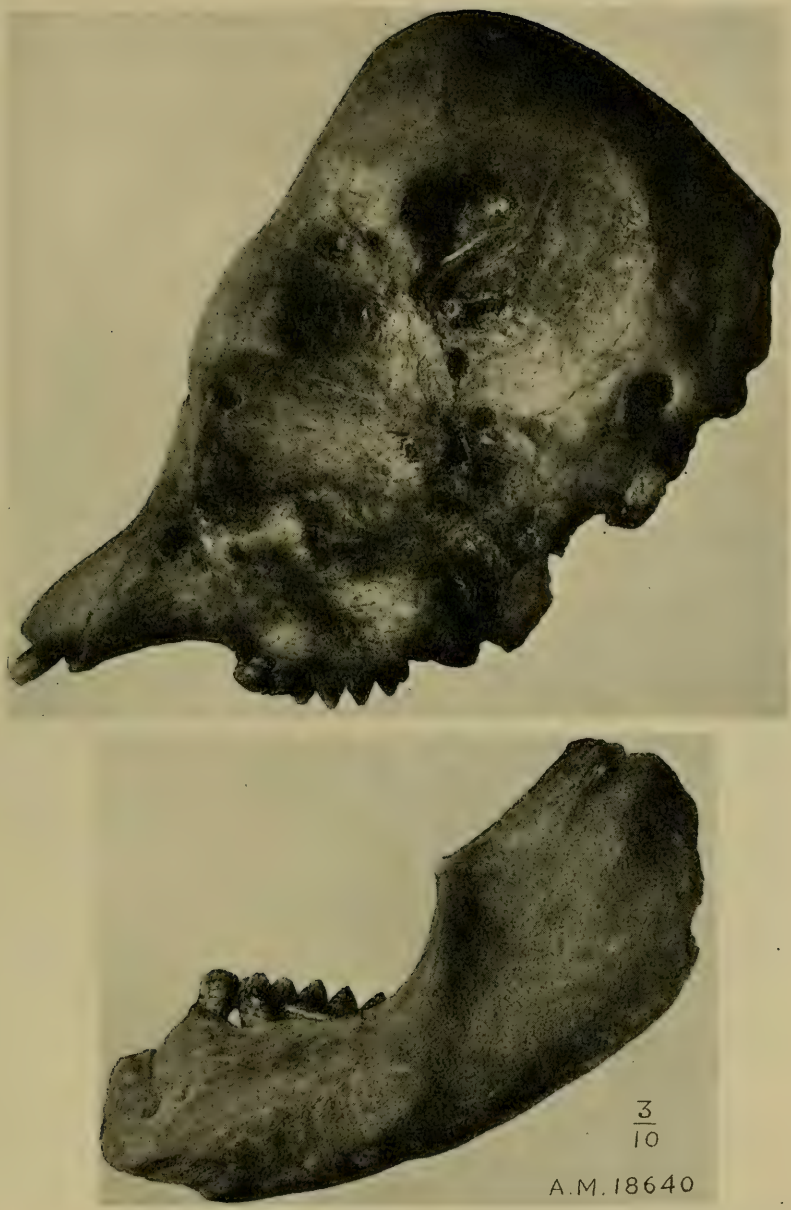

Fig. 4. *Stegodon orientalis.* No. 18640. Young skull and lower jaw, uncrushed. Three-tenths natural size.

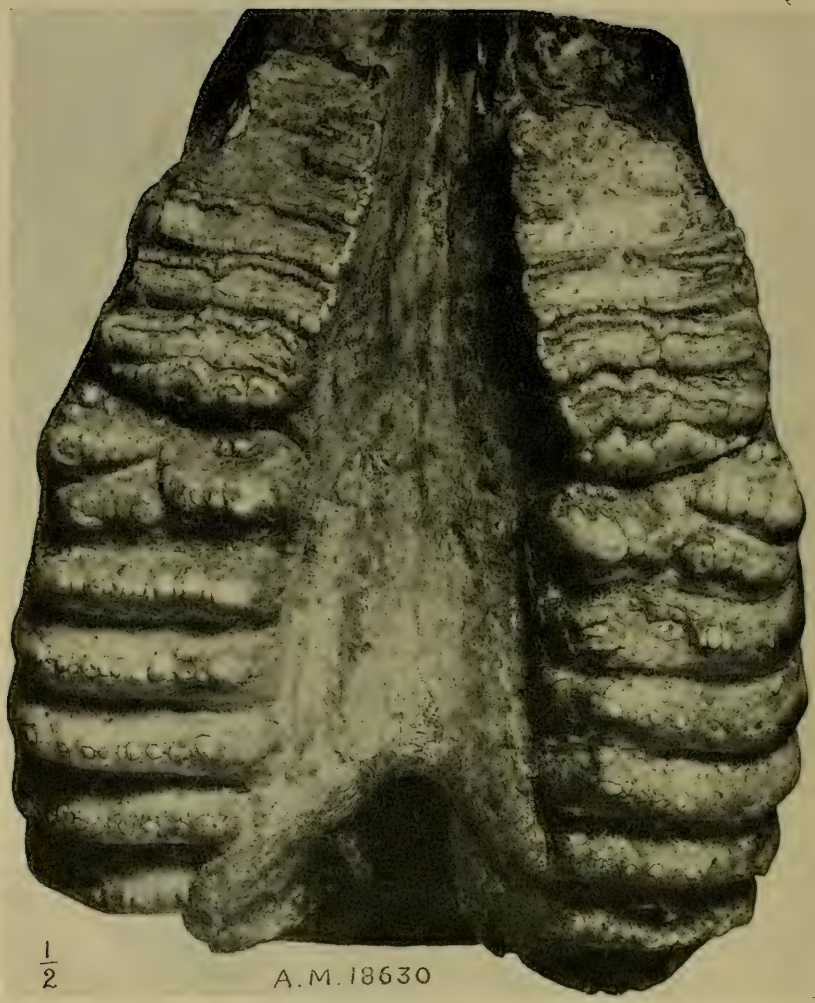

Fig. 5. *Stegodon orientalis.* No. 18630. Palate of adult skull. One-half natural size.

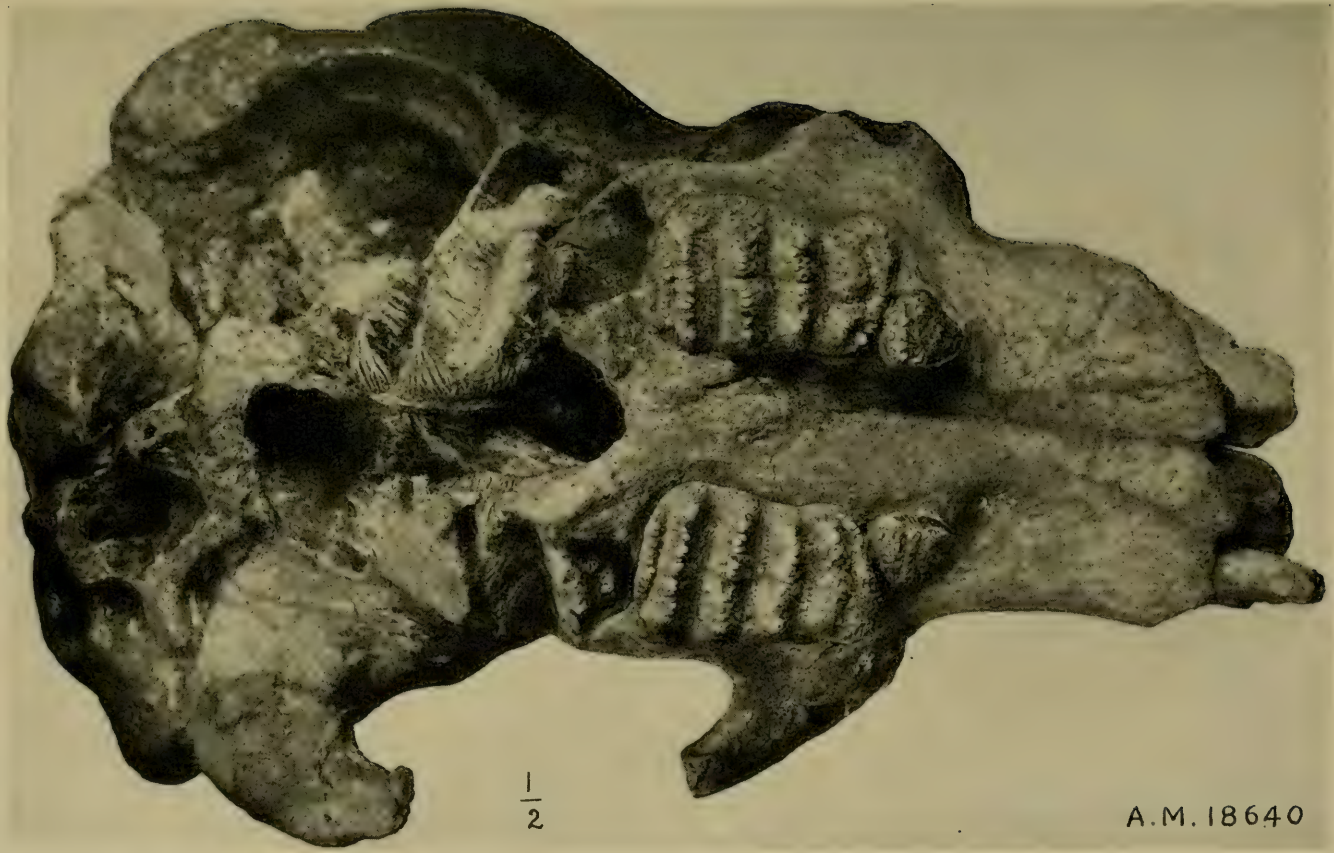

Fig. 6. *Stegodon orientalis.* No. 18640. Palatal view of young skull. One-half natural size.

species must be with *R. unicornis.* At all events, the Yen-ching-kao rhinoceros is a near relative of the typical modern Indian rhinoceros.

The type of *R. sinensis* consists of parts of upper and lower teeth, probably of different individuals. We designate the following as a neotype.

NEOTYPE.—A crushed skull, Amer. Mus. No. 18628.

CHARACTERS.—A large nasal horn. No clear indications of a second horn. Occiput apparently rather posterior in position. Teeth moderately hypsodont, slightly less so than in *R. indicus.* Premolars 130; length of molars, 160; p^1 small, deciduous. Both external ribs prominent on p^{2-4}, posterior rib weak on m^1, wholly absent on m^{2-3}, the anterior rib prominent on all three molars. Crochet prominent on p^3-m^3, doubled on p^4-m^1; crista rudimentary except on p^2, where it is prominent. No antecrochet save as an obscure swelling. Postfossette on p^3-m^1 only when considerably worn. The two inner cones of p^2 strongly twinned, slight twinning on p^{3-4}.

The above characters are shown on the neotype and in Owen's type, so far as it goes. A number of incomplete skulls, palates and upper jaws and teeth show more or less variation in the external ribs, details of the crochet, crista and posterior fossette, but in all it may be said that the crochet is strong and more or less reduplicate, the crista and antecrochet weak or absent, the postfossette moderately developed, the external ribs variable, the teeth subhypsodont, premolars considerably smaller than molars, but p^2 unreduced and only p^1 vestigial, molars subequal, m^3 smallest of the three.

The characters of the teeth in the neotype are strongly suggestive of affinity to the Indian and Javan rhinoceroses, combining peculiarities of the two; the referred specimens bring it on the whole nearer to the Indian species. None of our specimens has the premaxilla preserved sufficiently to demonstrate the presence or absence of upper incisors; but the cheek teeth are nearer to the true rhinoceroses than to *Atelodus* and the proportions of the anterior end of the lower jaw agree best with *R. indicus.* The neotype skull is too badly crushed to be decisive as to the characters of the occiput, and no other specimens show this region. The position of the horn, on the nasals but not quite terminal, is like *R. indicus* and unlike *Atelodus.*

In the skeleton, including especially the length and proportions of the limb bones and feet, all the Yen-ching-kao rhinoceros material agrees fairly closely with *R. indicus.*

Among the numerous fossil species described we find certain Indian and western Eurasian forms that may be nearly related, especially *R. platyrhinus, palæindicus, sivalensis.*

The species described by Koken and Schlosser are founded upon tooth distinctions, of which the constancy is doubtful, to judge from our

collections. Both Schlosser and Matsumoto, in sorting out the material described and assigning it to various species and horizons, have attached great importance to the degree of fossilization and the quality of the matrix. Wide variation is shown in our collections in this respect, from almost unaltered and recent-appearing to thoroughly fossilized teeth and bones in hard clay matrix. But we cannot associate these differences at present with any faunal distinctions and it is probable that they are due chiefly or wholly to the accidents of location of the specimen, whether in the path of mineralizing waters or protected from their action. The present species can be satisfactorily placed as to its relationships, but not as to its nomenclature and synonymy.

AFFINITIES.—*R. sinensis* is clearly excluded from *Aceratherium*, *Teleoceras* or *Cœlodonta* and apparently from *Opsiceros*. Affinity with *Ceratotherium* is not especially indicated. All the positive evidence goes to show that it is a near relative of the true *Rhinoceros*, but specifically distinct from either the Indian or the Javan species, nearer perhaps to the former.

Tapirus sinensis Owen

Besides the teeth described by Owen, Koken figured a number of teeth and Schlosser records two from the Haberer collections. The latter were obtained at I-chang, a hundred miles down-river from Yen-ching-kao; Koken's material is said to be mostly from caves in Yun-nan or other southern provinces. They are all referred to the Pleistocene by Schlosser. It would appear that Owen's species is closely related to *T. indicus*, perhaps doubtfully distinct. Our tapir material consists of skulls, jaws, etc., of a very much larger species described below. It is not close to the modern Malayan tapir; whether the genus is distinct remains to be determined. *T. sinensis* is not represented in the Granger collection.

Chalicotherium sinense Owen

Owen's collection contained one upper molar. Koken described a supposed p_4 (m_1 according to Schlosser). Our collection contains a single lower molar, No. 18453, probably m_3. It affords no especial light upon the relations to the Indian *C. sivalense*.

Hyæna sinensis Owen

No. 18392, upper and lower jaws, is referred to this species; also Nos. 18395–7, isolated parts of jaws.

Owen distinguishes the species as larger and more robust than the modern *H. crocuta*, much larger than the Asiatic striped hyæna, and as allied to the African and not to the Asiatic species, "unlike the European cave hyæna."

NEW GENERA AND SPECIES IN THE YEN-CHING-KAO COLLECTION

Spalacidæ

Rhizomys troglodytes, new species

TYPE.—No. 18408, skull and jaws.

PARATYPES.—Nos. 18401–18417, a series of skulls and jaws, some with parts of skeleton associated.

DISTINCTIVE CHARACTERS.—(*a*) Size large, length of skull incisors to condyles = 77–85 mm.; (*b*) skull rather long and narrow, postorbital crests contracting sharply behind the orbits to a long and well-marked sagittal crest; (*c*) infra-orbital foramen sub-triangular, the maxillary crest in front of it and plate beneath extended upward on the side of the muzzle almost to its upper surface; (*d*) nasals long, narrow, wedge-shaped, tapering backwards almost to a point; (*e*) squamosals fail to reach the sagittal crest superiorly or the postorbital constriction anteriorly; (*f*) occiput strongly sloped forward; (*g*) posterior nares narrow and contracted transversely; (*h*) bulla somewhat flattened inferiorly, strongly convex anteriorly, culminating in a ridge directly behind the posterior lacerate foramen, slightly reflexed on the anterior inner border against the basisphenoid; (*i*) carotid foramen lying close behind the basisphenoid-basi-occipital suture and the bulla extending a considerable distance in front of it; (*j*) bulla strongly reflexed posteriorly upon the surface of the paroccipital process; (*k*) inferior surface of auditory meatus strongly concave both ways, without any longitudinal ridge, and the opening large and flaring; (*l*) incisors strongly convex, the points of the upper pair directed somewhat backward, the anterior faces of the lower pair strongly flattened, of the upper pair, moderately so; (*m*) first upper molar somewhat, and first lower molar considerably reduced and m^1 wearing to a lower grinding plane than the others; (*n*) third upper molar unreduced, approximately equal to m^2 in size, the posterior portion of the third lower molar correspondingly enlarged and broadened.

Of the above characters, Nos. *c*, *d*, *e*, *f*, *g*, *h*, *i*, *k*, *l*, *m*, and *n* appear to be characteristic of *Rhizomys* proper as against *Nyctocleptes*. Nos. *a* and *j* resemble the latter, while *b* is peculiar. The affinities of the species are thus clearly shown to be with the much smaller *Rhizomys* of China, although in size and one or two characters associated with size it is suggestive of the large Malayan bamboo-rat, *Nyctocleptes sumatrensis*, etc., which it fully equals in size.

The above comparisons were made with modern skulls from South China collected by Mr. Andrews and a series of Malayan skulls in the National Museum loaned through the courtesy of Dr. Gerrit S. Miller and Mr. J. W. Gidley.

Fig. 7. *Rhizomys troglodytes.* Type skull, No. 18408. Natural size.

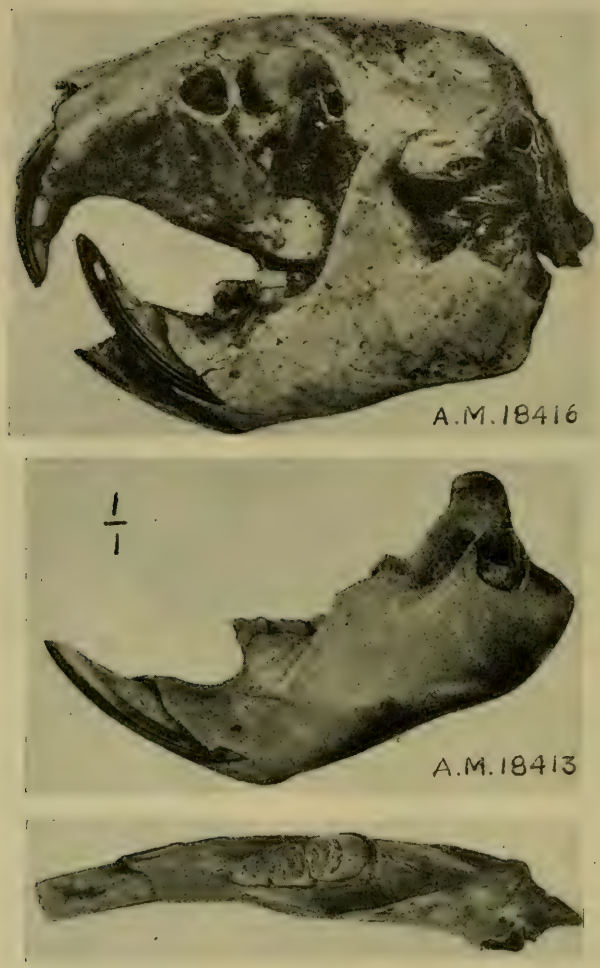

Fig. 8. *Rhizomys troglodytes.* Side view of skull and jaws, No. 18416. Outer and top views of lower jaw, No. 18413. Both natural size.

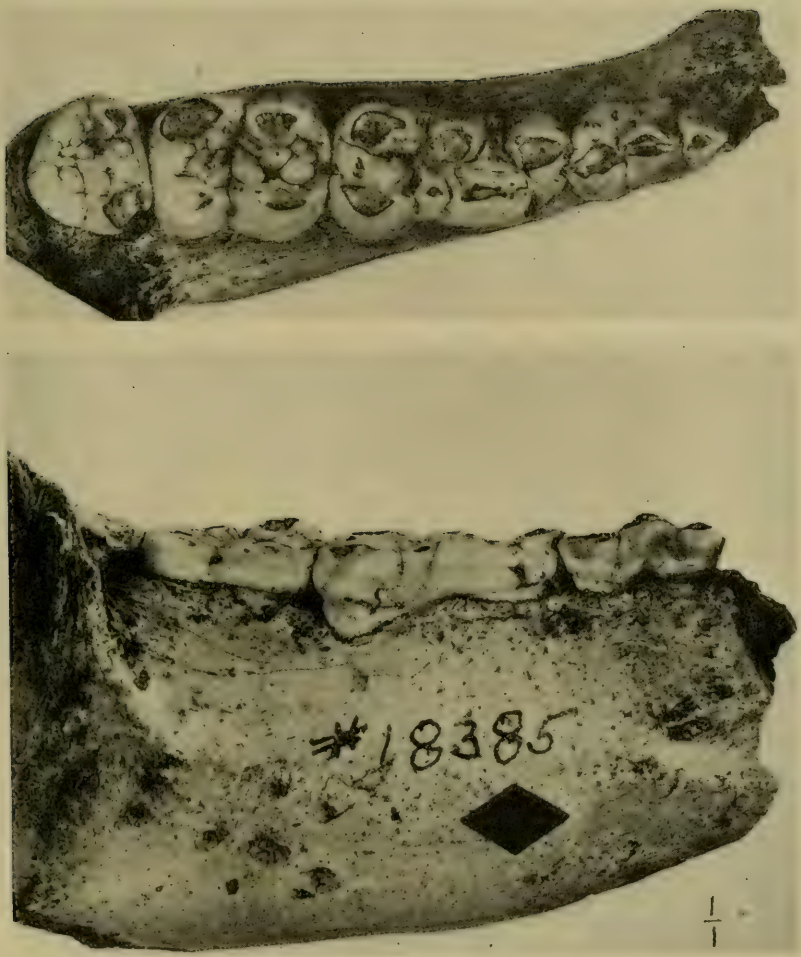

Fig. 9. *Æluropus fovealis*. No. 18385, type. Lower jaw, outer and crown view of teeth. Natural size.

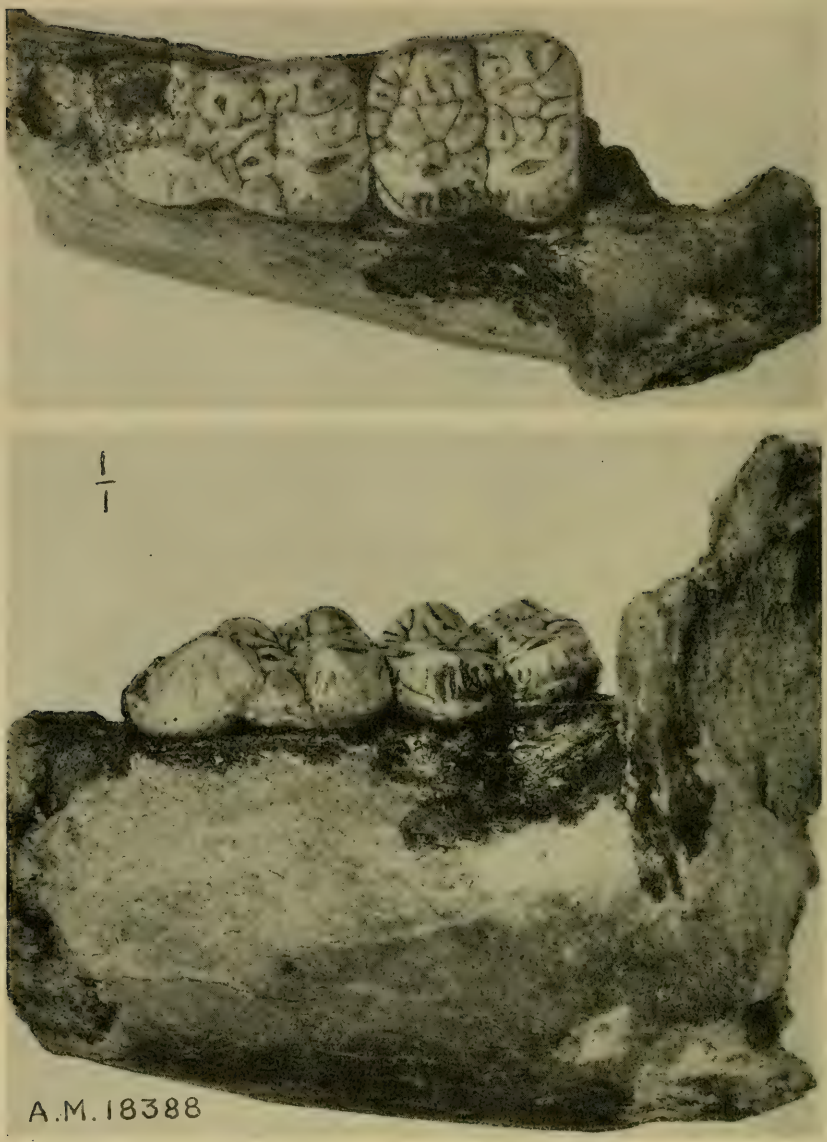

Fig. 10. *Æluropus fovealis.* No. 18388. Lower jaw, outer and top views. Natural size.

Ursidæ

Æluropus[1] fovealis, new species

TYPE.—No. 18385, right lower jaw with p_4 to m_3, also left m_3 of the same individual.

DISTINCTIVE CHARACTERS.—The teeth resemble those of *Æ. melanoleucus* as figured by Lankester, 1901, except in the following particulars: the protocone of p_4 is distinctly higher than the anterior and posterior cusps; m_1 retains more of the normal canassial construction, the anterior end being less quadrate, protoconid larger, paraconid more advanced and the whole tooth is relatively larger; m_2 and m_3 are broader, though not longer. Bardenfleth's figure in 1913 of the teeth of a specimen also in the British Museum agrees much more closely in proportions with our specimen and, if both are accurate, would suggest that the differences noted above are individual rather than specific. However, as it seems unlikely that a species of the Carnivora would persist unchanged from the Pliocene to the present day, it appears better to regard the species provisionally as distinct. Three other specimens, Nos. 18386–8, are referred to the species. Two of them show the unworn m_1 in broken lower jaws. The third is a lower jaw with $m_{1\text{-}2}$ complete, so much larger and more robust than the type that we hesitate to include it under the same species.

The affinities of *Æluropus* appear to be with *Hyænarctos*, as has been observed by Lydekker,[2] Winge[3] and other writers. Its systematic position appears to be clearly in the family Ursidæ,[4] although of a distinct subfamily from the true bears. Bardenfleth[5] has presented the evidence for this view very clearly. The occurrence of *Æluropus* almost completely modernized in the Pliocene, if these deposits are in fact Pliocene, contemporary, or nearly so, with *Hyænarctos*, shows that it cannot be a direct descendant, although *Hyænarctos* seems to be in general structurally ancestral.

Lydekker[6] has reported a species of *Hyænarctos* from the collection of Chinese fossils described by Owen. Schlosser[7] gives reasons (not very convincing) for regarding it as Pleistocene and notes an incisor and m_3 in the Haberer collection at Munich, but doubts their pertinence to this genus. They approach the amphicyons, differing from *Hyænarctos* in quite an opposite sense from the present species.

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[1] *Æluropus* = *Æluropoda*, for the purists.

[2] Lydekker, R. 1896. 'Geographical History of Mammals,' p. 321.

[3] Winge, H. 1896. 'Jordf. og. nulev. Rovdyr (Carnivora) fra Lagoa Santa,' p. 62. These are probably by no means the earliest authorities, for the comparison is too obvious to have escaped notice. It is at least implied in Flower's arrangement of the genera in the 'Catalogue of Mammals, Mus. Roy. Coll. Surgeons.'

[4] As placed by most authors. Osborn in the 'Age of Mammals,' following Lankester's authority, places it in the Procyonidæ.

[5] Bardenfleth, K. S. 1913. 'On the Systematic Position of *Æluropus melanoleucus*.' Mindesk. f. Japetas Steenstrup, Kobenhavn.

[6] Lydekker, R. 1885. 'Cat. Foss. Mam. Brit. Mus.,' Part I, p. 157, fig. 23.

[7] Schlosser, M. 1903. 'Fossile Saügethiere Chinas,' p. 23.

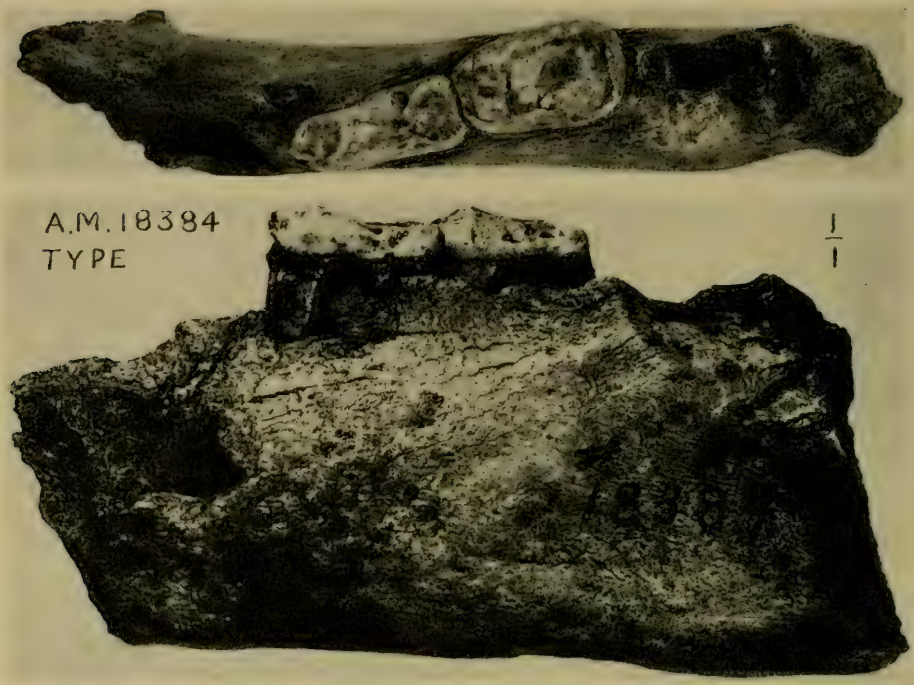

Fig. 11. *Ursus kokeni.* No. 18384, type. Lower jaw, outer and top views. Natural size.

Ursus kokeni, new species

Type.—No. 18384, a lower jaw with m_{1-2} and adjacent alveoli.

Distinctive Characters.—Jaw very short and deep as in the sun-bear *U. malayanus*, but size large, comparable with *U. arctos;* m_1 narrow and long, lacking the metastylid cusp of *U. malayanus;* m_2 rather short and wide, wider posteriorly than anteriorly.

It is very likely that the molar figured by Koken as *U.* aff. *japonicus* is of this species.

Arctonyx rostratus, new species

Type.—No. 18393, skull lacking the zygomatic arches and with damaged teeth.

Paratypes.—Nos. 18394, skull, and 18382, 18383, lower jaws.

Distinctive Characters.—Length of skull, premaxillæ to condyles, 148 mm.; sagittal crest narrow, distinct; $p\frac{1}{1}$ absent, $p\frac{2}{2}$ larger than in *A. collaris* and more clearly two-rooted, the diastema behind p^2 greater than length of p^3; p^4 larger with inner cusp better developed and more antero-internal; m^1 larger, broader and more quadrate in form; auditory meatus and posttympanic process broad, massive and

Fig. 12. *Arctonyx rostratus.* No. 18393. Type skull, top view. Natural size.

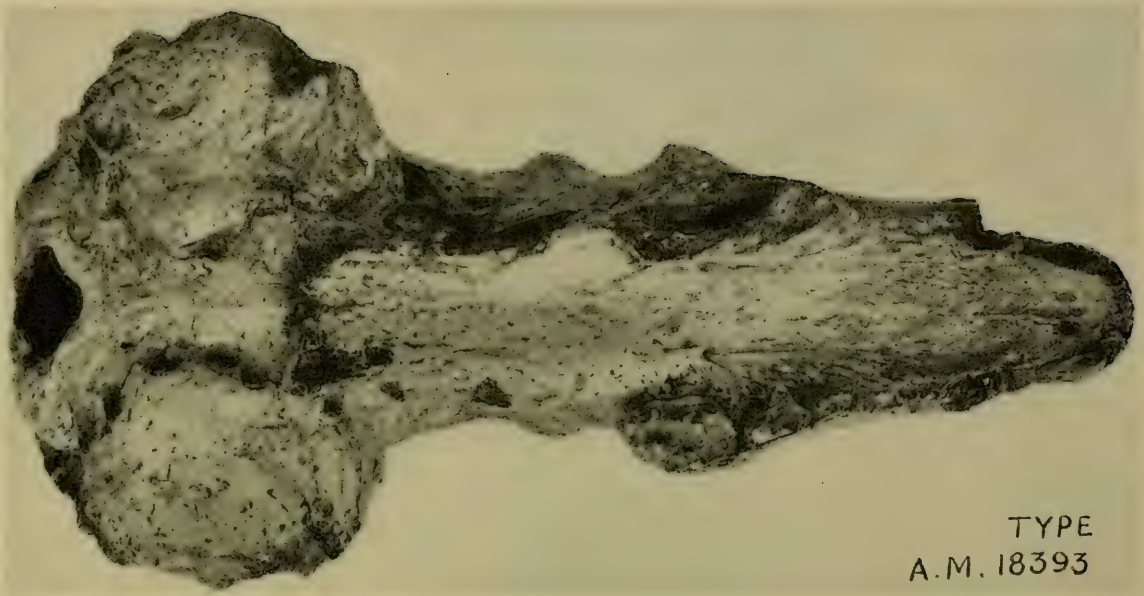

Fig. 13. *Arctonyx rostratus.* Type skull, No. 18393, palatal view. Natural size.

Fig. 14. *Arctonyx rostratus.* No. 18381. Lower jaw, outer and top views. Natural size.

flattened, occiput broader at the base. P_3 and p_4 are more robust than in *A. collaris* and there is no diastema between them; m_1 and m_2 are considerably larger and more robust, with the cusps more conical in form.

This species differs but little from Milne Edwards' drawing of *A. collaris*. The differences from a specimen obtained in the mountains of Shensi (with which the above comparisons are made) are more considerable but may also be reduced in essence to the greater size and robustness of the fossil species and the somewhat higher degree of specialization of its modern relative.

The construction of the teeth in *Arctonyx* is essentially the same as in *Meles*, to which it is rather nearly related, in spite of the wide difference in proportions.

Cyon antiquus, new species

TYPE.—No. 18389, a pair of lower jaws. No. 18583, parts of crania, limb bones and vertebræ of a canid of appropriate size and characters are provisionally referred to the species.

DISTINCTIVE CHARACTERS.—Metaconid distinct upon m_1 and m_2. Teeth slightly more robust than in our specimens of *C. alpinus*, more decidedly larger and heavier than in *C. javanicus*.

There is some question as to the validity of this species, as Mivart in his 'Monograph of the Canidæ' figures the metaconid as present on m_1 of both species of *Cyon*, although it is absent in our specimens referred to them. It may therefore be a variable character.

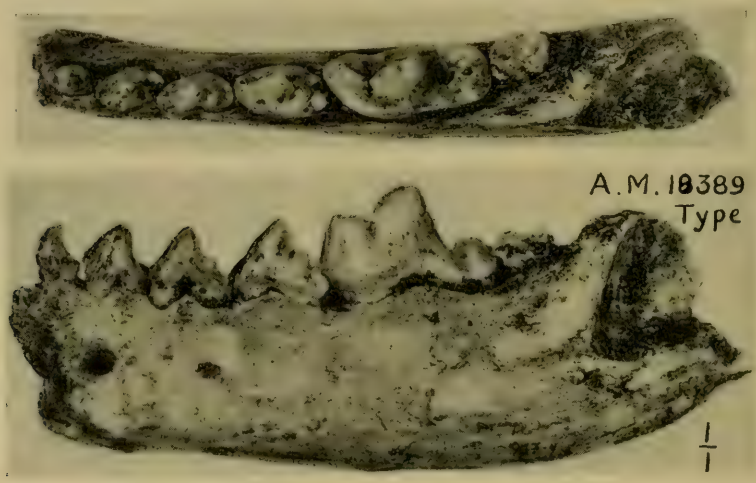

Fig. 15. *Cyon antiquus.* Lower jaw, No. 18389, type specimen, top and outer views. Natural size.

Felis aff. tigris Linnæus

No. 18624, a complete skull and jaws; also a part of skull with lower jaws associated, and a number of jaws and limb bones more or less associated, are referred here. In comparison with a series of skulls of the modern tiger we have been unable to recognize any constant distinctions for the fossil form, and therefore refer it to *F. tigris*, although a more minute and exhaustive comparison might very well show valid specific distinctions.

There is no doubt, at any rate, that it belongs nearer to the tiger than to the lion and that it is quite distinct from *F. cristata* of the Siwalik Pliocene.

Fig. 16. *Felis* aff. *tigris*. No. 18624, skull and jaws. One-half natural size.

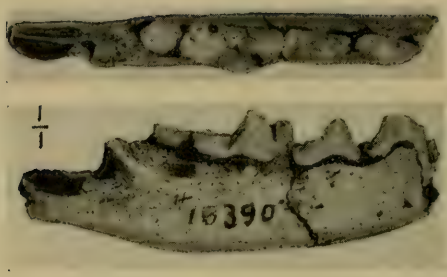

Fig. 17. *Viverra* sp. Lower jaw, No. 18390, top and outer views. Natural size.

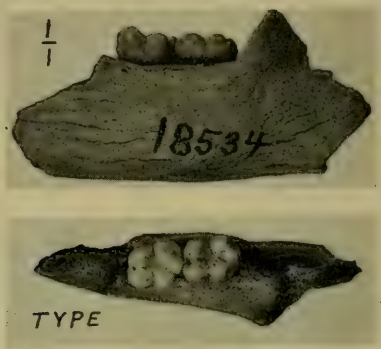

Fig. 18. *Bunopithecus sericus.* No. 18534, type, lower jaw fragment, top and outer views. Natural size.

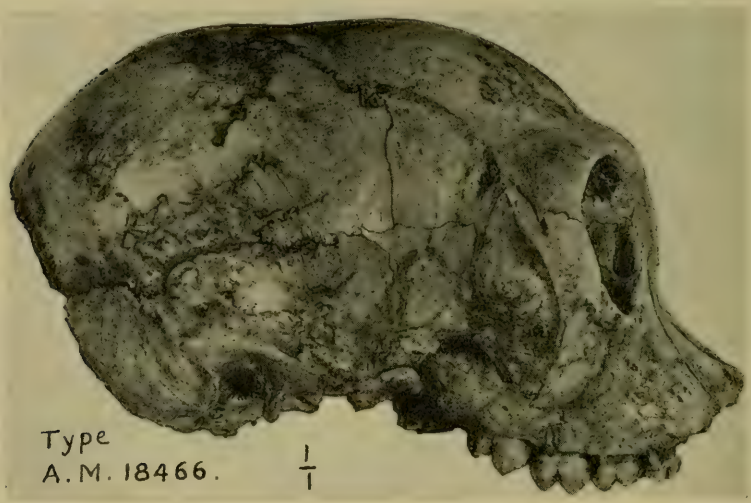

Fig. 19. *Rhinopithecus tingianus.* No. 18466. Type skull, side view. Natural size.

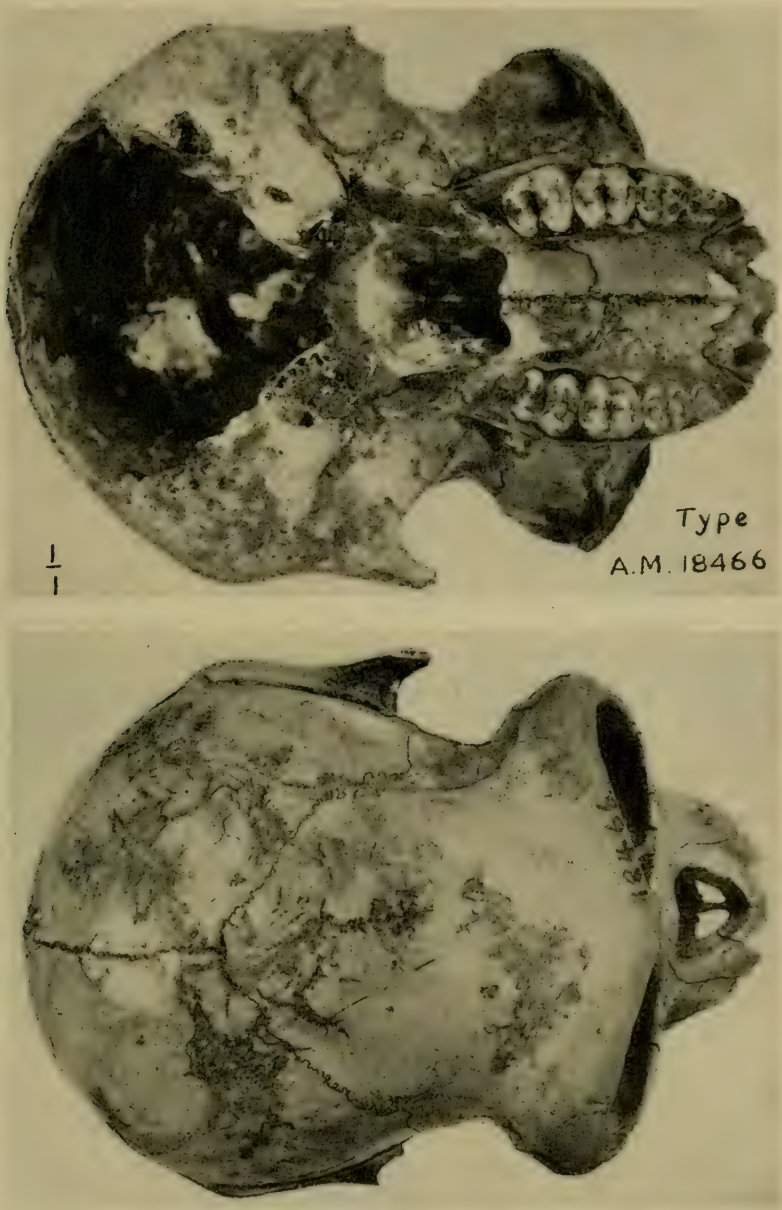

Fig. 20. *Rhinopithecus tingianus.* No. 18466. Type skull, top and palatal views. Natural size.

Bunopithecus sericus, new genus and species

TYPE.—No. 18534, a lower jaw with m_{2-3} on the left side.

GENERIC DISTINCTIONS.—Jaw and teeth much as in *Hylobates* except for greater width of molar and large size of hypoconulid on m_2 and m_3.

The heels are slightly broader than the anterior half of the teeth and the hypoconulid is as large as the entoconid on both teeth. In the gibbon it is small on m_2 and absent on m_3; m_3 is narrower and smaller than m_2 in the gibbon but broader in *Bunopithecus*.

The species is about the size of the hoolock.

Rhinopithecus tingianus, new species

TYPE.—No. 18466, a skull, immature, retaining the milk premolars, and the last molar not yet emerged.

PARATYPES.—Nos. 18467–9, upper and lower jaws.

DISTINCTIVE CHARACTERS.—Larger and more robust throughout than *R. roxellanæ*. Size about as in *R. bieti* but with much smaller teeth.

The modern langhur monkeys of this genus have a somewhat ill-defined range in northwestern and southwestern China and eastern Thibet. This species is typical of the genus, not in any marked degree primitive or synthetic in generic position. It is named in honor of Dr. V. K. Ting, the able and progressive director of the Geological Survey of China.

Tapirus (Megatapirus) augustus, new species

TYPE.—No. 18433, skull and jaws.

PARATYPES.—Nos. 18428, 18431, and 18432, skulls, the latter two with lower jaws.

DISTINCTIVE CHARACTERS.—Teeth and skull about one-fourth larger lineally than *T. indicus* or *terrestris* and almost as much exceeding *T. sinensis* in size. Anterior premolars more molariform than in *T. indicus*, the inner cusp and cingulum much more developed, especially in p^1 which in *T. augustus* is wider than long (?). Skull very short and deep, the vomer higher and thicker than in *T. indicus*, much more so than in *T. terrestris*.

This species far exceeds in size any living tapir of which we can find record and differs so considerably in proportions of skull and details of tooth construction that we consider it provisionally as representing a distinct subgenus. All of our tapir specimens appear to be referable to this gigantic species. *T. sinensis* is not present here, although the specimens provisionally referred to it by Schlosser may be *T. augustus*. Although resembling *T. terrestris* in the relative complexity of the anterior premolars, it appears in the skull to be an exaggerated type of *T. indicus*, deeper and shorter with more massive vomer, high-set nasals, etc.

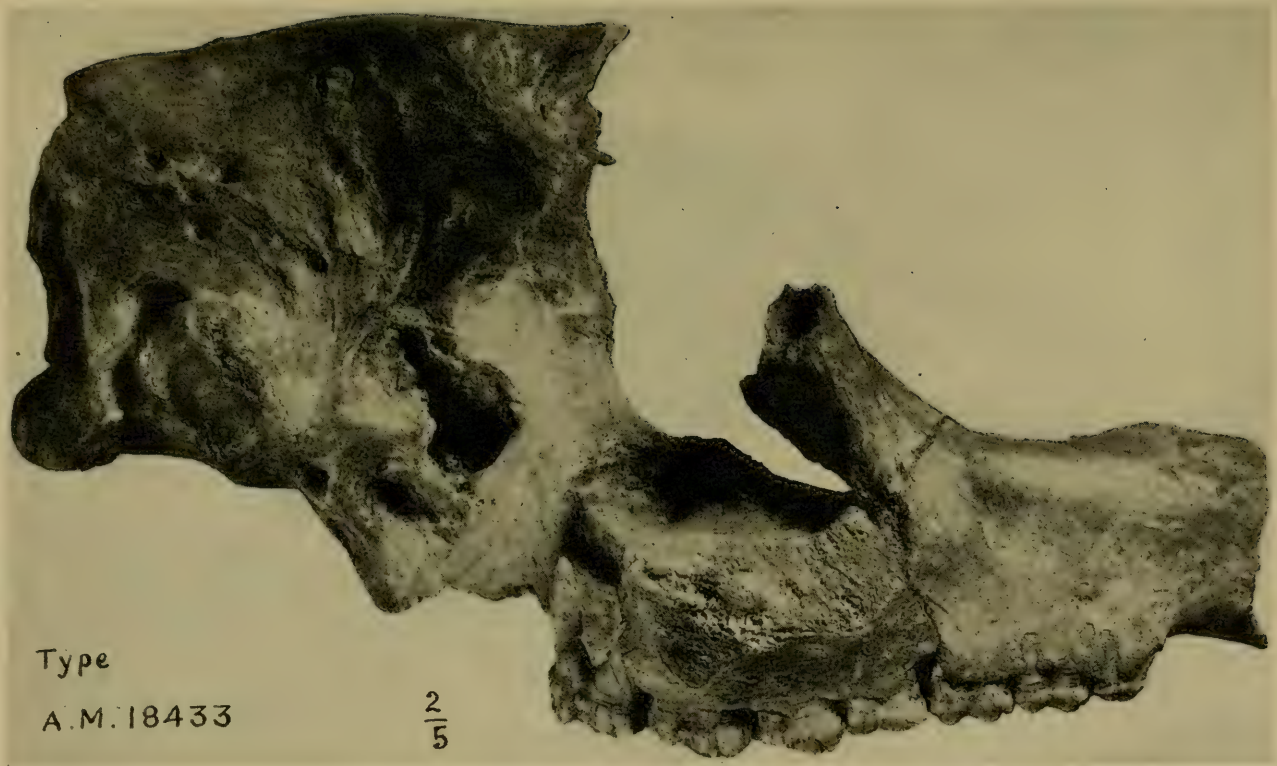

Fig. 21. *Tapirus* (*Megatapirus*) *augustus*. No. 18433, type skull, side view. Two-fifths natural size.

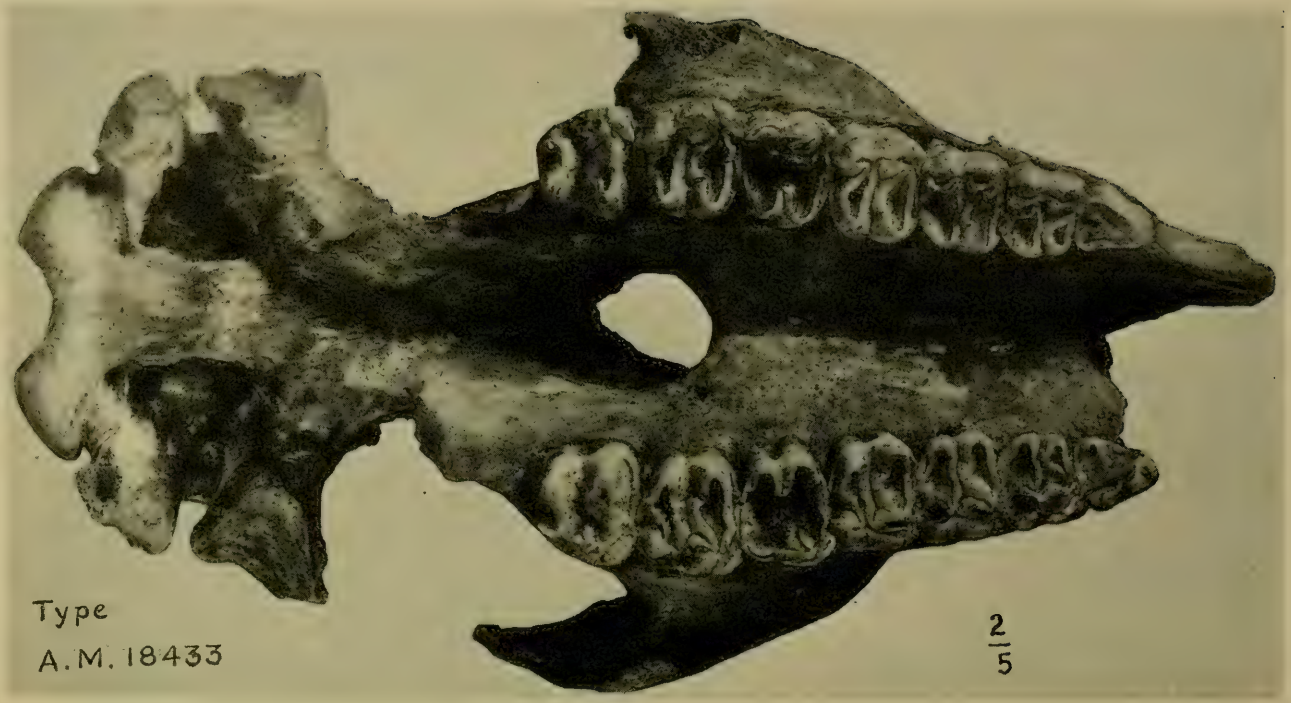

Fig. 22. *Tapirus augustus.* No. 18433. Palatal view of type skull. Two-fifths natural size.

Fig. 23. *Tapirus augustus.* No. 18433. Lower jaw of type, top view. Two-fifths natural size.

Fig. 24. *Tapirus augustus.* No. 18433. Lower jaw of type, outside view. Two-fifths natural size.

Measurements

	No. 18433	No. 18428	No. 18432	*T. sinensis*	*T. haysii* Phila. Acad.	*T. malayanus* A. M. 14106	*T. americanus* A. M. 36198
Skull length pmx-condyles	E. 530	E. 530				417	390
" width	E. 280						
Upper teeth, p^1-m^3	214	212	205		174	E. 151	145
" molars m^{1-3}	101	103	101		79		70
Diameters of p^1 a-p×tr.	27×25	26×23			20×19	18×14	17×17
" " p^2	27×31	27×33	28×34		21×25	20×23	18×22
" " p^3	30×36	29×38	29×37	25×31	21×25	23×27	19×25
" " p^4	29×38	29×39	30×38		22×26		19×27
" " m^1	31×38	31×40	31×37		24×28	24×25	19×24
" " m^2	36×40	35×43	34×40	29×31	26×30	27×30	24×26
" " m^3	34×40	34×38	34×40	27×31[1]	26×30		25×26
Lower teeth p_2-m_3			199		161	152	136
" molars m_{1-3}	104		107		89		70
Diameters of p_2			34×19		25×17	24×13	20×15
" " p_3	20×22		31×24	26×19	22×19	24×19	20×19
" " p_4	31×25		31×26		23×19	25×17	21×19
" " m_1	32×24		32×25	27×21	27×19	24×18	21×17
" " m_2	34×27		35×26	29×21	28×21	28×21	25×19
	38×28		38×27		28×21		26×19

[1]From Owen's figures.

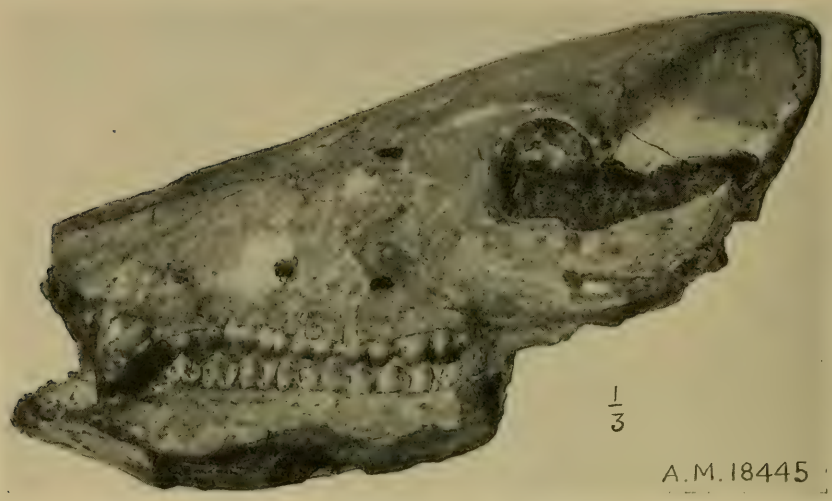

Fig. 25. *Sus* sp. cf. *hyotherioides* Schl. No. 18445, skull and jaws. One-third natural size.

Sus compare **S. hyotherioides** Schlosser

This is a species about the size of the modern *Potamochœrus* but p^4 is larger and more complex.

Proboselaphus watasei Matsumoto

Several incomplete skulls, numerous jaws and skeletal bones are provisionally referred to this species. If the reference be correct, it would appear to be rather nearly related to the nilghai (*Boselaphus*) of India.

Bibos geron Matsumoto

This species was based upon parts of upper and lower jaw. We refer to it a series of skulls, skeletons, upper and lower jaws, etc., of which No. 18465, a fairly complete skull, is selected as neotype. The affinity to the gaur and other species of this group is shown especially in the character of the horns, flattened, angulate, arising from the vertex of the skull and sweeping downward and upward, but not backward.

Koken and Matsumoto record *Buffelus* and *Bison* upon the evidence of teeth. While there is a very large series of Bovinæ skulls, jaws, etc., and a considerable variation in the characters of the teeth, we have not seen among the skulls and horns any evidence of any other true bovine type than *Bibos*. Whether the supposed distinctions among the teeth

Fig. 26. *Bibos ? geron* Matsumoto. No. 18465, skull, top and side views. One-sixth natural size.

Fig. 27. *Bibos ? geron.* No. 18465, palatal view of skull. One-sixth natural size.

are really constant characteristics of the several genera of Bovinæ remains to be verified by more careful comparative study of the materials.

It is quite clear, however, that there are two distinct types of Bovinæ represented in the foot material; one with extremely short metapodials, the other of larger size and with metapodials somewhat longer than in the American bison.

AFFINITIES OF THE YEN-CHING-KAO FAUNA

The following faunal list is a preliminary one and may be considerably modified and better defined by further study. It will serve, however, to show the general character of the fauna.

PRIMATES		
Bunopithecus sericus	cf. *Hylobates*	Malaysia
Rhinopithecus tingianus	" *Rhinopithecus*	W. China
FERÆ		
Ursus kokeni	" *U. malayanus*	Malaysia
Æluropus fovealis	" *Æ. melanoleucus*	W. China, Thibet
Arctonyx rostratus	" *A. collaris*	" "
Cyon antiquus	" *C. alpinus*	" "
Viverra sp.	" *Viverra* sp. div.	" "
Hyæna sinensis	" *H. crocuta*	Africa
Felis aff. *tigris*	" *F. tigris*	India, E. Asia
GLIRES		
Rhizomys troglodytes	" *R. sinensis*	S.-W. China
Lepus sp.		
PROBOSCIDEA		
Stegodon orientalis	" *Elephas*	India
PERISSODACTYLA		
Tapirus augustus	" *Tapirus*	Malaysia, tropical America
Chalicotherium sinense		
Rhinoceros sinensis	" *R. indicus*	India
ARTIODACTYLA		
Bibos geron	" *B. gaurus*	India
?*Bos* (cf. *grunniens*)	" *B. grunniens*	W. China, Thibet
?*Antilope*		
?*Proboselaphus watasei*	" *B. nilghai*	India
Gazella	" *G. gutturosa*	Thibet
Cervus sp.	" *C. wapiti*, etc.	Central Asia
Sus sp. cf. *hyotherioides*	" *Sus* sp. div.	Malaysia

The above list is remarkable, as a cave or fissure fauna, for the scarcity of rodents (other than *Rhizomys*) and small carnivora. While the remains of large animals are abundant and varied, the bamboo-rat is the only rodent, except for a single hare jaw, and no small mustelids or viverrids appear.[1] It is no less remarkable that no trace of Equidæ is found in it, nor of camels, giraffes, typical Canidæ or machærodonts. This, coupled with the abundance of tapirs and deer, may point to a heavily forested condition. The abundance of *Stegodon* and entire absence of *Elephas* and the presence of *Chalicotherium* are the only observed indications of Pliocene age; for the most part the fauna appears to be quite closely related to modern species and might well be considered Pleistocene. The faunal affinities appear to be principally Chinese, partly Malayan, not much Indian; there is nothing especially suggestive of North American or of Siberian affinity. A more careful comparison

[1]In his second season (1922–3) Mr. Granger reports finding good material of small carnivora.—W. D. M.

and identification of the whole fauna, especially of the smaller ruminants, might show a clearer differentiation from the modern species than we have observed in this preliminary study, but could hardly alter materially the geographic and environmental affinities of the fauna. It is such a fauna as one might expect to find in the valleys of southwestern China at any time before the appearance of civilized man, and under climatic conditions similar to those now prevalent. The effect of the clearing and cultivation of the valleys and the lower slopes of the hills by man has been, broadly speaking, to drive the smaller animals to the mountains and to exterminate the larger ones. Some of the extinct types have left relatives, more or less distant, in the jungles of southeastern Asia, more resistant to human encroachment than the Chinese hills. But the tapir, rhinoceros, gaur and *Stegodon* of the Yen-ching-kao fauna, although their nearest existing relatives are of tropical habitat, do not necessarily indicate a warmer Pliocene climate in China. They may quite well have been species adapted to a temperate climate, such as is more definitely indicated by the geographic affinities of the remainder of the fauna.

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56.(1181:51.7)

THE FAUNA OF THE HOULDJIN GRAVELS[1]

By W. D. Matthew and Walter Granger

The first discovery of *Baluchitherium* in Mongolia, as reported from the field by Andrews and Granger and published by Osborn in Asia Magazine and elsewhere, was in the Houldjin gravels near Iren Dabasu on the Kalgan-Urga caravan trail. The remains were very fragmentary and the identification wholly provisional. The geologic relations were described by Berkey and Granger in Novitates No. 42, p. 4. Granger's field identifications have now been revised by comparison of the material in the Museum, with the following results:

Field Identifications	Museum Identifications
1. A rhinocerid	? *Cænopus* or *Præaceratherium* sp.
	? *Cadurcotherium* sp.
2. A large carnivore	*Entelodon dirus*
3. An artiodactyl of size of Virginia deer	? *Entelodon* sp.
4. An enormous mammal, probably a perissodactyl and possibly related to or identical with *Baluchitherium*	? *Baluchitherium*
5. A tortoise of large size	? *Testudo*

This fauna is of Oligocene age but cannot be more exactly correlated until more completely known. It may be coëval with the Hsanda Gol fauna but as there is nothing in common save the very doubtfully identified *Baluchitherium*, it would not be safe to correlate it at present. The localities are more than a thousand miles apart and the character of the two formations quite different. It is more like the Ardyn Obo fauna; *Cadurcotherium* is probably the same. It compares also with the fauna described by Borissiak from the Turgai Oligocene.

Entelodon dirus, new species

Type.—No. 19181, last upper molar from Houldjin gravels, Iren Dabasu, Mongolia.

Diagnosis.—Size of *Dinohyus hollandi* but cusp construction more as in the gigantic Oligocene entelodonts; the posterior part of the molar much reduced, with small subequal metacone, metaconule and hypocone, the last set upon a wide but

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 16.

Fig. 1. *Entelodon dirus*, upper molar, m^3, right side, crown view. No. 19181, type. Houldjin gravels, Expedition of 1922. Natural size.

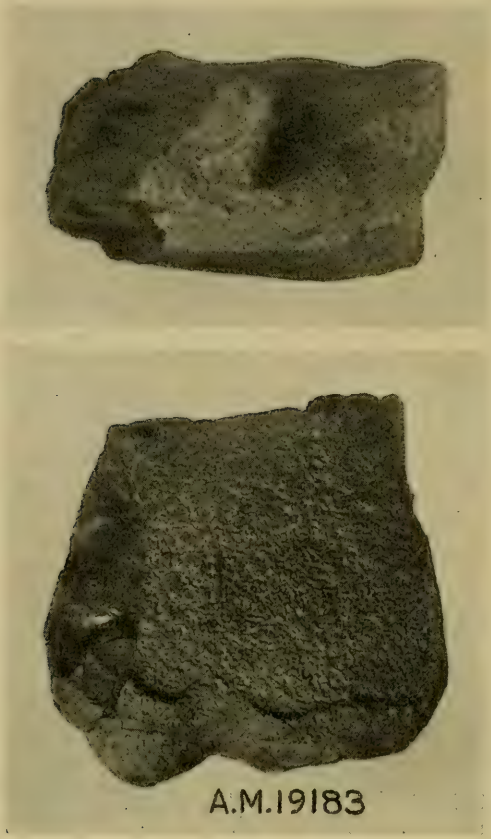

Fig. 2. *Cadurcotherium* sp., left lower molar, anterior end broken, crown and external views. No. 19183, Houldjin gravels, 1922. Natural size.

Fig. 3. *Cadurcotherium* ? right upper molar, external and crown views. Houldjin gravels, 1922. Natural size.

obscure posterior cingulum. Exterior cingulum narrow but distinct; anterior cingulum broad and well defined; paracone and protocone large, equal, the paracone with obscure anterior and posterior ridges and a rather more distinct ridge connecting it with the protocone. Protoconule quite vestigial.

The reference to *Entelodon* is in a broad sense, used as including the entire group of closely related genera or subgenera: *Archæotherium*, *Dæodon*, *Pelonax*, *Dinohyus*, *Megachœrus*, etc. It is not close to the typical *Entelodon magnus* of the Ronzon Oligocene nor to *Dinohyus* of the Lower Miocene of Nebraska. It agrees well enough with *Archæotherium* of the American Lower Oligocene except for its larger size, and with *Megachœrus* of the *Protoceras* beds (Upper White River) of South Dakota. It is not so close to the John Day entelodont "*Chœrodon*."

Fig. 4

Fig. 5

Fig. 4. *Cadurcotherium*, upper premolar, crown view. Houldjin gravels, 1922. Natural size.

Fig. 5. *Cænopus* or *Præaceratherium*, upper molar, m^3, right side, crown view. Houldjin gravels, 1922. Natural size.

The remaining "genera" of this group are not comparable, as their upper molars are unknown (*Pelonax*, *Dæodon*, *Boöchœrus*).[1]

In addition to the type species we refer provisionally to this genus a canine tooth and an astragalus, which, if correctly referred, represent a smaller species; but there is little to distinguish the astragalus from that of the anthracotheres, and the canine from that of the large amphicyonids, etc.

Cadurcotherium species

No. 19183, an incomplete lower molar, is referred to this genus. It is about the size of *C. cayluxi*, with which it accords in characters. A premolar also probably belongs here, and an anterior upper molar, m^1 or m^2.

Cænopus or **Præaceratherium** species

No. 19184, upper molar tooth, m^3, may be referred to this genus provisionally. It indicates a species of about the size of the larger individuals of *C. occidentalis*, and in about the same stage of molar evolution,

[1]The entire range of variation among these typical entelodonts is not wider than among many single genera of bunodont mammals, e. g., *Phenacodus*. As Sinclair has recently shown, there is a wide range of individual variation in teeth of this type.

Fig. 6. *Baluchitherium* ? lower molar, crown and external views. No. 19182, Houldjin gravels, 1922. Natural size.

but is somewhat more quadrate in form. No certain reference can be made in absence of the anterior teeth. Other species of *Cænopus* and *Trigonias* among the American rhinoceroses, as also *Aceratherium filholi* Osborn and *Ronzotherium reichenaui* Deninger, show this subquadrate form in m^3, which appears to be a rather variable species character. Both these European species are placed by Abel under *Præaceratherium.* Borissiak[1] has described under the name of *Epiaceratherium turgaicum* a small rhinoceros with which the Houldjin species may prove to be identical, at least generically.

?Baluchitherium

No. 19182, a lower molar and fragments of other teeth indicate a gigantic rhinoceros of size appropriate to Cooper's genus. A few very fragmentary remains of the skeleton, No. 19180, are of comparable size. These were found scattered in the gravels, along with equally fragmentary remains of smaller perissodactyls, presumably including the *Cadurcotherium* and *Cænopus* noticed above; also some fragments of a large tortoise.

[1]Borissiak, 1918, Mem. Soc. Pal. Russie, I, pp. 1–82, Pl. I–III.

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56.(1181:51.7)

THE FAUNA OF THE ARDYN OBO FORMATION[1]

By W. D. Matthew and Walter Granger

The Ardyn Obo formation was named and defined by Berkey and Granger in American Museum Novitates No. 77. A small collection of mammals was secured in 1922 at "Promontory Bluff" on the Sair-Usu-Kalgan trail, about 150 miles from Sair-Usu and 350 from Kalgan. It consists chiefly of an amynodont, apparently a species of *Cadurcotherium*, of which finely preserved skulls, jaws, limb-bones and feet were secured. These are described by Professor Osborn in another number of Novitates. In addition to these, fragmentary remains of a few other animals were obtained, affording the following faunal list:

Carnivora
- *Cynodictis* ? sp. . . . . anterior part of lower jaw (no molars)

Perissodactyla
- *Cadurcotherium ardynense* . . . . . skulls, jaws, limbs and feet
- *Ardynia præcox*, new genus and species . . . . . upper jaw, etc.

Artiodactyla
- *Eumeryx* sp. . . . . lower jaws
- *Schizotherium avitum*, new species . . . . . lower molar
- Anthracotheriid, gen. indet. . . . . lower molar

Chelonia
- *Testudo insolitus*, new species . . . . . parts of carapace and plastron; lower jaw

This appears to be an Oligocene fauna. *Cadurcotherium*, *Schizotherium* and *Cynodictis* are characteristic Phosphorites genera; the giant tortoise, while suggesting the giant tortoises of the Miocene and Pliocene in its size, is apparently a rather primitive stage in its costal plates. It may or may not represent the *Baluchitherium* fauna but cannot be very different in geologic age.

Its nearest geographic affinities, it will be observed, are with Western Europe, not with the United States. The bearing of this and other evidence upon Tertiary zoögeographic divisions and upon the centers of dispersal of different groups will be considered in later papers after the pertinent facts have been ascertained and placed on record.

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[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 17.

Fig. 1. *Ardynia præcox*, upper jaw, p^2-m^1 and m^3 of left side, external and crown views. No. 19156, type specimen, Ardyn Obo formation, 1922. Natural size.

Carnivore cf. *Cynodictis*

The anterior part of lower jaw with c-p_2 represents a slender-jawed, fox-like animal, whose exact relations are indeterminate. It agrees with *Cynodictis* so far as it goes.

Cadurcotherium ardynense Osborn

(See Amer. Mus. Novitates, No. 92)

Ardynia præcox, new genus and species

Type.—No. 19156, upper jaw with p^2-m^1; m^3 doubtfully associated. Ardyn Obo formation, Promontory Bluff, Expedition of 1922.

Characters:—Size of *Hyracodon* and crowns of teeth of about the same height and general aspect but premolars considerably reduced and last molar of normal rhinocerotid type, the ectoloph not extended behind the metaloph. The first premolar is absent, the second about half the transverse diameter of m^1, the third and fourth smaller than m^1. Ectoloph of p^2 somewhat convex, of $p^{3\text{-}4}$ flat externally;

metaloph and protoloph distinct on p^2, apparently so on p^{3-4}. Ectoloph of m^3 and probably of other molars flat or nearly so, the antero-external rib not conspicuous.

A number of fragments of lower jaws and teeth of a small rhinoceros and a premaxilla without teeth are of size appropriate to *Ardynia* but there is no proof of their association. If correctly referred, the lower premolars have somewhat the same construction as in *Cadurcotherium*, the molars are more like those of *Hyracodon*, and the premaxilla bore three equal incisors of larger proportionate size than in *Hyracodon*, but of similar arrangement. In absence of more definite proof of association the genus is provisionally referred to the Hyracodontidæ on the ground of the general appearance of the type and the provisionally referred premaxilla, but the premolar construction would suggest Amynodontidæ, and the third molar Rhinocerotidæ.

Fig. 2. *Schizotherium avitum*, third lower molar, crown and external views, Ardyn Obo, 1922. Natural size.

Schizotherium avitum, new species

TYPE.—No. 19157, lower m_3. Ardyn Obo formation, Promontory Bluff, Expedition of 1922.

CHARACTERS.—Size a little less than that of *S. priscum* (=*modicum*) of the Phosphorites; heel of m_3 narrow and more reduced, lacking the transverse cingular crest on each side of it that characterizes *S. priscum*. Trigonid and talonid of subequal width, while in *S. priscum* the trigonid is wider than talonid; length of tooth more than twice the width; in *S. priscum* it is somewhat less.

Exact comparison with *S. turgaicum* Borissiak[1] is not possible, as his material does not include the last molar. The Turgai species appears, however, to be very closely related to the Ardyn Obo animal.

An unnamed species from the Gaj formation of India, doubtfully referred by Pilgrim to *Schizotherium*,[2] appears to be of larger size than the three species of the Holarctic Oligocene.

Measurements of m_3

	S. avitum *No.* 19157	*S. priscum* No. 11077	No. 10495 (cast)
Length, of total, m_3	25.3	30.0	28.2
" of heel (hypoconulid)	2.2	3.2	2.7
Width of trigonid	11.9	15.1	15.0
" " talonid	12.1	13.9	14.0
" " heel (hypoconulid)	4.0	9.5	8.9
Index, length to trigonid width	2.13:1	1.99:1	1.88:1

Anthracotheriid, gen indet.

An incomplete lower molar indicates a small species of this family. It is comparable in size with *Microbunodon* of the Upper Oligocene of Europe, with the smaller *Ancodons* of the Upper Eocene and Oligocene. It compares more nearly with *Ancodon* in height and structure of the crown but is hardly determinable as to genus.

Eumeryx species

The type of this new genus is *E. culminis* of the Hsanda Gol formation in the Tsagan Nor basin. It is a small ruminant, scarcely larger than *Leptomeryx* of the American Oligocene and represented in the Hsanda Gol by numerous parts of upper and lower jaws, limb and foot-bones, which indicate a dentition intermediate between *Leptomeryx* and *Blastomeryx*, somewhat more advanced than in *Prodremotherium* and *Amphitragulus*, while the foot-bones show both metacarpals and metatarsals united into cannon-bones of characteristic Pecoran type, much like the earlier species of *Blastomeryx*.

This interesting form will be described more fully in a later article. The jaws from the Ardyn Obo formation are referable to the genus but it is doubtful whether they belong to the same species, as the construction of the premolars seems to be simpler and nearer to the tragulid type.

[1]Borissiak, A., 1921, Ann. Soc. Pal. Russie, III, p. 43.
[2]Pilgrim, G. E., 1912, Mem. Geol. Sur. Ind., Palaeont. Indica, N. S., IV, No. 2, p. 36.

Testudo insolitus, new species

TYPE.—No. 6275, parts of carapace and plastron of several individuals (co-types) from Promontory Bluff, Ardyn Obo basin, Mongolia.

CHARACTERS.—Middle costal plates not perceptibly wedge-shaped, their sides approximately parallel. Shell moderately thick, sutures slightly open in half-grown specimen, and surface rather heavily undulate. Upon the middle marginal plates the borders of the shields are marked by a somewhat raised ridge on the plate with a deep median furrow; elsewhere the furrows are normal; a precursor, apparently, of the condition seen in *T. cubensis* of the Pleistocene, where the ridge has become much more prominent than the furrow. I have not been able to find any description of this curious character in other species of *Testudo* either living or fossil; but it appears to be indicated in a drawing by Gervais of a costal plate of a tortoise from St. Gerand-le-Puy.[1] The species attains the size of the large tortoises so common in the American Miocene, but apparently retains the more primitive character of the Eocene and some Oligocene species in the uniform costal plates. The material is too fragmentary to render profitable any detailed description of the various pieces or discussion of its exact relationships. The curious resemblance to the extinct Cuban species may be interpreted as indicating some affinity between the two, but much more evidence would be needed to prove it. The shell is not thinned and incomplete to any noticeable degree as compared with other large Tertiary continental species.

An incomplete lower jaw, lacking the articular ends of either ramus is referred to this species.

Emydid, gen. indet.

A single fragment of a small emydid with the rugose surface of *Trachemys*.

Trionychid, gen. indet.

Two small incomplete plates represent a small trionychid.

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[1]Gervais, P., 1858, Zool. et Palæont. Franc., Pl. LIII, fig. 7.

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NEW CHINESE INSECTIVORES[1]

By Glover M. Allen

The mammals obtained by the Asiatic Expeditions of the American Museum of Natural History, under the leadership of Mr. Roy Chapman Andrews, include over 460 specimens of Insectivora, many of them of unusual rarity, such as the genera *Neotetracus*, *Scapanulus* and *Scaptonyx*. Most important are the excellent series of skins from western and southwestern Yunnan, which afford ample basis for demonstrating that distinct representative subspecies in many groups are to be found in the extreme southwest of that Province, and that these are readily distinguishable from those of the Li-chiang highlands whose summits run to 13,000 feet and over. These in turn are in some cases represented by distinct races farther north in Szechuan. Some of the western Yunnan races have lately been described by Mr. Oldfield Thomas from collections made by Mr. George Forrest. The intensive field work of Messrs. Andrews and Heller has resulted in the discovery of additional new races in this region, while their smaller collections from eastern China, Szechuan and southeastern Mongolia have been of much help in affording comparable material of other forms. The following appear to be new.

Talpidæ

Of the long-nosed, shrew-like moles of the genus *Rhynchonax*, the collection contains a fine series of fourteen skins from Mu-cheng, on the Salween drainage, southwestern Yunnan, taken at altitudes of from 6000 to 7000 feet; and a series of eight from the Snow Mountain (Ssu-shan), Li-chiang, Yunnan, from near timber-line at 10,000 to 12,000 feet. As might be expected the former series is strikingly darker than that from the higher level, with conspicuously blackish rumps. Both series differ again from typical *R. andersoni* of Szechuan of which a series is available in the Museum of Comparative Zoölogy, some of which have been identified as of this species by Mr. Oldfield Thomas of the British Museum. The two Yunnan forms may stand as subspecies.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 18.

Rhynchonax andersoni atronates, new subspecies

TYPE.—Female, skin and skull, No. 44343, American Museum of Natural History, from Mu-cheng, Salween drainage, southwestern Yunnan, 7000 feet altitude. February 13, 1917. R. C. Andrews and E. Heller.

DESCRIPTION.—A dark form, the rump nearly unmixed slaty black; skull smaller, with less reduced third upper premolar, than in typical *andersoni.*

General color above nearly "Prout brown" (Ridgway). The pelage consists of wholly black shining hairs mixed with others that are blackish slate basally, tipped with hazel. On the rump, the latter sort of hairs are fewer or absent, giving a strikingly blackish appearance to this region. The lower surfaces of body and limbs are uniform blackish slate. Backs of feet and the entire tail, scaly, with scattered minute blackish hairs; the tail usually not paler underneath.

The skull is smaller than in typical *andersoni* of Szechuan and the teeth are smaller throughout except that the third upper premolar, which in the latter is minute, about half the crown-area of the first, and barely reaches the level of the cingulum of the two adjoining premolars, is in this Yunnan animal much larger, of about the same crown-area as the first premolar with cingulum and crown well developed, the tip of the tooth standing well above the general cingulum level. In the lower jaw, the second incisor, instead of being minute, is as large as the canine, while in all, the small second premolar (p_2) is well developed, though slightly smaller than the canine; whereas in the Szechuan series it is either very minute or even altogether absent.

MEASUREMENTS.—The collectors' measurements are: head and body, 67 mm.; tail, 57; hind foot, 14; ear, 10; these are practically as in typical *andersoni.* The skull measures as follows (with corresponding dimensions of a Szechuan specimen in parenthesis): greatest length, 20.5 (22.0); basal length, 16.4 (17.6); palatal length, 9.2 (10.2); mastoid width, 11 (11.4); zygomatic width, 10.2 (10.6); width outside first molars, 6.0 (6.7); upper tooth row, 8.8 (10); lower tooth row, 8.0 (9.0).

REMARKS.—In addition to the series from Mu-cheng, a single skin from Pei-tai-ping, Mekong drainage, appears to be this form.

Rhynchonax andersoni nivatus, new subspecies

TYPE.—Male, skin and skull, No. 44352, American Museum of Natural History, from Ssu-shan (Snow Mountain), Li-chiang, western Yunnan, 12,000 feet altitude. October 22, 1916. R. C. Andrews and E. Heller.

DESCRIPTION.—Similar to typical *andersoni* but much paler with a smaller skull and larger third upper premolar. In size and cranial characters it resembles the preceding form but is much paler, lacking the blackish rump, and the tail is indistinctly bicolor.

General color above light cinnamon-brown, almost the same tone as in our *Sorex personatus;* fore legs and under parts "deep neutral gray" (Ridgway, 1912), much paler than in *andersoni* from Szechuan. In certain lights the tips of the hairs both above and below reflect the light in little glints. Tail fuscous above, pale beneath.

The skull is smaller than in the typical form, and closely resembles that of *atronates.* The third upper premolar is as large as the first, stands well in the tooth row with its cingulum on a level with those of the adjacent teeth, and is provided with a distinct crown about as high as the width of its cingulum. The second lower incisor

is larger than the canine, hence much larger than in Szechuan examples of *andersoni*.

MEASUREMENTS.—The collectors' measurements of the type are: head and body, 68 mm.; tail, 60; hind foot, 15. The skull measures: greatest length, 20; basal length, 16; palatal length, 9.7; mastoid width, 11; zygomatic width, 10; width outside first molars, 6.5; upper tooth row, 9; lower tooth row, 8.2.

REMARKS.—The series of nine skins from the Snow Mountain is very uniform in its paler brown tint, as compared with typical *andersoni* and the subspecies *atronates*. Indeed, so striking was the difference that the entire series was picked out at once in unpacking, without reference to the labels for locality. In both the Yunnan races the third upper premolar and second lower incisor are less reduced than in the Szechuan series, indicating the retention of a more primitive condition by the southern forms. The discovery of the genus in southwestern Yunnan at high altitudes is an interesting extension of its known range.

Soricidæ

Seventeen skins of small striped-backed shrews prove very interesting. Nine of these, from Li-chiang, Yunnan, seem to correspond closely with Milne-Edwards's description of *Sorex cylindricauda*. The dark line down the back is rather poorly defined, often amounting only to an indistinct darkening of the mid-dorsal area, as represented in Milne-Edwards's plates ('Recherches pour servir à l'Hist. Nat. des Mammifères,' 1868–74, Pl. XXXVIII *A*, fig. 3; XXXVIII *B*, fig. 3). The teeth also agree in that the fourth unicuspid is very little smaller than the three preceding, so that the entire four are nearly equal. In *Sorex bedfordiæ*, the three anterior unicuspids are subequal, the fourth much smaller in side view. Two specimens from Tai-pei-shan, southern Shensi, seem to be this, with much better-marked dorsal stripe. Five skins from western Yunnan, of this general type, seem to correspond with Thomas's *Sorex wardi fumeolus* (type locality Wei-chow, western Szechuan). They are much darker in color than *bedfordiæ* but with pale gray instead of brownish bellies. All these specimens were obtained at altitudes of from 10,000 to 12,000 feet. At 7000 feet on the Salween drainage, a single example was secured which is so much darker and smaller than all the rest that it evidently represents a distinct low-altitude race, probably related to *bedfordiæ* as its lower side is of the same dark color as the back instead of contrastingly pale. It may be known as follows.

Sorex bedfordiæ gomphus, new subspecies

TYPE.—Male, skin and skull, No. 44320, American Museum of Natural History, from Mu-cheng, Salween drainage, western Yunnan, 7000 feet altitude. February 11, 1917. R. C. Andrews and E. Heller.

Description.—A very small dark-brown shrew with black dorsal stripe.

General color above a rich dark cinnamon-brown, near Mars brown of Ridgway but clouded. A narrow blackish stripe runs from the nape to the base of the tail, its edges not sharply defined but merging gradually with the color of the back. Below, the chest and belly are washed with cinnamon-brown and the throat is clearer gray with a silvery sheen. Backs of feet and the tail all around clothed with minute dark hairs of about the same cinnamon-brown as the body.

In side view the three anterior unicuspids are subequal, the fourth decidedly smaller than the fifth, but in crown view the cross-section of the last is greater than that of the fourth, agreeing in these respects with *bedfordiæ*.

Measurements.—The collectors' measurements follow, with those of the type of *bedfordiæ* in parenthesis: head and body, 55 mm. (55); tail, 39 (55); hind foot, 13 (11). The skull is small and delicate; it measures: greatest length, 16.6; palatal length, 7.3; mastoid width, 8.0; width outside upper molars, 4.4; upper tooth row, 7.0; lower tooth row, 6.3.

Sorex excelsus, new species

Type.—Adult male, skin and skull, No. 44359, American Museum of Natural History, from summit of Ho-shan, Pei-tai, thirty miles south of Chung-tien, Yunnan, China, altitude 13,000 feet. November 29, 1916. R. C. Andrews and E. Heller.

Description.—A medium-sized shrew, of a general grayish brown above, silvery below, with sharply bicolor tail. Skull with long attenuated rostrum, anterior two unicuspids equal, the third and fourth smaller, the former slightly the larger of the two.

Entire dorsal surface of head and body nearly "Prout brown" (Ridgway, 1912), slightly grayer on the head, and faintly darker on the middle of the back. Below, silvery gray, the bases of the hairs "blackish plumbeous" but concealed by their pale tips; chin whitish. Backs of the feet clothed with short whitish hairs. Tail sharply bicolor, dusky above, whitish below, with a dark-brown pencil of longer hairs.

The skull shows no especial peculiarities except for its long slender rostrum. The teeth are conspicuously pigmented, and the upper unicuspids recall those of certain American species in that the anterior two are equal and larger than the posterior two which are nearly equal though the third is obviously larger than the fourth in side view.

Measurements.—The collectors' measurements of the three specimens, all from the same locality, are:

No.	Head and Body	Tail	Hind Foot
44357	62	50	14
44358	60	50	13.5
44359 (Type)	60	51	13

The skull of the type measures: greatest length, 18.7 mm.; basal length, 16.2; palatal length, 8.5; breadth of brain case, 8.6; breadth outside last molars, 4.6; upper tooth row, 8.2; mandible, 10.2; lower tooth row, 7.8; depth of brain case, 5.1.

Remarks.—This alpine shrew does not closely resemble any of the Chinese species yet described. In color and general external appearance, it is indistinguishable from *S. longicaudus* of the humid northwest coast

of America. Its skull, however, is longer, and in this respect, too, it exceeds its neighbors, *S. cylindricauda*, *S. bedfordiæ* and *S. wardi fumeolus* (the last perhaps best considered a race of *S. bedfordiæ*). These three have a more or less well-marked black dorsal line, no trace of which is present in *S. excelsus*, while their lower surfaces and the backs of their feet are darkened with a brownish wash. There is no suggestion of the tri-color pattern, with buffy sides, characteristic of the *S. araneus* group. It is not unlikely that the relationship between the new species and some of the American shrews is fairly close.

Soriculus caudatus umbrinus, new subspecies

TYPE.—Adult male, skin and skull, No. 44338, American Museum of Natural History, from Mu-cheng, Yunnan Province, China, Salween River drainage, 7000 feet. February 11, 1917. R. C. Andrews and E. Heller.

DESCRIPTION.—A small subspecies, most like *S. sacratus* Thomas, the Szechuan representative of *caudatus*, but differing in its much darker-brown coloring and in having the tail dark all around instead of bicolor.

General color above a uniform "seal brown" (Ridgway, 1912) instead of the "slate gray" of *sacratus;* below slightly paler brown (nearly "Brussels brown") tinged with gray. Backs of the feet and the tail all around light seal brown like the back.

Skull similar to that of *sacratus* in measurements, hence slightly smaller than that of *caudatus* of Nepal. The tips of all but the minute unicuspid and the last molar above are pigmented chestnut.

MEASUREMENTS.—The collectors' field measurements of the type are: head and body, 60 mm.; tail, 55; hind foot, 12. Average of nine specimens: head and body, 62 mm.; tail, 53.5; foot, 12.8.

The skull measures: greatest length, 18.1 mm.; palatal length, 8.1; mastoid width, 9.0; width outside molars, 5.0; upper tooth row, 8.1; mandible (exclusive of incisors), 9.5; lower tooth row, 7.3.

REMARKS.—This small and very dark-brown *Soriculus* is interesting not only as extending the known range of the species into the middle altitudes of southwestern Yunnan, but also as offering another instance of the response of a wide-ranging species to the climatic conditions of this area through the development of a smaller and darker race as compared with the representatives farther north.

Chodsigoa hypsibia parva, new subspecies

TYPE.—Male, skin and skull, No. 44390, American Museum of Natural History, from Li-chiang, Ssu-san-chong, Yunnan, 9000 feet altitude. October 12, 1916. R. C. Andrews and E. Heller.

DESCRIPTION.—A small dark representative of the more northern species, *hypsibia*.

General color a uniform "deep mouse gray" (Ridgway, 1912), scarcely lighter below, and with a faint brownish tinge in some lights. Feet pale, with scattered dark

hairs; tail dark above, pale whitish below, with minute short hairs not dense enough to obscure the scales. The general color is nearly the same as that of *Blarinella wardi*, an associated species.

MEASUREMENTS.—The smaller size of this little shrew is its most notable feature. The collectors' measurements of the four specimens are (compare with head and body, 84 mm., tail, 65, foot, 15 of *C. hypsibia*):

No.	Head and Body	Tail	Hind Foot
44390 (Type)	54	44	11.5
44391	55	43	11
44395	56	45	11
44396	55	45	11

The skulls of all four were badly crushed in the traps. None of the molars is pigmented, and the other teeth have merely the tip chestnut. The rostrum of the type has a width outside second molars of 4.2 mm. (6.1); length of upper tooth row, 6.6; of lower tooth row, 6.1; tip of lower incisor to condyle of jaw, 9.1 (12.3); to angle, 9 (11.5) (dimensions in parenthesis are of the type of *C. hypsibia*).

REMARKS.—Of this genus of shrews characterized by $\frac{8}{6}=28$ teeth, four specimens were captured at Li-chiang, which is apparently the most southern locality yet recorded for it. It is probably best considered a geographical variety of *C. hypsibia* of Szechuan, from which it differs in its notably smaller size and darker color. It is the smallest of the forms yet discovered.

Chodsigoa smithii parca, new subspecies

TYPE.—Male, skin and skull, No. 44409, American Museum of Natural History, from Ho-mu-shu Pass, western Yunnan, China, 8000 feet. April 6, 1917. R. C. Andrews and E. Heller.

DESCRIPTION.—A long-tailed species with nearly the external dimensions of *C. smithii* but with a much smaller skull and less attenuate rostrum. The ears and feet are slightly smaller and the latter are brownish instead of whitish.

General color above and below a "dark mouse gray" (Ridgway, 1912) with a slight brownish wash; the color is darkest on the rump, palest on the belly. Tail dusky brown above, scarcely lighter below, clothed with minute dark-brown hairs which do not exceed the scaly rings. Backs of the feet distinctly brownish, digits whitish.

The skull, though nearly the size of that of *C. hypsibia* and much less than that of *C. smithii*, is very different from either in having the rostrum relatively shorter and more gradually tapering from brain case to tip instead of having the premaxillary region abruptly narrowed. The teeth are smaller and more slender than in either.

MEASUREMENTS.—The tail is decidedly longer than head and body, more so than in typical *smithii*, but not so long as in the long-tailed *salenskii*. The collectors' measurements of the type follow, with those of a *C. smithii* from southern Shensi in parenthesis: head and body, 70 mm. (80); tail, 91 (83), foot, 17.5 (18). The skull measurements follow with those of *C. smithii* in parenthesis: greatest length, 19.3 mm. (22.5); palatal length, 9.0 (10); greatest width, 9.0 (10); width outside molars, 5.6

(6.6); upper tooth row, 8.5 (10); mandible, 12 (13); lower tooth row, 7.6 (9). Upper unicuspids subequal. In the type the tips of the large anterior incisors alone are pigmented, though in the other specimens the tips of the five anterior teeth are chestnut.

Remarks.—Notwithstanding the peculiar formation of the rostrum and the slightly greater proportionate length of tail, it seems best to consider these Yunnan shrews a race of the larger species, *smithii*, of which the collection contains two specimens from 10,000 feet in Tai-pei-shan, in the Tsing-ling Range of southern Shensi. A large series of *C. hypsibia* from the base of the same mountain has also been useful for comparison. The nearly equal size of the three upper unicuspids seems to be a character allying the new race to *smithii* rather than to *hypsibia*, in which the anteriormost seems to be the largest. In addition to the type and a second specimen from the same locality, the collection contains two other examples from Ssu-shan-chong, Li-chiang, Yunnan, 9000 feet, which are practically identical with them.

Crocidura ilensis phaeopus, new subspecies

Type.—Adult female, skin and skull, No. 56013, American Museum of Natural History, from Wanhsien, Szechuan Province, China. November 2, 1921. Third Asiatic Expedition.

Description.—A very small, dark-brown species of the *ilensis* group, distinguished by its dark-brown instead of whitish feet.

The entire dorsal surface of the body, the backs of the fore and hind feet, and the upper surface of the tail are dark brown, nearly "mummy brown" (Ridgway, 1912). At the lateral border the under side of chin, throat, forearms and belly becomes rather abruptly whitish, the hairs except at the chin white-tipped with "dark gull gray" bases. The base of the tail is gray beneath but terminally is much the same on both surfaces. The long bristles are scattered evenly throughout its length.

The skull has about the same dimensions as in its neighbors *shantungensis* and *coreæ*. It is small and delicately formed, the rostrum not especially elongated. The first upper unicuspid is double the height of the rounded posterior cusp of the anterior incisor. The second and third unicuspids are practically equal in height and cross-section, and reach the level of the anterior cusp (paracone) of the carnassial. The lacrymal foramen is exactly over the point of contact between first and second molars.

Measurements.—The collectors' measurements of the type are: head and body, 62 mm.; tail, 37; foot, 12; ear, 9. The skull measures: greatest length, 16.9 mm.; basal length, 15; palatal length, 7.6; width of brain case, 7.6; occipital depth, 4.0; mandible, 10.7; upper tooth row, 7.3; width outside molars, 5.0; lower tooth row, 6.6.

Remarks.—This very small brown species seems to be widely spread in Asia from Corea (*coreæ*) to Palestine (*portali*). From the typical subspecies, *ilensis*, and from the lowland form of eastern China, apparently identical with *shantungensis*, the race from the Szechuan highlands

differs conspicuously in its dark feet and tail. The Third Asiatic Expedition secured a fine series at Wanhsien and a single specimen at the base of Tai-pei-shan, Tsing-ling Mountains, on the southern border of Shensi, which are very uniform in this respect. A skin from Weihsien, in Shantung, and another from Shensi, 45 miles south of Fengsiangfu are paler with obviously whitish feet and lower side of tail. They evidently represent the race *shantungensis*, from which *coreæ* is apparently not very different. A skin from Ichang, which I had provisionally referred to *coreæ* (Mem. Mus. Comp. Zoöl., XL, p. 242, 1912), is, as might be expected, somewhat intermediate between the Shantung and Szechuan races, but on the whole, with its paler feet, is best referred to the lowland race (*shantungensis*). This species is not listed among the many small mammals secured for the British Museum by Anderson and other collectors in Szechuan and may be of local or rare occurrence.

Crocidura vorax, new species

Type.—Adult male, skin and skull, No. 44383, American Museum of Natural History, from Li-chiang, Yunnan, China, taken in timber-line forest on Ssu-shan (Snow Mountain), 12,000 feet altitude. October 15, 1916. R. C. Andrews and E. Heller.

Description.—A medium-sized, pale-brownish species, apparently allied to the *C. russula* group.

Color of head and body above a very pale grayish brown, nearly "wood brown" of Ridgway, and very closely like that of *Sorex personatus*, with a similar pepper-and-salt appearance, due to the presence of a narrow gray band below the brown tips of the hairs. This color gradually pales into the gray of the belly, with a faint wash of buffy on the chest. The bases of the hairs everywhere are slaty, becoming paler, almost "slate gray" below, where they show through slightly. Tail distinctly bicolor, darker than the back above (near "clove brown"); clear gray below. The hair of the tail is thick enough to conceal the scales, while the long bristle-like hairs are rather scattered, and are more numerous near the base of the tail. Ear thin and rather small, less conspicuous than usual, but not entirely concealed.

The skull is of about the same size as in *C. russula* of Europe, and has a low but well-defined sagittal ridge and more prominent lambdoid ridges. The first upper unicuspid is about twice the height of the cusp of the first incisor. The second and third unicuspids are practically equal in both vertical extent and cross-section; their tips are practically on the same line as the tip of the anterior cusp (paracone) of the succeeding (carnassial) tooth (instead of exceeding it as in *russula*). The height of the paracone of the carnassial above the anterior root is about equal to one-half the height of the main cusp, and equals the distance from the tip of the anterior cusp to the summit of the main cusp along the front face (in *russula* it is much less). The profile of the posterior edge of the carnassial is a wide, backwardly directed crescent, and the summit of the main cusp is about over the center of the base (a much longer tooth than in *russula*). The main cusp of the anterior incisor is slender and turned strongly downward.

Measurements.—The collectors' measurements of the type are: head and body, 72 mm.; tail, 51; foot, 13. Five other specimens from the type locality average: head and body, 64.2 mm.; tail, 40.6.

The skull of the type measures: greatest length, 19.8 mm.; basal length, 17.4; palatal length, 8.6; greatest width of brain case, 9.0; width outside molars, 5.7; mandible (excluding incisor), 10.4; upper tooth row, 8.3; lower tooth row, 7.6.

Remarks.—Its rather long fur, brownish coloration and thin small ears combine to give this mountain shrew much the appearance of a *Sorex*. The collectors' note states that the type specimen was seen devouring a mouse (*Apodemus*) in a trap. Two additional examples from lower altitudes to the eastward (Yangtse River, at Chih-tien and Taku Ferry, 6400 and 6000 feet respectively) are similar but differ slightly in having the paracone of the carnassial shorter than the unicuspids adjoining it.

What is obviously a representative of this same shrew farther southward and at a lower altitude is a single skin from the Mekong River. It is so very much richer in its brown coloration that it cannot be included with the Li-chiang specimens, and in common with other southern representatives of more northern species in this part of Yunnan seems worthy of distinction. It may be known as follows.

Crocidura rapax, new species

Type.—Adult male, skin and skull, No. 44321, American Museum of Natural History, from Ying-pan-kai, Mekong River, southern Yunnan, at 9000 feet. December 25, 1916. R. C. Andrews and E. Heller.

Description.—In size and proportions resembling *C. vorax* but the entire dorsal surface a richer brown, nearly "bister" of Ridgway (1912), slightly peppered with gray on the head and shoulders. Below a light "mouse gray." Feet clothed with minute gray hairs; tail bicolor like the body, the bristle-hairs rather few and scattered.

Skull like that of *C. vorax* but very slightly more delicate.

Measurements.—The collectors' measurements are: head and body, 64 mm.; tail, 42; foot, 12.5. The skull measures: greatest length, 18 mm.; basal length, 16.3; palatal length, 8; greatest width, 8.2; mandible, 11.4; upper tooth row, 8; width outside molars, 5.3; lower tooth row, 7.4.

Remarks.—This and the previous species are of about the same size apparently as *C. indochinensis* of Siam and I have referred to the latter a single specimen from Ho-mu-shu Pass, Yunnan, which agrees closely with the description given by Robinson and Kloss in its slaty under parts and dark mouse-gray instead of brown color above. Although treated as distinct species, it is likely that the two new forms are but geographical representatives of a single species.

A handsome series of twenty-two skins of *Anourosorex* proves to be very interesting, as it represents the two species *squamipes* and *assamensis*. Two skins from Tai-pei-shan, Tsing-ling range, Shensi, are apparently typical of *squamipes*, and extend its known range to this Province. They were caught at an altitude of 10,000 feet. Thirteen other specimens from various localities in southern Yunnan appear to represent a smaller geographic race, here described as new. A third lot from the Salween drainage, southwestern Yunnan, is again quite different, with larger, heavier skulls, less shiny fur, a greenish wash below, and brownish rumps. They are evidently referable to *assamensis*, but differ from it in size and color sufficiently to be worthy of recognition as an eastern form. The dentition in the two species is very similar, but in *squamipes* there is usually a shallow notch on the anterior edge of the second upper incisor, whereas in *assamensis* this is usually lacking. The descriptions follow.

Anourosorex squamipes capnias, new subspecies

Type.—Male, skin and skull, No. 44506, American Museum of Natural History, from To-mu-lang, Chung-tien district, Yunnan, 10,000 feet altitude. December 3, 1916. R. C. Andrews and E. Heller.

Description.—Similar to typical *squamipes* but smaller, the fur slightly grayer and less shining.

Entire upper surface a "dark mouse gray" with a finely peppered appearance on close inspection; lower surface of body with a light wash of "tawny olive." The entire pelage in certain lights is silvery, but less so than in typical *squamipes*. Both fore and hind feet are smaller and more delicate.

The skull is shorter and of slightly smaller proportions than in the latter, with which it shares the character of having a slight notch on the anterior border of the second upper incisors.

Measurements.—The corresponding dimensions of a typical *squamipes* from Szechuan are given in parenthesis following those of the type. Length, 90 mm. (100); tail, 14 (14); hind foot, 13 (16). Skull: greatest length, 23 mm. (25); basal length, 20.8 (23); palatal length, 11.5 (12.5); upper tooth row, 11 (12); mastoid width, 11.6 (13); mandible, 11 (12.2); lower tooth row, 10 (11).

Remarks.—In addition to the type, specimens were taken at the following localities in southwestern Yunnan: Mekong River, Siao-ke-la, 8000 feet; Mekong drainage, Chiang-wei, 8000 feet; Mekong River, Yin-pan, 9000 feet; Mekong River, La-chu-mi, 9000 feet; Ha-pa, 20 miles north of Taku, 10,000 feet; Peh-tai Mountain, 30 miles south of Chung-tien, 10,000 feet. It will be seen that all these places are at elevations of 8000 feet or over. The range of *A. assamensis* appears to be at a lower altitude, for the series from Mu-cheng, Salween drainage, was secured at elevations between 6000 and 7000 feet. The rarity of this

species in collections (the type has apparently remained unique) seems to have caused some doubt as to its distinctness from *squamipes*, and Wroughton has even proposed that the two be considered inseparable. But Anderson's figures and measurements, as well as his careful description, seem to leave no doubt that *assamensis* is a distinct species, with skull proportionally very much larger than in *squamipes*, equaling one-half the length of the vertebral column to the end of the sacrum. That of his type specimen is relatively enormous, much larger than any of the Mu-cheng series, which again are larger and heavier than those of *squamipes*. The skins have a peculiar greenish wash on the belly, quite different from any coloration found in the latter. The lack of a notch on the anterior edge of the second upper incisor seems also to be distinctive of *assamensis*. The type locality of *assamensis* is Assam, between Seebsaugor and Jeypur. The western Yunnan race may be described as follows.

Anourosorex assamensis capito, new subspecies

Type.—Adult male, skin and skull, No. 44510, American Museum of Natural History, from Mu-cheng, Salween drainage, Yunnan, 7000 feet altitude. February 10, 1917. R. C. Andrews and E. Heller.

Description.—Size less than in typical *assamensis*, the skull smaller; belly with a distinct greenish or yellowish-gray wash.

The dorsal surface of body is a dark mouse gray, a little darker than in the above race of *squamipes*, with a minutely peppered appearance. The long hairs on the rump just above the root of the tail are rusty-tipped, apparently the result of staining through the effect of some glandular secretion. Chin, throat, chest and belly gray tinged with greenish or yellowish. Pelage both above and below silvery when viewed from in front. Hind feet longer than tail.

Measurements.—The type measured by the collectors: length, 93 mm.; tail, 16; hind foot, 16.5. The skull measures: greatest length, 25.8 mm.; basal length, 23; palatal length, 12.5; upper tooth row, 11.7; mastoid width, 13.4; mandible, 13; lower tooth row, 10.8.

Remarks.—Compared with *A. squamipes capnias* the striking difference in color of the under surface, the larger size of the feet and skull, and the unnotched second upper incisor separate this form easily. The skull especially is more massive, with a much more prominent sagittal ridge. The seven specimens from the type locality are very uniform in the characters described.

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NEW BATHYERGIDÆ FROM THE OLIGOCENE OF MONGOLIA[1]

By W. D. Matthew and Walter Granger

The genera here described are from the Hsanda Gol formation in the Tsagan Nor basin of outer Mongolia, named and defined by Berkey and Granger in American Museum Novitates No. 77, May 25, 1923. They are from the red strata in the lower part of the variegated beds of that formation, the same horizon as the skull and other parts of *Baluchitherium* described by Osborn in Novitates No. 78, May 25, 1923, and from the same or neighboring localities.

The age of the Hsanda Gol formation was provisionally given as Miocene by Berkey and Granger, but the correlation of the fauna described in this and following articles shows that the variegated beds containing the *Baluchitherium* fauna are Oligocene, probably not later than Stampian.

Baluchitherium was first discovered by Forster Cooper in the Bugti Hills, Baluchistan, in beds correlated by him as Upper Oligocene.[2] The related or identical genus *Indricotherium* was described by Borissiak in 1915, from a formation which he correlated as Oligocene in the Kirghiz steppes north of Russian Turkestan.[3] The third discovery, made by the Third Asiatic Expedition of the American Museum, was at Iren Dabasu on the Kalgan-Urga caravan trail in eastern Mongolia, in the Houldjin formation[4] associated with a few very fragmentary remains of other animals. The fourth discovery in the Hsanda Gol formation is in association with a large and varied fauna mostly of small mammals. The correlation of this fauna will be discussed in a later contribution.

The rodents are the most abundant element of the collection. Many skulls, more or less complete, a few skeletons or parts of skeletons, and some thousands of jaws and fragments of jaws, were obtained by the Expedition in 1922 in the Tsagan Nor basin. They represent eleven species of nine genera, as follows:

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[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 19.

[2]Cooper, C. Forster, 1911, Ann. Mag. Nat. Hist., (8) VIII, p. 711, and later articles.

[3]Borissiak, A., 1915, Geol. Vestnik; 1917, Bull. Acad. Imp. Sci. Petrograd, (6) XI, p. 287.

[4]Granger and Berkey, 1922, Amer. Mus. Novit. No. 42, Aug. 7; Matthew and Granger, 1923, idem, No. 97.

Simplicidentata (Glires, *sensu stricto*)
- *Tsaganomys altaicus*, new genus and species
- *Cyclomylus lohensis*, new genus and species
- ? *Prosciurus lohiculus*, new species
- *Cricetops dormitor*, new genus and species
- *Tataromys plicidens*, new genus and species
- *Tataromys sigmodon*, new species
- *Karakoromys decessus*, new genus and species
- *Selenomys mimicus*, new genus and species
- *Eumys asiaticus*, new species

Duplicidentata (Lagomorpha)
- *Desmatolagus gobiensis*, new genus and species
- *Desmatolagus robustus*, new species

The first two genera are the subject of this paper; the remaining rodents of this fauna will be described in the next contribution.

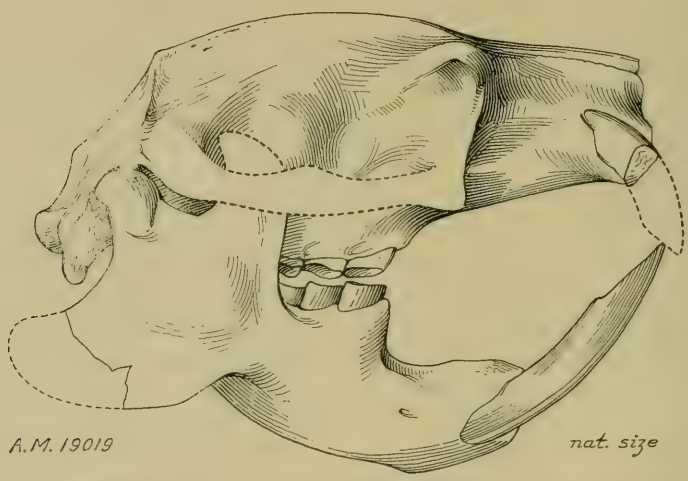

Fig. 1. *Tsaganomys altaicus*, skull and jaws, side view, natural size. No. 19019, type specimen, characters partly supplemented from Nos. 19021, 19030 and 19033.

Bathyergidæ

Tsaganomys altaicus, new genus and species

Type.—Amer. Mus. No. 19019, skull and lower jaws.

Paratypes.—Nos. 19020, 19029, 19030, 19033, 19037, 19038, skulls, some with lower jaws associated.

Horizon and Locality.—Oligocene, Hsanda Gol formation, red strata, Loh, Tsagan Nor basin, outer Mongolia.

Diagnosis.—Skull short, wide, robust, the occiput very broad and pitched heavily forward with prominent occipital and sagittal crests. Infraorbital foramen

small, oval, situated low down, apparently not traversed by any slip from the masseter, which has a scar for attachment on inferior face of spring of zygomatic arch as in *Bathyergus* (and *Paramys*, etc.). Above the root of the zygoma the orbits are built out laterally to a marked degree with a prominent sharp-edged crest in front, separating them from the muzzle. Although this crest in some ways resembles that of the sciuromorphs, it does not appear to have lodged a division of the masseter on its anterior face, but is more nearly analogous to the much less conspicuous preorbital crest of *Bathyergus*. Tympanic bulla broad and flattened anteriorly, extending postero-externally into a short ? meatus. Sagittal crest high, somewhat convex in

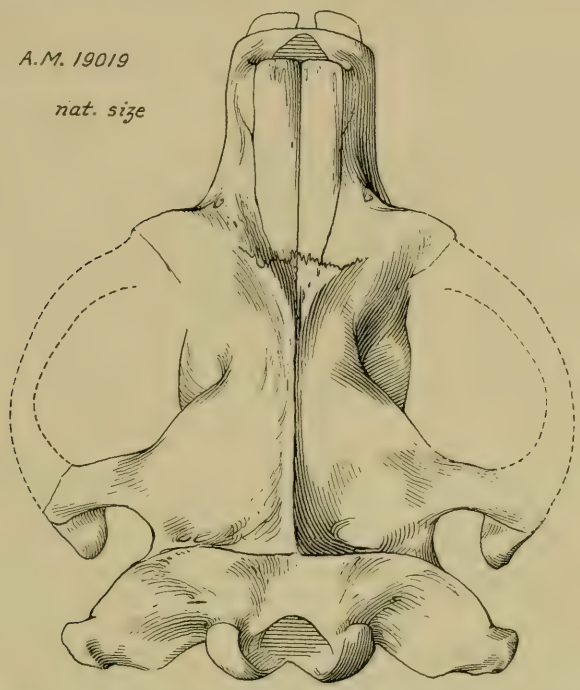

Fig. 2. *Tsaganomys altaicus*, skull, top view, natural size, type specimen.

outline, short, owing to the extreme forward pitch of occiput; postorbital constriction pronounced, abrupt. Interorbital space nearly twice as wide as in *Bathyergus;* nasals narrow with straight sides, increasing slowly but uniformly in width from back to front.

Incisors large, broad, with flat anterior faces ornamented with obscure longitudinal ridges. The socket for the upper pair forms a prominent bulge on the maxilla above the cheek teeth and the curvature is low in both upper and lower pair, so that they project strongly forward at the points. The socket of the lower pair is directly under the condyle of the lower jaw. Cheek teeth $\frac{4}{4}$, very hypsodont, of persistent

growth, without closed roots at any observed stage of wear, round or oval in cross-section, decreasing somewhat in diameter from $p\frac{4}{4}$ to $m\frac{3}{3}$. The crown pattern disappears at a very early stage of wear, as in *Bathyergus*, leaving only an encircling band of enamel. The crown pattern of the unworn lower molars appears to be one external and three internal inflections, the latter rapidly converted by wear into three shallow pockets and then disappearing. The structure of the unworn upper molars consists essentially of three shallow transversely-extended pockets, of which the center one is formed by ridges connecting protocone with paracone and metacone, the anterior and posterior ridges enclosed by anterior and posterior cingular crests, the first comparatively short, connecting protocone with parastyle, the second much longer, sweeping around the margin from behind the protocone to meet the metacone. The cones, however, do not exist as such, the whole tooth being reduced to a series of narrow crests and shallow basins. Jaw massive, corresponding with

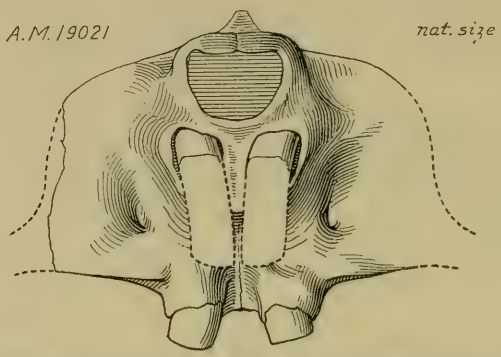

Fig. 3. *Tsaganomys altaicus*, front view of skull, showing small antorbital foramen with wide crest external to it. No. 19021, natural size.

Bathyergus in the relations of angle and coronoid so far as they are preserved.

The milk dentition is well shown in No. 19023; dp^3 is a small peg-like tooth with simple blunted crown; dp^4 has almost exactly the form and pattern of m^1 but is of smaller size and presumably shorter crowned; dp_4 is similarly like m_1 in pattern, but somewhat smaller, narrower, and with the anterior and posterior fossæ slightly impressed, the median inflections, both internal and external, more persistent and the external inflection directed more backward.

Remarks.—This appears, if properly referable to the family, to be the first fossil record of Bathyergidæ, hitherto known from the recent Ethiopian fauna. It is by no means close to the living genera and should perhaps be distinguished as a separate subfamily, **Tsaganomyinæ**, on the short massive proportions of skull with heavy forward pitch of occiput, wide differences in otic region and some rather minor differences in teeth. It suggests the Asiatic ancestry of the family, although it cannot be considered as even approximately ancestral to the living genera.

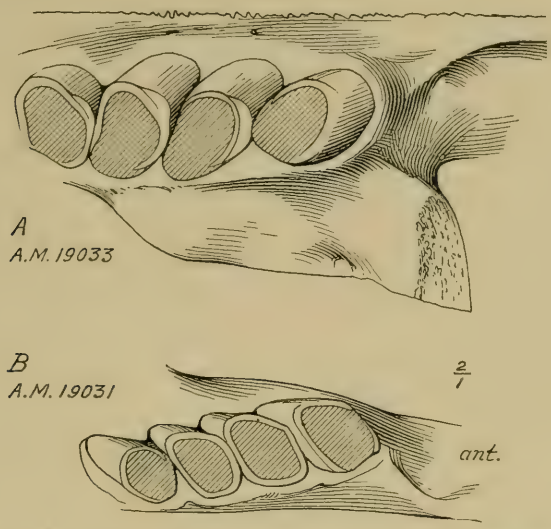

Fig. 4. *Tsaganomys altaicus*, upper and lower teeth of left side, crown views, twice natural size. Nos. 19033, 19031.

Cyclomylus lohensis, new genus and species

TYPE.—No. 19096, skull, badly preserved.

PARATYPES.—No. 19098, upper and lower jaw; Nos. 19095, 19097, palates; No. 19099, incomplete skull, badly preserved. All from same horizon and locality as the preceding species.

DIAGNOSIS.—Dentition apparently as in *Tsaganomys*, molars of similar apical pattern early lost, but less hypsodont and of much smaller size, the roots closing when full grown. Skull much narrower and smaller, the proportions more as in *Bathyergus* but the cranium not so flat and broad as in that genus; zygomatic arch of moderate proportions, the orbits not built out as in *Tsaganomys*, infraorbital foramen apparently small and low set, masseter attachment on under face of zygomata limited by a scar. The angle of the lower jaw springs from the side as in *Tsaganomys*, so far as the specimens show, but its exact relations are not so fully demonstrated.

The permanent premolar is preceded by a minute, simple dp^3 and a large round molariform dp^4, as in *Tsaganomys*.

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NINE NEW RODENTS FROM THE OLIGOCENE OF MONGOLIA[1]

By W. D. Matthew and Walter Granger

In the preceding number of Novitates eleven new species of rodents from the Hsanda Gol formation of Mongolia were listed and two of them described. The remaining rodents are described in this article.

Cricetopidæ

Cricetops dormitor, new genus and species

Type.—No. 19054, skull, lower jaw and fore foot.

Paratypes.—Several more or less complete skulls and numerous upper and lower jaws.

Horizon and Locality.—Oligocene, Hsanda Gol formation, near Loh in the Tsagan Nor basin, outer Mongolia.

Diagnosis.—Cheek teeth $\frac{3}{3}$, the upper series decreasing in length and width from first to third, the lower series subequal and of nearly square outline. Brachydont crowns, the cusps arranged in pairs, two pair each on $m\frac{2}{2}$ and $m\frac{3}{3}$, but a well-developed anterior pair on m^1 and a rudimentary anterior heel on m_1. In the lower teeth the outer cusps tend to be crescentic, the inner are nearly round; the upper teeth reverse this arrangement. The skull is cricetoid in proportions, rather long and narrow, arches well preserved on the type and several other specimens show that the infraorbital foramen was round and of rather large size, resembling some of the dormice, e. g., *Graphiurus*, also *Pseudosciurus* and other Oligocene genera and, to a less extent, the Dipodidæ, the masseteric scar on the zygoma wholly beneath it and defined by a clear-cut margin.

The teeth are very like those of *Cricetus* in proportions and pattern, to such a degree that a true affinity rather than parallelism may be indicated. The front of the zygoma, however, is unlike any true myomorphs but approaches the primitive construction which is universal in the Eocene, prevalent in the Oligocene, and preserved among the dormice (not in *Myoxus*) in *Anomalurus*, *Haplodontia* and *Bathyergus* with less alteration than in other modern rodents. The Dipodidæ have the i. o. f. greatly enlarged; cricetids and other myomorphs have the masseteric attachment on the zygoma extended forward and upward in a plate.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 20.

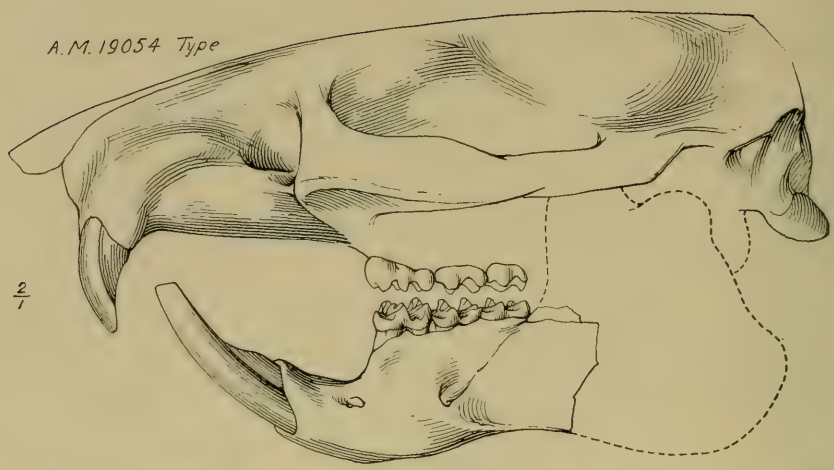

Fig. 1. *Cricetops dormitor*, skull and lower jaw, side view, twice natural size. Type specimen, No. 19054.

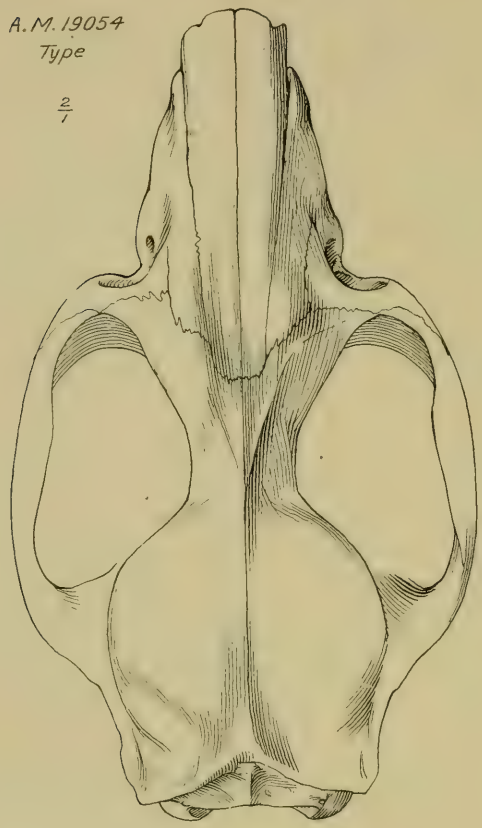

Fig. 2. *Cricetops dormitor*, skull, top view, twice natural size. Type specimen, No. 19054, the occiput supplemented from No. 19051.

This genus would apparently fall into the Dipodoidæ of Miller and Gidley's classification and, if we understand correctly the assumptions underlying their arrangement, could have nothing to do with the Cricetidæ. It appears inadvisable to accept these assumptions until their validity has been more conclusively proven; in some respects they do

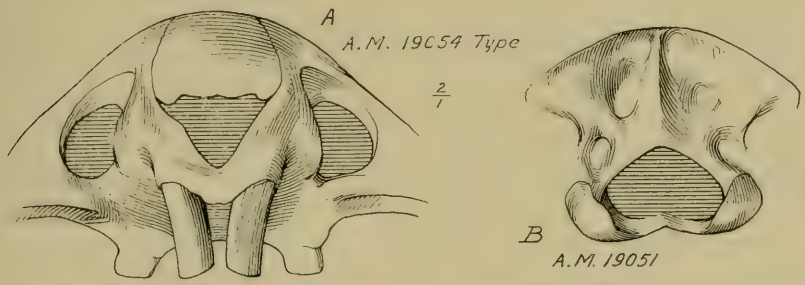

Fig. 3. *Cricetops dormitor*, anterior and posterior views of skull, twice natural size: *A*, anterior view, showing character of antorbital foramen, from the type; *B*, occiput from No. 19051.

Fig. 4. *Cricetops dormitor*, upper and lower teeth, crown views, enlarged to four diameters: *A*, upper teeth and roof of zygomatic arch from the type specimen; *B*, lower teeth, No. 19059.

not seem to us conformant to the general tenor of the evidence of fossil rodents, and have compelled these authors—as they admit at the beginning of their classification—to deny, practically, that any of the extinct types of rodents are either directly or approximately ancestral to any of the existing types, and to assign all of the numerous resemblances in

dentition, skull and skeleton which would suggest a more or less ancestral relationship, to parallel—or rather, convergent—evolution. No interpretation of the affinities of existing and extinct rodents can avoid the assumption of a large amount of parallelism, but it would seem that Messrs. Miller and Gidley have carried it to improbable extremes in support of certain preconceived theories of what can or cannot occur in the modification of the zygomatic and dental construction, and that a reasonable application of the law of probabilities to what we know of fossil rodents would lead to some modification of these theories and a resultant simplifying of their otherwise admirable revision, which we fully recognize as based upon a most thorough and complete review of the order, particularly as including the extinct as well as the existing genera. It is proper to emphasize, however, that they have not yet published the evidence in support of their conclusions, and this may prove to overcome the difficulties which we see in accepting them without certain modifications. The fauna herein described will add materially to the fossil evidence and in our opinion may make it necessary to reconsider to some extent the very complex and difficult problem of the true affinities and evolution of the major groups within the order. That, however, is an undertaking much beyond the scope of the present contribution.

It does not appear advisable to assign this genus to any recognized family, as its systematic position turns upon the above problem. It might be placed with the dormice save that this family includes, auct. Miller and Gidley, two groups of quite diverse affinities, and *Cricetops* appears to be quite as diverse from either as they are from each other. It might be referred to Pseudosciuridæ or Eomyidæ on the zygomatic characters, but the teeth are wholly unlike any of the genera of those families. The same objection applies to its reference to the Theridomyidæ. It is still less possible to associate it with *Ischyromys* or *Paramys* or with the Dipodidæ. Anomaluridæ in the broad scope given to the family by Winge and Schlosser would perhaps include this and the following genera, but it would require at least subfamily distinction. With it, in the same broad sense, might be placed a number of new genera from the Hsanda Gol, which are known only from upper and lower jaws and appear to have some resemblance in masseter attachments, although, except for *Selenomys*, they are quite diverse in dentition. Pending a reconsideration of the relations of these anomaluroid or dipodoid genera, it appears convenient to place *Cricetops* and *Selenomys* in a separate family and refer *Karakoromys* and *Tataromys* to the Eomyidæ.

Selenomys mimicus, new genus and species

Type.—No. 19085, an upper jaw.

Paratypes.—Nos. 19086–19093, a series of upper and lower jaws.

Horizon and Locality.—Hsanda Gol formation, near Loh, Mongolia.

Diagnosis.—Three subequal molar teeth, no premolars. (There is some doubt about the absence of the upper premolar.) Crowns of molars moderately high, each composed of four inward-facing crescents, an anterior and a posterior pair, as in ruminant molars. The lower jaw in front of the molars is rather thick, not deep, moderately long; incisor not preserved. Angle only partly preserved, appears to be straight, as in Myomorpha generally.

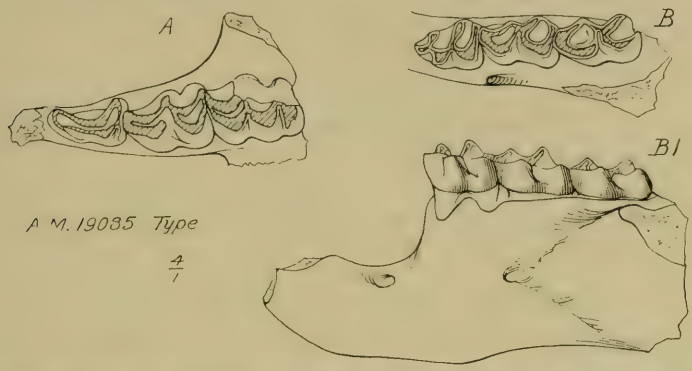

Fig. 5. *Selenomys mimicus*, upper and lower teeth four diameters: *A*, upper teeth, right side; *B*, lower teeth, left side, crown view; *B1*, external view of left ramus of lower jaw. All from the type specimen, No. 19085.

We do not know of anything near to this peculiar genus. It is provisionally associated with *Cricetops*, which has some suggestion of approach in pattern, but the jaw proportions are quite different. *Ctenodactylus* has a pattern which sugggests derivation from something of this type but it retains the premolar in upper and lower jaw which *Selenomys* has lost. So far as preserved, the character of the zygomatic arch accords with *Cricetops;* the genus is clearly not a myomorph and probably belongs in the same group as *Cricetops*.

? **Eomyidæ**

Tataromys plicidens, new genus and species

Type.—No. 19082, a palate with p^4–m^3, r. and l.

Paratypes.—Nos. 19081, 19083, 19084, upper and lower jaws.

Horizon and Locality.—Hsanda Gol formation, Loh, Mongolia.

Diagnosis.—Premolar smaller than the molars, trigonal with three submarginal crests, not at all molariform in pattern but of fair size. Molars with two principal

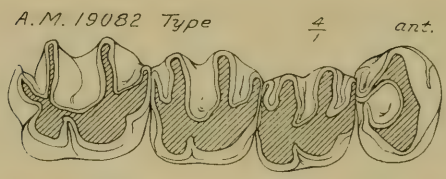

Fig. 6. *Tataromys plicidens*, upper teeth, right side, enlarged to four diameters. From type specimen, No. 19082.

transverse crests connected by an external commissure; on m^2 and m^3 supplementary anterior and posterior crests obliquely inward from the main crests opposite commissure. The lower molars reverse this pattern in the usual manner but the arrangement is less regular.

Tataromys sigmodon, new species

Type.—No. 19079, a palate.

Horizon and Locality.—Hsanda Gol formation, Loh, Mongolia.

Diagnosis.—Dentition and details of construction of teeth very close to *T. plicidens* but of smaller size, length of p^4–m^3 = 8.8 mm.

Karakoromys decessus, new genus and species

Type.—No. 19070, lower jaw, both rami with cheek teeth and left incisor complete.

Horizon and Locality.—Hsanda Gol formation, red beds, Loh, Tsagan Nor basin, Mongolia.

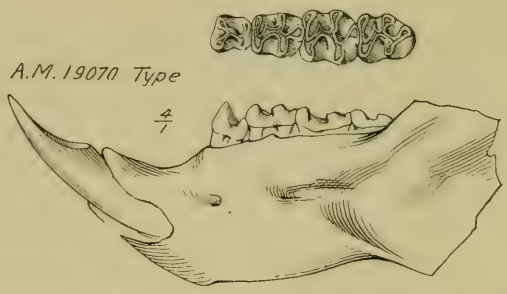

Fig. 7. *Karakoromys decessus*, lower jaw, type specimen, four times natural size, external view of left ramus and crown view of cheek teeth.

Diagnosis.—P_4 present, much smaller and simpler than molars. Molars increasing slightly in size from first to third, moderately brachyodont, longer than wide, the crowns with high transverse crests, a principal anterior (trigonid) and posterior (talonid) crest connected by a commissure, and a hypoconulid crest extending postero-internally from a point on the outer half of the talonid crest. P_4 with a single transverse crest and a wide but short posterior heel.

This genus appears to be nearly related to *Tataromys* in molar construction.

Paramyidæ

Prosciurus lohiculus, new species

Type.—No. 19100, upper jaw with p^3–m?.

Horizon and Locality.—Oligocene, Hsanda Gol formation, Loh, Mongolia.

Diagnosis.—Upper molars and p^4 with crests arranged much as in *P. vetustus*, but higher and lacking any trace of mesostyle on external margin between the crests. Size about a fourth larger than *P. vetustus*.

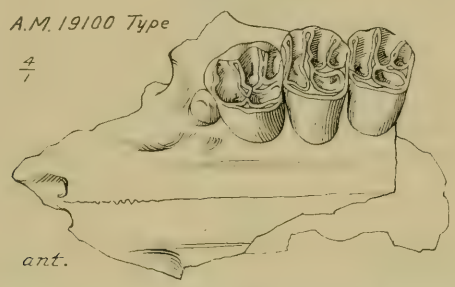

Fig. 8. *Prosciurus* ? *lohiculus*, upper jaw, four times natural size, type specimen, No. 19100.

This species is referred to *Prosciurus* provisionally. It is too imperfectly known for satisfactory allocation. It equally resembles in dentition several modern Sciurine genera or subgenera, but the masseteric scar appears to be confined to the inferior face of the zygomatic process of the maxilla, much as in *Prosciurus*, *Paramys* and related genera.

Eumys asiaticus, new species

Type.—No. 19094, upper jaw with m^{1-3}.

Horizon and Locality.—Oligocene, Hsanda Gol formation, near Loh, Mongolia.

Diagnosis.—Tooth pattern much as in *E. elegans*, masseteric plate of zygoma typically myomorph and closely resembling that of *Eumys* and *Cricetodon*. Size: $m^{1-3} = 5.5$ mm.; $m_{1-3} = 6$ mm.

This appears to be the only true myomorph rodent in the Hsanda Gol fauna. It is closely allied in tooth pattern to *Eumys* of the American and *Cricetodon* of the European Oligocene. The Miocene species of *Cricetodon* are, so far as I have examined, decidedly more advanced towards *Cricetus*.

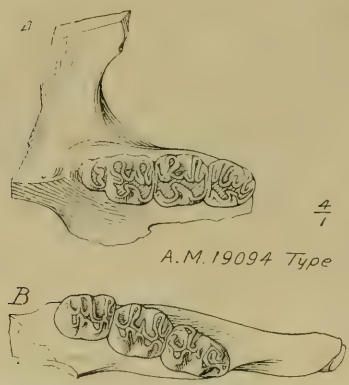

Fig. 9. *Eumys asiaticus*, upper and lower jaw fragments, four times natural size: *A*, upper jaw, left side, with m $^{1-3}$, showing also the obliquely-pitched masseter plate in front of zygomatic arch; *B*, lower jaw, right side. The anterior end of the upper jaw faces to left, of lower jaw to right. Type specimen, No. 19094.

Leporidæ

Desmatolagus gobiensis, new genus and species

TYPE.—No. 19103, upper jaw with p^2- m^3.

PARATYPES.—Various upper and lower jaws.

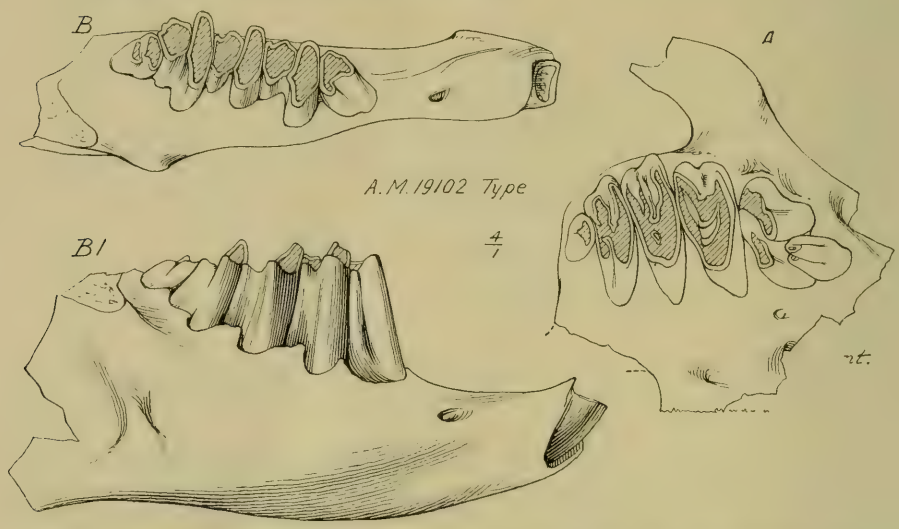

Fig. 10. *Desmatolagus gobiensis*, upper and lower jaw, four times natural size: *A*, crown view of upper cheek teeth; *B*, crown view of lower teeth; *B*1 external view of lower jaw, right side. Type specimen, No. 19102.

Fig 11. *Desmatolagus robustus*, upper jaw, crown view, four times natural size, showing p^3 - m^2 and roots of p^2 and m^3. Type specimen, No. 19116.

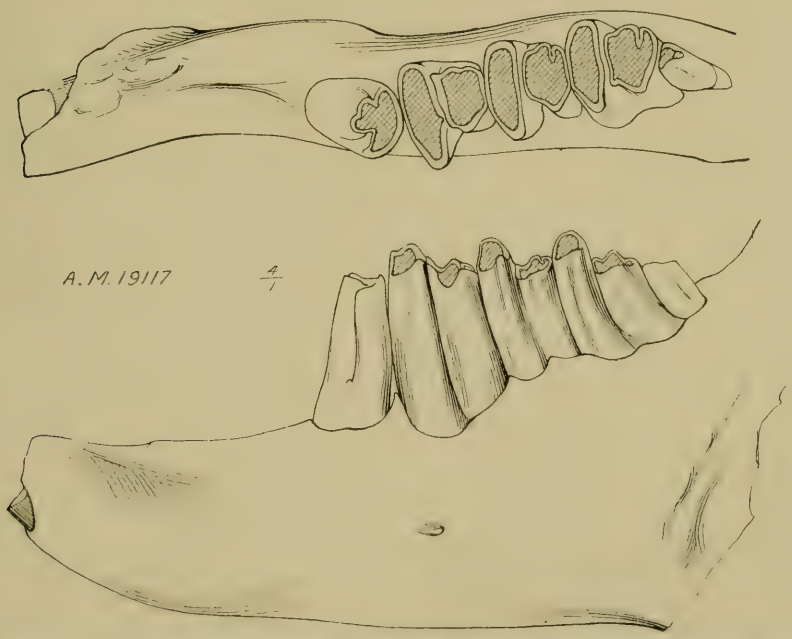

Fig. 12. *Desmatolagus robustus*, lower jaw, superior and external views, four times natural size. No. 19117.

Horizon and Locality.—Oligocene, Hsanda Gol formation, red beds, Loh, outer Mongolia.

Diagnosis.—Cheek teeth $\frac{6}{5}$ as in Leporidæ but the first and last teeth of the series ($p\frac{2}{3}$, $m\frac{3}{3}$) greatly reduced. Although it retains the formula of the Leporidæ, the genus undoubtedly is related to the Ochotonidæ and may be considered ancestral to some of the genera (not to *Titanomys*, which is stated to have rooted molars[1]). It is placed in the Leporidæ provisionally upon the formal distinction of the number of cheek teeth.

Desmatolagus robustus, new species

Type.—No. 19116, lower jaw with p_3-m_2.

Paratype.—No. 19116*a*, lower jaw with p_4-m_3.

Horizon and Locality.—Oligocene, Hsanda Gol formation, red beds, Loh, Outer Mongolia.

Diagnosis.—Size, one-half greater than the preceding, to which it is in other respects nearly alike.

[1]The published descriptions and figures of *Titanomys* do not seem to prove, however, that the permanent teeth have roots. In *Palæolagus* the milk molars have roots but the permanent teeth are rootless.

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56.9,74(118:51.7)

NEW CARNIVORA FROM THE TERTIARY OF MONGOLIA[1]

By W. D. Matthew and Walter Granger

Most of the species here described are from the Oligocene *Baluchitherium* zone, Hsanda Gol formation, in the Tsagan Nor basin, in outer Mongolia. One is from the Eocene Irdin Manha *Protitanotherium* zone in the Iren Dabasu basin, eastern Mongolia.

Paracynohyænodon morrisi, new species

Type.—No. 19160, lower jaw, immature, with m_1 unworn, p_3 and m_3 preformed, Irdin Manha beds. Found by F. K. Morris, 23 miles south of Iren Dabasu.

Characters.—The molars, as in Dr. Martin's type,[2] are distinguished from those of *Cynohyænodon* and *Tritemnodon* by the more compressed and secant character of the talonids. The species appears to be distinguished from the genotype, *P. schlosseri* of the Phosphorites, by the reduced and crowded premolars.

Hyænodon pervagus, new species

Type.—No. 19005, part of lower jaw.

Paratypes.—Nos. 19006, 19015, 19125, 1926, parts of jaws; No. 19002, hind limbs and feet.

Horizon and Locality.—Oligocene, Hsanda Gol formation, Loh, Mongolia.

Diagnosis.—Species of moderate size in the genus, about equalling *H. heberti* and *cruentus*. So far as comparisons can be made, it belongs among the shorter-jawed species. Distinguished from *heberti* by entire lack of anterior accessory cusps on premolars, by larger relative size of m_1, etc. The hind limb and foot bones are finely preserved and agree very closely with *H. cruentus* in size and in all details of construction.

Remarks.—*Hyænodon* is widespread in the Upper Eocene and older Oligocene of Europe (Débruge, Phosphorites, older Bohnerzen, Ronzon), in the Lower and Middle Oligocene of America (*Titanotherium* and *Oreodon* zones of the White River) and in the Lower Oligocene of Egypt (Fluvio-marine beds). Its occurrence in the Hsanda Gol points to a rather early Oligocene age for this formation.

Didymoconus colgatei, new genus and species

Type.—No. 19124, skull and jaws.

Paratypes.—Nos. 19003, 19004, lower jaws.

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[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 21.

[2]Martin, Rudolf, 1906, 'Revision obereoc. u. unterolig. Creodonten Europas.' Rev. Suisse de Zool., XIV, p. 424. *Paracynohyænodon schlosseri.*

Horizon and Locality.—Oligocene, Hsanda Gol formation.

Generic Diagnosis.—Dentition $\frac{?.1.3.2}{?.1.3.2}$. Incisors small, crowded, ? reduced; canines of normal carnivore type, $p\frac{4}{4}$ molariform; p^2 and $p_{2\text{-}3}$ simple, two-rooted, compressed, with sharp cusp and small posterior heel, p^3 with two external cusps. Molars of leptictid type, the trigonid of lower molars composed of two high round, twinned cusps and a small low paraconid, the heel rising sharply at posterior margin to a transverse crest, incompletely separated into hypoconid and entoconid. M_2 slightly larger than m_1, heel narrower than trigonid; m_1 with heel and trigonid of equal width; p_4 quite molariform (but the crown less worn and the tooth less fully emerged

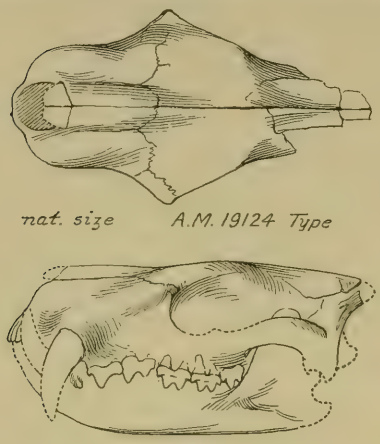

Fig. 1

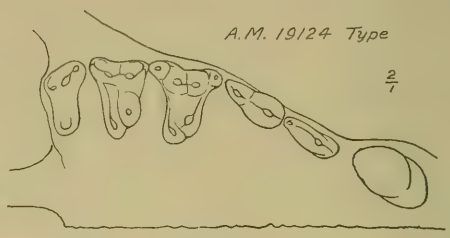

Fig. 2

Fig. 1. *Didymoconus colgatei*, skull and jaws, type specimen, side and top views. The original is somewhat broken and crushed and the distortion has been corrected in the drawing. Oligocene, Hsanda Gol formation, Mongolia. Natural size.

Fig. 2. *Didymoconus colgatei*, upper dentition, c^1-m^2. Principally from the type skull, supplemented by comparison of several referred specimens. Twice natural size.

from the jaw than the one behind it, and therefore assigned to the premolar series), the heel wider than trigonid, and paraconid a little stronger than on the true molars. Posterior mental foramen under p_3. Jaw short and deep with strongly sutured symphysis.

Upper molars transversely extended, m^1 consisting of a pair of separate subequal outer cusps, an inner conical protocone opposite the paracone and a strongly developed posterior cingular crest extending somewhat further inward than the protocone. On p^4 this posterior crest is represented chiefly by a posterointernal cusp with a rather rudimentary cingular crest extending from it toward the base of the metacone; the external stylar cusps, very rudimentaryon m^1, are quite distinct and the external cingulum, distinct on m^1, is obsolete. P^3 has two external cusps, the metacone much smaller.

Specific Diagnosis.—Size of *Spilogale*, c-m_2=28 mm.; lower jaw, shallower, depth below m_1=9 mm.; lower canine, comparatively small and slender.

Didymoconus berkeyi, new species

TYPE.—No. 19001, lower jaws, from the same horizon and locality as the preceding.

SPECIFIC DIAGNOSIS.—Size of *Mephitis*, c-m_2 = 3.5 mm.; lower jaw, deep, robust; lower canines, very large and stout.

REMARKS.—This genus is unlike any known Oxyænidæ, and in some respects it has a marked resemblance to Mesonychidæ, in others to Leptictidæ. The formula is not so positively determined as one would like, nevertheless it seems almost sure that the first molariform tooth is a premolar (as in Leptictidæ). The true molars have almost lost their carnivore construction, nevertheless one can see in the pattern that it is a derivative of the oxyænid type of carnassiform teeth with the carnassial socket between m^1 and m^2; the great posterior crest of m^1 is evidently an exaggerated cingulum and without it the tooth would be much of the *Limnocyon* pattern.

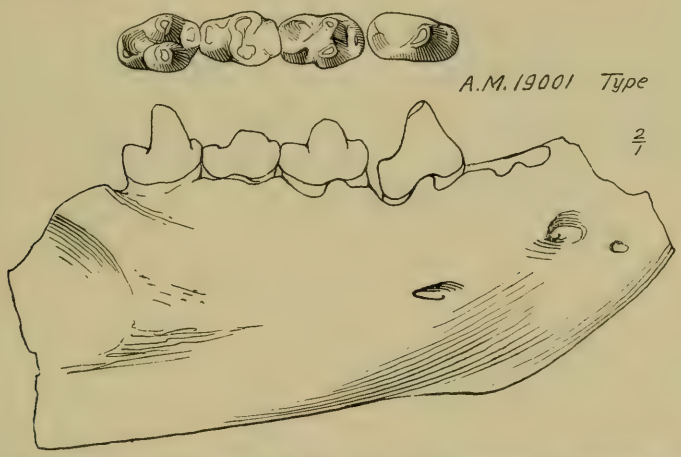

Fig. 3. *Didymoconus berkeyi*, lower jaw, type specimen, external view and crown view of teeth, p_3-m_2. Twice natural size.

In the lower molars the twinned conical cusps of the trigonid are leptictid in type, but the same construction is approached in *Dissacus* and *Hapalodectes* of the Mesonychidæ and in *Apterodon* among the hyænodonts. The short, heavy jaw, stout canines and massive compact symphysis are typically oxyænid, and the two subequal molars are as in the limnocyonines.

Amphicticeps shackelfordi, new genus and species

Type.—No. 19010, a skull.

Horizon and Locality.—Oligocene, Hsanda Gol formation, Loh, Mongolia.

Diagnosis.—Dentition $\frac{?,1,4,2}{?,1,1,2}$. Canines of moderate size. Premolar region rather short, premolars somewhat reduced, simple, stout, much as in *Cynodon*. P^4 fully carnassiform, protocone (deuterocone) anterointernal, well developed, forming a low, broad inner heel; no parastyle. M^1 large, much extended transverely, paracone close to antero-external margin, metacone only slightly smaller, more internal in position; protocone low and a heavy inner cingulum. M^2 quite small, aligned with inner margin of m^1, apparently not extending beyond inner half of the preceding tooth, the roots connate or single. Cranium wide and rather short, with heavy sagittal and occipital crests; basicranial region wide and short, tympanic bulla incomplete or loosely attached, paroccipital processes free, directed backward. Mastoid processes prominent, flattened and projecting laterally.

The lower jaw is very like that of *Cynodon*, except that the carnassial has a narrower and shorter heel with more distinct hypoconid crest and m_3 is absent. M_2 is not preserved in our specimens; its alveolus indicates a tooth of about the same size and proportions as in *Cynodon*, with connate roots.

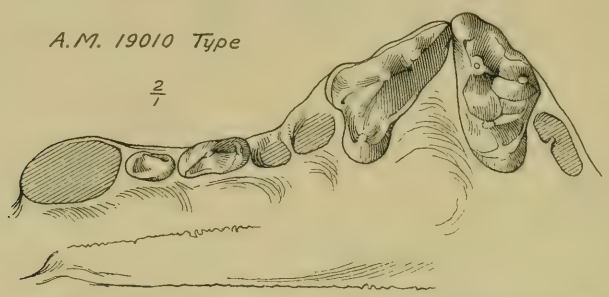

Fig. 4. *Amphicticeps shackelfordi*, upper jaw with the first, second and fourth premolars and first true molar preserved. From the type skull, No. 19010. Twice natural size.

This genus is intermediate between the cynodontoid and stenoplesictoid groups of the Phosphorite fauna. It has the sharply reduced post-carnassial dentition of the latter with the short, heavy precarnassial dentition of the former. It is not close to any one genus with which I have made comparisons and might be regarded as a highly progressive miacid rather than as a member of any of the existing families of fissipede carnivora.

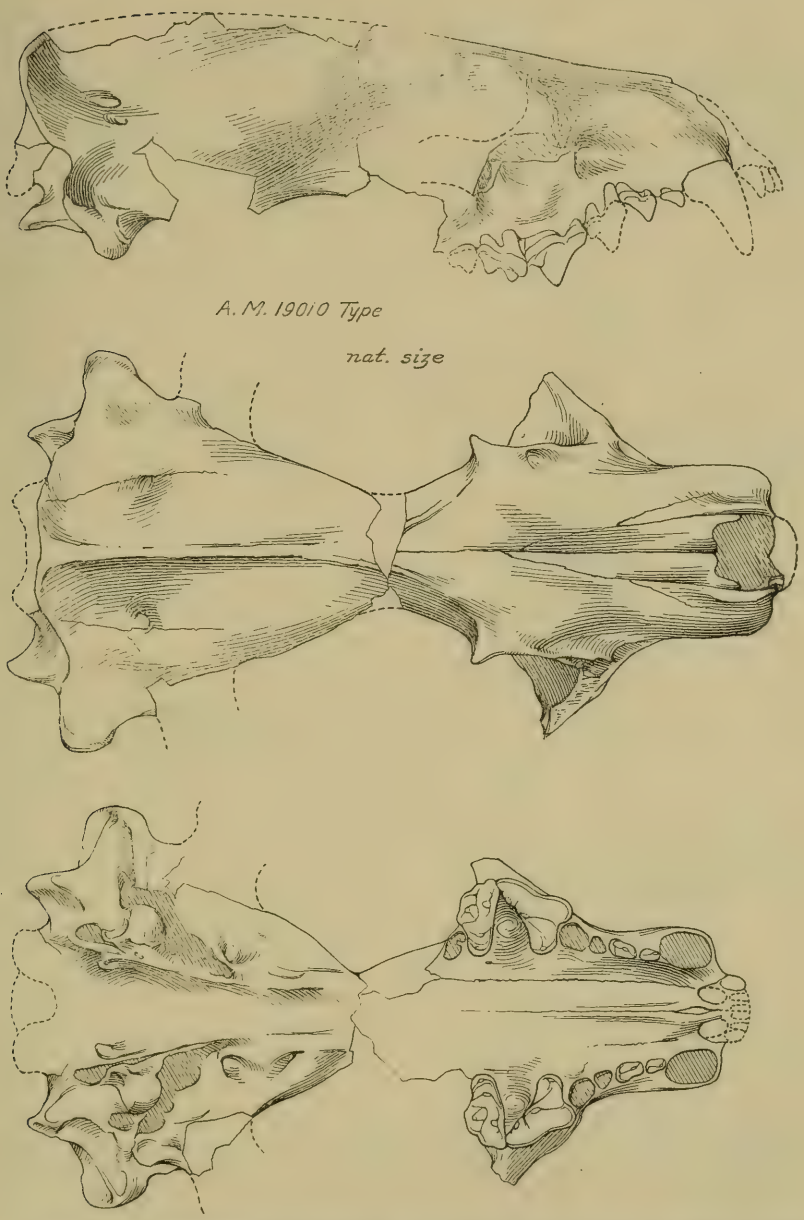

Fig. 5. *Amphicticeps shackelfordi*, type skull, side, top and palatal views. Natural size.

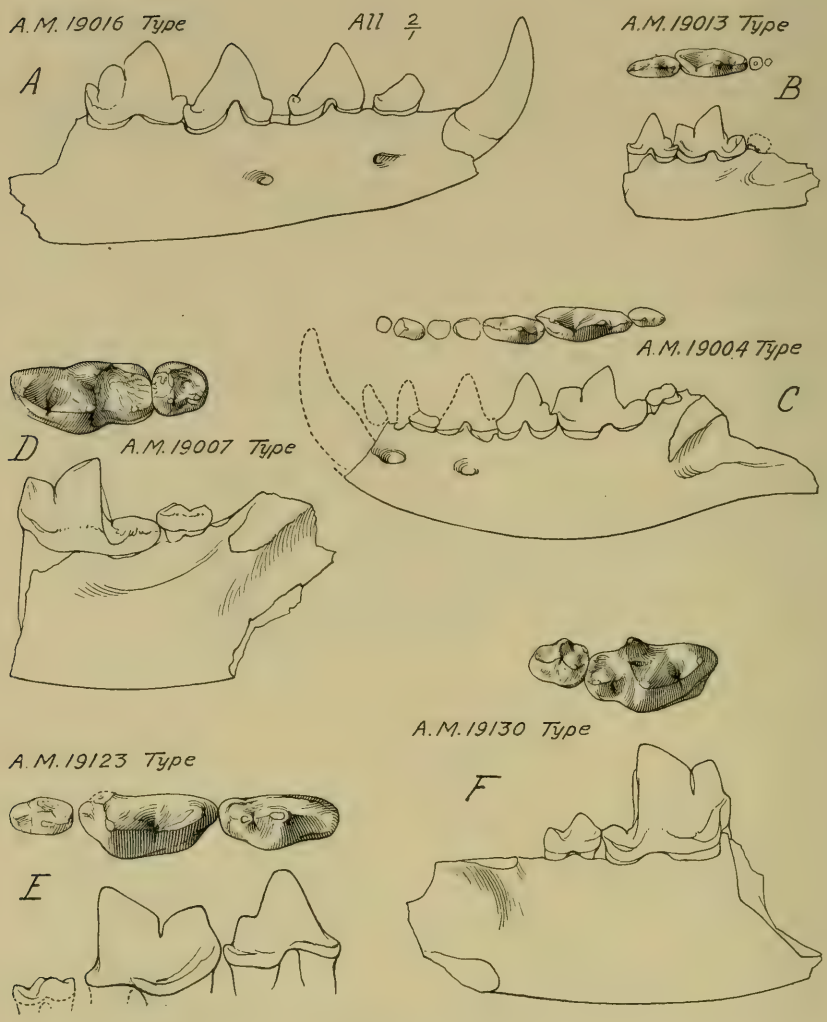

Fig. 6. Jaws of Carnivora from Hsanda Gol formation, external and crown views. *A*, ?*Cynodictis elegans*; *B*, *Bunælurus parvulus*; *C*, *Bunælurus ulysses*; *D*, *Cynodon* (*Pachycynodon*) *teilhardi*; *E*, *Palæoprionodon gracilis*; *F*, *Viverravus constans*. All twice natural size.

Palæoprionodon gracilis, new species

TYPE.—No. 19123, lower teeth and parts of skeleton.

HORIZON AND LOCALITY.—Oligocene, Hsanda Gol beds, Loh, Mongolia.

DIAGNOSIS.—Carnassial compressed, cat-like, with metaconid much reduced and heel vestigial. M_2 very small, narrow and elongate, with flattened trigonid of three low cusps and a trenchant heel. P_4 large, compressed much as in *Felis domestica.* Upper and lower canines subequal, very much alike, of moderate size, long, sharp-pointed, not compressed. Limb bones long and slender, humerus expanded trans-

Fig. 7. *Palæoprionodon gracilis,* limb bones and metatarsal of the type specimen (teeth shown in Fig. 6); outer views of humerus, radius and ulna, anterior view of third metatarsal. Natural size.

versely at distal end with strong epicondylar bridge. Radius slender, ulna wide and flattened at proximal half of shaft, the distal half triangular, considerably less than radius in sectional area.

Astragalus with narrow deep trochlea, the inner crest well developed. No fibular facet on calcaneum. Metatarsals long and slender; mt. I, vestigial or absent.

This species agrees with the Phosphorite genus in dentition, so far as known, and in the character and proportions of the limbs and feet as figured and described by Schlosser; its reference, however, is provisional until the dentition is better known.

Bunælurus ulysses, new species

TYPE.—No. 19004, left ramus of lower jaw with p_4-m_2 l complete.

HORIZON AND LOCALITY.—Hsanda Gol formation, Loh, Mongolia.

DIAGNOSIS.—Dentition c_1, p_4, m_2. First premolar one-rooted, others two-rooted, the fourth with small accessory cusp. Carnassial without metaconid, heel narrow, trenchant; m_2 small, two-rooted with narrow trenchant crown. Length c-m_2, estimated, 25 mm.; p_4-m_2 12.5 mm.

Bunælurus parvulus, new species

TYPE.—No. 19013, part of lower jaw from Hsanda Gol formation.

DIAGNOSIS.—Very like the preceding species, but smaller; p_4-m_2 = 9.5 mm.

We have referred these species to the American genus *Bunælurus*, which is separable from *Palæogale* by retention of a minute m^2 in the upper jaw. As the upper dentition of the Mongolian species is unknown, they might be referred to *Palæogale*, but the reduction of m_2 is relatively greater than in *P. felina*, conforming somewhat better with *Bunælurus*.

Cynodon (Pachycynodon) teilhardi, new species

TYPE.—No. 19007, lower jaw fragment with m_{1-2} and alveolus of m_3.

HORIZON AND LOCALITY.—Oligocene, Hsanda Gol formation, Loh, Mongolia.

DIAGNOSIS.—Size of *Amphicticeps shackelfordi*. Carnassial somewhat less robust and with larger and longer heel, the heel as wide as the trigonid surface, a shallow basin with wrinkles radiating from anterointernal notch to the marginal crests. M_2 subquadrate with proto- and metaconid cusp, hypoconid cusps somewhat smaller, and an internal and posterior marginal crest enclosing a small basin. M_3 smaller than m_2, the crown not preserved, two closely approximate roots.

REMARKS.—This species can be referred only provisionally until better specimens are available. It appears to fall within *Pachycynodon* rather than the typical *Cynodon*, by Teilhard's key to the Phosphorite genera.

Cynodictis ? elegans, new species

TYPE.—No. 19016, anterior part of the lower jaws with the canine and premolars preserved.

HORIZON AND LOCALITY.—Oligocene, Hsanda Gol formation, Loh, Mongolia.

DIAGNOSIS.—Size about that of the smaller individuals of *C. compressidens*, but distinguished from this species, as also from the American "*Cynodictis*," by the simple compressed p_3 without accessory cusps. The accessory cusp of p_4 is strong, well

separated, and somewhat external in position. P_1 is single-rooted with compressed crown, anteriorly pitched and recurved at the tip; p_2 is two-rooted, nearly as large as p_3, both being compressed simple crowns, p_4 with some forward pitching and recurving tip, p_3 nearly upright. The canine is quite small, slender, the jaw shallow and thin with loose symphysis extending back to the middle of p_2.

REMARKS.—This species is provisionally referred in absence of the molar teeth. See below under *Viverravus*.

Viverravus constans, new species

TYPE.—No. 19130, part of lower jaw with m_{1-2} preserved.

HORIZON AND LOCALITY.—Oligocene, Hsanda Gol formation, Loh, Mongolia.

DIAGNOSIS.—Size somewhat less than *V. sicarius;* the teeth show the generic characters in the high, somewhat compressed trigonid with angulate cusps, pr^d overtopping the others, heel small, sharply trenchant; m_2 tuberculosectorial with rather high trigonal trigonid of three subequal cusps and narrow trenchant heel; m_3 absent. Considerably smaller than *V. antiquus* of the Phosphorites.

REMARKS.—The reference of this species to *Viverravus* is necessarily provisional, but it agrees quite closely so far as it goes. It is quite possible, however, that the anterior portion of lower jaws provisionally referred to *Cynodictis* is the same species as No. 19130; in which case it certainly is not *Viverravus*, as p_3 of that genus has always a strong accessory cusp.

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NEW INSECTIVORES AND RUMINANTS FROM THE TERTIARY OF MONGOLIA, WITH REMARKS ON THE CORRELATION[1]

By W. D. Matthew and Walter Granger

Tupaiodon morrisi, new genus and species

Type.—No. 19134, upper jaw and part of skull, parts of lower jaw with m_{2-3}.

Horizon and Locality.—Hsanda Gol formation, Red beds, Loh.

Diagnosis.—Upper molars and premolars somewhat resembling those of *Ptilocercus*, but with larger and more separate hypocones on m^{1-2}. Incisors unknown. Canine and p^{1-2} small, two-rooted, with short stout cusp and rudimentary heel. P^{3-4} much larger with strong internal cusps, p^4 with strong metastyle blade and rudimentary tetartocone. M^{1-2} sub-quadrate with high, rather angular cusps, metastyle distinct, hypocone more developed and separated than in *Ptilocercus*, m^3 triangular with no metastyle or hypocone, proportioned about as in *Ptilocercus*. Lower

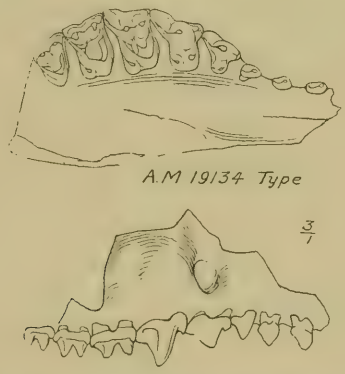

Fig. 1. *Tupaiodon morrisi*, right upper jaw, c-m^3, palatal and external views. Type specimen, No. 19134, Hsanda Gol formation, Mongolia. Three times natural size.

molars with rather short wide trigonid of three angular cusps, pr^d slightly highest, talonid as wide as trigonid, deeply basined with cusps at posterior angles, not as high as trigonid cusps. Infraorbital foramen above p^3; root of zygoma above m^2.

Size about that of the European mole or the short-tailed shrews. C-m^3 = 13 mm.

While provisionally referred to the Tupaiidæ, the true affinities of this genus are uncertain. It is excluded from Leptictidæ by the single

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 22.

outer cusp of p^4, prominence of paraconids and other characters, from the Soricoidea by the comparatively large and complex p^{3-4}.

? **Tupaiodon minutus,** new species

TYPE.—No. 19135, lower jaw fragment, p_3-m_1 right side.

HORIZON AND LOCALITY.—Same as preceding species.

DIAGNOSIS. Somewhat smaller than *T. morrisi*, the molars of nearly the same size, but narrower, with distinct external cingulum; anterior part of lower jaw much more slender and weak; p_3 two-rooted, simple, with single acute uncompressed cusp, minute anterior basal cusp and well-developed posterior basal cingulum; p_4 sub-molariform but smaller than molars, having two well-separated central cusps, a lower anterior cusp, and a broad low cingulum encircling posterior end of tooth. Length p_3-m_2 = 9 mm.

Palæoscaptor acridens, new genus and species

TYPE.—No. 19138, a lower jaw with p_4-m_3, associated with two others.

HORIZON AND LOCALITY.—Hsanda Gol formation, Red beds, 15 miles east of Loh, Mongolia.

DIAGNOSIS.—Dentition probably $\overline{2.1.3.3}$. First incisor (? i_2) enlarged, a long slender, simple procumbent tooth, enamelled, without heel or serrations; second incisor not preserved, the alveolus quite small, round oval; the canine small, root semi-double, crown premolariform and extended forward, followed by a similar but some-

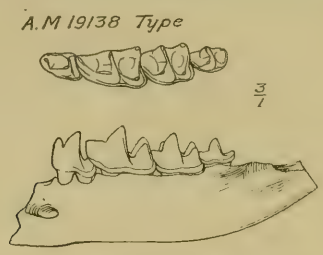

Fig. 2. *Palæoscaptor acridens*, lower jaw, left ramus, external view and crown view of lower teeth, p_4-m_3. Type specimen, No. 19138. Three times natural size.

what smaller and less forwardly extended tooth with semi-double root; the last premolar two-rooted, small, sub-molariform, with trigonid-like main cusp and small transversely-crested heel; m_1 much larger, with trigonid longer than wide, of three sharply angulate cusps, and deeply basined heel with acute cusps at posterior angles. M_2 considerably smaller than m_1, similar trigonid relatively lower and shorter; m_3 much reduced, with low single-cusped heel. The heel cusp is of considerable size on the type, but in other specimens it is vestigial; there is also a considerable range in size in the twenty or more fragmentary jaws that represent the genus; but we are unable to fix associated constant distinctions to divide the material into species.

Palæoscaptor rectus, new species

TYPE.—No. 19146, lower jaw with m_{2-3}.

HORIZON AND LOCALITY.—Oligocene, Hsanda Gol formation, Loh, Mongolia.

DIAGNOSIS.—Teeth, so far as shown, similar to those of *P. acridens*, except for considerably larger size and greater reduction of m_3, which has no heel. Lower jaw angle long, flat, projecting backwards in a rather slender process upturned towards tip.

Only one specimen of this species has been discovered.

AFFINITIES OF *Palæoscaptor*.—This genus is provisionally placed with the Soricidæ, but it is decidedly more generalized than any of the existing genera or of the better known extinct genera. The reduction of m_3 is greater than in any of the modern genera, either of moles or shrews; the primitive brachyodont trituberculy also distinguishes it from most modern Soricoidea, likewise from *Proscalops;* and the reduction of the anterior teeth is greater than in the moles, less than in the shrews, while the enlarged incisor shows no trace of the heel or serrated edge developed in the typical Soricidæ. It is possible that some of the imperfectly known Oligocene Soricoidea may approach it; none of the Bridger soricoids come very near to it. On the whole, it might very well represent an ancestral type from which the soricid genera could be derived.

Eumeryx culminis, new genus and species

TYPE.—No. 19147, fragments of upper and lower jaws and foot bones, probably of several individuals found together.

HORIZON AND LOCALITY.—Hsanda Gol, 10 miles west of Loh, "Grand Canon," probably below lava.

DIAGNOSIS.—General characters of the primitive Cervidæ. Upper canine, a large compressed, slender tusk. Molars brachyodont, the upper molars with prominent styles and anterior rib but no trace of posterior rib, the lower molars with slight traces of a "palæomeryx-fold." Four lower premolars in series, p_1 small, one-rooted and simple, p_{2-4} compressed, two-rooted, with inner crests nearly as in *Blastomeryx*, more developed than in *Prodremotherium*. Navicular and cuboid united, inner cuneiform separate. Median metacarpals and metatarsals united into cannon-bones, but the distal keels not extended over the dorsal surface. Fifth metacarpal and metatarsal coössified proximally, second separate.

Size about that of *Blastomeryx advena;* but there are a few specimens of considerably larger size that may prove to be a distinct species.

The above diagnosis is based upon a large number of fragments of jaws and bones of the skeleton of many individuals. There can be little doubt, however, that they belong all to one genus and mostly to one species, which is the only artiodactyl present. It is an interesting type, as representing a stage of ruminant evolution intermediate between

Leptomeryx and *Blastomeryx* in the structure of teeth and feet, somewhat more progressive in premolar construction than *Amphitragulus* and *Prodremotherium* of the Phosphorites but of smaller size and differing too much to refer it to any of the described genera. In the Phosphorites genera, according to Schlosser, the metacarpals are not united into a cannon-bone and the distal keels are less developed than in *Eumeryx*.

In the Lower Miocene species of *Blastomeryx* the teeth are very like those of the new genus except for loss of p_1, and the median metacarpals

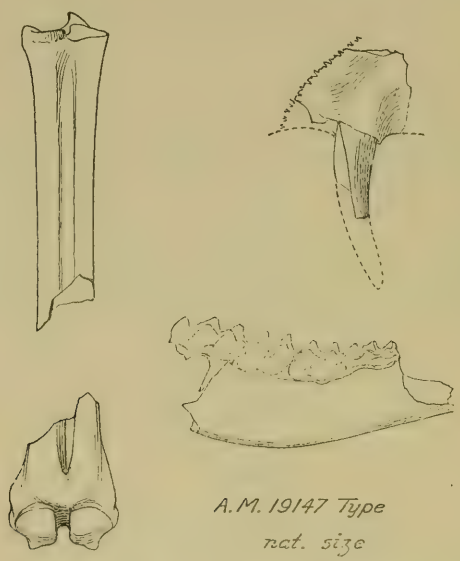

Fig. 3. *Eumeryx culminis*, fragment of upper jaw with canine tusk, lower jaw with dp_4-m_3, proximal and distal ends of metatarsus. Type specimen, No. 19147, Hsanda Gol formation, Mongolia. All natural size.

and metatarsals are similarly united into cannon-bones, mc ii remaining separate and complete; but the distal keels of the cannon-bones are extended over the front of the bone and the form and proportions of the cannon-bones have assumed more the type of the fully developed Cervidæ.

The new genus is of interest as fulfilling more nearly than any hitherto described the required characters for an early Oligocene direct ancestor of the Cervidæ.

List of the Hsanda Gol Fauna

Carnivora
- *Hyænodon pervagus*, new species
- *Didymoconus colgatei*, new genus and species of Oxyænidæ
- *Didymoconus berkeyi*, new species
- *Amphicticeps shackelfordi*, new genus and species
- *Bunælurus ulysses*, new species
- *Bunælurus parvulus*, new species
- *Palæoprionodon gracilis*, new species
- ?*Cynodictis elegans*, new species
- ?*Cynodon* (*Pachycynodon*) *teilhardi*, new species
- ?*Viverravus constans*, new species

Glires
- *Tsaganomys altaicus*, new genus and species of Bathyergidæ
- *Cyclomylus lohensis*, new genus of Bathyergidæ
- *Cricetops dormitor*, new genus and species of Cricetopidæ
- *Selenomys mimicus*, new genus and species of Cricetopidæ
- *Tataromys plicidens*, new genus and species of ?Eomyidæ
- *Tataromys sigmodon*, new species of ?Eomyidæ
- *Karakoromys decessus*, new genus and species of ?Eomyidæ
- ?*Prosciurus lohiculus*, new species of Paramyidæ
- *Eumys asiaticus*, new species of Cricetidæ
- *Desmatolagus gobiensis*, new genus and species of Leporidæ
- *Desmatolagus robustus*, new species of Leporidæ

Insectivora
- *Tupaiodon morrisi*, new species of tupaioid Insectivora
- ?*Tupaiodon minutus*, new species
- *Palæoscaptor acridens*, new genus and species of Soricoidea
- *Palæoscaptor rectus*, new species of Soricoidea

Perissodactyla
- *Baluchitherium*
- ?*Epiaceratherium*

Artiodactyla
- *Eumeryx culminis*, new genus and species, primitive Cervidæ

This fauna is about half made up of new genera; the remainder are referred, positively or provisionally, to known genera on the present evidence. *Hyænodon* ranges through the Upper Eocene, Lower and Middle Oligocene of Europe; in North America it is limited to Middle and Lower Oligocene; in North Africa it occurs in the Lower Oligocene. The Oxyænidæ range through the Eocene of North America and have one representative, *Thereutherium*, in the Phosphorites.[1] The remaining carnivora all belong to that primitive group of Fissipedia best represented in the Phosphorite fauna of France and very difficult to place in the accepted fam-

[1] *Oxyæna* is also recorded from the Phosphorites but upon quite insufficient evidence.

ilies of Fissipedia, as they are essentially transitional between the Miacidæ of the Eocene and the Mustelidæ, Viverridæ, and Canidæ of the later Tertiary and Recent. *Palæoprionodon*, *Palæogale*, *Cynodictis*, *Viverravus* and *Cynodon* are characteristic of the Phosphorites; *Bunælurus* of the Middle Oligocene of North America is almost identical with *Palæogale* of the Phosphorites, and *Viverravus*, although occurring in the Phosphorites, is typical of the Lower and Middle Eocene of North America. *Amphicticeps* is comparable with the cynodont and stenoplesictid groups of the Phosphorites. All of these carnivora are clearly in an Oligocene stage of evolution and appear to be rather early Oligocene.

The rodents are mostly new. One species is comparable with the Oligocene species of *Cricetodon* in Europe and with *Eumys* of the Middle Oligocene of North America; another with *Prosciurus* of the Lower (and ?Middle) Oligocene of North America. The remainder represent an Oligocene stage of evolution in the writers' view, but their true relations to the later Tertiary and existing rodents require further study.

The two insectivore genera are not closely comparable but would be, in our judgment, in an Oligocene stage of evolution. *Eumeryx* compares with *Prodremotherium* and *Amphitragulus* of the French Oligocene, and is decidedly more primitive than *Blastomeryx* of the Lower Miocene, but more modernized than any of the American Oligocene White River or John Day ruminants.

The character of the *Baluchitherium* fauna is peculiar as compared with most Tertiary mammal faunas, in the great abundance and variety of rodents and small carnivora, and scarcity of ungulates, especially artiodactyla. It represents probably a somewhat different facies from the badland faunas of Western America, or the fissure and quarry faunas of Western Europe. It may perhaps be a desert basin fauna. The association of true though primitive Cervidæ with a fauna rather closely correlated with the older Oligocene of Europe and America is of importance as indicating the Asiatic origin of this group, if the principles of evolution and dispersal be adopted which were outlined by Matthew in 'Climate and Evolution.' Hasty conclusions, however, are to be deprecated, as the evidence is still scanty and imperfectly studied and there is excellent prospect of obtaining more of it in the near future.

The Irdin Manha beds contain the following fauna:

Carnivora

Paracynohyænodon morrisi, new species of Hyænodontidæ

Mesonychid, undescribed

Insectivora

?*Pantolestes* of Pantolestidæ

Perissodactyla
Desmatotherium mongoliense Osborn
Protitanotherium mongolicum Osborn
Artiodactyla
Undetermined genus, Anthracotheriidæ

The age of the formation appears to be fixed as Upper Eocene by the occurrence of *Protitanotherium*. *Desmatotherium*, a Bridger Middle Eocene genus, might suggest somewhat earlier age, but the Mongolian species which Osborn has referred to this genus appears to be considerably more hypsodont and otherwise more advanced than its American relative. The absence of ancestral types for the Oligocene invasion of Europe and America is unexpected. The Irdin Manha may be correlated with the Pondaung fauna of Burma, which underlies a marine Upper Eocene formation. This would suggest that both may be Middle rather than Upper Eocene, and the same would probably hold for the Uinta of Utah.

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A NEW CROCODILIAN FROM MONGOLIA[1]

By Charles C. Mook

Among the Mesozoic Reptilia collected by the Third Asiatic Expedition in 1923 there is a small crocodilian which represents a new genus and species, possibly a new family. It was found by Mr. Walter Granger at Shabarakh Usu, on the Kwei Hua Chung—Uliassutai trail. The horizon is the Djadochta Beds, of lower Cretaceous, or possibly Comanchean, age. The specimen consists of skull and jaws, moderately well preserved.

Shamosuchus djadochtaensis, new genus and species

Type.—Skull and jaws, incomplete. Amer. Mus. No. 6412.

Generic Characters.—Absence of mandibular foramen, prominent postero-external process of squamosal, exoccipital comprising a considerable portion of the condyle.

Specific Characters.—Median ridge on frontal bone, prominent ridges on lachrymals, medium size of supratemporal fenestræ, and their position close to the median line and far from the posterior and external borders of the cranial table.

The skull is comparatively broad for its length. The tip of the snout is not preserved, but the convergence of the lateral borders of the skull and of the two rami of the mandibles indicates clearly that the skull was short. The cranial table is relatively large, and its posterior border is strongly curved. It is flat in the portions preserved. The facial region of the skull is broad and flat. The supratemporal fenestræ are of moderate size. They are situated on the anterior portion of the cranial table, relatively near the mid-line of the skull. They are comparatively far from the external and posterior borders of the table. Their length is somewhat greater than their breadth. The orbits are large. The apertures of the anterior portion of the snout are not preserved. The internal narial aperture on the palate has been pushed out of position with respect to its surrounding bones by crushing, but it was apparently similar in form and position to that of the eusuchian crocodiles of to-day and did not resemble the aperture of the Mesosuchia.

The premaxillaries are not preserved. The maxillaries occupy more than two-thirds of the total breadth of the snout. The anterior teeth are

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 23.
Contributions to the Osteology, Affinities and Distribution of the Crocodilia. No. 13.

Fig. 1. *Shamosuchus djadochtaensis*, new species. Type skull, Amer. Mus. No. 6412. Natural size. A, superior view; B, posterior view.

lacking. One tooth of the middle region is of average proportions and is moderately sharp. Four small teeth near the posterior end of the left side are short-crowned and sharp. They are considerably longer in their

antero-posterior than in their transverse diameters. Several teeth slightly farther forward on the right side are similar, except that they are slightly sharper. No button-like, crushing teeth are present. The maxillo-nasal sutures converge sharply forward. The borders of the maxillaries, near these sutures, are slightly elevated.

The nasals are very narrow at their anterior ends, where they are broken off. They broaden rapidly in the posterior direction, reaching their maximum breadth at their junctions with both lachrymals and prefrontals. From these points backward they narrow rapidly. The posterior end of each nasal is somewhat abruptly pointed. The two posterior points are separated by the blunt anterior wedge of the frontal. The superior surfaces of the nasals are slightly concave from side to side. Along the median line there is a deep excavation.

The lachrymal is a distinctive bone. It is completely preserved on the left side only. Its suture with the maxillary is very irregular. The inferior process, extending backward below the anterior border of the orbit, is relatively long and slender. The anterior process is both long and broad. On it is situated an elevation which is prominent near the center of the maxillo-lachrymal suture. This elevation extends inward and slightly forward. Near the center of the lachrymo-prefrontal suture it turns sharply forward and extends parallel with the nasal border of the lachrymal, joining the ridge on the maxillary mentioned above. The anterior branch of the elevation is low and narrow and not prominent. The lateral branch is very prominent. It slopes forward and outward with a gentle concavity, and backward and inward with an abrupt depression. There is a small flat area between the elevation and the suture with the prefrontal. The lachrymal occupies a considerably greater portion of the orbital border than does the prefrontal.

The prefrontal bone is roughly triangular, the long base of the triangle being the inner border of the bone, composed of the naso-prefrontal and prefronto-frontal sutures. This border is somewhat convex toward the median line. The other two sides of the triangle are the orbital border of the bone and the lachrymo-prefrontal suture, both of about the same length and both concave outward. The bone is crossed by a low ridge which extends outward and forward from the center of the prefronto-frontal suture to the angle of the ridge on the lachrymal.

The anterior portion of the frontal is preserved. It is finely pitted and is elevated along the median line into a keel. Consequently the portion preserved resembles one of the nuchal scutes of the exoskeleton. The breadth of the interorbital portion is considerable. The

anterior process is broad and blunt, wedging apart the posterior terminations of the two nasals. Near the borders of the anterior wedge there are two deep pits opposite the ends of the prefrontal ridges.

A portion of the left postorbital is preserved. Its orbital border is incomplete. It occupies only about one-fourth of the external border of the cranial table,—an unusually small proportion.

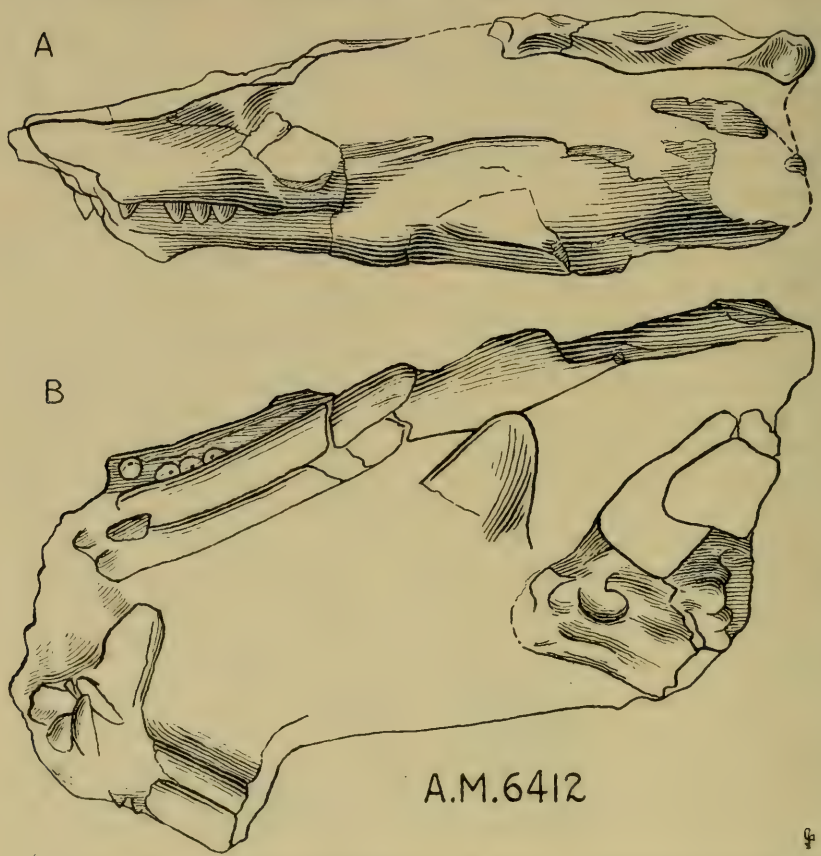

Fig. 2. *Shamosuchus djadochtaensis*, new species. Type skull, Amer. Mus. No. 6412. Natural size. A, lateral view, left side; B, inferior view.

The squamosal of the left side is preserved. It is relatively large, occupying about three-fourths of the external border of the cranial table. This unusual proportion is due to the backward extension of the postero-external corner of the bone backward in the form of a prominent

posterior process. This process is thickened at its end, and there is a shallow concavity anterior to the thickening, extending as a groove over the side of the cranial table and separated from the anterior portion of the bone by a shallow oblique ridge.

The parietal is not preserved, but the squamosal ends in the specimen at what is apparently the squamoso-parietal suture. This extends forward and slightly inward. The parietal must have occupied not more than 40 per cent. of the posterior border of the cranial table, and perhaps much less.

A portion of the supraoccipital is preserved. This bone evidently occupied a small portion of the posterior of the cranial table, also a very small portion of the surface of the table. The postero-inferior plate of the bone extends downward more than one-half the distance from the cranial table to the foramen magnum.

The exoccipitals almost entirely surround the foramen magnum, only a small portion of the condyle being composed of basioccipital. The region of the pterygoids is so badly crushed that its characters are not positively distinguishable.

Portions of both mandibular rami are preserved. They converge sharply toward each other in the anterior direction. Their most notable characteristics are a considerable lateral thickness, especially of the splenial bones, and the absence of a mandibular foramen.

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THE GREAT BATHYLITH OF CENTRAL MONGOLIA[1]

By Charles P. Berkey and Frederick K. Morris

INTRODUCTION

This paper is in the nature of an announcement rather than a discussion. It does not attempt a review of the literature on this subject. Pumpelly, von Richthofen, Loczy, Obruchev and others have noted granite in the Gobi or in adjacent regions. At some other time, an attempt will be made to summarize the geological observations of those who preceded us; and then, we are confident, it will be found that many additional occurrences, some of them far beyond the limits of our own territory, should be regarded as belonging to the same great geologic unit that is emphasized here.

The Third Asiatic Expedition, in the early stages of its traverse across Mongolia, repeatedly noted occurrences of granite. Some are small intrusives, whereas others cover extensive areas of undetermined boundaries. They are associated with so great a variety of other rock formations of widely different ages, that at first there was little to suggest their possible unity. Because of the fact also that the granites themselves show considerable variety of minor character, it was assumed that they were essentially independent intrusion phenomena that might have as great age differences as the hosts with which they are associated.

As the traverse was extended northward from Kalgan, however, a certain similarity of rock type and of field relation was noted, suggestive of a possible common origin. This became all the more impressive in the north and west, where, in many places, the rock floor for tens of miles together is made up wholly of granite.

It is the purpose of this paper to indicate some of the evidence bearing on the structural and genetic relations of these granites, and to support, in more definite terms than has hitherto been done in the publications of the Expedition, the conclusion that they represent a great granite bathylith.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 24.

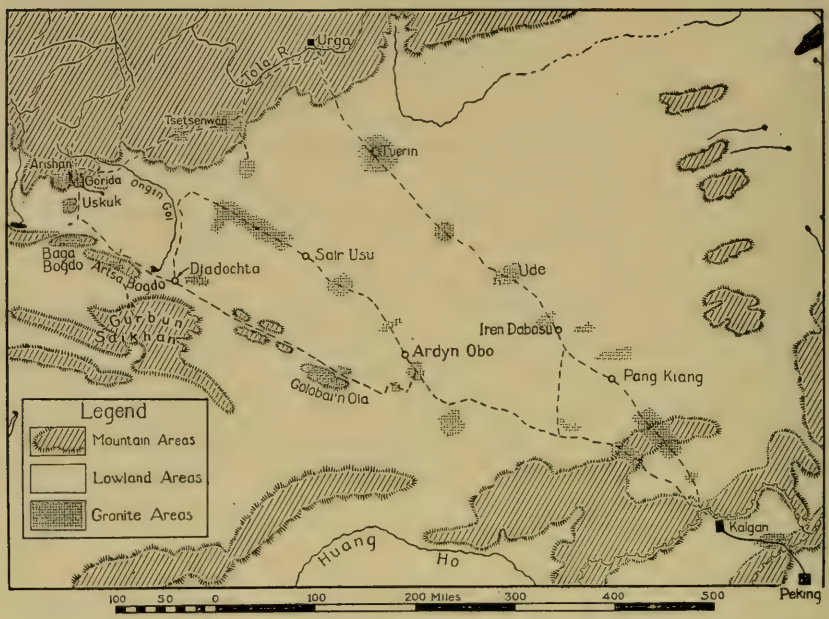

Fig. 1. Location map of the central portion of Mongolia.

This map covers a total area of about 475,600 square miles, showing the principal visited localities where granites of the type believed to belong to the Great Bathylith are extensively exposed. There are doubtless many other exposures lying beyond the reach of the traverse of the Expedition. These already mapped, however, serve the present purpose. A lateral extent of more than 720 miles is indicated, and the total area is probably much greater than the map itself.

SPECIAL LOCALITIES

Many localities exhibit granite outcrops, but particularly prominent and suggestive are those of the granite hills along the Urga trail from 100 to 150 miles out from Kalgan, the vicinity of Ude, 230 miles out, and another stretch of ten miles beginning at 430 miles out. At Mount Tuerin, 500 miles out from Kalgan, granites of several varieties form the floor for 35 miles, the mountain itself being only an erosion remnant wholly composed of granite of a single type. Along the south side of the Tola River on the way from Urga southwestward to Tsetsenwan, intrusive granites in the form of great dikes and bosses become more and more abundant and stand out as prominent elements in the topography. Here the contrast between the erratic igneous bodies and the simple uniform features developed by erosion of the regularly folded graywacke series is very striking indeed. The interrelations of the intrusive bodies and the graywackes, as well as the effects produced, are remarkably well displayed.

The Tsetsenwan district itself exhibits some of the most illuminating relations, for at this place, about 150 miles west of Urga, erosion has cut down through the graywacke roof, not only exposing the massive granite beneath, but also furnishing illustration of the phenomena that might be expected near a great igneous contact. There for a hundred miles, 100 to 200 miles southwest of Urga, the granite either forms the surface or lies so close below that it has broken through in numerous places and has affected the overlying rock in the characteristic manner of contact metamorphism. The same granites outcrop again at the Ongin Gol, thirty miles farther west, and at Arishan, the holy mountain of Sain Noin, thirty

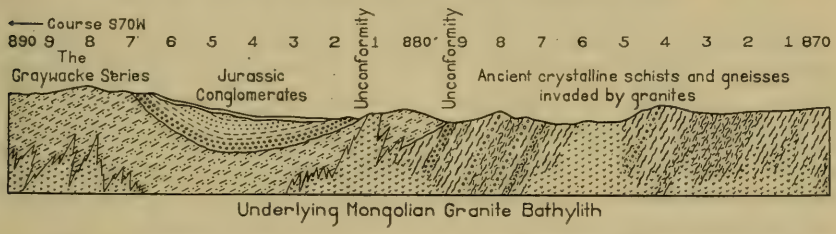

Fig. 2. Geologic cross section of 20 miles between Tsetsenwan and the Ongin Gol.

The underlying granites are repeatedly encountered, and where critical structural relations between the granite bathylith and the ancient gneisses and schists can be seen. Here ancient metamorphic series, separated by conglomerates, are invaded by the granite in a complex way, following the structural weaknesses of the older rock and giving rise to more intimate mixture than is noted where graywacke forms the roof. The contact line is, therefore, more sharply defined with the graywacke than with the older metamorphics. The section includes a small synclinal remnant of the much younger Jurassic conglomerates.

miles farther in the same direction. At Gorida on the Uliassutai trail, midway between Sair Usu and Uliassutai, and at Baga Bogdo, of the Altai system, even the mountains are of granite which has been lifted into prominence by faulting in later time. These are a thousand miles distant from the first occurrences. At many other places between Baga Bogdo and Kalgan there are equally good examples, such as that on the Uliassutai trail, west of Sair Usu, and the mountain area Golobai'n Ola, as well as the large area of granite along the same trail, 400 miles southeast of Sair Usu, within a hundred miles of Kalgan.

Some of these are places where granites have been developed in great prominence, and where their relations to the older and the younger rocks are clearly shown. The structural relations of other long stretches, as well as the connection of one outcrop with another, must of course be inferred. Such of these relations as can be determined make it abundantly evident that most of the granites of Mongolia must be intimately related to one another; and the most satisfactory explanation for them is that

they represent one great underlying granitic mass of enormous dimensions, exposed in patches over the entire area touched by the travels of the Expedition, wherever erosion has stripped off the formations that constituted its roof.

Evidence has accumulated also to show that such mineralogic and textural variety as the granites themselves exhibit probably originated in the processes of differentiation within the magma, and in the process of absorption or syntexis belonging to the normal life history of this ancient magma.

CHARACTERISTIC FEATURES

Facies of the Rock.—Typically, the granites of Mongolia are light pink or somewhat reddish in color, and are comparatively coarse-grained. In both color and texture, however, they vary greatly. Orthoclase feldspars of light tints are dominant. Quartz is abundant, but even this mineral varies considerably. The dark constituents vary greatly in amount and range from dominant biotite to dominant hornblende, biotite being much the more common. Thus there is a good deal of mineral variation in different localities or individual instances, but the surprising thing after all is the similarity that one finds in them, even in widely separated localities.

Although the common structure is massive and comparatively coarse-grained, there are varieties of strongly porphyritic habit, occasionally an obscure gneissoid arrangement of constituents, and varieties also that range from fine to extremely coarse grain. The larger areas exhibit the most massive habit and the most uniform quality. In many places, these granites are slightly miarolitic and show some pegmatitic tendency, but this is not a striking feature. In the Mount Tuerin area, a hornblende granite, judged to be a facies of the same rock, develops black stains which we believe indicate a small manganese content.

All of these varieties we judge to be understandable as facies of the same magmatic type.

Forms.—By far the larger number of individual examples appear in the form of dikes, irregular intrusions or lit-par-lit injections. Besides these, masses of very great extent are found, which are best understood as bosses or cupola-like upward extensions of the bathylithic mass, which have been truncated by erosion. Some of the larger areas are twenty miles or more across, with only minor remnants of the former roof to break the monotony. More rarely, one finds very much more intimate relation between the granite and the older country rocks. The granitic

material forms fine injection-bands, and sometimes it is even more intimately mixed, as though it had literally soaked the formation until the whole has become a veritable complex of original rock and introduced granite. All gradations are found, from extensive masses many miles across, that must be part of the major bathylith itself, to dikes of all sizes, and to the most delicate, penetrating stringers and impregnations that seem to die out as they penetrate and mingle with the enclosing host rock.

In other places, especially where the granite cuts the younger formations, there is a sharper contact, though still a very complex one. For instance, at the holy mountain Arishan, the edges of the graywacke are abruptly truncated by the granite. Angular masses of granite rise into the graywacke and send upward long dikes, some of which, branching, completely enclose blocks of graywacke. Pendants of the graywacke extend down into the granite, and xenoliths lie isolated near the contact. These relations suggest that the invading magma reached its present position partly, at least, by stoping.

Thus the mode of emplacement of this great body has probably varied from place to place, involving at least three methods of attack upon the roof:

1. By injection, soaking and even solution and replacement, involving metamorphism of the strata so invaded.
2. By magmatic stoping of xenolithic blocks whose place the magma takes.
3. By mechanical pushing and displacement of overlying rocks.

The three methods are not mutually exclusive, except that simple stoping does not include much of the more complex and intimate mode of attack named as method 1. The third method, that of mechanical displacement, involves the question of the extent to which a large uprising mass of magma may deform rocks and actuate orogenic movements. It is probable that the bathylith caused more or less movement, and, on a relatively small scale, we can see that this has been the case. It is difficult, however, to evaluate the part in deformation actually played as a whole by the bathylith.

Although the common representative is a biotite granite, the fact that there is no distinguishable difference of meaning or structural relation in the hornblende granites or in any of the other varieties makes it look reasonable that they are all simply facies of the same magma, due to a moderate amount of differentiation. There are, however, other masses of exactly the same relations whose compositions depart much more

from the average. Included in these are occasional syenites and diorites, and, rarely, still more basic types. If one includes the "serpent-form" dikes to be described in a later paragraph, and other small masses associated with the granite as host, which are most reasonably explained as closing-stage representatives of internal solidification, the range is still greater. Thus even dolerites and gabbros, found at a few places, may be included among the differentiates of the bathylithic magma.

Stratigraphic Relations.—These granites cut a great variety of rock formations. No member of the ancient crystalline, metamorphic floor has wholly escaped either actual intrusion or some of the contact effects of this invading magmatic mass. It is clearly younger than any of the pre-Cambrian formations, because it cuts even the great graywacke series of the Tola River region, which has been referred to in previous communications as the Khangai series of graywackes and slates and is regarded as probably the equivalent of the Nan K'ou series of China, the latest of the pre-Cambrian formations.[1] Wherever the relations are clear, it is evident that the folded Khangai graywacke series and the whole confused complex of still earlier series together constitute the roof beneath which this magma solidified.

Subsequent erosion has exposed remnants of this roof that must have extended downward into the magma itself like great pendant projections. Thus, one frequently crosses such surrounded bodies of older rock from granite on one side to granite again on the other, and, because of the insignificant soil cover, one can observe in as much detail as could be desired every transitional and transforming step with all the field relations and effects characteristic of such a history. Some of these roof pendants are most impressive field exhibits, those seen in the Tsetsenwan district being on a particularly large scale. At occasional points, the intimate relations of granite and older rock can be seen in still greater detail, attended by typical contact phenomena.

It is clear, therefore, that the granites cut through formations up to and including the Khangai graywackes. But, because of the scarcity of rocks of determined Paleozoic age, it is much less certain what the relations of the bathylith to the Permo-Carboniferous series of sediments are. No direct associations of bathylithic granite and these upper Paleozoic strata have been observed thus far.

Erosion has uncovered also the relation between the granites and the still younger strata in very many places. At Tsetsenwan the lower

[1]von Richthofen, Ferdinand. 1887. "China," II, p. 306.
Willis, Bailey, Blackwelder, Eliot, and Sargent, R. H. 1907. "Research in China," Part I, p. 123, Carnegie Institution of Washington, Publication 54.

Jurassic conglomerates have this relation, and it is clear that the granites had been exposed by deep erosion before that period. (Fig. 3.) In many places, also, Cretaceous and Tertiary strata lie on a granite floor. This fact indicates that, at the time of general post-Jurassic peneplanation and before the development of the later basin sediments, the granites of Mongolia were exposed over immensely larger areas than now.

Contact and Mineralization Effects.—At most places, contact phenomena are not very marked; but typical effects are observed at many places, the sum of which gives the usual list of transformations due to the influence of such a unit. In the Tsetsenwan region, for example,

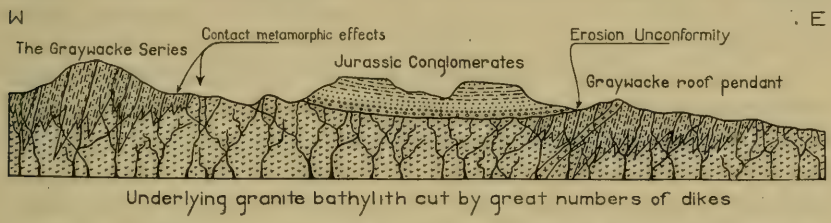

Fig. 3. Diagrammatic cross section of a critical structural relation at Tsetsenwan.

This section lies about 200 miles west of Urga, where erosion had exposed the granite bathylith and carried away most of its roof of graywacke before the Jurassic sediments were laid down. A synclinal remnant of Jurassic conglomerate is preserved here, although several thousand feet of these strata are to be found only a few miles away. Two great denudation epochs, therefore, are represented by these profile lines, and the section illustrates well one of the important unconformities of the region. This particular area exhibits a very fine development of the serpent-form dikes, which cut both the granite and the roof in great numbers, but which are most prominent in the granite areas.

the graywacke-slate series is very heavily tourmalinized, and much epidote is developed. Sometimes there is excessive induration and silicification, as well as silication of the adjacent or overlying rock. Doubtless, also, some of the variations in crystallinity of the overlying metamorphic rocks are due to the greater or smaller influence of the underlying bathylith. For example, the graywacke series, which normally exhibits abundant evidence of its clastic character and is not markedly crystalline, becomes in some places quite strongly schistose with well developed metaphenocrysts. In certain places, it was possible to demonstrate that this metamorphism was due to the presence of the granite. In others, where no granite was visible, its presence close below has been inferred. The only satisfactory working hypothesis is that all excessive metamorphic effects were due to the influence of the granite bathylith.

Thus, in crossing certain country, there are surprising changes in the quality or condition of formations that are elsewhere uniform and simple. Such changes become intelligible in the light of such relations as

are here implied; but they seem anomalous, until one has discovered that, immediately beneath, lies the granite bathylith, and that the effects produced are such as are reasonably to be expected from its influence, even though the granite itself does not reach the present surface.

These metamorphic areas of obscure relation have been checked up repeatedly and compared with the effects produced where the relations are perfectly plain, and there is, in our opinion, no doubt whatever of the major facts. We consider the underlying granite, therefore, to be the dominant cause of all the more pronounced contact metamorphism.

The striking thing, of course, is that metallic mineralization is absent. In the whole of central Mongolia, from the Kalgan border to the Tola River on the north and from the meridian of Baga Bogdo on the west to the Kalgan-Urga trail, surprisingly few traces of metallic minerals have been seen. Even at points where contact phenomena are developed on a magnificent scale, as at Tsetsenwan and at Sain Noin, no important metallic mineralization was noted. Quartz veins, on the other hand, are common, and in a few places such products are developed in great abundance; but none of the veins thus far inspected has noticeable metallic content. In spite of the observed poverty in metallic mineralization, it may well be that elsewhere, particularly on the margins of the bathylith, beyond the reach of our traverse, more favorable conditions for its occurrance exist.

The Serpent-form Dikes.—One of the most striking features of certain areas is the great number of dikes that cut the granite. They occur literally in thousands and take prevailingly most erratic serpent-like courses. At places such as Tsetsenwan, where, from any good vantage point, it is possible to look out and down upon a large stretch of such country, the whole landscape looks as if it were a tangle of serpent-like forms. In composition, they almost exhaust the range of porphyries. They vary from quartz porphyry and trachyte porphyry at the acid extreme to comparatively basic types,—at least to andesite porphyry and even, though more rarely, to a basaltic type. In size are they equally variable, some of the larger intrusions reaching such dimensions as to form prominent ridges; and they cut each other in a most confusing way. The tangle of tortuous forms is, however, the most impressive feature. Similar structural relations were found at the holy mountain of Sain Noin, but the country there does not lend itself so well to surface display. These dikes stand up under weathering better than does the granite host, and this accentuates the peculiar physiographic effect referred to in the term serpent-form dikes.

What the genetic relation of these dikes is to the granite bathylith is a matter much more difficult to determine, but they have not been noted in such profusion in any place, except in the districts where, judging by the abundance of roof pendants and xenoliths, the present surface is very near the roof contact. They are believed to have originated as an end-product of the deeper interior cooling of the magma mass itself, and thus they actually represent facies of the magmatic differentiation of the bathylithic magma.

Other Intrusives.—There are older granites, such as those that form an integral part of the ancient gneisses, which we have tentatively called Archæozoic and have correlated with the T'ai Shan complex in China.[1] Possibly some granites, younger than the T'ai Shan, are yet older than the great bathylith. Such granites are found injecting schists which we believe to be correlated with the Wu T'ai Shan series as described by Willis and Blackwelder for China.[2]

A few andesite dikes were found cutting the marine limestones of Permian age. Intrusions also of granite porphyry, syenite porphyry and porphyrites of various kinds have invaded the Jurassic conglomerates, sandstones and shales, and there are abundant surface flows with ash and tuff beds associated with these strata in some localities. Some of these porphyry masses are large, and, in many places, the different porphyry units cut each other in a most confusing way, giving a veritable complex of intrusives that completely dominates the geologic structure. The flows include many rhyolitic, fewer trachytic and some andesitic lavas.

After the late Jurassic or post-Jurassic revolution, basaltic lavas and dikes are found in the Lower Cretaceous (Comanchean) formation of Oshih (Ashile), again in the early Eocene basin of Gashato, and in the Oligocene of Hsanda Gol. Similar lavas and volcanic plugs are associated with the sedimentary strata of Wan Chuan Pass above Kalgan, on the eroded edge of the plateau. Most of these flows are basalts, although trachytes and rhyolites also are met with.

How many of these other intrusives, some much older and some much younger, have had a genetic dependence on the underlying granite may be impossible to determine; but it is reasonable to believe that both some of the antecedent and some of the subsequent igneous outbreaks were connected with active stages of the life history of the Great Mongolian Bathylith.

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[1]Willis, Bailey, Blackwelder, Eliot, and Sargent, R. H. 1907. "Research in China," Part I, p. 19, Carnegie Institution of Washington, Publication 54.

[2]*Op. cit.*, p. 109.

LOWER PORTION OF THE GENERALIZED GEOLOGIC COLUMN FOR CENTRAL MONGOLIA

COVERING THE STRUCTURAL UNITS OF THE BASIN FLOOR

NOT HITHERTO SUBDIVIDED	MESOZOIC	GREAT UNCONFORMITY				
		ALL ROCKS BELOW THIS LINE ARE FOLDED				
		EARLY MESOZOIC	TSETSENWAN SERIES	JURASSIC	A GREAT SERIES OF CONGLOMERATES, SANDSTONES, AND SHALES, WITH ASSOCIATED LAVA FLOWS, TUFFS AND ASHES; CARRYING OBSCURE PLANT REMAINS AND LOCALLY, COAL; THE WHOLE ABOUT 20,000 FEET THICK APPARENTLY CORRESPONDS TO LOWER JURASSIC OF NORTHERN CHINA	
	UNCONFORMITY					
	PALEOZOIC	LATE PALEOZOIC	SAIR USU SERIES	PERMIAN	LIMESTONES SHALES SANDSTONES SLATES QUARTZITES CONGLOMERATES	A SERIES OF CHARACTERISTIC INVERTEBRATE FOSSILS
				CARBONIFEROUS		
	UNCONFORMITY COVERING EARLY PALEOZOIC TIME					
	GREAT BATHYLITHIC INVASION					MONGOLIAN GRANITE BATHYLITH
RECOGNIZED IN PART BY EARLIER EXPLORERS	PROTEROZOIC	LATE	NAN K'OU SYSTEM A NAME PROPOSED FIRST BY VON RICHTHOFEN AND GIVEN DEFINITE RANK BY WILLIS IN CHINA	THE SINIAN SYSTEM OF GRABAU	THE KHANGAI SERIES	THE TOLA RIVER GRAYWACKES AND SLATES WITHOUT FOSSILS
		EARLY	WU-T'AI SYSTEM AS USED BY WILLIS IN CHINA			SCHISTS PHYLLITES LIMESTONES DOLOMITES QUARTZITES GREENSTONES
	ARCHEOZOIC	ARCHEAN	THE T'AI-SHAN COMPLEX AS USED BY WILLIS IN CHINA			CRYSTALLINE LIMESTONES, SCHISTS, AND COMPLEX INJECTION GNEISSES

GENERAL INFERENCES

From the distribution and character of these granites and from their structural relations to the recognizable forms of the region, it is a fair inference that a great granite bathylith underlies all the country traversed by the Third Asiatic Expedition and even extends considerably beyond it in every direction. To the bathylith belong all of the large areas of granite in the Gobi region, including that which comprises Baga Bogdo of the Altai mountain system, which has been pushed up thousands of feet by later faulting. It is a fair inference, also, that most of the small occurrences, thousands of dikes and other forms of this general type preceding Jurassic time, have come from the same source and only represent the extreme outward penetration of this mass as it invaded the overlying formations.

From the facts given, it is clear that in age the bathylith is younger than any of the pre-Cambrian series, and is clearly younger than the Khangai graywackes, of whatever age the latter may be. It is clear, also, that the bathylith is so much older than the great conglomerate series judged to be of lower Jurassic age, that there was time entirely to remove the roof by erosion over large stretches of country before these conglomerates were laid down. Somewhere between the latest pre-Cambrian, therefore, on the one hand, and the early Mesozoic represented by the Jurassic conglomerates on the other, the granites invaded the overlying terrane of Mongolia. But this is a big gap,—the whole of the Paleozoic is left out of the calculation.

It is certain, however, that the graywacke-slate series was folded before the maximum invasion of granite, so that a mountain-making epoch intervened between the making of the graywacke formation and the full development of the bathylith. If, therefore, the graywackes are really latest pre-Cambrian, as now believed, time must be allowed in the Paleozoic era for this igneous invasion.

It is difficult to determine the relation to authentic Paleozoic strata, because of the very slight development of rocks of this age. Some question also arises as to the uncertainties of the age of the graywacke-slate series. The best that can be said at present is that the Paleozoic strata were not affected by the granites in those places coming under observation, and the similarity of habit in this respect to that of the Jurassic conglomerates, which are clearly very much later, leads to the tentative conclusion that the granite bathylith is itself of early Paleozoic age.

For this bathylith, which in dimensions seems to compare favorably with the greatest bathyliths thus far known in other parts of the world, we propose the name "the Great Mongolian Bathylith."

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PSITTACOSAURUS AND *PROTIGUANODON:* TWO LOWER CRETACEOUS IGUANODONTS FROM MONGOLIA[1]

By Henry Fairfield Osborn

The preliminary description of these iguanodonts[2] was, prior to the complete exposure and restoration of the two type skeletons, an extremely long, difficult and delicate process, followed by detailed drawings and restorations which give us an exceptionally complete knowledge of these animals. The types are:

Oshih (Ashile) Formation.—*Psittacosaurus mongoliensis* (Amer. Mus. 6254), an almost perfect skull and jaws with greater part of skeleton.

Ondai Sair Formation.—*Protiguanodon mongoliense* (Amer. Mus. 6253), an imperfect skull and left jaw with a practically perfect skeleton.

These two types resemble each other in so many characters that they obviously belong to a distinct family of iguanodonts to which the name Psittacosauridæ has been applied.[3] These short-skulled iguanodonts derive their family name Psittacosauridæ from the very deep parrot-like beak, with small nostrils located at the top of the very deep maxilla. There is still some question as to the validity of the subfamily name Protiguanodontinæ proposed at the same time.

The characters which *Psittacosaurus* and *Protiguanodon* exhibit in common are: (1) Cranium relatively short and broad, premaxillaries and anterior portion of dentaries edentulous; maxillary teeth of iguanid type. Functional teeth in a single row. Nine dentary teeth in *Protiguanodon;* 7+ maxillary teeth in *Psittacosaurus.* (2) Neck short; cervicals, 6 with 5 free ribs. (3) Thoracics: 16 in *Psittacosaurus* and 15 in *Protiguanodon.* (4) Sacrals: 5 in *Psittacosaurus*, 6 in *Protiguanodon.* (5) Caudals: 43 estimated in *Psittacosaurus*, 43 actual in *Protiguanodon.* (6) Cervicals, thoracics and sacrals: 27 in both *Psittacosaurus* and *Protiguanodon.* (7) Shoulder girdle with free clavicle, coracoid and coracoid foramen, and distally expanded, elongate scapula. This is the first record of the occurrence of a clavicle in ornithischian dinosaurs. (8)

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 25.

[2]Osborn, H. F. 1923. "Two Lower Cretaceous Dinosaurs of Mongolia." Amer. Mus. Novitates, No. 95, October 19, pp. 1–10.

[3]Idem, p. 6.

Fore limb, total length from humerus to extremity of phalanges, 250 mm. *Psittacosaurus;* 245 mm. *Protiguanodon.* (9) Pelvic girdle of characteristic iguanodont type, elongate ilium, pre- and postpubic extension, elongate ischium. (10) Hind limb, total length, 470 mm. *Psittacosaurus;* 435 mm. *Protiguanodon.* (11) Manus in both genera with 4 free carpalia, Digit I, 2 ph., D.II, 3 ph., D.III, 4 ph., D.IV, reduced, 1 vestigial ph. (12) Pes in both genera enlarged, elongate, 4+ free tarsalia in *Protiguan-*

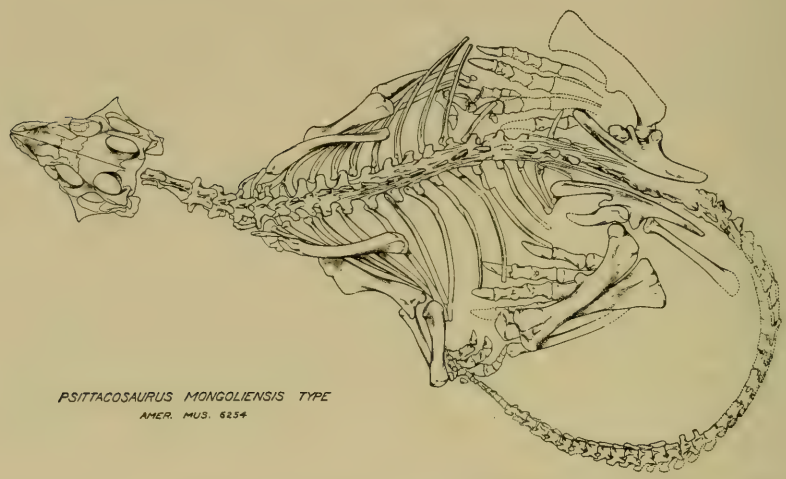

Fig. 1. Type skeleton of *Psittacosaurus mongoliensis* Osborn (Amer. Mus. 6254).

Since the original description the skeleton has been completely exposed and is very accurately represented in this figure as it lies in the matrix. The original pencil drawing is full size; the present figure is reproduced one-eighth natural size. The missing parts are represented in dotted lines.

odon, tibio-tarsus closely united but not coalesced. Digit I, 2 ph., D.II, 3 ph., D.III, 4 ph., D.IV, 5 ph., D.V, vestigial mts., 0 ph. (13) Osseous tendons extending from fourth or fifth thoracic through the sacral series to the anterior caudal.

The above practically common characters, which indicate a marked affinity between these two animals, are accompanied by certain differences in proportion of the fore and hind limbs as shown in the following table of measurements:

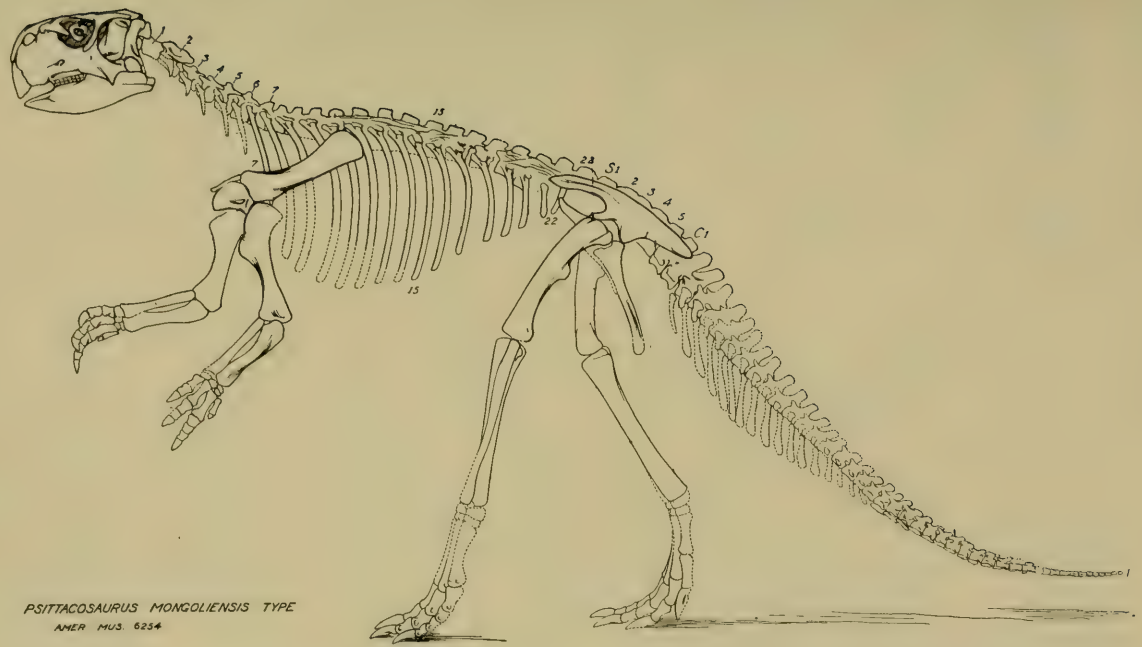

Fig. 2. Reconstruction of the *Psittacosaurus mongoliensis* type skeleton (Amer. Mus. 6254) in its lateral aspect. One-eighth natural size.

The skull in this reconstruction combines sclerotic ring and dental characters observed in the type (Amer. Mus. 6254), also in the referred specimen (Amer. Mus. 6261) from the same geologic formation. Eight maxillary teeth are restored from the referred skull (Amer. Mus. 6261); the corresponding dentary teeth are conjectural. These restored parts are indicated by dotting.

	Psittacosaurus	*Protiguanodon*
Axial length from premaxillaries to 43d caudal	1310 mm.	1350 mm.
Length of fore limb extended	250	245
" " hind limb extended	470	435
" " humerus	119	123
" " ulno-radius	90	90
" " manus	85	92
" " femur	162	158
" " tibio-fibula	179	167
" " pes		158
" " " Digit III	93	89
Ratio, femur to tibia, femoro-tibial	90%	89%
" fore limb to hind limb, brachio-crural	53%	56%

COMPARISON.—The above linear measurements as well as the femoro-tibial and brachio-crural ratios are very similar, demonstrating that both animals were: (1) Essentially bipedal in locomotion, with fore limbs well raised above the ground, a brachio-crural ratio of from 53% to 56%. (2) Manus functionally tridactyl, since D.IV is greatly reduced. (3) Pes also functionally tridactyl-subtetradactyl, because D.I is of considerable size although well raised off the ground, while D.V is vestigial. (4) Osseous tendons connecting the fourth thoracic with posterior sacral or first caudal vertebra, indicating adaptation to a bipedal gait. (5) The normal walking position was probably semi-erect, as indicated in figure 2 (*Psittacosaurus*), figure 5 (*Protiguanodon*). (6) The ilio-sacral articulation of *Psittacosaurus* includes five vertebræ, while the ilio-sacral articulation of *Protiguanodon* includes six vertebræ. (7) Limb and foot bones of *Psittacosaurus* are somewhat more massive, while the limb and foot bones of *Protiguanodon* are somewhat more slender. (8) Scapular arches, including clavicle, coracoid and scapula, are of about the same proportions in both species. (9) Pelvic girdle of *Psittacosaurus*, including the ilium, ischium and pubis, somewhat more massive than the pelvic girdle of *Protiguanodon*, in which the iliac crest is slender, the prepubic process much more slender and the ischium more slender and elongate than in *Psittacosaurus*. (10) There are 16 thoracic ribs in the *Psittacosaurus* thorax, which are slightly more robust than the 15 ribs in *Protiguanodon*. (11) From a comparison of the ten adaptations to a bipedal locomotion, we conclude that *Protiguanodon* was somewhat more cursorial in habit than *Psittacosaurus*.

A number of important additional characters in the pelvis should be noticed: (a) The absence of the "obturator processes" on the ischium, both in *Psittacosaurus* and *Protiguanodon*, a conspicuous difference from *Thescelosaurus*, *Camptosaurus*, *Trachodon*, *Iguanodon*, in which these

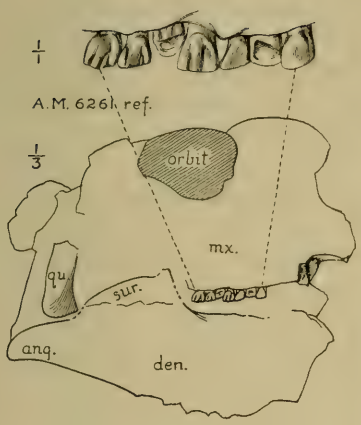

Fig. 3

Fig. 3A

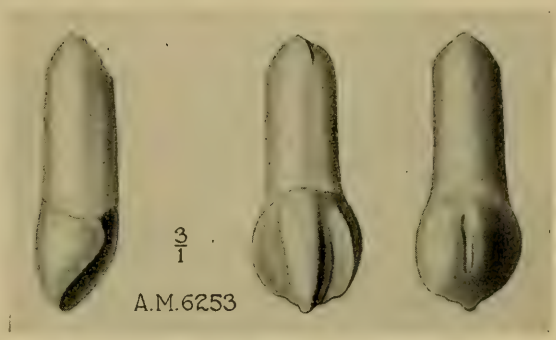

Fig. 3B

Fig. 3. Referred skull of *Psittacosaurus mongoliensis* (Amer. Mus. 6261).
Found in the same formation (Oshih) as the type. This skull contains seven maxillary teeth *in situ*. Skull, one-third natural size. Seven maxillary teeth, natural size. Two of the same teeth are shown in Fig. 3A enlarged three diameters.

Fig. 3A. Two superior teeth in referred skull of *Psittacosaurus mongoliensis* (Amer. Mus. 6261) enlarged three diameters.
For comparison with restored tooth of *Protiguanodon mongoliense* type (Amer. Mus. 6253) enlarged three diameters.

Fig. 3B. Type maxillary tooth of *Protiguanodon mongoliense* (Amer. Mus. 6253) enlarged three diameters; anterior, exterior and interior aspects. After Osborn, 1923, Fig. 5.

processes are present. (b) Superior border of ilium not reflected laterally, —an important character separating *Psittacosaurus* and *Protiguanodon* from *Iguanodon, Trachodon, Troödon.* (c) Prepubic process shorter than anterior process of ilium, differentiating *Psittacosaurus* and *Protiguanodon* markedly from *Iguanodon, Trachodon, Thescelosaurus, Camptosaurus.* (d) Ischia much flattened dorsoventrally. (e) Ischia not curved downward toward the posterior ends, distinct from *Iguanodon, Camptosaurus, Troödon.* (f) Postpubic processes short and slender,—probably a reduction character.

The Psittacosaurus mongoliensis Skeleton

Skull.—The perfectly preserved skull was described and figured in great detail in the type description[1] in which the skull characters are

[1]*Op. cit.*, pp. 2-6.

summarized as follows: "*Psittacosaurus mongoliensis.* Herbivorous diapsid reptile with predentary bone and horny beak. Maxillary teeth compressed, not fully known. Skull short and deep, narrow anteriorly, broad posteriorly. Rostrum prominent, parrot-like, edentulous. Nostrils small, orbits large. Infraorbital region and jaw heavy, with attachment for powerful muscles. Primitive dermal armature in head region; lateral osseous horns on jugals."

To the above description should be added the osseous sclerotic ring in the orbit represented in figure 2 and which is now exposed in the orbits of the skull. The osseous horns below the orbits and the impressions of the epidermal armature at the side of the jaw and throat led Osborn to the following conjecture:[1] "Genotype of Psittacosauridæ, new family. Skeleton and teeth only partly known; supposed primitive armored dinosaurs, possibly related to the fully armored Upper Cretaceous types."

Gregory remarks that Osborn's term "osseous horns" on the jugal appears to be misleading; he believes that they correspond with a strong downwardly directed process on the jugal correlated with a development of the masseter muscle. Osborn is still disposed, however, to maintain that the osseous protuberances of the jugals are defensive bony spines (compare *Ankylosaurus*) and not muscular adaptations, and that the dermal impressions of the throat in *Psittacosaurus* are part of a dermal defensive system.

Teeth.—The teeth in the type skull (Amer. Mus. 6254) are still deeply buried in the matrix. Fortunate, therefore, is the discovery in the same Oshih formation of a second specimen of skull and skeletal parts (Amer. Mus. 6261) apparently referable to the species *Psittacosaurus mongoliensis*, in which seven of the maxillary teeth are preserved. These referred teeth are shown natural size in figure 3 and enlarged three diameters in figure 3A; the sculpturing of these teeth is apparently different from that of the type tooth of *Protiguanodon mongoliense* (Fig. 3B).

Family Psittacosauridæ: Skull abbreviate; rostrum edentulous, prominent, parrot-like; jaws deep; teeth 7–9, trilobed, brachyodont in dentaries and maxillaries; nostrils small; orbits large; cervicals 6; thoracics 16–15; sacrals 5–6; caudals 43+; clavicles reduced; brachiocrural ratio 53–56%; bipedal locomotion; manus and pes tridactyl-subtetradactyl; gait cursorial; ischia flattened, a broad ischiac symphysis.

Subfamily Protiguanodontinæ Osborn, 1923, p. 6: Type *Protiguanodon.* Cannot be further defined until it is known what the complete separation is between *Psittacosaurus* and *Protiguanodon.*

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[1]*Op. cit.*, p. 6.

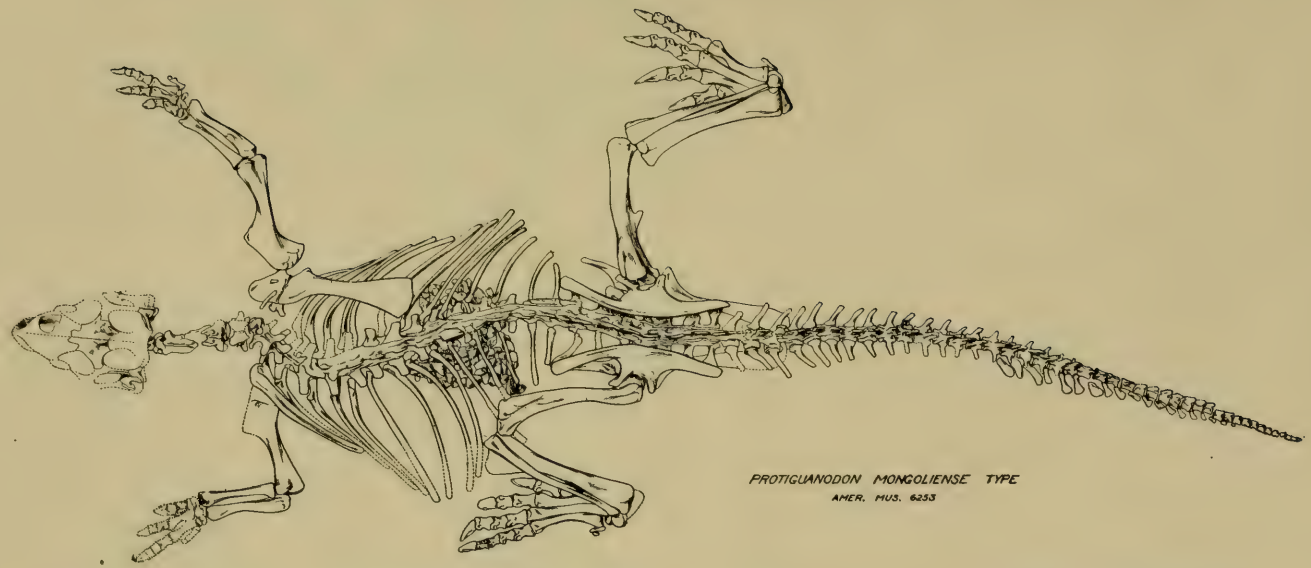

Fig. 4. Type skeleton of *Protiguanodon mongoliense* Osborn, 1923 (Amer. Mus. 6253). Ondai Sair formation, Mongolia.

Since the publication of the original description, this type skeleton has been completely exposed and is very accurately represented in the present figure as it was found in the matrix, the only restored portion being the skull. The original pencil drawing is full size; the present figure is reproduced one-eighth natural size. The missing parts are represented in dotted lines. The skull is largely restored (dotted lines), in comparison with *Psittacosaurus;* see also Fig 6.

Generic Distinctions.—These two animals prove to be so similar in general size, proportions, gait, skeleton and limb segments, that while specific distinctions are very obvious indeed, and *generic* distinctions are more difficult than was at first supposed by Osborn (*op. cit.*, pp. 9, 10), yet the genera may be distinguished as follows:

Psittacosaurus	*Protiguanodon*
Cranium solid, with suborbital horns, large occipital condyles, epidermal tubercular armature on throat and side of face. (See remarks, Gregory, Granger.)	Cranium slender, bones light, small occipital condyles (suborbital region and epidermal armature unknown at present).
Neural arch of atlas vertebra elongate.	Atlas vertebral elements apparently abbreviate.
Superior maxillary teeth flattened, with asymmetrical trilobate sculpturing (Figs. 3, 3A).	Superior maxillary teeth convex, with symmetrical trilobate sculpturing (Fig. 3B).
Maxillary teeth: 7+. Thoracic vertebræ: 16. Sacral vertebræ: 5. Pubis large, postpubis slender.	Dentary teeth: 9. Thoracic vertebræ: 15. Sacral vertebræ: 6. Pubis and postpubis slender.

Comparison of **Psittacosaurus** and **Protiguanodon**

Dentition.—The striking difference in the external sculpture of the extremely short-crowned or brachyodont teeth is well displayed in *Psittacosaurus* (Figs. 3, 3A), and in *Protiguanodon* (Fig. 3B); see also Fig. 4 of Osborn, *op. cit.*, p. 8. The *Psittacosaurus* teeth, viewed externally, are relatively broad, flat, and the median ridge is on the posterior half of the tooth, whereas in *Protiguanodon* (Fig. 3B) the contour is a deep oval, the median ridge very prominent and directly in the center of the tooth. On wear these teeth become trilobate.

Skull.—The fully preserved skull of *Psittacosaurus*, described and figured in detail in the type description (Osborn, *op. cit.*, Figs. 2A, 2B, 2C), differs from that of all iguanodonts previously described in its solid, massive characters, the sutures being partly closed, excepting the premaxillo-maxillary; this skull certainly had a powerful horny beak like that of a chelonian and was adapted to feeding upon very resistant plants. In the referred skull (Amer. Mus. 6261) the sclerotic ring and the same characters are observed; the dentaries are relatively short and massive. The sclerotic ring is observed in the type skull of *Psittacosaurus*. Granger believes that the supposed "epidermal tubercles" on the side of the skull of *Psittacosaurus*, regarded as epidermal impressions by Osborn, more strongly resemble concretions such as may be seen where no organic remains are present.

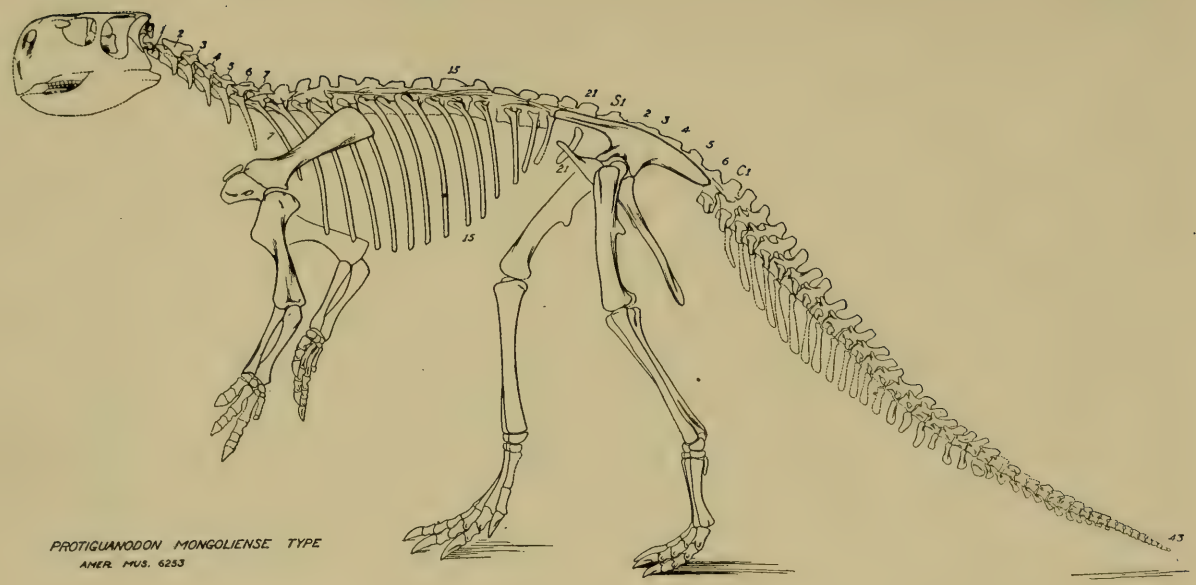

Fig. 5. Reconstruction of the *Protiguanodon mongoliense* type skeleton (Amer. Mus. 6253) in its lateral aspect. One-eighth natural size.

Outline of the skull drawn in dotted lines from *Psittacosaurus*.

In the type skull of *Protiguanodon* (Amer. Mus. 6253), as shown in figure 6, there is a marked contrast in the relatively slender character of the bones, the apparent sutural separation, the relatively small and broad occipital condyles, the very deep depression of the dentary below the nine dentary teeth. The inference is that this skull was adapted to less resistant food.

Gregory further observes: "All the fragments of the *Protiguanodon* skull, when compared with *Psittacosaurus, Camptosaurus, Iguanodon,* etc., show that it is unmistakably much closer to *Psittacosaurus.* The small nostril, located at the top of the deep maxilla, the form of the frontoparietal, of the quadrate, squamosal, etc., differ from *Psittacosaurus* chiefly in greater slenderness." That *Protiguanodon* is on the whole far more primitive than *Iguanodon* one can hardly doubt, but that it is geologically older, he would question for the following reasons: "(a) *Hypsilophodon* is certainly far more primitive than *Iguanodon,* but both occur in the Wealden. (b) *Troödon* of the Lance (Upper Cretaceous) is far more primitive than the ankylosaurs of older formations. (c) *Thescelosaurus* is a survivor in the Lance, retaining many primitive features recalling *Hypsilophodon* of the Wealden."

Vertebræ.—Correlated with the massive skull of the *Psittacosaurus* type is the unusual elongate neural arch of the atlas (C 1) that may be seen in figures 1 and 2. The axis (C 2) and remaining cervicals (C 3–7) appear to be of the same length in the two genera. The thoracics, including neuropophyses, pre- and postzygopophyses and parapophyses, exhibit the same general characters in both genera. Ten bicipital ribs are observed in *Psittacosaurus*; 9+ bicipital ribs in *Protiguanodon.* Five sacrals unite with the iliac crest in *Psittacosaurus;* 6 sacrals unite with the iliac crest in *Protiguanodon.* Eight free caudal ribs are observed in *Protiguanodon;* the anterior caudals of *Psittacosaurus* are imperfectly preserved; the 9th to the 20th caudals in *Protiguanodon* have consolidated ribs or pleurapophyses; the 15th to the 34th caudals in *Protiguanodon* bear chevrons.

Limb Characters.—The limb characters in *Psittacosaurus* and *Protiguanodon* are clearly displayed in figures 1, 2, 4 and 5; resemblances and contrasts are as enumerated above. The ulna, radius and manus resemble in proportions the manus of *Hypsilophodon foxii;* Digit IV is somewhat more reduced than that in *Hypsilophodon,* and there is no trace of D.V; large D.I is closely applied to D.II and shows no sign of the abduction characteristic of *Iguanodon.* The manus is still of locomotor type and shows little if any prehensile adaptation. The

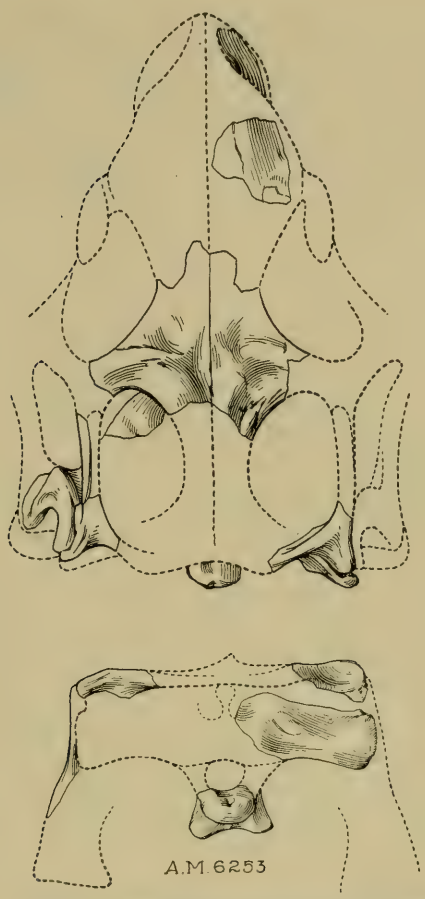

Fig. 6. Type skull, largely restored, of *Protiguanodon mongoliense* (Amer. Mus. 6253).

The type jaw of the same skull is shown in Osborn, 1923, p. 8, Fig. 4.

pes of *Protiguanodon* (Fig. 4) is double the size of the manus, from which we may infer that the pes performed twice as much work as the manus.

Locomotion.—The proportions of the organs of the axial and appendicular skeletons are approximately similar to those of *Iguanodon bernissartensis*. In *Iguanodon* the vertebral column on the whole is relatively more massive. The ossified tendons of *Iguanodon* extend down along the sides of the elongated spines of sixteen to twenty of the anterior caudals,

whereas in *Protiguanodon* the ossified tendons stop at the first or second caudal. The neural spines of the anterior caudals are not elongate.

Consequently, we infer that adaptation to bipedal locomotion, to a suberect position, to arboreal feeding habits, was much further advanced in *Iguanodon* than in *Protiguanodon*. This comparison supports the idea that *Protiguanodon* of Mongolia is far more primitive in structure and may belong to a much older geologic stage than *Iguanodon* of the Wealden of England and Belgium.

Pelves of **Psittacosaurus** and **Protiguanodon**

Comparison of the pelves of these Mongolian species with the pelves of five other iguanodonts seen in the diagrammatic drawing (Fig. 7) shows the dominant ornithischian type. We observe that the prepubis of *Psittacosaurus* and of *Protiguanodon* is more abbreviate than in any of the other genera, while the postpubis has the same proportions as in *Trachodon*, somewhat less developed than in *Iguanodon*, far less developed than in *Camptosaurus*, *Thescelosaurus* or *Hypsilophodon*. The ischia of *Protiguanodon* and *Psittacosaurus* are relatively well developed; a very distinctive feature of the ischium is the ischiac symphysis, namely, the broad plate-like union of the ischia posteriorly, as observed in *Thescelosaurus*. The ilia are relatively longer than in any of the other iguanodonts figured.

Consequently, we may sum up the comparative characters of the pelvis in *Psittacosaurus* and in *Protiguanodon* as follows: (1) Prepubis slender; small pubic foramen. (2) Postpubis very slender, closely apposed to ischium. (3) Ischia relatively elongate, flattened, produced into a very broad ischiac symphysis. (4) Ilia relatively elongate and depressed, extending anteriorly beyond the extremity of the prepubis.

Comparison of Pelves.—In figures 8 and 9 we are afforded a detailed study of the pelvis in *Psittacosaurus* and in *Protiguanodon* made after complete removal from the matrix, that of *Protiguanodon* being especially perfect in preservation. It is shown that: (1) The postpubis

Fig. 7. Pelvic characters of the Iguanodontia. Diagrammatic.

The seven pelves here figured are reduced for purposes of comparison to the same absolute size, regardless of actual wide differences in scale. The pelves should be examined in descending geologic order as follows:

Montana, Upper Cretaceous. *Trachodon mirabilis*. After Brown, 1913.
Montana, Upper Cretaceous. *Thescelosaurus neglectus* (Amer. Mus. 5889). After Brown.
Belgium, Lower Cretaceous. *Iguanodon bernissartensis*. After Dollo, 1883, slightly modified.
Wyoming, Upper Jurassic. *Camptosaurus medius*. After Gilmore, 1909.
Mongolia, Oshih Formation. *Psittacosaurus mongoliensis* (Amer. Mus. 6254). After Osborn, 1923.
Mongolia, Ondai Sair Formation. *Protiguanodon mongoliense* (Amer. Mus. 6253). After Osborn, 1923.
England, Lower Cretaceous, Wealden. *Hypsilophodon foxii*. After Hulke, 1882.

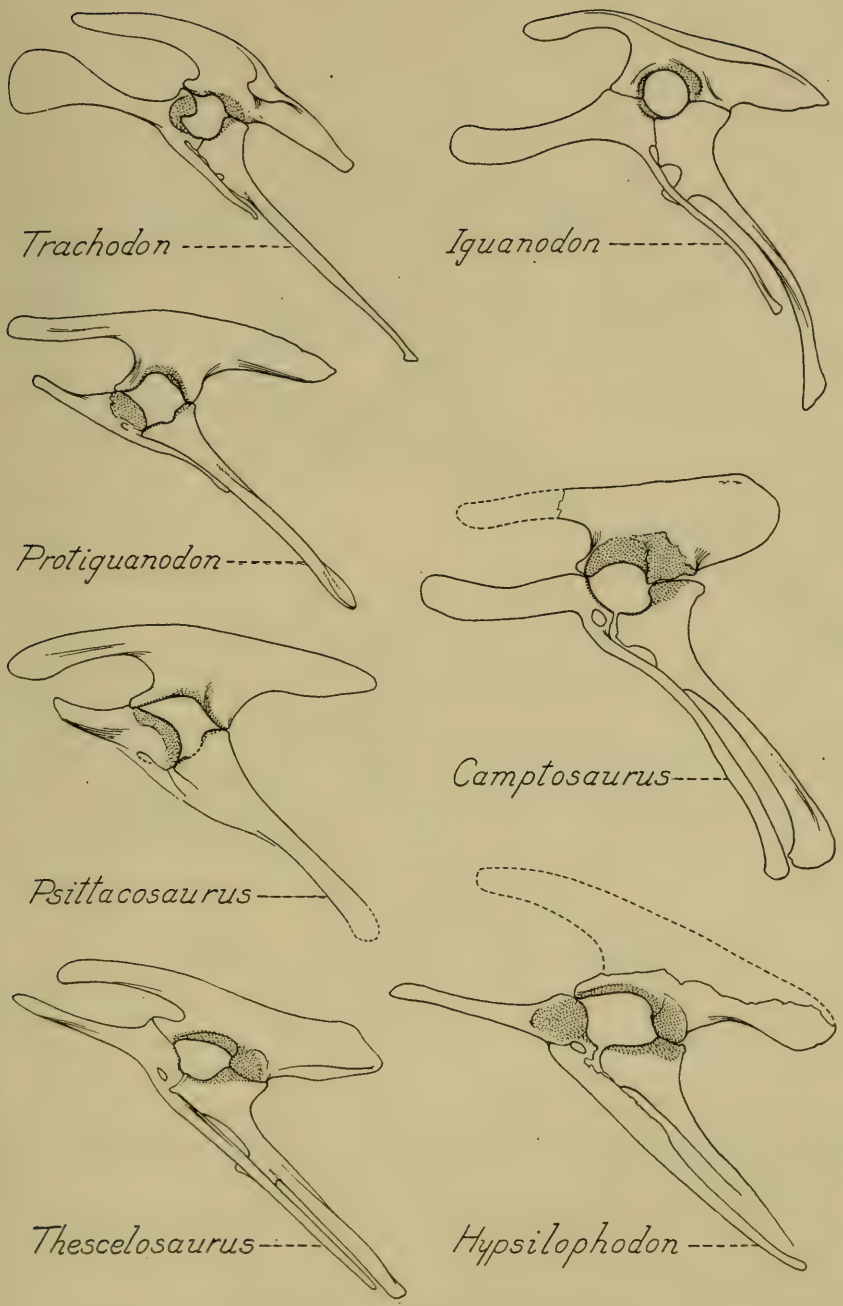

Fig. 7. See legend on opposite page.

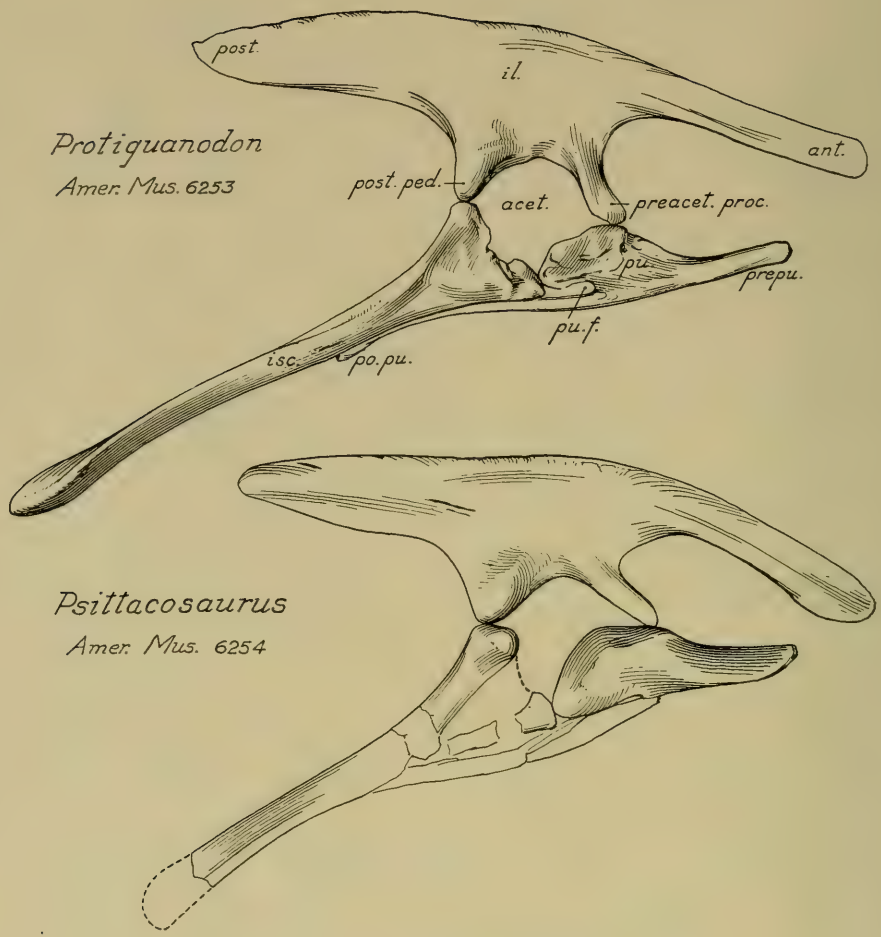

Fig. 8. Pelves of *Psittacosaurus* and *Protiguanodon*.

Lower. *Psittacosaurus mongoliensis*, type skeleton (Amer. Mus. 6254), drawn from both sides.

Upper. *Protiguanodon mongoliense*, type skeleton (Amer. Mus. 6253), right lateral aspect partly reconstructed from left side.

Both figures one-half natural size.

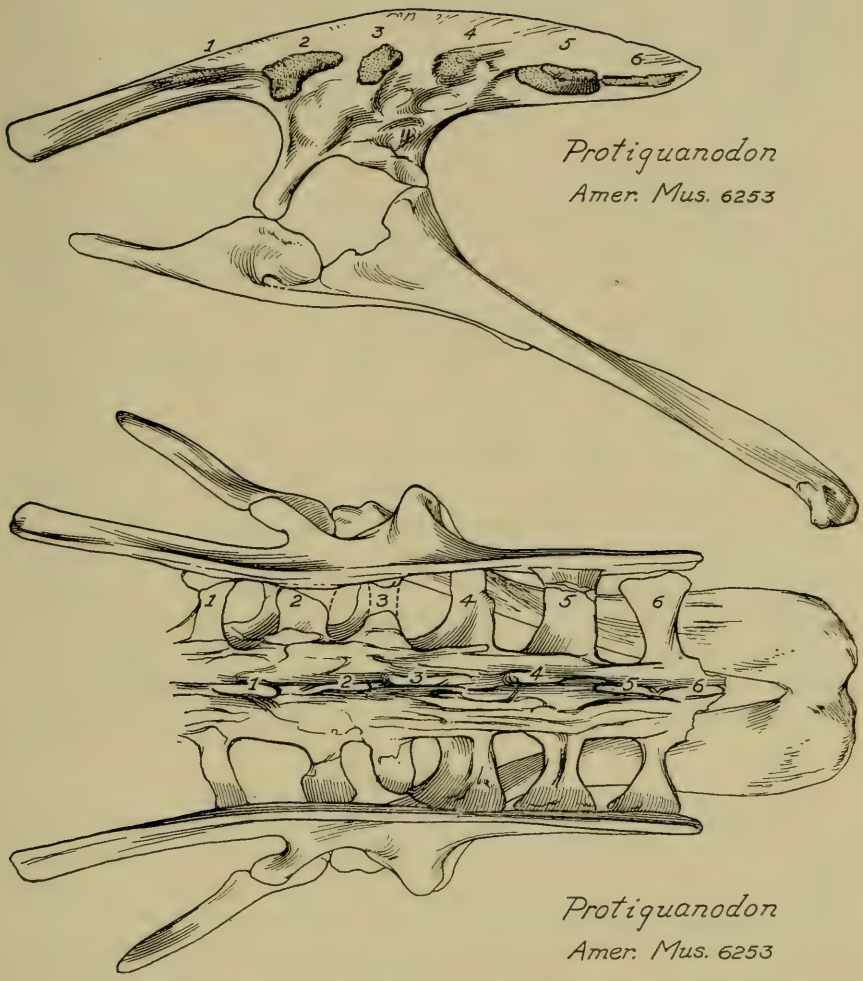

Fig. 9. Pelvis and sacrum of *Protiguanodon mongoliense*, type skeleton (Amer. Mus. 6253).

Upper. Internal aspect of right os innominatum showing attachment of 6 sacral vertebræ.
Lower. Superior aspect of pelvis showing 6 sacral vertebræ, also coalescence of ischia at the ischiac symphysis.

is elongate, slender and closely appressed to the flattened under surface of the ischium; (2) the prepubis (Fig. 8) is much more robust in *Psittacosaurus* than in *Protiguanodon;* the pubic foramen is apparently an enclosure between the postpubis and the peduncle or acetabular border of the pubis. As these pelves are primitive, the postpubis appears as of secondary origin, or part of the extension of the primitive pubis. In figure 9 there is clearly shown the internal and superior aspects of the *Protiguanodon* innominate bone, namely: (1) Ilium with rugose attachment of six sacral vertebræ; slender anterior or pubic peduncle. (2) Short ischiac peduncle. (3) Slender prepubis when seen from above. (4) Flattened ischia, when seen from above, conjoined posteriorly into the ischiac symphysis.

Comparison (Fig. 7) of the pubic components in these iguanodonts would support the view that the prepubis is the primary element (=pubis), the postpubis a secondary element.

Prepubis.—Gregory remarks that the *Protiguanodon* skeleton affords convincing evidence for his view that the prepubic processes of Ornithischia diverge widely on each side toward the last rib. He doubts whether the pelves of *Psittacosaurus* and *Protiguanodon* afford any support of the view (see Osborn above) that the postpubis is a new process. These animals are very far removed in skull and other structures from the primitive Triassic Pseudosuchia which appear to be their nearest relatives. The postpubic process lies immediately below the pubic foramen in the position of the true pubis of embryo birds and adult Triassic *Erythrosuchus;* consequently the postpubis=pubis.

Acknowledgments

The author is greatly indebted to the following persons in the preparation of this article: First, to Otto Falkenbach for many weeks of laborious and skilful work in exposing and restoring these type skeletons. Second, to Mrs. L. M. Sterling for her skill in preparing life-size illustrations of these two skeletons, which will subsequently be published, the present reduced illustrations doing scant justice to the original pencil drawings. Third, to Professor William K. Gregory for valuable notes and suggestions throughout the study of the skeletons and for the critical comments which are inserted in the present text, together with the comments of Mr. Walter Granger on the "epidermal tubercles."

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56.81,9(117:51.7)

SAUROPODA AND THEROPODA OF THE LOWER CRETACEOUS OF MONGOLIA[1]

By Henry Fairfield Osborn

The discovery of Sauropoda was one of the most interesting results of the Expedition. From the Psittacosaurus mongoliensis life zone, Oshih (Ashile) formation, Red Mesa, Oshih Basin, Mongolia, were collected by the Expedition of 1922 two characteristic sauropod teeth which bear considerable resemblance to those of *Camarasaurus* Cope and of *Caulodon* Cope, and are widely different from those of *Diplodocus*

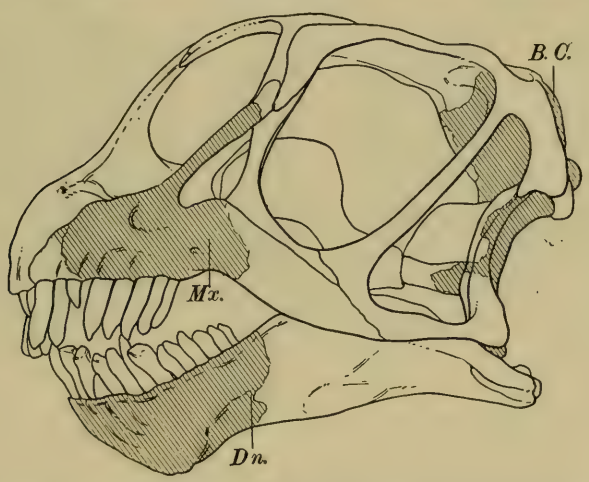

Fig. 1. Key to *Camarasaurus* skull (Amer. Mus. Cope Coll. 5761), shaded; outlines restored from referred skull (Amer. Mus. 467). One-tenth natural size. After Osborn and Mook, 1921, p. 286, fig. 29.

Marsh. Both the characters of the teeth and their occurrence in a new locality and life zone prompt their reference to a new genus of Sauropoda, family Camarasauridæ.

A comparison of the type and paratype teeth with those of *Camarasaurus* (see Osborn and Mook, 1921, pp. 286, 287, Figs. 29 and 30, Fig.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 26.

1 of this article) indicates that the type teeth of *Asiatosaurus* belong in the lower jaw, the smaller type tooth being posterior, the larger paratype tooth being anterior in position; the family resemblance to *Camarasaurus* is quite strong. The generic characters are very distinct; all the teeth of *Camarasaurus* (*op. cit.*, Fig. 30) and of the type of *Caulodon diversidens* (*op. cit.*, Pl. LX) have subspatulate crowns, expanding at the base, contracting toward the summit, with a prominent median and symmetrical internal ridge. Compare *Asiatosaurus* type (Fig. 2) with *Caulodon diversidens* type (*op. cit.*, Pl. LX, figs. 1*a*, 1*b*, 5*a*, 5*b*). A second important difference is the asymmetry of the summit of the crown in *Asiatosaurus* as compared with the symmetry of the crown summit in *Camarasaurus*. A third difference is the more robust fang anteroposteriorly seen in the paratype (Fig. 3) of *Asiatosaurus*, as compared with the much less robust fang in the large anterior and central teeth of *Camarasaurus*.

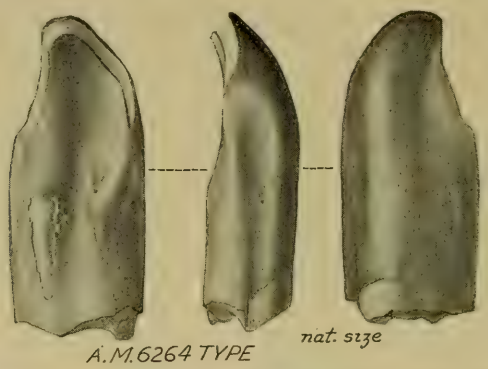

Fig. 2. Type of *Asiatosaurus mongoliensis* (Amer. Mus. 6264). Supposed posterior tooth in the dentary series. Natural size.

Asiatosaurus mongoliensis, new genus and species

TYPE.—The tooth chosen is the most characteristic (Amer. Mus. 6264), reproduced herewith natural size (Fig. 2); this is believed to be a posterior tooth of the lower jaw or dentary bone. The paratype (Amer. Mus. 6294) is of much larger size and is believed to be an anterior tooth of the dentary. The type and paratype teeth have certain general characters in common but differ greatly in size.

HORIZON.—Oshih (Ashile) formation, Psittacosaurus mongoliensis life zone, Mongolia.

LOCALITY.—According to Granger these teeth were found approximately on the same level about one hundred feet apart; we are certain that they do not belong to the same individual; it is probable that they belong to the same species. We cannot be positive, however, that they belong to the same species, or as to their position in the jaw, until more complete material is found with the teeth *in situ*.

Generic Characters.—*Asiatosaurus*, derived from the Greek 'Ασια, Asia, and σαύρα, lizard. Type: (?Posterior) maxillary or dentary tooth, small, concavo-convex; subspatulate crown, slightly expanding superiorly; two lateral external and one median internal vertical grooves. Paratype: (?Anterior) enlarged tooth with transverse equaling anteroposterior (ap. 126 mm. = tr. diameter) diameter of fang, expanded summit, convexo-concave (internal section), shallow lateral and internal vertical grooves.

Type Description.—(1) The type tooth (Fig. 2) measures 41 mm. in height as preserved, 47 mm. in circumference, 18.2 mm. in anteroposterior direction (i.e., parallel with the direction of the tooth-row) and 11.7 mm. perpendicular to this direction; the external surface is convex in both vertical and horizontal directions; near

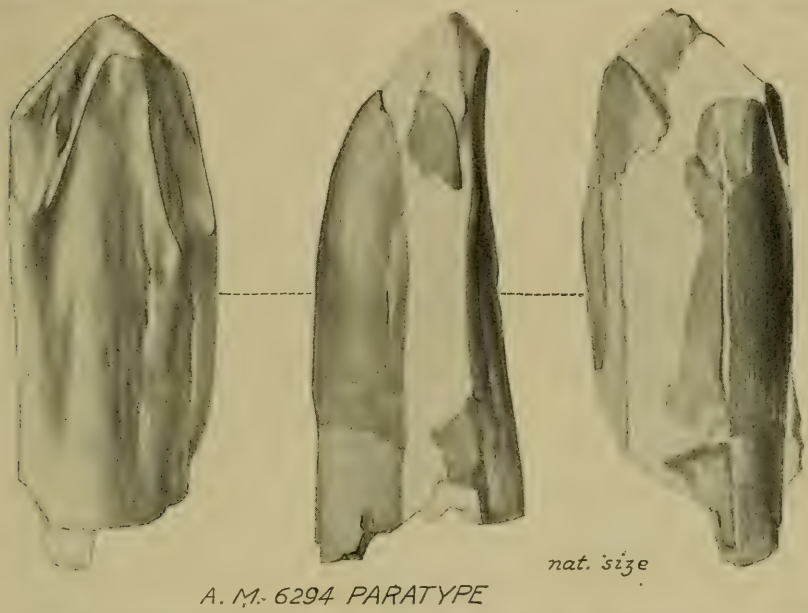

Fig. 3. Paratype of *Asiatosaurus mongoliensis* (Amer. Mus. 6294). Supposed to be an anterior tooth of the dentary. Natural size.

each edge is a broad, shallow vertical groove. (2) The internal surface is flat at the base, but concave in both vertical and horizontal directions near the apex of the crown. The surface therefore roughly resembles the inner or upper surface of a spoon. A small median groove extends vertically through the base of the bowlshaped depression. (3) The edges are straight and parallel near the base of the tooth, but near the crown are beveled by worn surfaces; the latter are asymmetric in development, one being rather convex in profile and extending down only 15 mm. from the apex, while the other is concave and extends downward about 30 mm. The two worn surfaces unite at the apex into a single surface. The unequal degree of wear on opposite edges gives an asymmetric appearance to the entire tooth. The worn surfaces face some-

what inward, being entirely visible on the internal aspect of the tooth, and not at all visible on the external aspect. This indicates that the tooth is near the posterior end of the dental series.

Comparison of its asymmetrical form with that exhibited by the teeth in the mounted skull of *Morosaurus* in the American Museum (Amer. Mus. 969) indicates that it belongs to the right side.

PARATYPE.—(1) The paratype tooth (Amer. Mus. 6294) is about 74 mm. in length as preserved, and about 80 mm. in circumference; at the base its anteroposterior diameter is equal to its transverse, 27 mm. The crown is damaged, the expanded upper portion being broken; near the tip the anteroposterior diameter exceeds the transverse.[1] This contrasts with the broader and more flat horizontal sections of Cope's *Camarasaurus* (=*Caulodon*) teeth. (2) The external surface of the tooth is convex, both in vertical and horizontal directions. The internal surface is slightly concave vertically, and near the tip horizontally as well. For two-thirds of its length, however, the concavity of the internal surface is interrupted by a low vertical ridge which disappears near the tip of the crown; this ridge is not as prominent as similar ridges in the type teeth of Cope's *Camarasaurus* (=*Caulodon*); it is faintly striated vertically. Anteroposteriorly the crown is somewhat asymmetrical, but less so than in *Camarasaurus*. The summit of the tooth is imperfect, but the portion preserved exhibits a considerable amount of wear surface on the external side of the tooth; a small, smooth surface on each inner edge may indicate wear. The great extent of worn surface on the external side of the tooth indicates that this is a lower tooth, and its large size and robust proportions indicate that it was situated near the anterior end of the jaw.

Amer. Mus. 6532. Another tooth referable to *Asiatosaurus* was found in the Oshih Basin, August, 1923 (Field No. 378). A sauropod tooth fragment also from the Oshih Basin bears the same field number, i.e., 378.

SAUROPODS OF THE OSHIH AND ONDAI SAIR FORMATIONS

In all, the remains of eight individual sauropods were found in the Oshih and Ondai Sair formations, of slightly different geologic ages and at different levels, indicating that this was an important center of sauropod distribution, as follows:

OSHIH FORMATION, PSITTACOSAURUS MONGOLIENSIS LIFE ZONE, EAST END OF RED MESA.

1. Type of *Asiatosaurus mongoliensis* (Amer. Mus. 6264).
2. Paratype of *Asiatosaurus mongoliensis* (Amer. Mus. 6294); same level as type, 200 yards distant.
3. Several limb bones, weathered, broken, and not collected; same level as type and paratype teeth, not far distant.

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[1]The term "anteroposterior" here refers to the direction parallel to the toothrow, and "transverse" at right angles to this direction. These directions may or may not correspond with the general directions of the skull, depending upon the position of the tooth.

4. Referred tooth of *Asiatosaurus* (Amer. Mus. 6532), Field No. 378.
5. A sauropod tooth fragment (Field No. 378).

THREE MILES EAST OF RED MESA, FROM A HIGHER LEVEL, ABOUT 600 FEET.

6. Amer. Mus. 6533, two anterior dorsal vertebræ, badly weathered, several ribs, and one chevron; three ribs and chevron collected (Field No. 106); see photograph, Fig. 4.
7. Single dorsal vertebra, badly weathered, not collected. Found 100 feet from vertebræ (Amer. Mus. 6533) possibly belonging to the same individual.

ONDAI SAIR FORMATION, MT. USKUK.

8. One rib (Amer. Mus. 6258).

Fig. 4. Two anterior dorsal vertebræ, several ribs, and a chevron of a sauropod dinosaur *in situ*. Oshih (Ashile) formation, Oshih Basin, August, 1923; Albert F. Johnson, collector. Owing to their much weathered and disintegrated condition, the two vertebræ were not taken.

CONCLUSION.—Awaiting the evidence afforded by more perfect material, *Asiatosaurus* seems to resemble *Camarasaurus* in the subspatulate form of the summit of the crowns, in its large anterior teeth diminishing gradually to the smaller posterior teeth of similar general spatulate pattern. We await with interest comparison of these teeth with those of the analogous African genera.

Fig. 5. Type of *Prodeinodon mongoliensis* (Amer. Mus. 6265), Oshih (Ashile) formation, Oshih Basin, Mongolia; collected by Walter Granger. Natural size.

Prodeinodon mongoliense, new genus and species

TYPE.—Amer. Mus. 6265. Upper section of a carnivorous dinosaur tooth, Oshih (Ashile) formation, Mongolia (Fig. 5). Collected by Walter Granger.

PARATYPE.—Complete carnivorous dinosaur tooth (Amer. Mus. 6531), Oshih (Ashile) formation, Mongolia. Collected by Walter Granger.

HORIZON AND LOCALITY.—Oshih (Ashile) formation, Psittacosaurus mongoliensis life zone, Red Mesa, Oshih Basin, Mongolia.

GENERIC CHARACTERS.—A theropod or carnivorous dinosaur, tooth crown with flattened sides, rounded anterior border, compressed posterior border terminating in a serrate ridge. Diameters: ap. 134 mm., tr. 82 mm. Closely minute serrations of posterior edge.

The Theropoda or carnivorous dinosaurs of the period, contemporaries of *Psittacosaurus* and *Asiatosaurus*, are represented by a single tooth fragment (Amer. Mus. 6265) which is shown natural size in figure 5, as collected by Granger in 1922. As *Asiatosaurus* may prove to be close to *Brachiosaurus* or to *Camarasaurus*, so this carnivorous dinosaur tooth may prove to belong to an Old World or New World genus such as *Megalosaurus* Buckland, *Dryptosaurus* or *Allosaurus* Marsh. Meanwhile it is provisionally given the name *Prodeinodon*, referring to its greater geologic age than *Deinodon* Leidy of the Judith River, Upper Cretaceous.

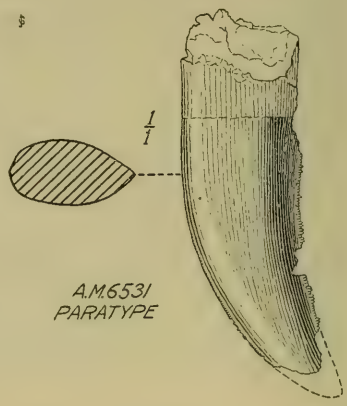

Fig. 6. Paratype of *Prodeinodon mongoliensis* (Amer. Mus. 6531), Oshih (Ashile) formation, Oshih Basin, Mongolia; collected by Walter Granger, August, 1923 (Field No. 378). Natural size.

In the type of *Megalosaurus* (Buckland, 1824, Owen, 1860, p. 260, fig. 75) both the anterior and posterior edges of the teeth are serrate; the teeth so far as preserved are similar or homodont.) The teeth of *Deinodon* are also sharpened on both edges (Leidy, 1860, Pl. IX, figs. 21–48); they are heterodont, the anterior teeth (named *Aublysodon* by Leidy) being rounded in front and flattened behind with double serrations on the two posterior borders. The present type of *Prodeinodon* agrees most closely with the tooth figured by Leidy (Leidy, 1860, Pl. IX, figs. 33

and 34, described on p. 144). Leidy observed that *Deinodon* was probably heterodont; the same may be true of *Prodeinodon*. A closer resemblance to the *Prodeinodon* type is seen in Lambe's figure of *Deinodon explanatus* Cope (Lambe, 1902, p. 49, Pl. xv, figs. 11 and 12, Fig. 7 of this article). Consequently the generic name *Prodeinodon* is selected for this Oshih type of Mongolia. The tooth differs in its more rounded and less laterally compressed section from the tooth referred to *Deinodon explanatus* Cope.

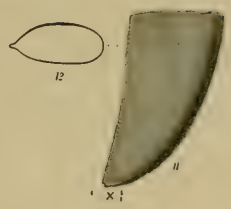

Fig. 7. Referred tooth of *Deinodon explanatus* Cope. After Lambe, 1902, Pl. xv, Figs. 11 and 12. Twice natural size.

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56.78M(1181:51.7)

A NEW SPADEFOOT TOAD FROM THE OLIGOCENE OF MONGOLIA WITH A SUMMARY OF THE EVOLUTION OF THE PELOBATIDÆ[1]

By G. K. Noble

The Third Asiatic Expedition of the American Museum discovered in the Hsanda Gol formation in the Tsagan Nor basin of outer Mongolia a beautifully preserved pelobatid. This single specimen is of unusual interest as representing the group from which the modern spadefoot toads arose, to spread on one side across Europe and on the other into North America. It is the oldest known fossil which belongs unquestionably to the Pelobatidæ.

The Hsanda Gol formation has been assigned to the Oligocene.[2] The specimen described below was found associated with a varied mammalian fauna, mostly rodents. Eleven species and nine genera of the latter have already been described by Matthew and Granger.[3] The formation consists mostly of sandy clays. The terrain during Oligocene times was therefore similar to that to which modern spadefoot toads are restricted, except that it may have contained more clay and less sand. The climate was apparently semiarid.

Pelobatidæ

Macropelobates osborni,[4] new genus and species

Type.—No. 6252; an incomplete skeleton, crushed anteriorly, but well preserved.

Horizon and Locality.—Hsanda Gol formation, Tsagan Nor basin, Mongolia.

Diagnosis.—Undoubtedly a pelobatid in that it exhibits the following characters: Anomocœlous[5], with the coccyx not ankylosed to sacrum; coccyx with a single condyle; teeth present on upper jaw; coracoids suggesting an arciferal condition; an enormous prehallux (spade); epiphyses absent (cartilaginous); a bony encrustation on the frontoparietal, nasal and squamosal.

Agrees with *Pelobates* in: Maxillary teeth guarded mesially by a ridge, but this more pronounced than in *Pelobates;* neural processes of anterior vertebræ long and

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 27.

[2]Matthew, W. D., and Granger, Walter. 1923. Amer. Mus. Novitates, No. 101, p. 1.

[3]*Op. cit.*

[4]Named for Professor Henry Fairfield Osborn, who has been so largely the inspiration of the Third Asiatic Expedition.

[5]For this term see Noble, 1922.

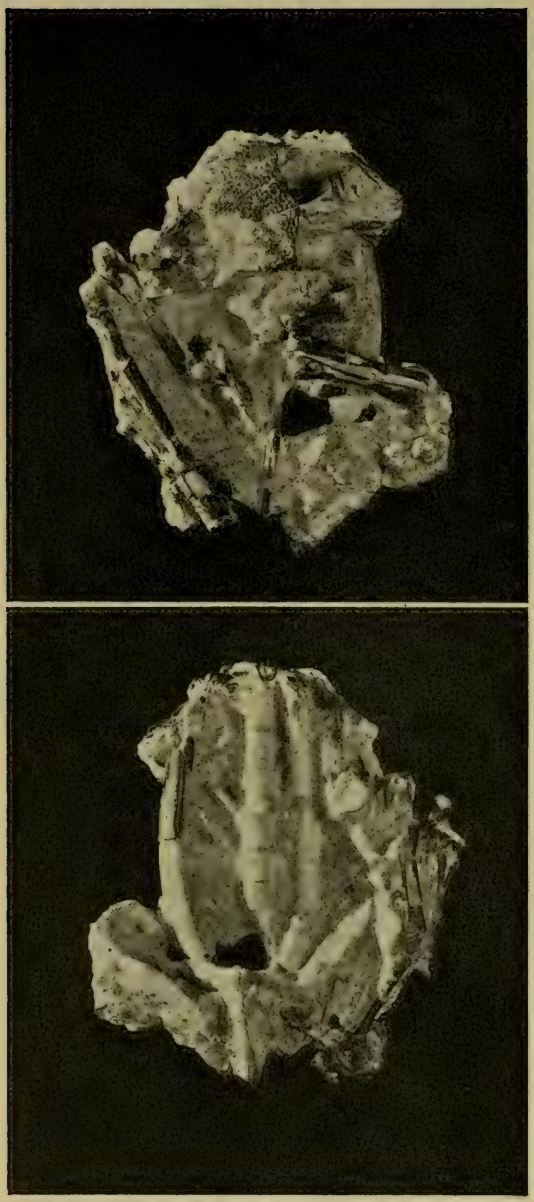


Fig. 1. *Macropelobates osborni* Noble, type specimen. A, dorsal, and B, ventral aspect.

A

B

Explanation of Fig. 1: Ast., Astragalus; Cal., Calcaneum; Coc., Coccyx; Eth., Ethmoid; Fem., Femur; Fr. p., Frontoparietal; Hum., Humerus; Il., Ilium; Mx., Maxilla (fragment); Na., Nasal (fragment); Pr. h., Prehallux; Pro., Proötic; Pub. isch., Puboischium; Rad. ul., Radioulna; Sac. Sacral diapophysis; Sc., Scapula (part); T. fib., Tibiofibula; Vert. 2., Vertebra (apparently the 2d); Vert. 3., Vertebra (apparently the 3d).

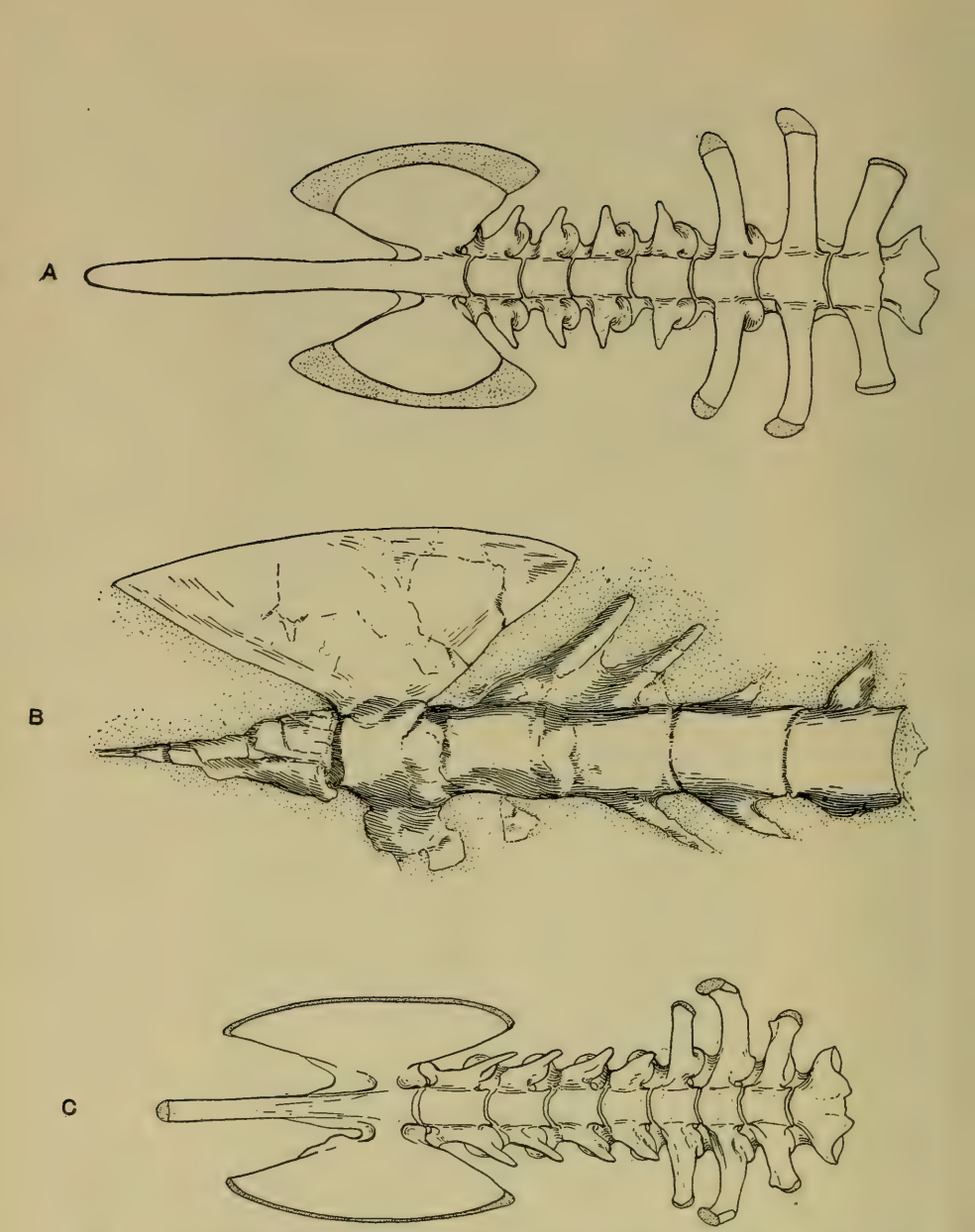


Fig. 2. Vertebral columns ventral aspect. A, *Scaphiopus couchii* Baird; B, *Macropelobates osborni* Noble; C, *Pelobates fuscus* (Laurenti).

pointed (possibly exaggerated through crushing); coracoid with an expanded mesial end; squamosal with a large sheath of bony encrustations upon its lateral surface; presacral vertebræ with transverse processes directed very obliquely forward (but not quite as much as in *P. fuscus*).

Agees with *Scaphiopus* in: Puboischial plate as long as at least three presacral vertebræ; ilium longer than the femur; coccyx longer than the sacral wings; only one segment in the prehallux (as in *S. couchii* and *S. hammondii*, but not *Scaphiopus holbrookii* and *S. dugesii*).

Distinguished from the other fossorial pelobatids by: Size very large; coccyx and sacrum not fused (this condition appears as a variation in *Pelobates*); transverse processes of vertebræ immediately anterior to the sacrum, narrow; sacral diapophyses as wide as the ventral surfaces of three and one-half presacral vertebræ (three in *Scaphiopus*, five in *Pelobates*); transverse diameter of sacral wings contained in the longitudinal diameter a trifle over two times; coccyx slender; radioulna rather wide and slightly curved (Fig. 3E); astragalus and calcaneum very slender (Fig. 3G); puboischial plate solid, the pubis apparently ossified and forming part of this plate.

Description of Type Specimen.—Skull strongly ossified and sheathed as in *Pelobates* with a secondary deposit of bone, the frontoparietal completely covered with this pitted sheathing (except anteriorly where it has obviously been broken away); a fragment of a nasal present and covered with this ossification; the squamosal destroyed anteriorly, but the remaining part sheathed laterally as in *Pelobates*, this sheathing more than twice as long and twice as wide as the anteroposterior diameter of the unsheathed dorsal surface of the squamosal. Ethmoid entirely ossified, lateral wings fairly well preserved and similar to the ethmoid of *Scaphiopus* except that they appear more massive; left nasal represented by two fragments which would indicate that the nasals had originally the same form as in *Scaphiopus* and *Pelobates*, at least they were in broad contact in the mid-line; frontoparietal single, its bony sheathing fractured along the sides posteriorly and hence no lateral processes as in *Scaphiopus* or *Pelobates;* both proötic and dorsal part of the squamosal exposed and without bony encrustations; squamosal and pterygoid represented only by fragments which may be matched with parts of the homologous bones in *Scaphiopus;* a fragment of the right maxilla present; the teeth walled in mesially by a pronounced ridge (Fig. 4A).

Vertebral column typically anomocœlous, the coccyx articulating by a single condyle with the sacrum; the dorsal surfaces of only three of the vertebræ exposed and these surfaces very much broken. Apparently the anterior vertebræ were provided with long transverse processes and the neural spines were long and slender; the longest neural spine retained is slightly longer than the ventral surfaces of any of the presacral vertebræ, and about equal to the greatest anteroposterior diameter of the exposed dorsal surface of the proötic. The transverse processes of the two vertebræ immediately anterior to the sacrum well preserved, these proportionately more slender than in *Pelobates* and directed not so obliquely forward as in that genus. The longest of these transverse processes is a little longer than the greatest length of any of the vertebræ, possibly just equal to these vertebræ if they were disarticulated. Sacral vertebræ with strongly dilated diapophyses, the transverse diameter of these wings slightly shorter than half the longitudinal diameter; longitudinal diameter of these diapophyses equals the longitudinal diameter of three and one-half presacral verte-

bræ; coccyx broken but longer than the longitudinal diameter of the sacral wings, nearly equal in length to five of the vertebræ together; coccyx in no way contributing to the sacrum.

Coracoids both broken but very similar to *Pelobates;* the mesial end expanded, this expansion over twice as wide as the narrow middle portion of the coracoid; glenoid part of the coracoid expanded about once and a half or more the width of the narrow portion of the coracoid. Both humeri broken but the fragments in no way different from those of *Pelobates;* radioulna broken but apparently wider than in *Pelobates* and with a shallower distal articulation (Fig. 3E); part of the right scapula present, massive; two fragments, which I take to be the right and left suprascapulæ, differ from similar structures in *Pelobates* and *Scaphiopus* in having the posterior process narrower, more massive (Fig. 4B).

Pelvis apparently more complete than in *Pelobates* and *Scaphiopus;* pubis may have been ossified, at least there is no space for a pubic cartilage. Longitudinal diameter of the acetabulum equals the distance between the posterior margin of the acetabulum and the posterior margin of the ischium; longitudinal diameter of the puboischial plate equal to the length of three and one-third vertebræ; ilium, as measured from the apparent suture between the ilium and ischium, distinctly longer than the femur; femur very slightly longer than the tibiofibula; femur and tibiofibula without epiphyses (these cartilaginous in life). Calcaneum and astragalus much slenderer than in either *Pelobates* or *Scaphiopus* (Fig. 3F and G); calcaneum slightly longer than astragalus; these elements free from each other and less in contact than in *Scaphiopus;* calcaneum slightly less than half the length of the tibiofibula. Prehallux enormous and formed of a single bone, which apparently is in contact with the astragalus as in *S. couchii* and *S. hammondii* and not separated by a bone (which has been variously named) as in *S. holbrookii* and *P. fuscus;* apparently a single bone lateral to the prehallux and also a space for a cartilage as in *S. couchii.* Prehallux less than half as long as the third metatarsal; the metatarsals more or less complete; the third metatarsal a trifle shorter than the astragalus.

MEASUREMENTS

Length of frontoparietal	20	mm.
Distance from middle of occiput to edge of squamosal	21	"
Longitudinal diameter of the exposed dorsal surface of proötic	6	"
Transverse diameter of the squamosal encrustation	6.5	"
Distance from the posterior edge of the base of the sacral diapophysis to the anterior margin of the fourth vertebra anterior to the sacrum	26.5	"
Longitudinal diameter of the sacral diapophysis	22	"
Transverse diameter of the sacral diapophysis	9.5	"
Coccyx	24.5	"
Radioulna	19.5	"
Ilium from ilioischial suture	44	"
Femur	41	"
Tibiofibula	40	"
Calcaneum	19.5	"
Longitudinal diameter of prehallux	6.8	"
Height of prehallux	5	"

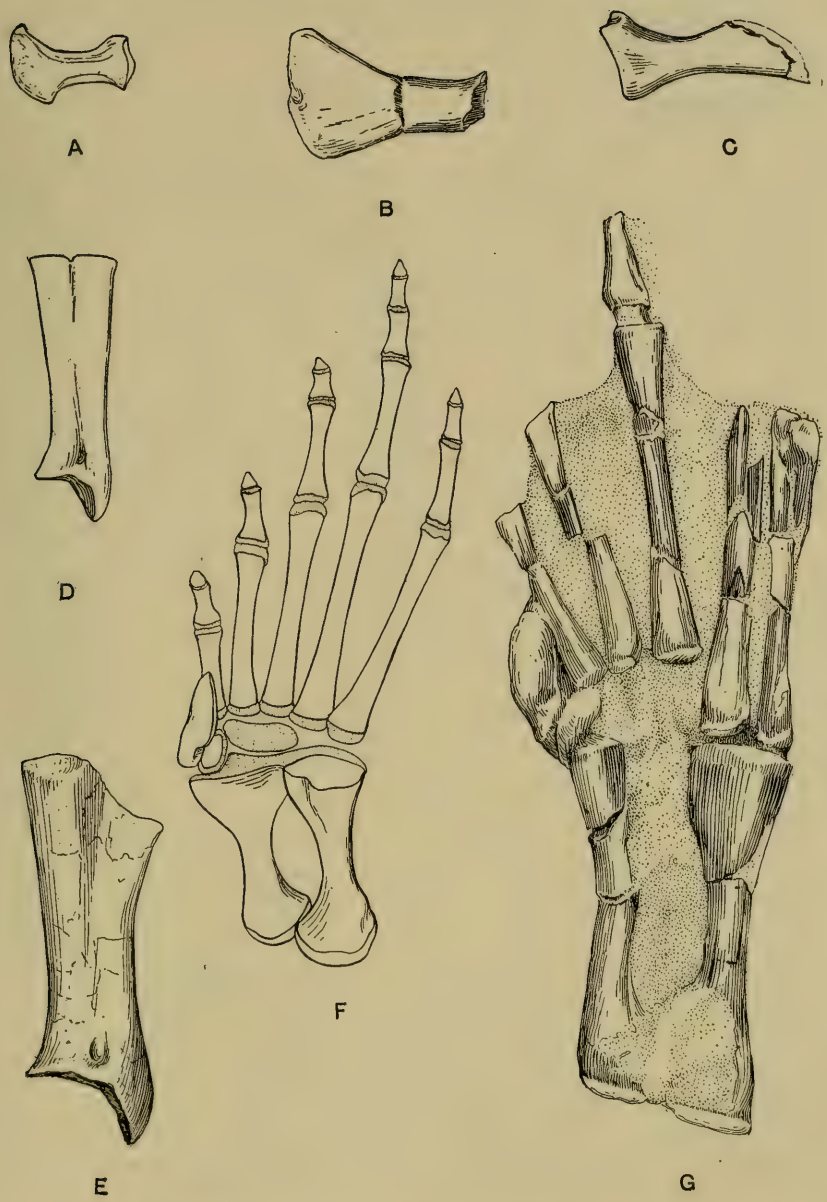


Fig. 3. A comparison of various skeletal elements of *Pelobates*, *Scaphiopus* and *Macropelobates*. A, left coracoid of *Pelobates fuscus* (Laurenti); B, left coracoid of *Macropelobates osborni* Noble; C, right coracoid of *Macropelobates osborni* Noble; D, left radioulna of *Scaphiopus couchii* Baird, median aspect; E, left radioulna of *Macropelobates osborni* Noble, median aspect; F, left foot of *Scaphiopus couchii* Baird, ventral view; G, left foot of *Macropelobates osborni* Noble, ventral view.

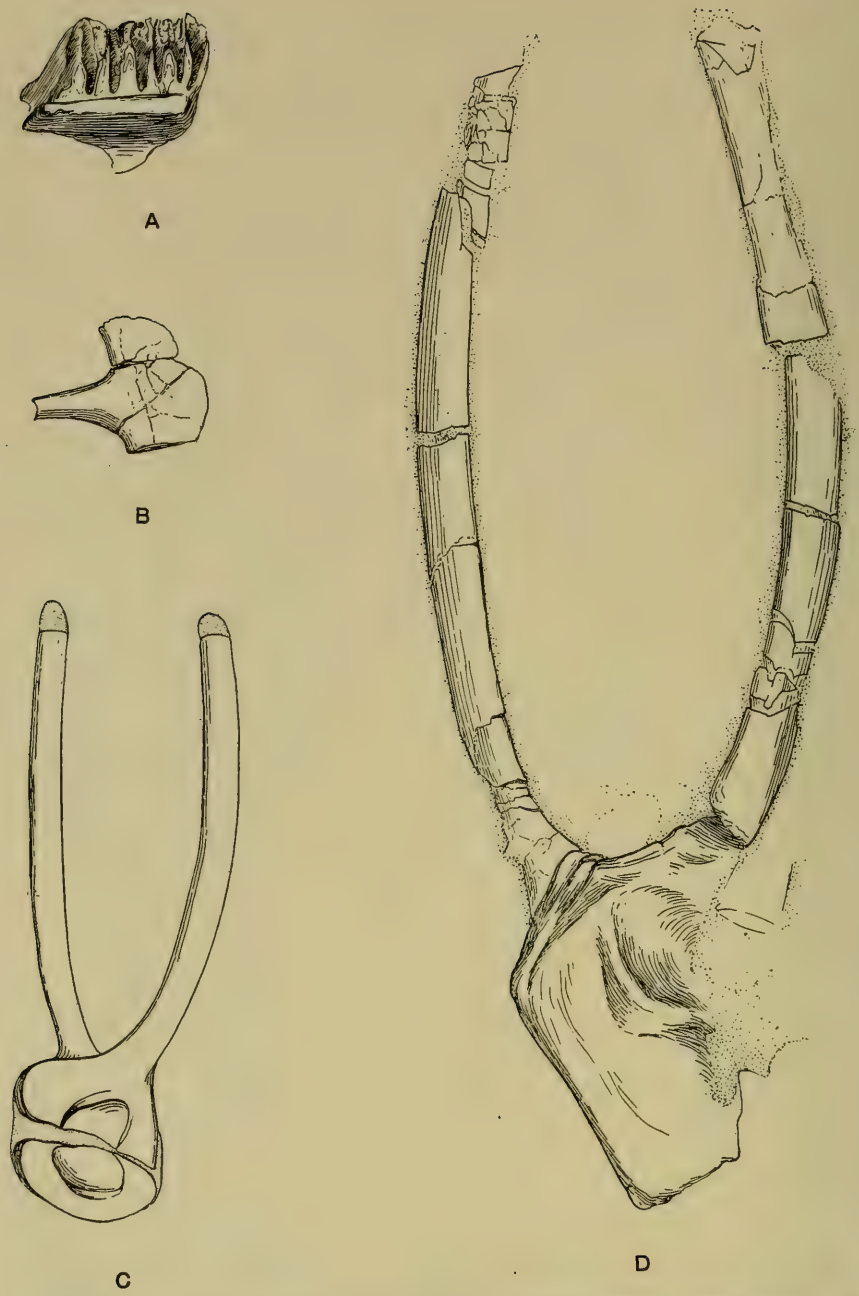


Fig. 4. A, fractured piece of maxilla of *Macropelobates osborni* Noble; B, a portion of the suprascapula of *Macropelobates osborni* Noble; C, pelvic girdle of *Scaphiopus couchii* Baird; D, pelvic girdle of *Macropelobates osborni* Noble.

THE ORIGIN AND DISPERSAL OF THE PELOBATIDÆ

The species described above exhibits the characteristic features of the fossorial pelobatids. These diggers are not the most primitive pelobatids. They form a rather uniform group, and some, such as Fejérváry (1921, 1923), who delight in naming every series of related genera, would distinguish this group as a subfamily. I have recently had occasion to sketch the broad lines of evolution within the Salientia (Noble, 1922). Since then it has been my privilege to study more intensively the primitive discoglossids. This work has served to strengthen the theses expressed and has lent no support to the recently devised "systems" of Bolkay (1919, 1922) and Fejérváry (1917, 1921, 1923). As a matter of fact, the first of these systems is based upon a misconception as clearly shown by Fejérváry (1921), while the second has little in its support, if enough forms are considered. The double sacrum which Fejérváry discusses in such detail cannot be considered primitive or very distinctive. *Atelopus*, for example, may or may not exhibit such a condition.

The pelobatids arose from the more primitive discoglossids of which *Liopelma* and *Ascaphus* are the only surviving representatives. This group was characterized by such fundamental features as amphicœlous vertebræ, a coccyx with a single condyle, and ten vertebræ, exclusive of coccyx which is itself of a primitive type. The pectoral girdle is exceedingly primitive in lacking an acromion and in having the scapula extending down into the "procoracoid region" as a single element. These features will be discussed in more detail elsewhere, but in the present connection, I desire to emphasize the primitive nature of these two genera, and hence will distinguish them as a family distinct from their discoglossid relatives. For this family the name **LIOPELMIDÆ**[1] seems appropriate.

The more generalized pelobatids as represented by *Megalophrys* have advanced beyond the Liopelmidæ in: (1) the ossification of the intervertebral cartilages (centra) which usually adhere to the more anterior vertebræ forming a procœlous vertebral column; (2) reduction of the number of presacral vertebræ to eight; (3) loss of ribs apparently by fusion with the vertebræ; (4) restriction of the ossification in the ventral part of scapulocoracoid and the development of an acromion; (5) reduction of pubis and expansion of sacral diapophyses. There were other less obvious changes in the hyoid and appendages. The musculature, however, was not greatly modified, except that certain elements such as the caudalipuboischiotibialis were lost. The pelobatids appar-

[1]I follow present-day custom in using the oldest generic name in forming the family name.

ently early developed excessive bony or calcareous deposits in their derm, for we find such encrustations not only in the integument of the head but also along the back of several species of *Megalophrys*.

The second stage in the progressive modification of the pelobatids is represented by *Macropelobates*. The prehallux has become enlarged, the bony encrustations ankylosed to the skull and the sacral diapophyses greatly expanded. The two former modifications are apparently adaptive and correlated with a fossorial life. The modern spadefoot toads differ only slightly from *Macropelobates*. The coccyx has become ankylosed to the sacrum (remaining free as a variation in some specimens of *Pelobates*).[1] No modern spadefoot toad attains the size of *Macropelobates*. There are also differences between these genera in proportion which seem to make the recent forms better diggers.

The final modification in the evolution of the pelobatids was one which has occurred many times in the specialization of the Salientia. The maxillary teeth were lost. This change accompanied a dwarfing in size and a modification in structure. The tympanum was lost and the eustachian tubes became vestigial. The two genera *Ophryophryne* and *Scutiger* which exhibit this change may have evolved directly from *Megalophrys*, for their osteology is very similar in spite of their different outward appearance. They exhibit, however, the enormously expanded sacral diapophyses of *Pelobates* and similarly curved procoracoids (Boulenger, 1919; Procter, 1921). A determination of the exact relationships of these genera will have to await a more detailed study of their osteology and myology.

It may be asked, when did the changes outlined above actually occur? The Liopelmidæ are found to-day only in the northwestern United States and in New Zealand. It is probable, therefore, that they existed in southeastern Asia during late Mesozoic or early Tertiary times. By the Oligocene the spadefoots had evolved and were living in Mongolia. Since then they have succeeded in migrating westward across favorable sandy areas of Asia to western Europe and eastward across the Bering Strait connection, southward to southern Mexico. The toothless forms are found to-day only at high altitudes in certain mountains of Sikkim, Kashmir, Tonkin, Tibet and the Chinese province of Szechuan. They apparently arose from stocks existing in this region. The distribution of the other genera cannot be so easily accounted for. *Pelodytes* has been considered by Boulenger (1899) as close to *Pelobates*,

[1]It is fused in 10 specimens of *Scaphiopus holbrookii*, 2 of *S. couchii*, 1 of *S. dugesi*, 2 of *S. hammondii*, and 2 of *Pelobates fuscus* in the American Museum.

but it exhibits many unique features and it does not seem likely that this genus arose directly from *Pelobates*. *Megalophrys*, although primitive in many respects, has extended its range only from southern China and the Philippines to India. Although found in the Malay Archipelago and in Borneo, it apparently never succeeded in pushing south and eastward into those East Indies which are not typically oriental in their faunal relations. No pelobatid occurs in New Guinea, as usually stated in textbooks (Nieden, 1923). *Asterophrys* is a brevicipitid as pointed out by Van Kampen (1923). I suggested (1922, p. 73) that *Lechriodus* (= *Batrachopsis*) was probably a toothed bufonid. Thanks to the kindness of Dr. P. N. Van Kampen, I have recently examined a specimen of *L. melanopyga* and may now confirm that opinion.

In Figs. 5 to 7, I have shown the pectoral musculature and thigh musculature of this specimen. The following features stamp *Lechriodus* as a bufonid in spite of its expanded sacral diapophyses:

(1) Sartorius distinct from the semitendinosus.
(2) Semitendinosus deep, not visible ventrally.
(3) Tendon of semitendinosus piercing gracilis major and minor (as in various Australian bufonids).
(4) Episternocleidohumeralis longus[1] distinct from supracoracoideus.
(5) Supracoracoideus profundus distinct from supracoracoideus superficialis.

None of these features is found in any pelobatid (*Scaphiopus*, *Pelobates*, *Pelodytes* and *Megalophrys*).

Lechriodus also has a double condyle on the coccyx which is found among pelobatids only in the specialized *Pelodytes*. I have discussed (Noble, 1922, p. 11) the several exceptions to the form of the sacrum as being diagnostic of family relations. *Lechriodus* may now be definitely relegated to the Bufonidæ.

If no pelobatids are found in the Papuan or Australian region, has the family arisen since the Indo-Australian connection was broken? This seems to be the best interpretation. If, therefore, we place the origin of the Pelobatidæ at the beginning of the Tertiary, we have still to account for the somewhat restricted range of the apparently primitive *Megalophrys*. Many factors, such as desert barriers or temperature, may have prevented their spread, but of these we have no definite knowledge. All evidence points toward an origin of the pelobatids in southern Asia during early Tertiary times, and to their differentiation, during the Oligocene or earlier, into spadefoots which have succeeded in spreading

[1] I have followed the nomenclature of Anthony and Vallois, 1914, Bibliog. Anat., XXIV, p. 271.

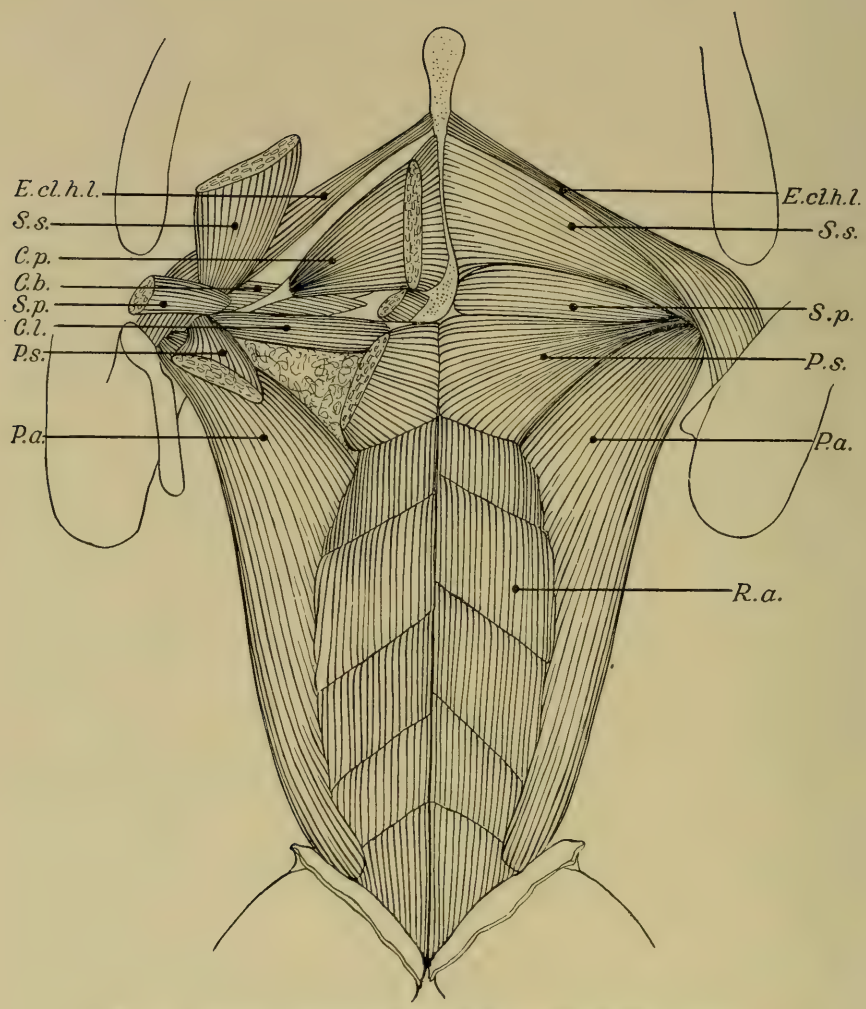


Fig. 5. Pectoral musculature of *Lechriodus melanopyga* (Doria).

A. cl. h, Acromio cleidohumeralis; C. b., Coracobrachialis brevis; C. l., Coracobrachialis longus; C. p., Coracoradialis proprius; E. cl. h. l., Episternocleidohumeralis longus; P. a., Pectoralis abdominalis; P. s., Pectoralis sternalis; R. a., Rectus abdominis; S. p., Supracoracoideus profundus; S. s., Supracoracoideus superficialis.

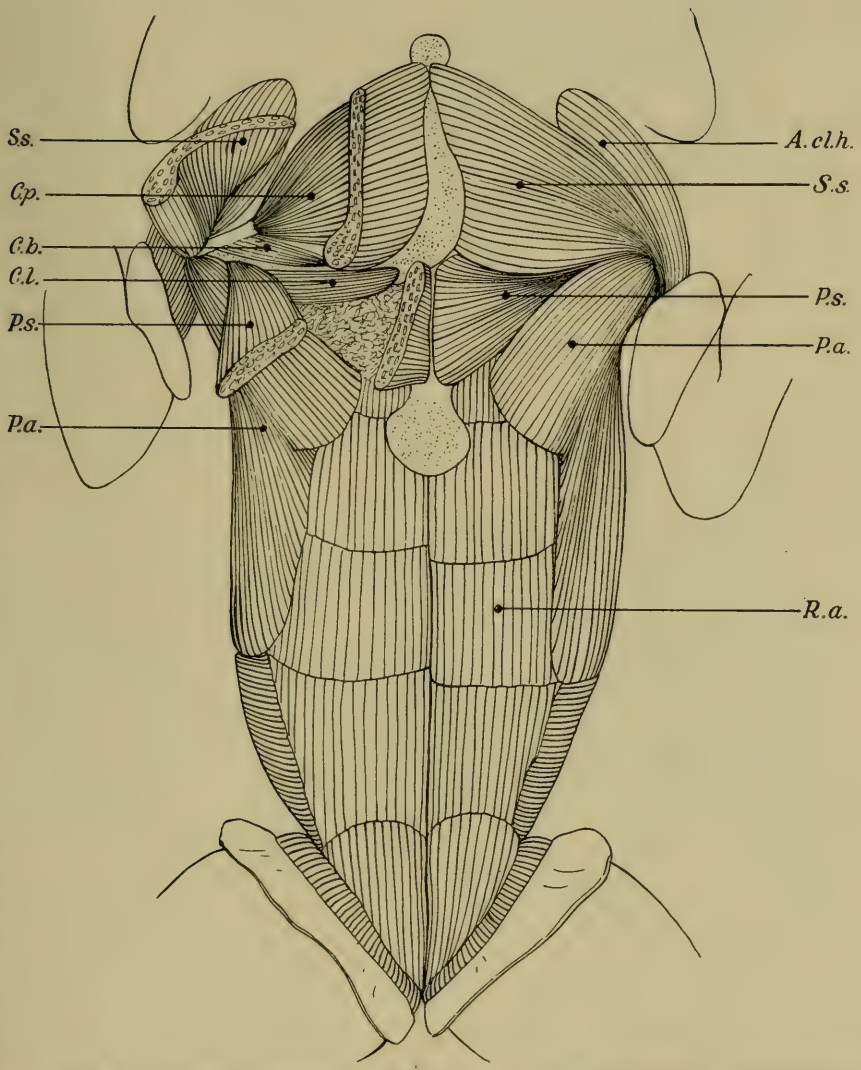
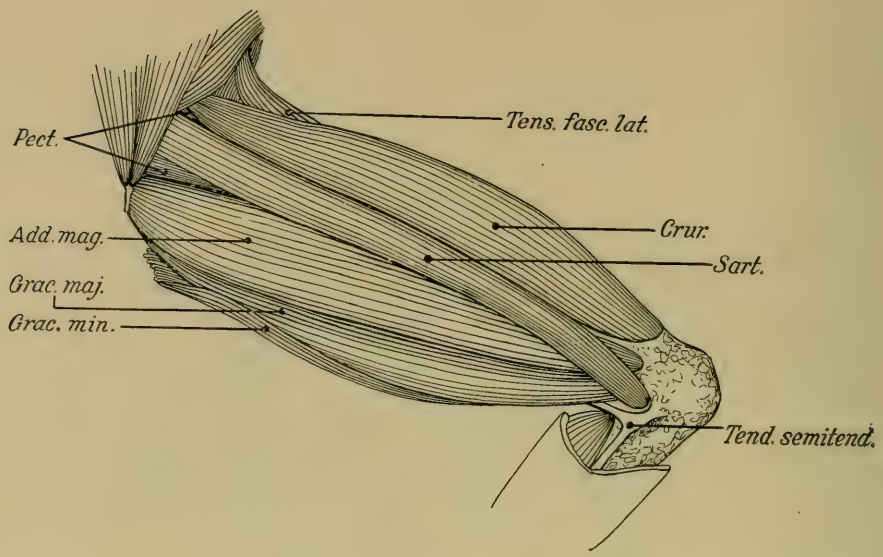
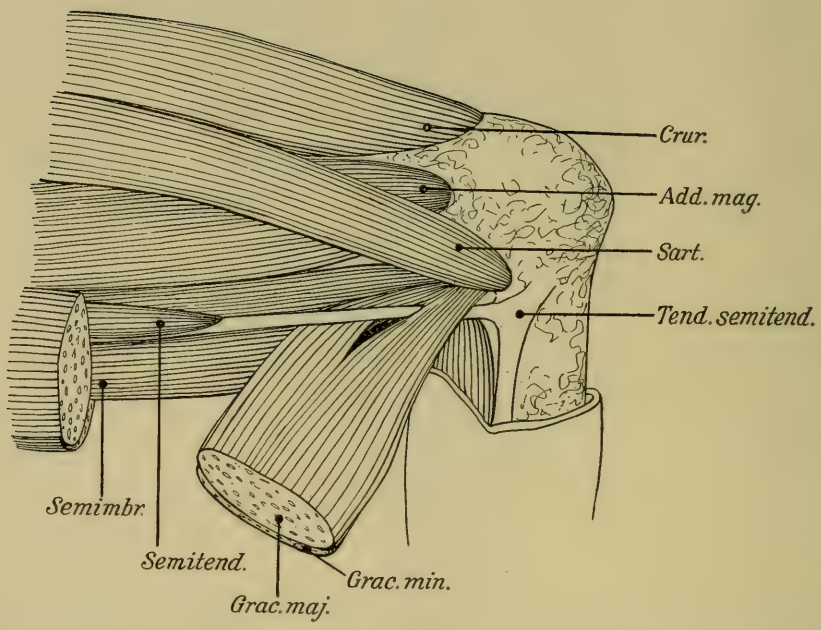


Fig. 6. Pectoral musculature of *Megalophrys hasseltii* (Tschudi). Abbreviations same as in Fig. 5.



A



B

Fig. 7. Thigh muscles of *Lechriodus melanopyga* (Doria), ventral aspect. A, the superficial muscles; B, the distal muscle complex.

Add. mag., Adductor magnus; Crur., Cruralis; Grac. maj., Gracilis major; Grac. min., Gracilis minor; Pect.=Pectineus Sart., Sartorius; Semimbr., Semimembranosus; Semitend., Semitendinosus; Tens. fasc. lat., Tensor fasciæ latæ; Tend. semitend., Tendon of semitendinosus.

westward into Europe and eastward to Mexico and eastern United States. Finally, part of the primitive stock residing in the mountains of southern Asia was modified by a loss of their dentition.

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MICROTINES COLLECTED BY THE ASIATIC EXPEDITIONS[1]

By Glover M. Allen

The field work carried on by the Second and Third Asiatic Expeditions of The American Museum of Natural History under the able leadership of Mr. Roy Chapman Andrews has resulted in the accumulation of a splendid series of voles and other microtines including a large number from the highlands of western Yunnan (a locality that has lately yielded many novelties), series from near Peking, from localities in Shensi Province, and from central Mongolia. In working out the identifications of these specimens, one is impressed by the number of microtine types occurring in eastern Asia. These are, many of them, superficially much alike, although their dental characters at once mark them off into groups which are of greater or less superspecific value. These have usually been considered subgenera, but, partly for convenience, have by some authors been accorded full generic standing. The occurrence of various intermediate steps in details of tooth-pattern, together with their general external resemblances, leads me to prefer for the present the more conservative course of regarding most of these groups as subgenera, pending some future and comprehensive review.

Among the many interesting facts of distribution brought out by these collections, a few may be particularly noted. The moist uplands of Szechuan have a characteristic series of species whose range extends southward into the high country of Yunnan, where local forms may develop. The eastward extension of many types common in western Asia is brought out by the occurrence in the Mongolian high plateau of species of *Ellobius* and *Lagurus*, and representatives of *Microtus obscurus*, and a form of the subgenus *Alticola*. The great tongue of high desert extending across Mongolia forms an effective barrier to the further southward progress of certain species common farther north where there is a certain amount of sheltering forest—such, for example, as *Evotomys* and *Myopus*.

At the suggestion of Mr. Andrews, the complete list of species obtained is here given, together with a brief diagnosis as a help to those

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 28.

who may have opportunity to do field work in the same country. High credit is due him for the abundance and excellent quality of the material he has brought back from this little-known area.

Myopus saianicus Hinton

A short-tailed lemming with a dull-reddish back and slaty head, sides and belly. Specimens of this genus have been very rare in collections. Middendorff reported it nearly seventy-five years ago from the Okhotsk Sea, but his record was long believed to be erroneous since it had previously been known from northern Europe only. In 1912 Hollister described *M. morulus* on the basis of a single specimen from the Altai Mountains; while another taken in the Syansk Mountains, one hundred miles west of Lake Baikal, has lately been made the basis of *M. saianicus* by Hinton. To the latter I have referred the fine series of fourteen taken at two different localities, fifteen miles north and forty-five miles northeast, respectively, of Urga, and four others from Sain Noin Khan. It seems likely that the Altai and the Syansk forms must be very closely related, and both perhaps hardly more than subspecies of *M. schisticolor* of Europe. The present series from the forest area bordering the northern Gobi establishes the occurrence of the genus in Mongolia and perhaps marks its southern limit of distribution in that country.

Evotomys rutilus russatus (Radde)

This red-backed mouse was abundant in the wooded country forty-five miles northeast of Urga, Mongolia, where a large series was obtained. These differ from a series from the Altai referred to *rutilus* in their slightly brighter colors and in having the tails usually more or less reddish like the back instead of blackish as in these latter. Although no specimens of *rutilus* from the Obi region are available as topotypes, it is assumed that the Altai specimens are the same, and I have therefore applied Radde's name to the Mongolian series. His figures and description (1862, 'Reise Siberia,' I, p. 186, Pl. VII, figs. 2, 2 *a-e*) seem to indicate this animal clearly enough, even to the reddish tail, in spite of doubts that have been expressed on account of his rough outlines of the enamel pattern of the teeth.

Evotomys rufocanus (Sundevall)

In addition to its cranial characters, this species can be distinguished from the preceding by its duller red back and the slaty muzzle, cheeks,

and sides. A good series was secured along the southern border of the forest at stations fifteen miles north and forty-five miles northeast of Urga, Mongolia, as well as at Sain Noin Khan to the westward. It seems to occur, therefore, in the same general localities as the smaller red-backed mouse. I have carefully compared this series with topotypes of *rufocanus* from Sweden and can find no tangible differences. Apparently, however, the species becomes more richly colored with more ochraceous flanks in Korea, a form to which the name *regulus* has been given. This should evidently be considered a subspecies, *Evotomys rufocanus regulus*. Mr. Andrews obtained a small series of this form in Korea during a previous expedition.

Evotomys rufocanus shanseius (Thomas)

In this race the back is less rufous, the sides more ochraceous, with a resulting paler, yellowish-brown appearance. It was originally described as a full species, *Craseomys shanseius*, type from the spruce forest, one hundred miles northwest of Tai-yuan-fu, Shansi, but the series now at hand including ten from Kwei-hwa-ting, Shansi, and five from one hundred miles northeast of Peking, indicates that its range passes into that of *rufocanus* on the eastward, although separated from it on the north by the Gobi plateau and Ordos Desert in Mongolia. Indeed, Thomas has referred a single specimen from sixty miles east of Peking to *regulus*, but the additional skins from that region secured by the Asiatic Expeditions of The American Museum of Natural History are quite indistinguishable from the pale form, *shanseius*. These two forms should be regarded as geographic subspecies of *E. rufocanus*.

Microtus (Eothenomys) melanogaster confinii (Hinton)

Externally this is a small dark vole with blackish slaty belly; many of the long hairs on sides and belly have burnished tips. The type locality is the Kiuchiang-Salween divide in latitude 28° north, altitude 11,000 feet. This is the southern representative of *melanogaster* of Sze-chuan and occurs on the mountains of southern Yunnan at altitudes from 6000 feet (Salween drainage) to over 10,000 feet (Pei-tai Mountain, south of Chung-tien). A series secured by the Second Asiatic Expedition includes two which, as noted by the collector, contained on February 8, 1917, one and two embryos respectively, a number correlated no doubt with the reduced number of mammæ.

Microtus (Eothenomys) fidelis (Hinton)

The largest, known member of the subgenus, a very reddish-looking vole with large skull and hind foot. The type came from the Li-chiang range, Yunnan, in latitude 27° 30′ north. A fine series was secured from the same area by the Second Asiatic Expedition, as well as others from Chunglu, Siao-ke-la, Chiangwei and Yangtsien, on the Mekong River between altitudes of 6000 and 9000 feet; Ha-pa (north of Taku), 10,000 feet; Yangpi River (Tengyueh road) at 5000 feet; Tali Lake, 6500 feet; and other localities. The entire series is very uniform in its characters. In two cases, three embryos were found in specimens captured the first week in October, and two in a female taken October 30, 1916. These are not only late litters but, as in the case of the preceding species, indicate a correlation between the small number of young per litter and the reduced number (four) of mammæ. It is possible also that the breeding season extends over a longer period than in some other microtines.

Microtus (Eothenomys) proditor (Hinton)

Externally like *M.* (*E.*) *fidelis* but the tail and hind foot smaller; the tooth pattern is slightly more complicated (especially m^3) and somewhat transitional between that of *fidelis* and the species of the subgenus *Anteliomys*. The type came from the Li-chiang range, Yunnan, at 13,000 feet altitude, and the series of ten specimens brought back by the Second Asiatic Expedition is from the same range, at the following localities: Ssu-shan-chong, 9000 feet; Peswi, 10,000 feet; Ssu-shan (Snow Mountain), 12,000 feet; timber-line, 13,000 feet. Evidently it is a species of high levels.

Microtus (Eothenomys) olitor Thomas

A small dark grayish-brown species with a very small skull. Three specimens were secured at an elevation of 7000 feet on the Mucheng-Salween drainage, western Yunnan. The type locality is Chao-tung-fu, Yunnan. This species is apparently the least common of the members of the subgenus in Yunnan. Its small size is at once distinctive, while the tooth pattern is interesting in its resemblance to that of *Anteliomys* in the increasing complexity and form of the third upper molar and the elimination of the postero-internal angle of the first upper molar.

Microtus (Anteliomys) custos Thomas

This species bears much resemblance to *M.* (*E.*) *fidelis* and *proditor* in its general appearance and reddish-brown coloration, but the belly is usually much grayer, and the tooth characters are distinctive. The posterior edge of the palate usually shows two slight projections, one on either side of the mid-line, which in *M.* (*A.*) *chinensis* meet to form a short median spine. It is an alpine species and was described from specimens taken at A-tun-tsu, northwestern Yunnan, at over 11,000 feet altitude. The Second Asiatic Expedition secured a series at To-mu-lang, 10,000 feet, and at the same altitude at Tu-gan-sha, both localities near Chung-tien. Others were taken at Ying-pan-kai and La-chu-mi, 9000 feet. One specimen (No. 44141) has an incipient postero-internal cusp on the two anterior upper molars, reminiscent of their fuller development in certain species of the subgenus *Eothenomys*. On the Li-chiang range this species is represented by an allied form, rather sharply marked off by the peculiarities of the nasal and intermaxillary bones, and may be described as follows.

Microtus (Anteliomys) custos rubellus, new subspecies

Type.—Adult female, skin and skull, No. 44001, American Museum of Natural History, from Ssu-shan (Snow Mountain), Li-chiang range, at timber line, 13,000 feet. October 13, 1916. R. C. Andrews and Edmund Heller.

Description.—Similar in general to *M. custos* but slightly more reddish above, the belly clearer gray, lacking the decided brownish wash. The skull differs notably in that the nasals are exceeded by the premaxillaries in their backward extension.

General coloration above, a dull rusty brown, nearly uniform, though slightly clearer along the flanks. The individual hairs are slaty at base, with an ochraceous terminal portion that becomes more rufous near the tip which is black. At the sides this minute black tip is often lacking, producing the clearer effect. Entirely black hairs are scattered throughout the pelage. Entire lower surface of the body gray or bluish gray, sometimes with a very faint wash of brownish on the chest. Feet and tail dusky above, the latter paler (grayish) below.

The skull appears to average a little larger than in typical *M. custos*. The most noticeable difference is in the relations of the nasals and the premaxillæ. In *M. custos* the posterior extension of the nasals exceeds that of the premaxillæ, whereas in *M. c. rubellus* they are uniformly shorter and do not (or rarely) extend even as far back as the terminal border of the premaxillæ. The palate, instead of ending in a median spine (as in *M. chinensis*), has a slightly projecting edge with usually two small blunt points. The teeth are essentially as in *M. custos*.

Measurements.—The collector's measurements of the type are: head and body, 100 mm.; tail, 41; hind foot, 18.5. Four other adults (topotypes) measured as

follows: head and body, 100, 100, 102, 105; tail, 44, 39, 40, 32; hind foot, 18.5, 18, 19, 17. The average of five adults of typical *M. custos* from the Chung-tien district is: head and body, 93.6; tail, 44; hind foot, 17.9.

The skull of the type measures: greatest length, 24.5 mm.; condylobasal length, 24.4; palatal length, 13.1; interorbital width, 3.7; zygomatic width, 14.2; mastoid width, 11.0; occipital depth including bulla, 8.0; upper molars (alveoli), 6.1; lower molars (alveoli), 5.9; tip of mandible to condyle, 15.2. These measurements are a very little larger than the average of adult *M. custos.*

This representative of *M. custos* (type from A-tun-tsu, 11,500 to 12,500 feet), like many other of the small mammals from the snow peak of the Li-chiang range, is sufficiently different to be worth recognizing as a distinct local race. It is much paler underneath, practically lacking the brownish wash so conspicuous in *M. custos*, and the body is a very little redder. In series, *M. custos* shows a slight contrast between the dull reddish tint of the head and the brownish of the back, whereas in *M. c. rubellus* there is less contrast, and the general tone is redder. The difference in the relations of the nasals and the premaxillæ is striking and fairly uniform in a large series. Apparently the larger species, *M.* (*Anteliomys*) *chinensis*, is not represented here, but reaches its southern limit on the divides northwest of A-tun-tsu, whence, under the name *wardi*, a form has been described by Thomas and again recorded by Hinton.

Microtus (Caryomys) aquilus (G. M. Allen)

A series of fifteen skins of this dark-brown, long-tailed vole from Tai-pei-shan, Tsing-ling range, southern Shensi, 10,000 feet, is apparently the same as the species I described in 1912 as *Craseomys aquilus*, which proves to be one of the *Caryomys* group with closed triangles in the first lower molar. This in turn may be found inseparable from *M.* (*C.*) *alcinous* Thomas, from Wei-chow, western Szechuan, but in the absence of typical specimens for comparison may at present stand. Probably *M.* (*C.*) *eva* (from Kansu) is one of the same group, and the others should be treated as subspecies of it.

Microtus (Alticola) worthingtoni semicanus, new subspecies

Type.—Adult male, skin and skull, No. 57805, American Museum of Natural History, from Sain Noin Khan, Mongolia. June 5, 1922. Third Asiatic Expedition.

Description.—Similar to *worthingtoni* but with larger skull, longer tooth rows and with a buff lateral line and buff wash over the lower surfaces.

General color above a buffy gray slightly darkened with scattered black hairs. The individual hairs are slaty at base with a broad subterminal band of white which

passes into pale buff for a very short distance below the minute blackish tip. Sides of nose, front and back of ears nearly "pinkish buff." Entire under parts, including the upper lips, lower cheeks, sides of neck, as well as the feet, legs and tail all around, buffy white, the hairs on legs and body with dark bases. The mixed gray of the back is sharply defined at the sides of head and body and the buff is here clearer and brighter, forming an indistinct lateral line (about "pinkish buff"). Vibrissæ very long, the longest about 50 mm., some black, some white.

The skull is larger throughout with longer tooth rows than in typical *worthingtoni*, with which it shares the well-defined first outer re-entrant angle of the last upper molar. The first lower molar, in addition to the posterior transverse loop, has two completely closed triangles on each side and an anterior trefoil, the inner loop of which is slightly larger than the outer.

Measurements.—The collector's measurements of the type are: head and body, 110 mm.; tail, 30; foot, 19; ear, 20. The skull measures: greatest length, 29.1 mm.; condylobasal length, 28.7; palatal length, 15.0; zygomatic width, 16.7; mastoid width, 14.4; diastema, 9.0; tip of mandible to condyle, 18.0; upper cheek teeth (alveoli), 6.7; lower cheek teeth (alveoli), 6.5.

This is undoubtedly a close relative of *Alticola worthingtoni* of the Tian-shan, nearly a thousand miles to the westward. In color, the two are closely similar except that the Mongolian animal is distinctly buffy instead of clear white below, and the ears and sides of the flanks are even clearer buff. The much larger size of the skull and teeth are further distinctive, and distinguish it from the subspecies *subluteus* of Yarkand as well. From *albicauda*, the species is apparently quite distinct, as pointed out by Miller, while the Altai species, *strelzovi*, is smaller and grayer with a much more flattened skull.

The fine series of this large gray microtine extends the known range of the subgenus northeastward into central Mongolia, which may be near the limit of its distribution in this direction. In addition to some twenty-seven specimens from the type locality, others were secured at Hurum-tu, 7000 feet, Gun Burte, 6800 feet, and forty miles south of Tzetzenwan.

Microtus (Lasiopodomys) brandti (Radde)

A pale sandy-colored vole with long claws on both fore and hind feet. A large series was secured by the expeditions of 1919 and 1922 in the northern part of Mongolia at distances of from eighty to one hundred and forty miles southeast of Urga and at Hurum-tu (7000 feet), Tzetzenwan and vicinity, Sain Noin Khan and on the Ongin River. Radde's type series came from localities on the Mongolian high steppe and near Tarei Nor, so that these may be considered typical. So far as may be judged from the description, *Microtus warringtoni* Miller from Tabool, Mongolia, is quite the same. The latter was supposed to be larger than

typical *brandti*, but the comparisons were made with Büchner's figures and description of specimens obtained by Prjevalski in northeastern Tibet. Many of the specimens from southeast of Urga exceed *M. warringtoni* in size of skull. Possibly there is a decrease in size westward. A brood of four very young mice was found June 24 near Urga.

Microtus mandarinus (A. Milne-Edwards)

A buffy-brown short-tailed vole with unusually long silky fur which almost hides the small round ears. The original specimen was secured by Père David in "la Mongolie chinoise avec les espèces précédentes," that is, in Shansi, probably near Saratsi, whence came several other species described from the same collections. A series of eleven specimens collected near Kwei-hwa-ting in the same province, are therefore practically topotypes, as the localities are hardly fifteen miles apart. These specimens agree well with Milne-Edwards's description and figure, even to the white of the throat. The whitish belly is usually slightly tinged with buffy. The rediscovery of this species in northern Shansi is noteworthy in connection with Thomas's suggestion that the original specimens may have come from southern Shensi. The Kwei-hwa-ting series is apparently somewhat larger but otherwise very similar to *M. johannes* (from Ko-lan-chow, Shansi), which is at most but a subspecies of *mandarinus*. In addition to this lot, a second series of fourteen was secured in Chili Province, one hundred miles northeast of Peking, which differ in the generally darker color, especially of the under side as compared with those of the drier interior. They seem to be a well-marked subspecies, and may be described as follows.

Microtus mandarinus fæceus, new subspecies

Type.—Adult male, skin skull, No. 56358, American Museum of Natural History, from Chili Province, 100 miles northeast of Peking, China. March, 1922. Third Asiatic Expedition.

Description.—Similar to *M. mandarinus* but darker above, with a clear slaty throat, and slaty belly heavily washed with buffy.

General color above a nearly uniform "hair brown" rather than the brighter "wood brown" of typical *mandarinus*, a result of the greater admixture of black hairs and of the narrower subterminal ochraceous rings of the parti-colored hairs. The general effect is of a much darker, less buffy pelage. The flanks are a slightly clearer buff, deeper in tone than in the typical form, "warm buff" instead of "light ochraceous buff." The ventral surface is very different in the two. In typical *mandarinus* it is grayish or whitish throughout, with a light wash of "pale ochraceous buff" over the chest and belly. In *fæceus*, the whitish is lacking so that the slaty bases of the hairs are not concealed; the chin and throat are therefore dark slaty gray, and the chest and belly similar, strongly washed with "warm buff," which, being confined to

the extreme tips of the hairs, does not conceal their dark bases. Feet covered with short dusky and silvery hairs, the former more in evidence on the basal portion and metapodial area. Tail bicolor, its upper surface like the back, lower surface buffy. Ears small, concealed in the fur. Feet averaging slightly larger and longer than in the typical form, 19 to 21 mm., against 17 or 18 in the latter.

No field measurements or skulls accompany the Chili series.

This darker form of *mandarinus* is readily distinguishable on account of its lack of whitish-tipped hairs below, resulting in a contrasting dark slaty throat and a slaty belly washed heavily with buffy, whereas the typical form is gray-bellied, with or without a light buffy tint over the chest and abdomen, and is less dark above.

Microtus (Neodon) irene Thomas

Externally a rather grayish-brown vole, with white hind feet, a bicolor tail, and blue-gray belly. Some individuals have a slight tinge of buff below. The first lower molar has but four closed triangles. A small series was secured in northern Yunnan near Pei-tai, a locality some thirty miles south of Chung-tien. Here, at 13,000 feet, about the summit of Ho-shan, it was evidently common, and perhaps at its southern limit, for none was obtained in spite of careful trapping on the Li-chiang range to the southward. Its chief distribution, so far as known, is in Szechuan Province, whence came the original specimens (at Ta-tsien-lu). It now appears, also, that the series secured by Zappey at Ramala Pass (16,000 feet) and Shuowlow (13–15,000 feet) on the Tibetan border of Szechuan are this species and not *M. mandarinus* as I recorded in 1912.

Microtus (Stenocranius) angustus Thomas

A pale, almost buffy vole, with rather small ears and short tail; the skull is of the long, narrow type (*Stenocranius*). This is evidently an abundant species of the grass-lands over much of the Mongolian plateau. It was described from specimens obtained by Anderson at its extreme southeastern border, about one hundred miles northwest of Kalgan, Chili Province, after his expedition had topped the southern escarpment and descended slightly to the tableland. The Asiatic Expeditions under Mr. Roy C. Andrews, continuing on the same caravan route, secured a large series on the way to Urga. The localities are: 140 miles southeast of Urga; 120 miles, 60 miles, and 40 miles southeast of the same place in successive stages of the journey, and again some 45 miles northeast of that center. To the westward, it was found in numbers at Sain Noin Khan and a single one was secured at the Ongin River. Partly grown young were caught during July.

Microtus poljakowi Kastchenko

A very small dark vole, with small hind foot (16 mm.), short bicolor tail, and whitish belly. The even admixture of black and buffy-tipped hairs above gives a uniform "pepper-and-salt" effect. The skull is barely 23 mm. in greatest length. This species is based on the *Arvicola gregalis* of Radde who found it in the Apple Mountains, Dauria, Baikal region. The Asiatic Expeditions obtained it near Urga, at stations 15 and 45 miles northeast and 40 miles south of that center. Elsewhere on the Mongolian plateau it was not met with.

Microtus mongolicus (Radde)

A medium-sized species with coarse dark brownish fur, and a general ochraceous or buffy tint that appears especially on the lower edge of the cheeks, the end of the muzzle and faintly over the belly. This was described by Radde "aus den daurischen Hochsteppen, von dem Umgegenden des Tarei-nor," and is evidently a common and characteristic vole of the northern part of Mongolia. A large series was secured at localities 35 and 45 miles northeast, and 15 miles north of Urga, but it was not found to the westward.

Microtus obscurus (Eversmann)

A species closely resembling *M. mongolicus* but distinguished by the blue-gray belly, pale instead of dark-brown feet, and by the absence of the buffy tint of the under surface and the patch about the vibrissæ and cheeks, which are blue-gray instead. It apparently occurs with *mongolicus* in certain localities, possibly, however, with some difference in habits or choice of situation. A large series was secured at points 15 miles north and 45 miles northeast of Urga as well as at Sain Noin Khan, to the westward. These have been compared with a series from the Altai Mountains, the type locality, but no tangible differences were made out, though the skulls seem a little larger in the Mongolian specimens. It is apparently another of the Altai species that has extended eastward into northern Mongolia.

Microtus calamorum superus Thomas

A large, long-tailed species with the dark coloring of the common field-vole. Four specimens from 45 miles south of Fengsiangfu are practically topotypes of this slightly smaller race of the Yangtze Valley meadow-mouse. As suggested by Thomas, it resembles *Arvicola* in having but five instead of six plantar tubercles, and in the long tail

(slightly more than half the length of head and body). It lacks the quality of fur found in the water-voles of Europe, however, and so more nearly resembles the American species of this subgenus.

Lagurus przewalskii (Büchner)

A pale yellowish mouse with very small ears, minute tail, and well-clawed feet with hairy soles. This microtine has become so modified both exteriorly and in the shape of the skull with its enlarged auditory region, that it seems deserving of full generic standing as Thomas has advocated. Its adaptations seem to fit it for a life in sandy deserts. The Third Asiatic Expedition secured specimens at Tsagan Nor, Loh, Ussuk, and Artsa Bogdo, on the Mongolian Plateau. These, although from stations nearly 800 miles from the type locality (Gass, Zaidam, Tibet), seem to agree closely with Büchner's description and plate, thereby serving to extend considerably the known range of the species.

Ellobius larvatus, new species

Type.—Adult male, skin and skull, No. 57886, American Museum of Natural History, from Artsa Bogdo, Sain Noin, Mongolia, altitude 6500 feet. August 21, 1922. Third Asiatic Expedition.

Description.—Face from the upper lips to a line half-way between the eye and the ear, and on the forehead to a transverse line at the same level, contrastingly dark, "clove brown," passing rather abruptly into the color of the back, which from the lower half of the cheeks and the occiput to the root of the tail is clear "cinnamon buff," through which the slaty bases of the hairs appear faintly. Feet thinly covered with short white hairs which form a stiff fringe at the sides. The entire under surface, the limbs and flanks are dull gray, the individual hairs with short white tips and conspicuous slaty bases (near "blackish mouse gray"). The very short tail is clothed with cinnamon-buff and clove-brown hairs, with a very small terminal tuft of white. A few whitish hairs are also present about the ears.

The skull is smaller than in *E. tancrei* and *E. albicatus* of the Altai and Hami Mountains respectively, which it resembles in its narrow strap-shaped interparietal; but it differs in having the supraoccipital ridge bowed forward instead of directly transverse along the posterior border of the interparietal. The upper incisors are strongly inclined forward. The crown outline of the posteriormost upper molar is like that of a figure 8 with the anterior and posterior edges flattened so as to be nearly transverse, while each side is strongly concave.

Measurements.—The collector's measurements of the type and three other specimens from the same locality are:

No.	Head and Body	Tail	Hind Foot	Sex
57881	110 mm.	13	23	♀
57883	110	10	24	♀
57885	108	12	24	♀
57886 (type)	105	11	23	♂

The skull of the type measures: greatest length, 32 mm.; condylobasal length, 29.8; palatal length, 8.0; diastema, 11.8; zygomatic breadth, 21; mastoid breadth, 14; interorbital breadth, 5.6; upper tooth row (alveoli), 8.0; tip of mandible to condyle, 22; lower tooth row (alveoli), 7.5; interparietal, 6.6×2.5.

A series of seven adults from the type locality is fairly uniform in its pale cinnamon-buff color above with dark facial mask and white-tipped belly-hairs. A young one taken August 22 is a uniform gray all over with darker muzzle.

This is a smaller, paler species than *E. tancrei* of the Altai, or *E. albicatus* of Chinese Turkestan, some 600 miles to the westward. From the latter it differs further in its shorter tail and in having the supra-occipital ridge bowed forward at the center. *E. cœnosus* of the Tian-shan is a larger, darker species with squared, instead of strap-shaped, interparietal, and with a buffy belly. The relationships of this new species may prove to be with *E. fusciceps* and its dark subspecies *ursulus* of northwestern Dzungaria, which it resembles in size. The discovery of this species considerably extends the known range of the group into the Mongolian region.

Ellobius orientalis, new species

Type.—Adult male, skin and skull, No. 57893, American Museum of Natural History, from Iren Dabasu, eastern Mongolia. April 25, 1922. Third Asiatic Expedition.

Description.—Smallest of the known species of the genus, with bright cinnamon back, white belly, and reduced dark facial area.

The dark face-patch is much less extensive than in the previous species, and covers the forehead from the muzzle to or including the eye, at the level of which it merges with the general dorsal coloration. The face-patch itself is nearly "fuscous" (Ridgway, 1912). The rest of the upper surface, from the eyes to and including the tail, as well as the sides of the face from the muzzle backward as high as the level of the eye, is uniform clear "pinkish cinnamon"; this color, however, hardly reaches the flanks, which with the entire lower surfaces are dull white, with the dark slaty bases of the hairs showing through everywhere. The feet are sparsely clothed with short whitish or silvery hair. The character of the pelage is quite different from that of *E. larvatus*, not loose and fluffy showing the dark bases above, but shorter and closer, helping to produce a more uniform clear coloration. There is a minute tuft of whitish hair springing from the front of each ear and one at the extreme tip of the tail. The latter has a few coarse dark hairs interspersed with the cinnamon.

The skull compared with that of *larvatus* is much smaller but of the same general shape, with the white upper incisors strongly thrown forward. The interparietal, however, is less narrow though not square, the audital bullæ are obviously more flattened, and the mesopterygoid fossa is relatively much shorter. The squamosal and the zygomatic process of the maxillary in *E. larvatus* do not quite meet, but a small portion of the jugal intervenes, whereas in *E. orientalis* the jugal lies wholly dorsal to these two bones which meet below its posterior end.

The last upper molar instead of being shaped like a flattened figure 8 is nearly a triangle with concave sides and blunted angles, the inner anterior of which is produced conspicuously inward, obviously exceeding the outer anterior angle in length.

Measurements.—The collector's measurements of the type and three other specimens are respectively: head and body, 108, 100, 95, 95 mm.; tail, 10, 9, 9, 8; foot, 21, 20, 19, 19.

The skull of the type measures: greatest length, 28.5 mm.; condylobasal length, 26.5; palatal length, 16; diastema, 10; zygomatic breadth, 19; mastoid breadth, 13; interorbital breadth, 5.2; upper tooth row (alveoli), 6.4; tip of mandible to condyle, 20; lower tooth row (alveoli), 6.8; interparietal, 6.5×4.

This appears to be a perfectly distinct species from *E. larvatus*, and, occurring at a locality some 500 miles farther to the eastward, not only extends the known range of the genus to the eastern part of the Mongolian plateau but constitutes its easternmost record. Compared with the latter species it is not only much smaller and brighter-colored, with noticeably shorter and weaker feet, but the last upper molar is much reduced and the jugal is excluded from the lower margin of the zygoma by the meeting of the maxillary process with the squamosal.

Basin Structures in Mongolia

By Charles P. Berkey and Frederick K. Morris

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OF

The American Museum of Natural History

FRANK E. LUTZ, Editor

The following are the more recent papers on VERTEBRATE PALÆONTOLOGY. Orders should be addressed, Library, The American Museum of Natural History, 77th St. and Central Park West, New York City.

VERTEBRATE PALÆONTOLOGY

Reptilian and Stegocephalian Remains from the Triassic of Pennsylvania in the Cope Collection. By F. von Huene, 1921, Bulletin, XLIV, Art. 19, pp. 561–574, 20 text figures. 20c.

New Fossil Rodent from Ecuador. By H. E. Anthony, 1922, Novitates, No. 35, pp. 1–4. 10c.

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Some Skulls of *Perchœrus* [*Thinohyus*] from the White River and John Day Formations. By Helga S. Pearson, 1923, Bulletin, XLVII, Art. 3, pp. 61–96, 17 text figures. 40c.

A Contribution to the Knowledge of *Mœritherium*. By H. Matsumoto, 1923, Bulletin, XLVIII, Art. 4, pp. 97–139, 11 text figures. 40c.

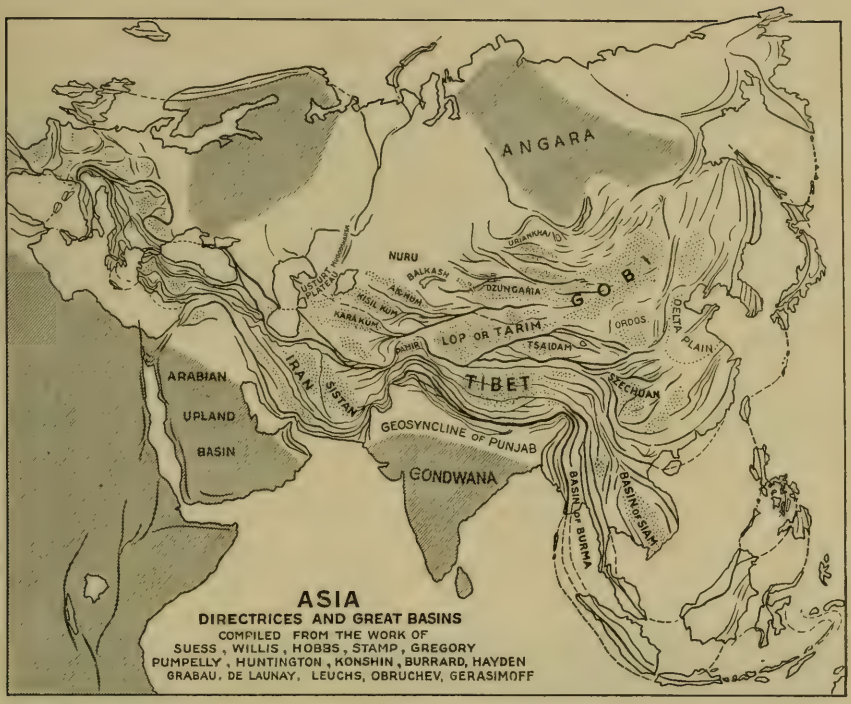

Fig. 1. Map of Asia, showing the trend of mountain ranges, and the position of the great basins.

Large positive elements are shaded in slanting lines. The great structural basins are stippled.

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Article V.—BASIN STRUCTURES IN MONGOLIA[1]

By Charles P. Berkey and Frederick K. Morris

CONTENTS

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 29.

INTRODUCTION

Between the vast areas of Asia enjoying ocean drainage lies a series of great interior basins of diverse type, extending from the Amur headwaters in the northeast to the Caspian in the southwest; and from the Arctic divide to the Himalayas. These basins, as indicated on the accompanying map (Fig. 1), are the Gobi, the Dzungaria (or Sinkiang), the Lop (Tarim or Taklamakan), the Balkash and Aral-Caspian, besides high intermontane basins like Tibet and Iran. All these are semiarid steppe-countries, including desert ranges, broad, open minor basins, and occasional depressions with lakes and salt pans.

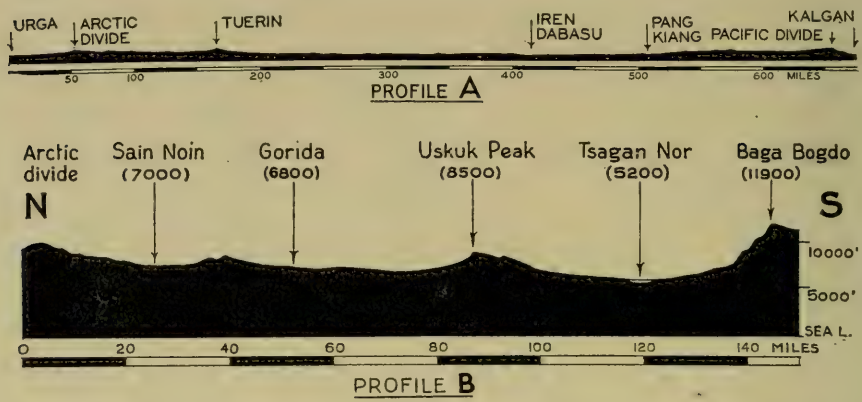

Fig. 2A. Profile across the Gobi region between Kalgan and Urga, showing a broad, very shallow downwarp between the Arctic and Pacific divides. Vertical scale × 10.

B. Profile across the northern part of the Gobi region, between the Khangai and Altai mountain ranges, showing stronger warping and block-faulting in this part of the great basin than in the eastern section. Vertical scale × 10.

The Gobi, easternmost of the great basins, has a width of, roughly, 500 miles north and south, and a length of 1,000 miles east and west. The entire country from the southerly margin to the Arctic divide is warped into a gently sloping concavity, or broad open syncline, whose central portion is 3,000 feet lower than the outer margins. Thus the rims of the basin stand from 5,000 to 7,000 feet above the sea, and the broad downwarped expanse between forms a basin-shaped plateau, parts of which are real desert. Generalized profiles are plotted in figure 2. We judge that the eastern profile represents almost pure warping, while the western profile is the result of warping plus extensive faulting in the midst of the original basin.

Fig. 3. Map of the Gobi region.

The mountainous areas are shaded with slanting lines. The lowlands are white, while the deeper depressions are stippled. This map serves as a location map for the talas named in the text, and also shows the routes of the Expedition. The index-letters have the following meanings: AO, Ardyn Obo; D, Djadochta; G, Golobai; GS, Gurbun Saikhan; ID, Iren Dabasu; IM, Irdin Manha; K (northwest of Peking), Kalgan; K (in the west, just north of the initial A of ALTAI), Kobdo; MT, Murukh Tchu; O, Oshih (Ashile); OS, Ondai Sair; PK, Pang Kiang; SM, Shara Murun; U (south of the K of KHANGAI), Uliassutai.

The great basin of the Gobi contains many minor basins, which we are calling "talas," from a Mongol word for an open steppe-country (Fig. 3). The following talas may be demonstrated: the Dalai Nor tala, now draining through the Argun river to the Amur; the Iren tala; the Gashuin Nor, or Edsin Gol tala; the Kisin or Shargin tala; the Khara and Dzapkhin, or Kirghiz Nor tala, in which are the cities of Kobdo and Uliassutai; the Tez, or Ubsa Nor tala. Each tala has its own local interior drainage and is bounded by inconspicuous warp divides or by mountain ranges, or both, separating it from neighboring areas of similar habit.

Again, within each tala there are still smaller basins, which contain sediments of late Mesozoic or Tertiary age, or both. These smaller units appear as broad level spaces whose surface is beveled by the Gobi peneplane, the remarkably smooth flat surface of which is one of the most striking features of Mongolia. These basins of the third order of magnitude are the units of special interest to this investigation. Inquiring of the Mongols as to the derivation of the word "gobi," it was found that such open level-surfaced basins are called "gobis," and we can think of no better term by which to call them in science. A cross section taken from one of the field books will serve to show the typical structure of such a minor basin, or gobi, in a restricted sense (Fig. 4).

NATURE OF THE ROCK FLOOR

The oldrock floor is a complex of ancient sedimentary strata, metamorphic rocks and intrusive igneous masses, both large and small. The oldest rocks recognized by us are complex injection-gneisses, crystalline limestones and related rock types exhibiting the most complex structural conditions and mixtures of composition found in the whole region. They appear to be more deformed, more modified, and richer in injected igneous material than any of the other series, and they are the most confusing to interpret. They should be the oldest of all and may indeed correspond to the Archæan of other lands. On these grounds they are judged to be Archæan, and to represent the T'ai Shan complex described by Willis and Blackwelder as occurring in China proper.[1]

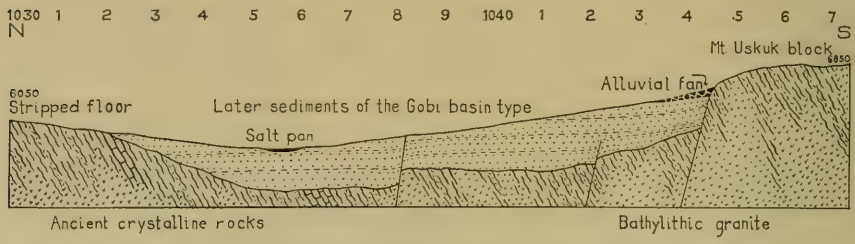

Fig. 4. Cross section from the geologist's field notebook, showing the basin north of Uskuk Mountain.

Ancient crystalline rocks—gneisses, schists and interbedded limestones, invaded by granites representing the Great Mongolian Bathylith, form the warped floor on which later sediments have been accumulated. Further deformation with faulting has affected the basin, pushing up the Mt. Uskuk block and making possible development of alluvial fans. Erosion has stripped some of the floor and has carved a broad shallow valley in the sediment, in the almost abandoned depressions of which a salt pan is located. This section is almost continuous with Fig. 10, which lies south of the Uskuk block.

The next younger series includes schists and crystalline limestones which are found in the Tsetsenwan hills. Between Shara Murun and Ardyn Obo, there is a great series of greenstones and phyllites which we consider to be older than the Khangai graywackes next to be described. The fact that these series have not been observed in close contact with one another makes it difficult to determine their exact relations. They are very clearly more intensely modified by metamorphic processes and constitute a more varied series than does the graywacke series referred to as the Khangai, and they evidently belong to a more ancient geologic time. Perhaps the early Proterozoic system, the Wu T'ai Shan, as used in China, is large enough to hold them.

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[1]Willis, Bailey, Blackwelder, Eliot, and Sargent, R. H. 1907. "Research in China," I, pp. 19, 59, 99, 157; II, p. 1; Carnegie Institution of Washington, Pub. 54.

The most widespread sedimentary unit was given the field name "Khangai series," from a range of mountains of that name on the Arctic divide. The total thickness of the series is not less than 20,000 feet. It consists almost wholly of graywackes, siliceous argillites and slates. Locally, red jasper or blue siliceous limestone is found with these strata, but these types do not figure heavily in the series as a whole. The rocks are not very highly metamorphosed, and yet they are surprisingly unfossiliferous. The immense extent, great thickness and uniform character of this formation are most impressive. The strata are everywhere strongly folded, and because of the lack of fossils, together with the general structural relations, are judged to be late pre-Cambrian—possibly to be correlated with the Nan K'ou of Richthofen and Bailey Willis,[1] or the Sinian of Grabau,[2] as described for China.

Besides many minor intrusive bodies, all these series of rocks are cut by an immense bathylith, dominantly granite, the great stocks of which are exposed over broad areas. Apophyses from it were found as far north as the Khangai range and the Gangin Daba and Olon Obo mountains, and it is our belief that the granite of Nan K'ou Pass above Peking belongs to the same unit. Possibly this bathylith is genetically responsible for the mineralization of the gold veins north of Urga and in the Uliassutai country.

Overlying these formations unconformably are marine limestones, limy shales and sandstones with fossils of Mississippian, possibly of Pennsylvanian, and certainly of Permian age. All are very complexly folded and faulted and have been almost completely swept away in the course of later erosions. Only two comparatively small infolded synclinal and graben-fault remnants of the sedimentary formations of this short-lived, but significant, Paleozoic geosyncline were found in Mongolia. A few dikes cut these beds, but no large intrusives seem to have reached them.

Unconformable, also, upon the pre-Paleozoic rocks, is an extensive and persistent series of continental conglomerates, sandstones and minor shales, with interbedded tuffs and surface flows, the aggregate thickness of which is in places more than 10,000 feet. Obscure woody plant-remains are found in these coarse clastics, and at one locality several thin seams of coal were seen. All are strongly folded and the question may be raised whether the same disturbance folded these that plicated the marine

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[1]von Richthofen, Ferdinand Freiherr. 1882. "China," II, pp. 316–317, Berlin. Willis, Bailey, Blackwelder, Eliot, and Sargent, R. H. 1907. "Research in China," I, p. 123, Carnegie Institution of Washington, Pub. 54.

[2]Grabau, A. W. 1922. "The Sinian System," Bull. Geol. Soc. China, I, p. 44.

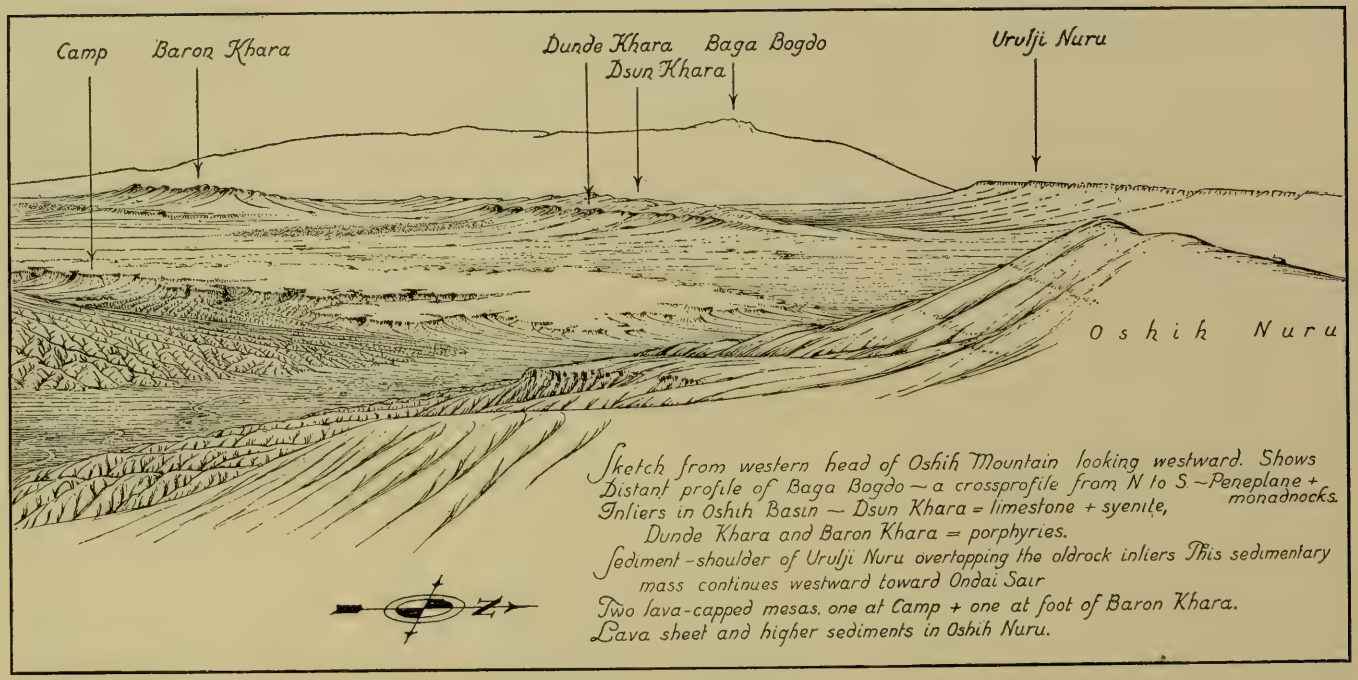

Fig. 5. Sketch in the Oshih basin, looking westward.

Baga Bogdo, seen in profile from north to south, shows the narrowness of the Altai range in this dimension. Two low ranges of hills in the middle distance consist, the one of folded trachyte porphyry, and the other of crystalline limestone, cut by syenite. The high shoulder at the right, called Urulji Nuru, represents sediments that once extended over the hard-rock ridges. At the foot of these ridges are two areas of badlands, the southern one capped by a lava sheet. The lava reappears in the broad mesa in the center of the sketch. A fault runs along the nearer front of this mesa, and the edge of the lava bends notably downward toward the spectator. The edge of the faulted lava sheet reappears in Oshih Mountain in the extreme foreground. The sketch emphasizes the unevenness of the old floor and the enormous amount of sediment that has been stripped from it.

Paleozoic beds. At another time, we may submit evidence for the view that the two series were folded at different times and that the conglomerate series is approximately of the same age as the folded coal-bearing conglomerates and shales of northern China, which are conceded to be of Lower Jurassic age. The latest mountain-folding, then, follows the development of these Jurassic strata and, if this correlation proves admissible, must be of Middle or late Jurassic date.

At this point in the geologic column, a complete change of structural behavior takes place. All earlier rocks are mountain-folded and extensively deformed, whereas those strata that lie above them are not folded at all, and, although they are tilted and warped, or broken, they are only locally much deformed even in this way. The Jurassic unconformity marks, therefore, the most significant break in the whole geologic column for central Mongolia. It marks the change from repeated deformative revolutions to a state of much greater stability and the establishment of a continental history that has persisted unbroken to the present day.

BASIN SEDIMENTS

All these older disturbed rocks were worn down to a mature, rolling, locally baseleveled surface before the first of the nearly horizontal sediments in which we find vertebrate fossils was laid down. A sketch (Fig. 5) made in the Oshih (Ashile) basin, oldest of the gobis, shows, besides sediments and an interbedded lava flow, two inliers, one of the pre-Cambrian limestone, the other of possible Jurassic porphyry flows; both have been brought into view by the stripping away of the sediments rather than by local uplift or by faulting. The later sediments, such as those of Urulji Nuru, doubtless once covered the tops of these inliers and probably even such mountain groups also as the more distant Baga Bogdo, Artsa Bogdo, and the Gurbun Saikhan,—the easterly representatives of the Altai mountain range.

The Oshih beds contain sauropods and primitive armored dinosaur bones and may prove to be Lower Cretaceous (Comanchean) in age.[1] The sediments are entirely of inland continental type—sands, gravels, clays, paper shales, gypsum-bearing clays—and of moist to semiarid climatic association. The entire fauna is non-marine and very difficult to correlate with the faunas of other regions. It clearly represents an inland, relatively isolated basin.[2] At this remote time, then, Mon-

[1]Osborn, Henry Fairfield. 1923. "Two Lower Cretaceous Dinosaurs of Mongolia." Amer. Mus. Novitates, No. 95, pp. 1–10.

[2]Reis, O. 1910. "Die Binnenfauna der Fischschiefer in Transbaikalien." Explor. Géolog. Chemin de Fer, Sibérie, Petrograd. Cockerell, T. D. A. 1924. "Fossils in the Ondai Sair Formation, Mongolia." Amer. Mus. Bull. (in press).

golia and Angara were dry land, warping into inland basins at first of swampy deposition, with lacustrine and flood-plain types predominating, but later and intermittently developing more pronounced aridity.

ORIGIN OF DEPRESSIONS

In a paper now in preparation, we discuss the origin of depressions in the Gobi desert of to-day, and attempt a review of the literature on this subject. A brief statement must suffice for the present.

The text of this paper will make it clear that the basins cannot all be of the same age; it is very improbable that just the same climates prevailed during all the periods recorded by basin sediments, although we shall offer evidence in another paper to support the thesis that the climate of Mongolia in the past has varied between relatively narrow limits,—between semiarid and desert conditions. It is improbable, furthermore, that the relief was similar in all the periods represented, but it must have ranged from a peneplane to a surface rugged enough to provide coarse rubble. The part played by warping has been touched upon. The basin or depression which now contains the sediments is not by any means coextensive with the original area over which those sediments were deposited, yet we must deal primarily with the basins that have retained sediments to the present day.

We believe that the basins of deposition were not of simple origin, but were the resultant of a number of interacting agencies. To choose a single general case as an illustration, let us suppose, in Tertiary time, a region of moderate relief, including areas of oldrock and of basin sediments, dissected in part by stream work and in part by deflation. The following variable quantities will enter into the problem:—

1. Greater and lesser depth of eroded hollows.
2. Greater and lesser areas of hollows.
3. Hollows or depressions in oldrock areas, where all the sediments deposited in the hollow must be derived from the slow decay of the hard rock. This introduces in turn a new variable, the amount and character of loose material available in the hard rock area. A long quiescent period, and especially a moist climatic rhythm, would have developed a good mantle of soil.
4. Hollows in or near sediment basins, where easily eroded material may be washed out or blown out, offering a great supply of sediment.
5. Disposition, no less than amount, of water supply.
6. Relation of prevailing winds to source of sediments.

Independently of all these variables, it seems necessary to introduce the hypothesis of periodic warping, as will be made clear in the pages that follow.

In figure 6 we show a region of low, mature relief, broad lowlands or hollows alternating with higher regions. In figure 7 these are warped into very gentle swells and depressions, which, save by chance, bear no relation to the topography. Where a downwarp coincides with a lowland, as in figure 7, A-B, the condition will be most favorable to the retention of sediment, and the basin will be filled. Where an upwarp coincides with high ground, as in figure 7, C-D, a broad divide will be formed, from which debris will be washed into surrounding regions. If an erosion-hollow is upwarped, its resultant behavior will depend roughly

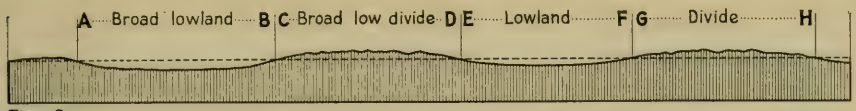

Fig. 6.

Fig. 7.

Fig. 6. Lay figure of a maturely dissected region of low relief, before warping.

Fig. 7. The same region, after warping,—showing how basins and uplands may be the result of original relief and deformation combined.

Let both higher relief and upward movement be denoted by the + sign, while lowland and downwarp are denoted by the — sign. Then in A-B, both relief and movement are negative, so that a basin is formed. In C-D, both influences are positive, while in E-F and G-H, positive and negative elements combine, making either basin or highland according as the relief factor is greater or less than the warping. Thus in the Oshih basin, Fig. 5, ridges of hard-rock have formed part of the lowland, and have been covered by sediments.

upon the algebraic sum of two opposite influences, the depth of the hollow and the amount of uplift. Thus, if the upwarp is less than the depth of the hollow, as in figure 7, E-F, the hollow still remains, though diminished as a possible repository of sediments. Where a divide is downwarped, it will be included in a basin and will be covered over with sediments, if the downwarping considerably exceeds the height of the divide; otherwise it may still remain a divide.

If we suppose that, in general, the basins formed where all the conditions were most favorable, the amount of warping that need be assumed would be reduced to a minimum. The relative part played by wind and water in the erosion of primary hollows or valleys forms an important subject in itself, and a report on the evidence is in preparation.

TYPES OF GOBI BASINS

Two types of gobi basin are distinguished: first, the faulted or piedmont gobi basin, found along the base of the fault-block mountains of the Altai; and second, the warped or plains type, in the less disturbed areas. The types are not sharply demarked from one another, but the distinctions are instructive.

1. The faulted, or piedmont, gobi basins are distinguished by: (a) greater thickness of sediment; (b) great range in texture of sediment,—including paper shale, fresh-and-brackish-water limestones, clay, sand, gravel and coarse rubble, even with great bowlders; (c) wide range of time-periods represented in the sediments,—which implies longer life of the basin as a locus of warping; (d) igneous flows, which are common

Fig. 8. Cross section of the Djadochta region.

This is a simple faulted type of gobi basin. The beds near the mountain front dip 56° north. Younger beds are encountered as one goes toward the mountain front. In this respect the basin is comparable to the Baga Bogdo piedmont basin, Fig. 10. It is not positively known that Oshih beds underlie the Djadochta; their presence is inferred. Compare with Fig. 11.

in these basins. Volcanism seems to have been associated with faulting, and all the more disturbed basins observed by us contain lava flows (Fig. 8).

2. The warped, or plains, gobi basins are shallower and contain thinner sediments, of but few periods, so that the gaps in the geologic record are even larger than in the sediments of the piedmont basins. The range in coarseness of sediment is less wide—sandy clay, sands and small-pebble gravels predominate. In addition, there are a few occurrences of fresh-water limestones, dense limy marl, marly sandstone, and thin beds of gypsum. None of the warped basins has been markedly disturbed by faulting or tilting.

None of the basins of either type contains a complete record of the sedimentation; none even contains all the horizons represented in Mongolia. In each basin, the sedimentary formations are separated by disconformities or by angular unconformities, representing long gaps or erosion-intervals in the geologic record.

These facts will be considered in some detail, and will be marshaled in support of three theses, as follows:

1. Warping took place in a series of successive increments of movement, separated by pauses or intervals of quiescence long enough in some instances to permit the peneplanation of faulted and warped sediments, and to allow for a complete change of fauna.

2. The locus of warping shifted from place to place; that is, after deposition of one formation in a given basin, warping did not as a rule continue in that basin, but rather in another place, which, in turn, having received a shallow filling of sediment, passed into a quiescent period, and

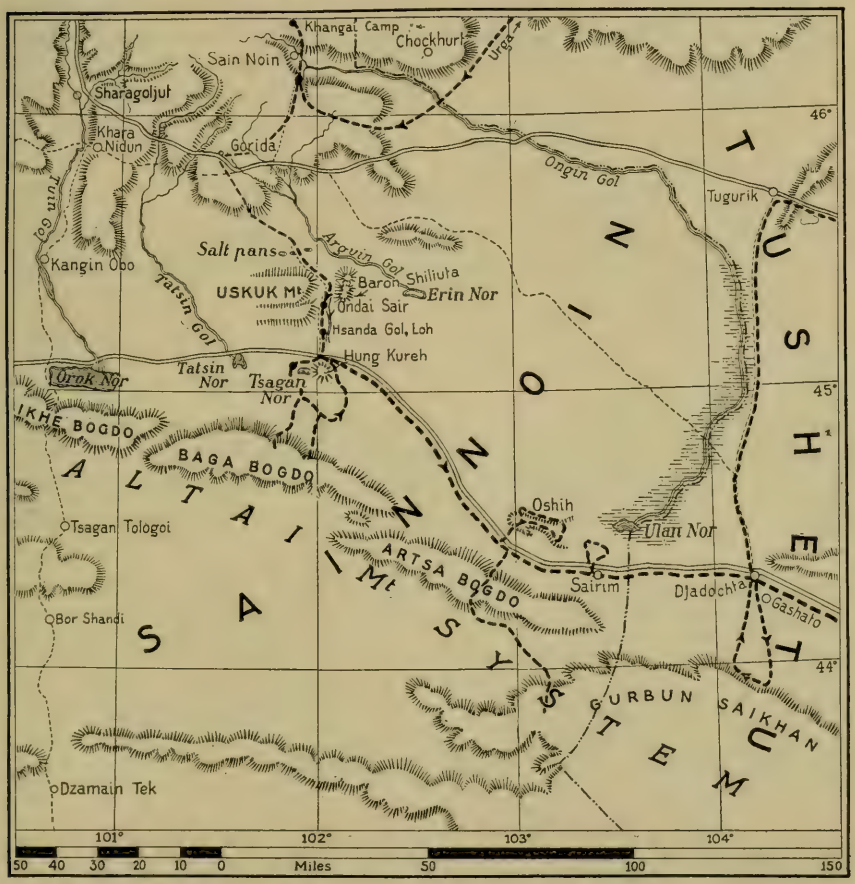

Fig. 9. Sketch map of the eastern Altai region, showing location of stations mentioned in the text.

The limits of the sediment basins are not sufficiently known to justify an attempt to draw them.

the next locus of deposition was in still another basin, or possibly back in the first. Each basin had its rhythm of alternating deposition and quiescence, which probably implied removal of part of the earlier deposit. Some basins, however, continued to warp intermittently during longer periods of time than others.

3. Small units, such as the Mongolian gobi basins, carrying shallow sedimentary fills, probably cannot of themselves set in motion the deep-seated shift of material required by the theory of isostasy. It is not improbable that we sometimes overestimate the effect of the positive weight of the sediments, as well as of the negative load due to stripping of up-arching areas, as the actuating causes of warping. This thesis does not imply that the authors do not accept the principle of isostasy as applying to earth movements of the first magnitude.

We will describe two basins briefly, a faulted or piedmont basin, and a warped or plains basin.

Faulted or Piedmont Type of Gobi Basin

Each of three ranges of the eastern Altai, the Baga Bogdo, Artsa Bogdo and Gurbun Saikhan, presents essentially a fault-front along its northern margin (Fig. 9).

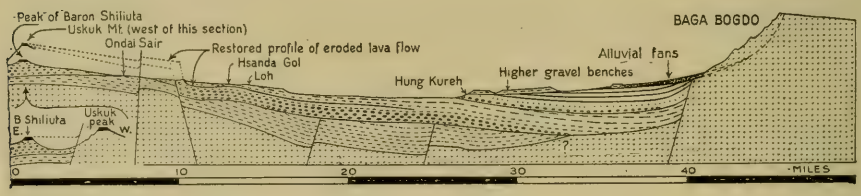

Fig. 10. Cross section of the Baga Bogdo faulted gobi basin.

Though on a much smaller scale, this section is almost continuous with Fig. 4, lying south of the latter. The Uskuk fault-mountain lies just west of the section and so is drawn in dotted lines. Part at least of the sediments once rested upon the Uskuk block, because remnants of sediments have been found upon it, and apparently the same lava flow that is seen in the sediments caps the granite of Uskuk peak. These relations are indicated in the dotted lines. The lava-capped butte, Baron Shiliuta, is seen projected against the higher peak of Uskuk. A short cross section, oriented east-west, is introduced to show the relation between these two peaks. The Cretaceous Ondai Sair beds are much more deformed than the Tertiary formations, which overlie them unconformably. Tertiary beds are also deformed by both faulting and warping. The southern part of the section, between Hung Kureh and Baga Bogdo, is much more disturbed than is represented in this drawing, and carries the latest sediments of the region. The Gobi peneplane is highly developed in this district, and is itself deformed. Since the peneplane bevels Pliocene beds, this section is one of our best means of determining the date of its formation.

In the Baga Bogdo piedmont basin (Fig. 10) the following section is recorded, from oldest to youngest:[1]

[1]Berkey, Charles P., and Granger, Walter. 1923. "Later Sediments of the Desert Basins of Central Mongolia." Amer. Mus. Novitates, No. 77.

1. The oldrock floor, consisting of schists, marbles, graywackes and slates, all of diverse pre-Cambrian age invaded by granite. Infolded in this complex are conglomerates and sandstones, locally containing seams of coal, which are judged to be Lower Jurassic in age. These form part of the rock floor, not part of the basin sediments.

2. The Ondai Sair sands and paper shales, of Lower Cretaceous (Comanchean) age, resting upon the old floor. They are at least 500 feet thick, and are faulted and tilted.

3. About 3,500 feet of early Tertiary gravels, sands and sandy clays resting unconformably upon the Ondai Sair. They include at least one lava flow, and are in places uptilted and faulted, but they do not share all the disturbances of the Ondai Sair. The higher beds carry the Lower Oligocene *Baluchitherium* fauna, and are called the Hsanda Gol formation, a name which is provisionally extended to the base of the conglomerates, though the lower beds may yet prove to be Eocene.

4. The Lower Miocene clays of Loh, less than 100 feet thick, resting upon the Hsanda Gol clays, without any obvious physical disconformity. Going southward along their dip (Fig. 10), we found that they were succeeded by an undetermined thickness, probably as much as 1,000 feet, of sandy clays and sands, in which as yet no fossils have been found.

5. The Hung Kureh sands and clays, about 2,000 feet thick, gravelly toward the base of the exposure. They carry a fauna of late Pliocene age, according to the opinion of Mr. Walter Granger, paleontologist of the Expedition. They have been disturbed by tilting and faulting, which may be of the same age as that which deformed the older Tertiary beds, but which are probably of later date.

6. A mantle of coarse rubble, clearly derived from Baga Bogdo. This coarse rubble is at least 2,000 feet thick, is partly consolidated, and is unfossiliferous, so far as we now know. Its age may be latest Pliocene or Pleistocene.

The thicknesses of all the formations exposed in the basin add up to 8,500 feet, but, since the whole thickness of some of the members is not known, it may be as much as 10,000 feet. Only a fraction of these strata was accumulated in any one period, yet this basin is the longest-lived and most active basin yet observed in Mongolia, containing the oldest and the youngest basin sediments of which we have record.

Among the features that bear upon the problem of basin-structure may be mentioned the following:

1. The sedimentary formations dip toward the Altai, and younger beds are encountered as we go southward toward the Altai front.

2. The conglomerate at the base of the Tertiary consists of well-rounded pebbles that were derived almost certainly from the Jurassic conglomerate of the general Uskuk region. It would seem that these beds were washed into the basin from the north, rather than from the south, implying that the present Altai was not a notable range in the early Tertiary.

3. The Hung Kureh formation consists of fine materials everywhere except toward the base, where it grades into gravel, and therefore indicates no very marked relief in the Altai region in Pliocene time. The first evidence of rugged relief is the deluge of coarse rubble overlying the Hung Kureh.

We infer from these facts that deformation has been secular and progressive, with long periods of quiescence alternating with periods of disturbance. Thus faulting and tilting took place after the Lower Cretaceous (Comanchean) and after the Pliocene, at least, and possibly after the Miocene as well.

An even more suggestive example is found in the Oshih and Djadochta divisions of the Altai piedmont basin. The Oshih is the piedmont basin of the Artsa Bogdo range. Here are about 2,000 feet of very considerably faulted and tilted sediments. The faults are of small throw, ranging from five feet to 200 feet, and in one instance possibly even more; the dips, apart from drag in the fault zones, do not exceed 24°, and are for the most part 10° or less. The Oshih contains fossils of about the same age as the Ondai Sair and is almost undoubtedly continuous with it.

South of the Artsa Bogdo range lies a basin whose sediments contain reptile bones, which Granger judges to be of Oshih age,—indicating either a former extension of the Oshih basin over the site of the present Altai, or an entirely different basin separated from the northern Oshih by a Lower Cretaceous divide.

North of the Gurbun Saikhan, about forty miles east of Oshih, lies a piedmont basin whose floor is not exposed, so far as observed. This basin contains the Djadochta sands, of Cretaceous age, with the *Protoceratops* fauna and the dinosaur eggs. The sand of the Djadochta is very fine, of uniform red color, and about 500 feet thick. The beds dip gently southward into the Gurbun Saikhan piedmont basin, and have been very faintly tilted and arched, but not faulted.

These sands cannot have been derived from the direct weathering of the Gurbun Saikhan, which is composed of such rocks as graywackes, argillites, phyllites, limestones, serpentines and diorites. They must have been derived instead from a preëxisting sand that had already undergone

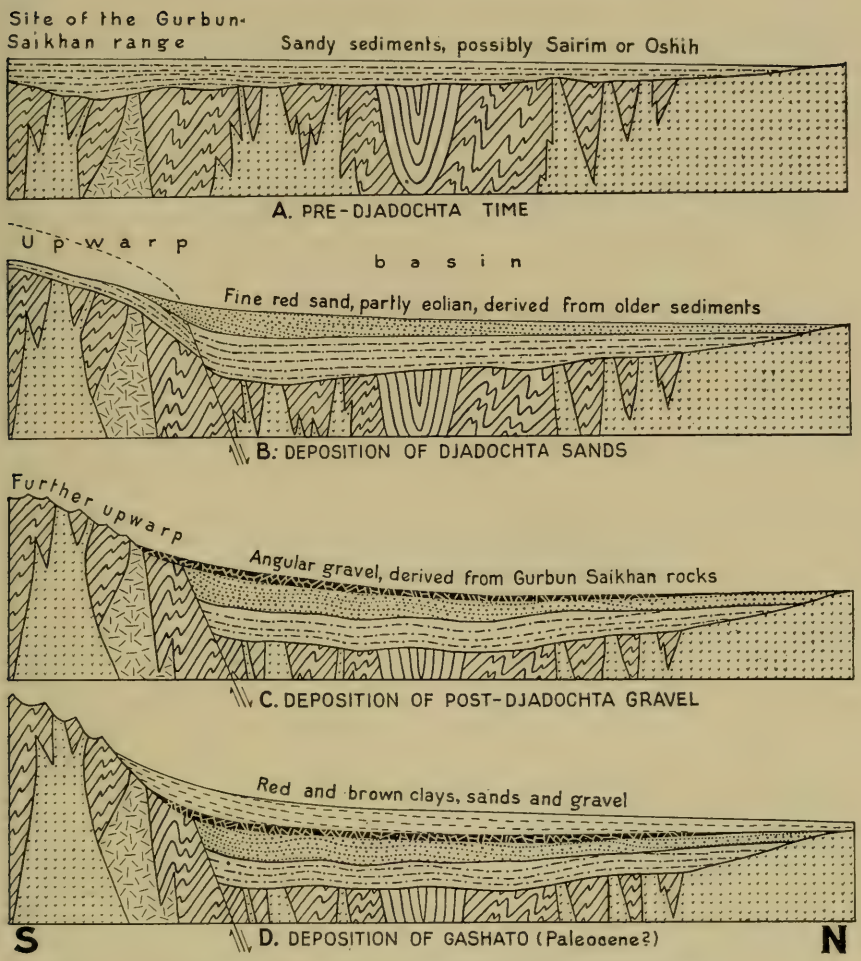

Fig. 11. Four stages of warping indicated in the Djadochta basin.

A shows an old basin of sandy sediments deposited upon a floor of complex old rocks. B shows initial upwarp that caused the Djadochta sands to be washed down into the newly formed basin, without, however, exposing crystalline rocks of the present Gurbun Saikhan range. C shows the deposition of a gravel of angular pebbles, derived from the Gurbun Saikhan rocks, and hence implies that those rocks have been laid bare. D shows the deposition of the Eocene Gashato beds, the peneplaned remnant of which is at least 300 feet thick, and may be much more. The structure of the rock floor of the basin is inferred from the granite exposed to the north of the basin, and the rocks observed in the Gurbun Saikhan range. The successive warpings of relatively small throw suggest the method by which this wing of the Altai was made.

considerable assorting. The only earlier sand of which we have knowledge in the region is the Oshih. Now the highest member of the Oshih that we have seen is a red-and-white sand, called the Sairim member, which is strikingly similar to the Djadochta sand in composition and texture.

Its present easternmost outcrops lie less than forty miles from the present westernmost outcrops of the Djadochta, and both formations must have been more extensive in the late Mesozoic. We suggest that the Oshih, at least in its upper members, may once have overlapped the present site of the Gurbun Saikhan (Fig. 11A). It is not improbable that when uplift began in early Djadochta time, the present Gurbun Saikhan rocks were not exposed, but that the overlying Oshih sands were eroded and washed into the newly formed basin, to become the Djadochta deposits (Fig. 11B). As evidence for this view, we cite the facts that a gravel of angular pebbles overlies the Djadochta, and that these pebbles are all of Gurbun Saikhan origin, which suggests that the next, post-Djadochta, increment of warping brought the Gurbun Saikhan rocks to light (Fig. 11C).

The age of these gravels is known approximately, since they lie underneath the Gashato clays and gravels which carry an early Eocene fauna, according to identifications by Granger (Fig. 11D).

Therefore, the chief dates of warping in this basin fall: (1) in Oshih (Lower Cretaceous) time, when the pre-Djadochta sand-terrane was being deposited over a large part of the eastern Altai region; (2) in Djadochta time (early Cretaceous ?); (3) in post-Djadochta time, when the Gurbun Saikhan rocks emerged; (4) in Gashato (early Eocene) time.

Warped Type of Gobi Basin

The Irdin Manha basin includes the Iren Dabasu, limited on the north by slate hills, and the Shara Murun, limited on the west by complex old crystalline rocks. The southern boundary consists of hills of granite, schist and graywacke. We have not seen its eastern boundary, but the basin covers an area of at least 10,000 square miles (Fig. 12).

Within the basin is a succession of sediments which do not extend throughout the basin, but which overlap in a complex manner, each occupying a special area (Fig. 13).

The oldest sediment is the Iren Dabasu, of late Cretaceous age, not more than 180 feet thick, resting directly upon the crystallines. It is succeeded by lake beds which, though nearly barren of fossils, yielded a tooth of a small lophiodont, which should prove them Eocene. Upon these barren rocks rest the Lower Oligocene Houldjin gravel, here fifteen feet thick, but apparently thickening northwestward to fifty feet or more.[1]

[1]Matthew, W. D., and Granger, Walter. 1923. "The Fauna of the Houldjin Gravels." Amer. Mus. Novitates, No. 97.

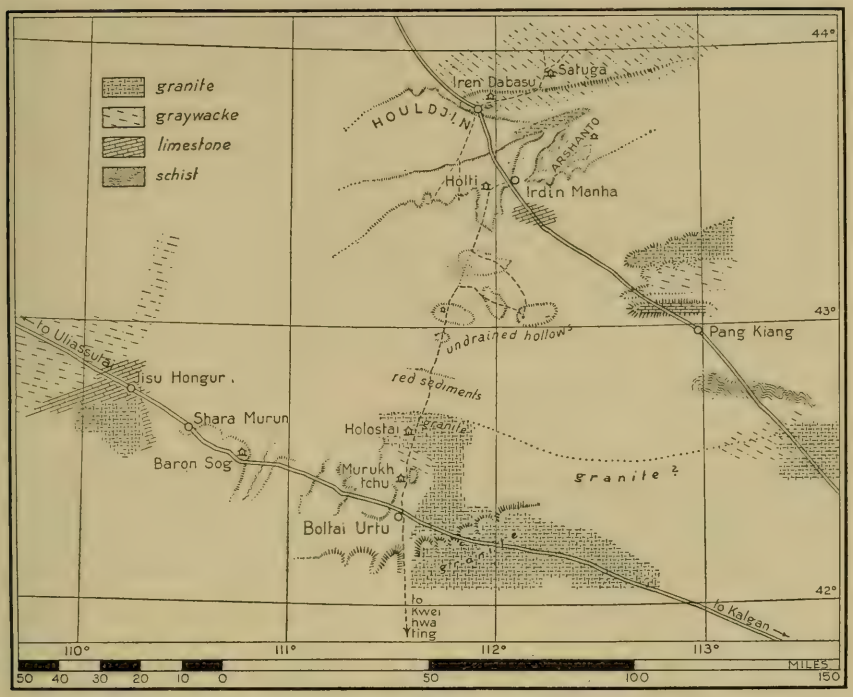

Fig. 12. Sketch map of the Irdin Manha region.
This map serves to locate the stations mentioned in the text, but not to delimit the basin.

At Irdin Manha, twenty miles southeast of Iren Dabasu, the Houldjin is not found, and the section exposed consists of 40 to 100 feet of gray sands, with a rich titanothere fauna, which may be late Middle or even Upper Eocene.[1] Beneath the titanothere beds there are red clays, provisionally called Arshanto, and probably to be correlated with the barren beds above the Iren Dabasu. The Arshanto may prove to be only the lower Irdin Manha, or it may be separated from the Irdin Manha by a disconformity. The base of these beds has not been seen.

The Pang Kiang beds, 60 miles farther south, are about 500 feet thick. In some places at least they rest directly upon the old crystalline rocks. Only one fossil has been found in the Pang Kiang, a fragment of a rodent jaw. Dr. Matthew identifies this as an ochotonid, which is in-

[1]Granger, W., and Berkey, C. P. 1922. "Discovery of Cretaceous and older Tertiary strata in Mongolia." Amer. Mus. Novitates, No. 42.
Berkey, C. P., and Granger, W. 1923. "Later Sediments of the Desert Basins of Central Mongolia." Amer. Mus. Novitates, No. 77.
Osborn, H. F. 1923. "Titanotheres and Lophiodonts in Mongolia." Amer. Mus. Novitates, No. 91.
Matthew, W. D., and Granger, W. 1924. "New Carnivora from the Tertiary of Mongolia." Amer. Mus. Novitates, No. 104.

sufficiently diagnostic to serve as an index of the exact age of the formation. He says, however, that this jaw could hardly be older than Miocene.[1] The exact relations of the Pang Kiang to the Irdin Manha must await further field study.

About 75 miles south of Irdin Manha, and 50 miles southwest of Pang Kiang, at the temple Murukh Tchu, a group of clays and sands lies directly upon the crystallines. About 150 feet are exposed, but the thickness may be 200 feet. No fossils were found in these beds.

Twenty-five miles south of Murukh Tchu, at Boltai Urtu, a great mass of conglomerates, about 1,000 feet thick, rests upon the oldrock floor and dips westward and northward away from the oldrock rim of the

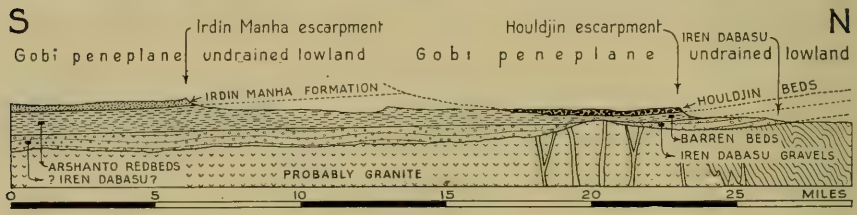

Fig. 13. Cross section of a repeatedly warped basin, from Iren Dabasu to Irdin Manha.

The section shows at least three periods of basin-making, and three unconformities. The unconformities lie (1) at the base of the Cretaceous Iren Dabasu beds, upon the uneven floor of crystalline rocks; (2) at the base of the Middle or Upper Eocene Arshanto (lower Irdin Manha) formation, upon the slightly disturbed Cretaceous beds, and even upon knobs of the old crystallines; (3) at the base of the Lower Oligocene Houldjin gravels, upon the eroded Eocene. Each unconformity implies a long period of quiescence before the deposition of the next succeeding sedimentary formation. The fact that the area became alternately a locus of deposition and of erosion seems to imply a periodic warping of the region. All thicknesses are twice exaggerated.

basin. These conglomerates pass northwestward under and interdigitate with sand and clay sediments which at Shara Murun bear a rich fauna of titanotheres and lophiodonts (Fig. 14). Professor Osborn regards this fauna provisionally as being somewhat younger than the Irdin Manha.[2]

These complex relations are represented diagrammatically in figure 15. No one place in this broad basin shows a complete section, even of the formations represented in the basin as a whole. All the formations are thin, their combined thickness probably nowhere exceeding 1,000 feet. In most parts of the basin it must fall short of this amount.

There are at least three gaps or breaks in the record, representing non-deposition or even removal of sediment: (1) pre-Cretaceous, a great unconformity, between the Iren Dabasu and the pre-Cambrian slates; (2) Cretaceous-Eocene, between the Iren Dabasu and the "barren

[1]Personal communication.
[2]Personal communication.

beds" (Arshanto?); (3) Eocene-Oligocene, between the barren beds at Iren Dabasu and the Houldjin. Two other disconformities, of very minor value, may possibly be present,—one between the Arshanto and the Irdin Manha, and the other between the Irdin Manha and the Shara Murun.

The basin is not walled in by definite mountain uplifts, nor have we seen evidence to indicate that the hard-rock boundaries are faulted against the basin, except for very minor faulting at the southern boundary, 55 miles south of Iren Dabasu (Fig. 15). It represents, on the contrary, a broad, very gentle warping. The sediments now found in it have less than their former thickness, for the region has been peneplaned.

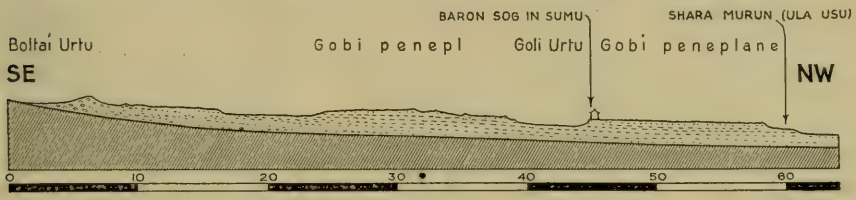

Fig. 14. Cross section of a warped gobi basin, from Boltai Urtu to Shara Murun (see map, Fig. 12).

The section shows conglomerates at Boltai Urtu resting directly upon the complex rock floor. These conglomerates die out westward, passing underneath, and grading into the sands and clays which at Shara Murun carry a rich fauna of Middle or Upper Eocene age.

The relation, too, of the sediments themselves suggests the former greater extent and thickness of the Houldjin at least, if not of the Irdin Manha also (Fig. 13).

The physical history of this great basin must consist of a series of gentle warpings followed by sedimentation, and the epochs of sedimentation were separated by longer periods in which sediments either were not laid down or have since been removed. In the epochs of filling, the deposition exceeded the removal of material from the basin, and this excess of deposition over removal is essentially the measure of warping. In the far longer quiescent periods, removal of material either balanced or exceeded the amount of sediment made available for the streams of that day, so that either no sediments were permanently retained in the region, or, more probably, part of what had been laid down in the preceding epochs of deposition was carried away. The absence of deep channels in the underlying sediments implies that the older beds were reduced to a smooth surface—a local peneplane—before the newer beds were laid down.

The vast lengths of time represented by the periods of quiescence or stability, the thinness of the sediments, the wide area covered and the absence of large faulting or great mountain uplift bordering these basins are all cited to support the thesis that the weight of sediments alone could not have caused the warping; first, because the thickness is too slight to have disturbed the isostatic equilibrium of the earth's crust, second, because the long periods of quiescence indicate that the crust sustained not only the positive weight of the sedimentary load without

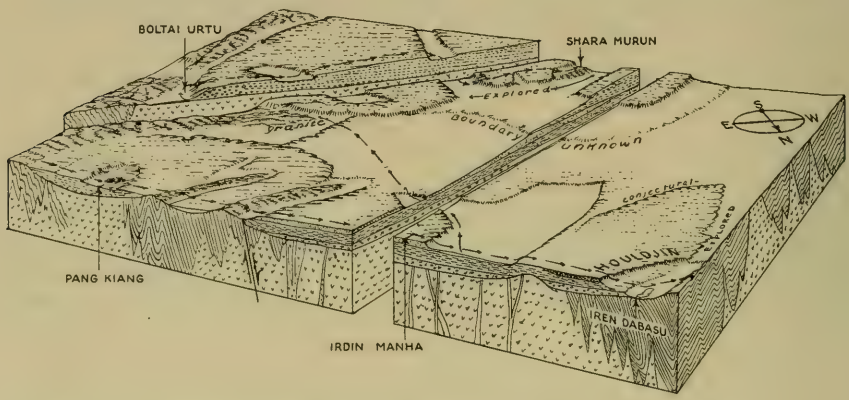

Fig. 15. Block diagram to show the general relations of the formations.

The left-hand or front edge runs northwestward and shows the basins between Pang Kiang and Iren Dabasu (compare with Fig. 13). The rear diagonal cut shows the section between Boltai Urtu and Shara Murun (compare with Fig. 14). The cut from front to rear shows one interpretation of the relations between the Irdin Manha and Shara Murun formations. It is possible that further studies by Osborn, Matthew and Granger may result in correlating these two formations.

being depressed by it, but also the negative load due to peneplanation without being uplifted. Instead, the next deposit of sediment, resting disconformably upon the older deposit, marks a new increment of downwarp following the peneplanation.

GENERAL RELATIONS AND INFERENCES

Many other examples could be offered from every gobi basin we have studied, and all will be described in the larger report now in preparation. But we believe that the examples we have given are typical, and are enough to support the thesis that warping was a slow and discontinuous process, taking place by a series of small increments of movement; and that the sediments are to be correlated with the warping, recording, if the records could be read, both the upwarp that determined the removal of sediment from the upland, and the downwarp of the basin receiving it.

In figure 16 are plotted the thickness of sediments actually observed in the most important basins. Distances and directions between stations are plotted from the westernmost basin at the left to those along the Kalgan-Urga trail at the right. The column for China is generalized from J. G. Andersson's "Essays on the Cenozoic of Northern China."[1]

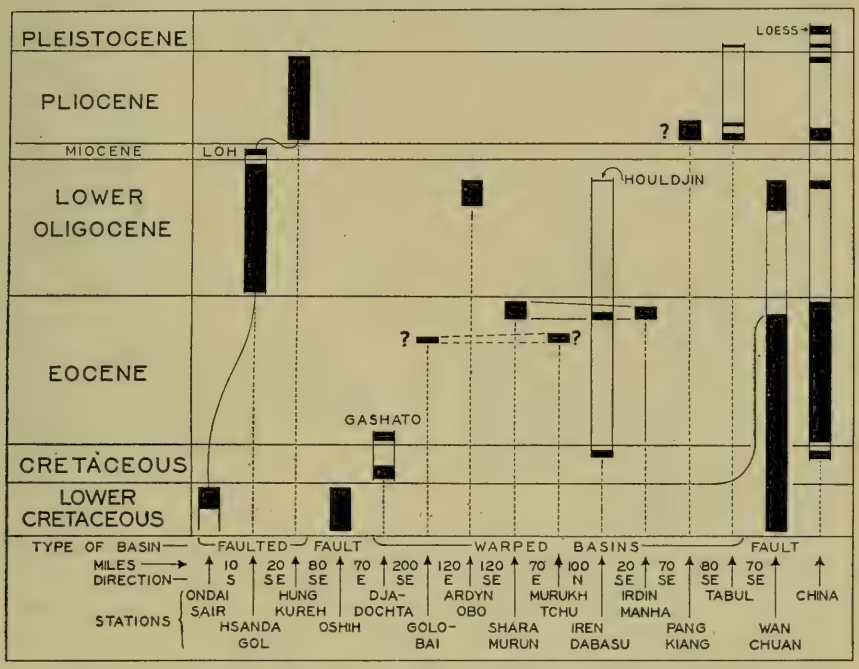

Fig. 16. Columnar diagram of the formations thus far observed in Mongolia.

Thicknesses are plotted to scale. It will be seen that the faulted basins contain far thicker deposits than do the warped basins. The diagram brings out clearly the shifting of the locus of deposition from place to place. The distances indicated at the bottom of the diagram are measured between stations or camps, not between the limits of the basins. The section for northern China is compiled from J. G. Andersson's "Essays on the Cenozoic of Northern China."

The diagram shows clearly the thinness of the sediments actually observed in contrast with the vast lapses of time involved. In figure 17 the columns for Mongolia are condensed into one for comparison as to thickness with those of the Rocky Mountain region, and with the American marine column, emphasizing the relative thinness of the deposits thus far observed in Mongolia.

Among the most interesting inferences which the facts support is the shifting of the locus of deposition from place to place. The Lower

[1]1923. Mem. Geol. Surv. China, Ser. A, No. 3.

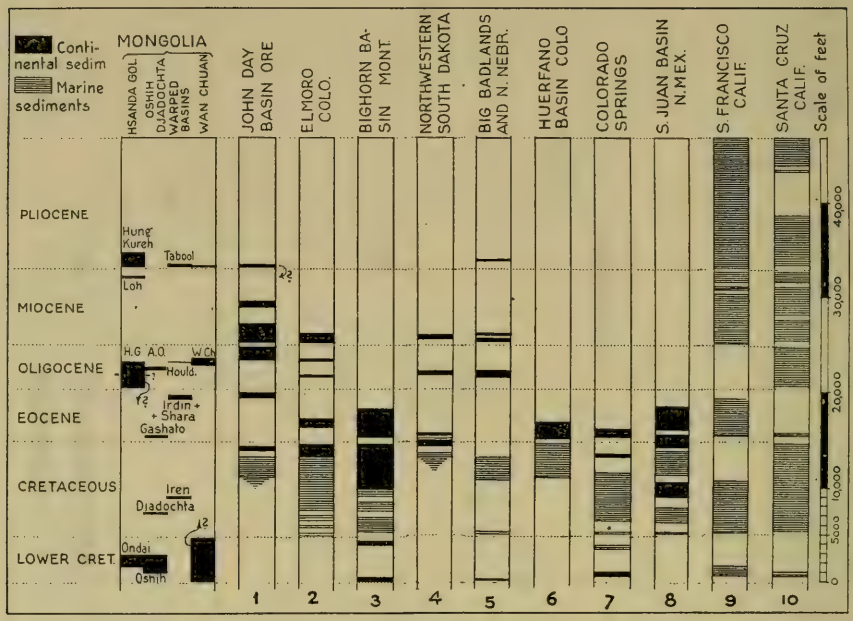

Fig. 17. The columns in Mongolia are shown in condensed form at the extreme left. The numbered columns represent typical sections in the western United States. Formations chiefly of marine origin are represented by parallel lines, while those chiefly of continental origin are in black. References are as follows:

1, Sinclair, W. J. 1909, quoted from Osborn, H. F. 1910. "Age of Mammals," p. 359.—2, Hills, Richard C. 1899. "Elmoro Folio, Colorado," U. S. Geol. Survey, Geol. Atlas, folio 58.—3, Fisher, Cassius A. 1906. "Geology and Water Resources of the Bighorn Basin," U. S. Geol. Survey, Prof. Paper 53.—4, Winchester, Dean E., Hares, C. J., Russell, Lloyd, and Parks, E. M. 1916. "The Lignite Fields of Northwestern South Dakota, U. S. Geol. Survey, Bull. No. 627, p. 16.—5, Darton, N. H. 1905. "Preliminary Report on the Geology and Underground Water Resources of the Central Great Plains," U. S. Geol. Survey, Prof. Paper 32. Wanless, Harold R. 1923. "The Stratigraphy of the White River Beds of South Dakota," Proc. Am. Phil. Soc., LXII, No. 4.—6, Osborn, H. F. 1897. "The Huerfano Lake Basin, Southern Colorado, and its Wind River and Bridger Fauna," Bull. Am. Mus. Nat. Hist., IX, Art. 21.—7, Finley, George I. 1916. "Colorado Springs Folio, Colorado," U. S. Geol. Survey, Geol. Atlas, folio 203.—8, Sinclair, W. J., and Granger, Walter. 1914. "Paleocene Deposits of the San Juan Basin, New Mexico," Bull. Am. Mus. Nat. Hist., XXXIII, Art. 22. Bauer, C. M., and Reeside, J. B., Jr. 1920. "Coal in the middle and eastern parts of San Juan County, N. Mex.," U. S. Geol. Survey, Bull. No. 716 (g.).—9, Lawson, Andrew C. 1914. "San Francisco Folio, California," U. S. Geol. Survey, Geol. Atlas, folio 193.—10, Branner, J. C., Newsom, J. F., and Arnold, Ralph. 1909. "Santa Cruz Folio, California," U. S. Geol. Survey Geol. Atlas, folio 163.

Cretaceous Oshih and Ondai Sair gobi basins are almost certainly connected. Deposition must have begun in the Oshih earlier than in the Ondai Sair, since the Oshih beds are thicker, coarser and carry a fauna of rather more primitive aspect, and since the paper shales and large sauropods are found only in the upper beds of the Oshih, whereas they occur in the lower beds of the Ondai Sair. After deposition of the Oshih and Ondai Sair, sedimentation in this region ceased, or, if beds were deposited, they have been removed by erosion; but at Djadochta, forty miles east of Oshih, a gobi basin received 500 feet of early Cretaceous fine red sands probably derived from the destruction of Oshih beds. The next Mesozoic deposits of which we have knowledge are at Iren Dabasu, 380 miles farther east, where late Cretaceous beds rest directly upon pre-Cambrian slates. The locus of deposition had shifted, therefore, during Lower Cretaceous (Comanchean) and Cretaceous time.

Returning to the Altai and referring again to figure 16, the Gashato beds, which are the lowest Eocene strata we have seen, rest on the angular gravel which covers the Djadochta red sands (Fig. 11). The gap between the Djadochta and the Gashato represents the time recorded in the Iren Dabasu trachodont beds, plus an interval of Cretaceous and Paleocene or Eocene time that has left no sedimentary record so far as we now know. No younger formation was seen in this region, but both to the west and to the east there are later sediments. The Irdin Manha and the Shara Murun formations represent the highest Eocene yet found in Mongolia. They rest in some places upon the oldrock floor, but in other places they may lie upon Cretaceous or older Eocene sediments.

Thus, although we do not know the age of the Murukh Tchu or the Golobai, the facts demonstrate that there has been a shifting of the locus of deposition during the Eocene from the Altai region in earlier Eocene toward the Iren Tala in later Eocene time.

The oldest Oligocene beds yet seen in Mongolia are, apparently, those of Ardyn Obo, which rest directly upon the crystalline oldrock floor. The Oligocene of the Houldjin bench at Iren Dabasu should be rather younger, since it contains *Baluchitherium* bones. The *Baluchitherium* beds of Hsanda Gol have been called Lower Oligocene by Dr. Matthew.

Whether or not these three formations prove to be of the same age, the evidence of shifting of the locus of deposition is convincing. In at least three widely separated regions, warping recommenced in Lower Oligocene time, so that beds of this age were laid down, in one locality upon eroded Lower Cretaceous (Comanchean) beds, in the second upon

the bare crystalline rocks, and in the third upon Eocene beds of doubtful correlation, somewhat older than the typical Irdin Manha (Fig. 16).

The only Miocene beds yet seen in Mongolia are those of Loh, which rest upon the Hsanda Gol without any notable appearance of a break in sedimentation. Thus far, this is similar to the findings in China where Dr. Andersson[1] refers a few beds to the "Lower Pliocene or Upper Miocene."[2]

This almost complete absence of the Miocene over vast areas of basin-lands constitutes one of the major problems of the region. Some of the elements of the problems are:

1. No marine Miocene beds are known in northern Asia, though Miocene lignites are reported as far north as the New Siberian Islands[3] hence the sea was remote and the Angara-Gobia continent was broad during that period.

2. The suggestion made by the patchy distribution of the earlier formations, as already recited in this paper, is that the deposits are all inland deposits. Despite the intermittent warping to form basins and receive sediments, therefore, the continent as a whole was stable and was undergoing removal rather than deposition of sediments.

This should imply either that we should find inland sediments of Miocene age more extensive than we have yet found, or that northern Asia was undergoing marked erosion during the Miocene.

The gaps in the record may represent periods of relative quiescence in which sediment was not being deposited, or was being eroded. If an upwarp was in progress, it is hard to see why a corresponding deposition should not be found as a record of it, unless the entire region was subject to erosion at the time. Such general erosion would be recorded in a peneplane, like that which beveled the Mesozoic beds prior to the deposition of the Tertiary. The preservation of vast areas of relatively thin, soft sediments, which represent many diverse horizons, and which are slightly or not at all disturbed, leads one to believe that the country was not greatly uplifted, and that it was suffering but little warping or denudation during the long intervals represented by the gaps in the sedimentary record.

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[1]Andersson, J. G. 1923. "Essays on the Cenozoic of Northern China," Table II. Mem. Geol. Surv. China, Ser. A, No. 3.

[2]A note recently published, entitled "Biological and Palæontological Collecting in Northern China," in the China Journal of Science and Arts, II, 1924, pp. 72–73, states, "The most recent expedition carried out by the two scientists [refering to Père Emile Licent and Père Teilhard de Chardin] resulted in the discovery in the valley of Shara Ossa Gol, a river in Mongolia to the north of Kansu, of a rich find of fossils and archæological specimens in deposits running in a complete series from the Miocene of the Upper Tertiary to recent strata of Neolithic age."

[3]Toll, Baron E. W. 1900. "Carte géologique du Nord de la Sibérie Orientale," reproduced in Petermann's geographische Mitteilungen, XLVI, Pl. XIII, quoted from Suess, 1902. "La Face de la Terre." III, 1, p. 29.

It seems to follow, independently of the inferences just offered, that the weight of the sediment could have had no causal relation to the depression of the earth's crust. The fact that areas as large as 10,000 square miles in extent are floored by thin formations, as in the case of the Irdin Manha-Shara Murun basin, seems to indicate that these beds were laid down upon a relatively flat surface that did not tend to sink under the load. The crust evidently supported these and other formations while they were peneplaned. The peneplanations are taken to imply great stability and rigidity of the bedrock floor,—that is, the crust neither sank under the load sufficiently to deform the sediments and encourage thicker deposits, nor rose under the negative load, when the region was eroded to a peneplane. In a paper to be offered later, a review of the diastrophic periods in Mongolia will be attempted, but at present it is enough to say that we believe that isostatic balance can be overset only by very large positive and negative loads, and that the stripping and loading observed in Mongolia have been of an order of magnitude too small to overcome the inertia of the earth's crust, even where fault lines exist. In the dynamics of the region, the sediments played a passive part. Basin-warping and mountain-building were complementary parts of a great orogenic movement or succession of movements, and were controlled, we believe, by deep-seated causes.

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STRUCTURAL ELEMENTS OF THE OLDROCK FLOOR OF THE GOBI REGION[1]

BY CHARLES P. BERKEY AND FREDERICK K. MORRIS

INTRODUCTORY STATEMENT

Reference has been made in several preceding articles on the Gobi region to the ancient rock floor, on which the so-called later sediments were laid down. The break between these two groups of formations separates comparatively simple strata above from very complexly interrelated series of much more ancient and obscure formations below. In the structural units of this complex floor is recorded all of the pre-Cretaceous history that is now readable in this portion of the Asiatic continent. The major structural elements of it have been indicated without special comment, in connection with other problems, and it has already been pointed out that a wide range of geologic time is represented, stretching from the Jurassic back to very early pre-Cambrian time. Nowhere, however, has there been any adequate description defining the chief field units. This paper is directed particularly to these elements of the ancient floor.

TWO MAJOR DIVISIONS OF ROCK FORMATIONS

Very large areas in the Gobi region are covered with younger sediments that lie nearly flat. The strata themselves are simple and, wherever they are disturbed, the deformation is of comparatively simple type also,—either gentle warping or, somewhat more rarely, sharp flexure and actual normal faulting.

In all other areas, much more complex rock formations are exposed, representing a more ancient floor which is doubtless continuous beneath all of the sediments. Wherever the old-floor rocks are encountered, the type of deformation and the degree of internal modification exhibited by them are very different from those of the simpler overlying strata. Everywhere these floor rocks are folded, often are cut by igneous intrusives, and to a marked degree are metamorphosed. These features are, of course, more pronounced in the older members.

Wherever the rocks of these two very different types of formations, the sedimentary cover and the floor, are seen in contact, or where their

[1]Publications of the Asiatic Expeditions of the American Museum of Natural History, Contribution No. 20.

structural relations can be determined, a very great unconformity is found between them. The hiatus is so great that mountain-folding and erosion of thousands of feet of material were accomplished before the first basin sediments were laid down. Furthermore, it appears that during this interval an entire change in the diastrophic habit of north central Asia came about. Mountain-folding characterized the deformations that took place before that time, whereas warping and block faulting, without mountain-folding, characterized subsequent epochs.

Late Mesozoic and Tertiary continental sediments carrying a remarkable new fauna constitute the formations developed above the unconformity. The rocks below, representing together all the ages preceding the Lower Cretaceous, form the floor immediately beneath these sediments wherever they occur, and form the present surface in other parts of the region. The overlying sediments are at best but a thin veneer with many interruptions, and the dominant structural foundation for the whole of Mongolia is the ancient rock series below the great Mesozoic unconformity.

Traces of the peneplane developed at that time still form major elements of the topography, and surprisingly large tracts of this old floor are to-day entirely bare. Many of these bare areas have been covered at one time or another by later sediments, only to be denuded subsequently to some of the minor warpings of Tertiary time. In the more elevated areas, of course, agents of erosion working toward a new level have dissected this old surface, leaving only upland remnants of the former peneplane, whereas in well-protected areas little change has been effected in all the intervening time.

SUBDIVISION OF THE ANCIENT FLOOR

From the great variety of rocks noted as belonging to this ancient floor, and the very great differences of physical condition represented by them, it is evident that this floor is of compound make-up. It has been possible to distinguish several sharply defined series of sedimentary strata, other more obscure metamorphosed formations and definite igneous units. These have, in some cases, prominent structural breaks between them, or have structural relations characteristic of important differences either in age or in origin. Some are strictly igneous types of large extent and evident structural importance; some, on the other hand, are profoundly metamorphosed and have taken on all the complexities usually characterizing the crystalline gneisses and schists of very ancient time; still others are only moderately affected by such internal and modi-

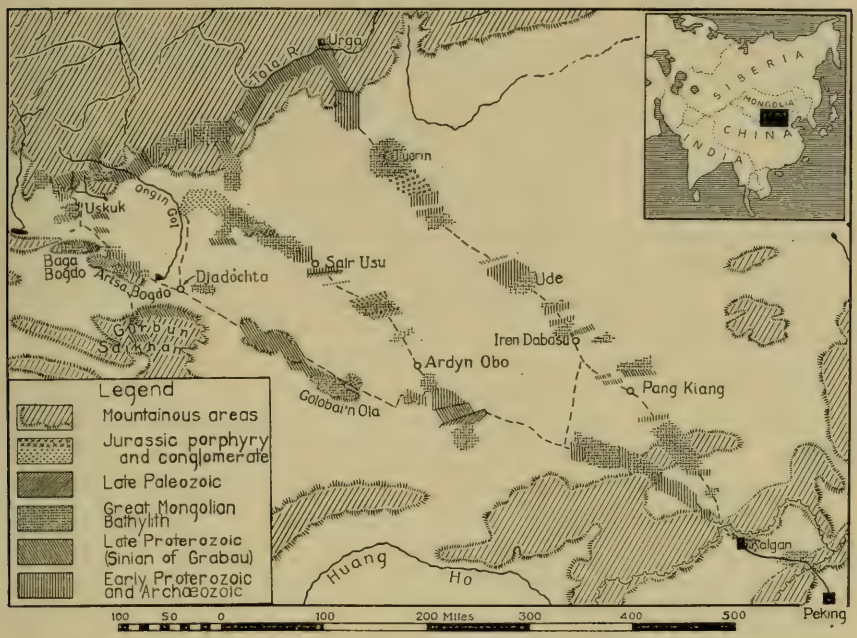

Fig. 1. Sketch map of central Mongolia, showing general geology of the rock floor along the route traversed by the Expedition.

Mountain areas are shaded by coarse slanting lines. An attempt has been made to distinguish the major groups of floor rocks along the route by different patterns. The younger basin sediments along the same lines of march are left white.

fying processes, and consequently are regarded as of much later age, corresponding in some degree to their greater simplicity.

At least six great groups are thus distinguished, some of which are capable of additional subdivision (Fig. 1). This is true particularly of the lowest, most ancient one, where for present purposes all the strongly metamorphosed units are grouped together. These major groups, in descending order, are as follows:

6. Mesozoic porphyry intrusives, cutting all formations up to and including the sedimentary series involved in the last folding of the region previous to the development of the great Mesozoic unconformity.

5. A great series of folded conglomerates and sandstones of continental type, considered to be of Jurassic age.

4. Strongly folded, fossiliferous Paleozoic strata of marine origin.

3. An extensive underlying and invading mass of granite, described as the Great Mongolian Bathylith.

2. A very thick and widely extended series of folded, unfossiliferous graywackes and slates, older then the granite bathylith and only moderately metamorphosed. We have called this the Khangai series, and consider it to be of late pre-Cambrian age.

1. Still more ancient, underlying complex groups of quartzites, slates, phyllites, schists, gneisses, crystalline limestones and other associated metamorphic rocks. This complex is made up undoubtedly of more than one series. The upper members are judged to belong to the division distinguished in China as the Wu T'ai system, and the oldest members are regarded as local representatives of the T'ai Shan complex.

Mesozoic Intrusives

A very great variety of porphyries, occurring both in dikes and in irregular forms of much larger extent, have been seen at many places. Typically, they are associated with and cut the latest sedimentary series preceding the great unconformity. This clearly establishes the fact that they are the youngest of the formations of the ancient floor. The strata above the unconformity are now regarded as of earliest Lower Cretaceous age, whereas those immediately below are judged on rather obscure grounds to be Jurassic. These intrusives, therefore, must also be of Jurassic age.

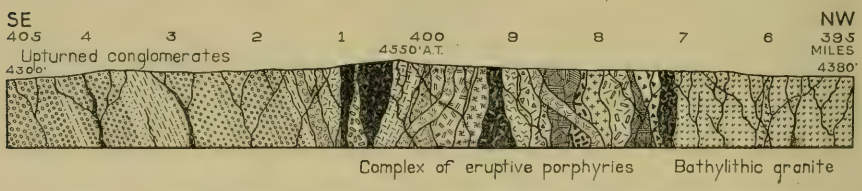

Fig. 2. Reproduction of ten miles of structure-section from the geologist's field notebook, 70 to 80 miles southeast of Sair Usu on the Uliassutai trail.

Chiefly Mesozoic rocks. Folded Jurassic conglomerates are seen at the left, cut by dikes. A complex of eruptive porphyries, probably also Jurassic, occupies the center. Both rest unconformably upon the Great Mongolian Bathylith, which occupies the right-hand end of the diagram. The extreme simplicity of the desert peneplane is well shown, contrasting with the complex underground structure.

Representatives of this group are very widely distributed, and in places exhibit a formidable complexity of relations. So many different units are represented, and they cut one another in so irregular a way, that in certain areas they form a veritable igneous complex (Fig. 2).

The commonest type is an acid porphyry, ranging in minor character from that of a simple quartz porphyry to granophyre and granite porphyry of comparatively massive habit. Intermediate composition is common also, and occasionally there are more basic types, so that the

compositional and structural range is very great indeed. The most constant characters are fine grain, dense texture, only moderately porphyritic habit. These rocks are brittle and exhibit a very broken condition, due apparently to their deformation. This physical condition, together with the great irregularity of form and occurrence as part of a confused complex, is not so strikingly exhibited by any other series of rocks.

Wherever such an igneous complex intrudes the Jurassic strata, the original sediments are entirely displaced and none of the original structural trend is preserved. Areas represented by such rocks, observed at several points, cover many square miles. The best examples are those seen at Tsetsenwan, at Sain Noin, in the Mt. Uskuk district, in the Artsa Bogdo range, on the Sair Usu trail east of the Ongin Gol, and on the trail southeast of Sair Usu. It is worth noting that igneous activity of a somewhat similar sort is prominent in China also, in association with exactly the same sorts of sedimentary formations. The type is constant enough in character, no matter how widely the occurrences are separated, to warrant the belief that some very widespread general source for these intrusions must have existed, operating under regional rather than very local control. We are inclined to the belief that the active history of the great granite bathylith, in spite of its much greater age, is in some way tied up with the genesis of the Mesozoic intrusions. There is a certain difference of habit, one age after another, that makes the whole lot look like a genetic succession, as if they all, from beginning to end, represented only stages in the active history of a single great, slowly differentiating and repeatedly rejuvenated bathylithic mass. Perhaps these peculiar porphyries are only the normal product of a particular stage from this master source (Fig. 7).

Jurassic Sediments

The youngest of the sedimentary groups forming the old floor is a great series of conglomerates and sandstones of continental type, simply folded or sometimes block-faulted, and quite free from important metamorphism. A great proportion of the material is coarse-grained, and considerable thicknesses are strictly conglomerates. Other great thicknesses are simple, well-bedded sandstones. Occasionally interbedded finer sandstones occur in considerable prominence, but as far as noted there are no large developments of shale or limestones in this series. Nowhere is there any evidence of marine conditions. The entire series consists of stream deposits. The only fossils seen are plant remains,

chiefly stems, very poorly preserved. In certain portions of the series, however, there are thin beds of coal of very low grade. Even in these beds, the original fossil forms are poorly preserved, and are nearly destroyed by deformation, so that the fossil content has proved thus far to be quite inadequate to determine the age of the beds (Fig. 3).

The material of these sediments is largely quartzose or at least very siliceous, and the forms of the fragments indicate much wear. The three striking features are the enormous thickness of the series, its wide distribution and the abundance of quartz pebbles and grains.

These rocks were found at several widely separated localities, the principal ones being at "Camp Jurassic," 50 miles north of Ude; at Tsetsenwan, 125 miles west of Urga; at Sain Noin, 300 miles west of Urga; in the Mt. Uskuk region, 40 miles north of the Altai Mountains;

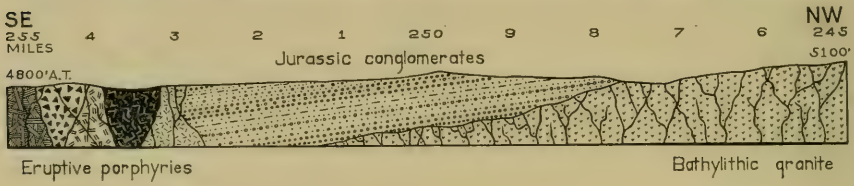

Fig. 3. Typical section of rock floor.

One of the important rock-floor formations is the Jurassic conglomerates. This series itself lies unconformably on other older groups, and is commonly cut by a great complex of intrusive porphyries. The section used here is a reproduction of ten miles of field traverse on the Uliassutai trail, 80 miles northwest of Sair Usu.

in the Artsa Bogdo range; on the trail midway between Sair Usu and Ardyn Obo, and at a few other spots where field relations and evidence were too obscure to determine the extent and local importance. As a matter of fact, there is evidence that strata of this series formerly extended over a much greater area than that covered by the Expedition.

Almost everywhere these strata stand on edge, or at least are strongly folded,—more seldom they are mashed and faulted, while occasional synclinal remnants show little disturbance. The total thickness in the district where this point could be best determined, is no less than 25,000 feet, and at several other places great thickness is indicated, although estimates were not made. Doubtless these strata form the floor beneath the covering of simple sediments at many places, but it appears that erosion has cut so deep into the geologic structure of that time that only the lowest portions of the synclinal folds and the bases of fault blocks are preserved. South of Tsetsenwan, we observed a vast series of surface volcanic rocks,—flows, ash and tuff beds, all of which shared the deformation of the Jurassic conglomerates. They range, like

the intrusive rocks, from rhyolitic through andesitic types, though basalts are present in minor proportion. They are regarded as a surface-flow expression of the same magmas that penetrated the Jurassic, and are now found as intrusive bodies cutting the conglomerate series.

In age the whole series is pre-Cretaceous and precedes the general peneplanation. On the other hand, the series lies above another unconformity, the exact position of which in the geologic scale is undetermined, except that it lies above the latest Paleozoic sediments. These strata, therefore, are apparently mid-Mesozoic, and are in all essential respects analogous to and in many important features similar to the Lower Jurassic strata of China proper. The fossil evidence for age determination is inadequate, but there are enough points of similarity in type of strata, character of content and deformation history to warrant tentative assignment to the same age. No fossils other than plant remains are found in either. On this basis we are referring to this series as wholly of Jurassic age, although there is no good evidence against the presence of representatives of the Triassic also. In any case, the series must be regarded as a unit, in which the only breaks of consequence are those marked by the great igneous intrusions, described under the preceding heading.

These intrusions occur at so many places, where they are associated with the Jurassic sediments directly, that one is impressed with the necessity of accounting in some way for this close association. It may very well be that the deformation that accomplished the foldings and faultings of Jurassic time was connected with and occasioned by igneous activities in the depths beneath, one expression of which is marked by these intrusives. Down-faulting blocks, therefore, or very deep down-foldings may mark the places of weakness which guided the outbreak, and thus both the sedimentary remnants and the associated intrusives are now preserved together. Other higher portions were more successfully removed by erosion.

Paleozoic Strata

It is a most striking fact that all the sediments thus far found in central Mongolia, from the present back to the break at the close of Paleozoic time, are of continental type. But beneath the unconformity, at the base of the so-called Jurassic sediments, there is a great series of strata of marine origin, carrying abundant and characteristic fossils. These beds include basal sandstones of only moderate development, with much greater thicknesses of limestones and shales preserved in down-

folded remnants. Several thousand feet in thickness have been seen, but the actual total or maximum thickness is unknown.

Strata of this age have been found in only two areas, both southeast of Sair Usu. Undoubtedly they constitute an eastward extension of the ancient folded Altaides of Suess, but the Tertiary faulting that has raised the modern Altai ranges did not extend into this portion of the desert; so that the representatives of the folded Paleozoic strata have not been uplifted, and are still simply part of the peneplaned floor.

The larger proportion of the strata is judged by Dr. A. W. Grabau, from fossil collections made during the first season of the Expedition's work, to be of Permian age, but there is a continuation downward into a still earlier period, at least into the Pennsylvanian. Curiously enough, no representatives of these strata were seen in the Altai Mountains them-

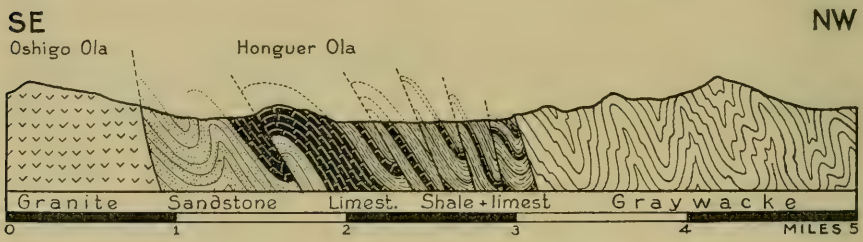

Fig. 4. Cross section of an area of marine Permian beds, noted on the Uliassutai trail, about 120 miles southwest of Iren Dabasu.

The complexly folded and faulted sandstones, shales and limestones now occupy a graben between a broad area of granite hills on the southeast and a broad area of the Khangai graywackes and other old rocks on the northeast.

selves, either in the Artsa Bogdo or the Baga Bogdo districts, although a single hand specimen carrying fossils of Paleozoic age was found loose on the northerly flanks of the Gurbun Saikhan. From this it seems probable that representatives of Paleozoic age are to be found somewhere to the south in that region. Probably marine Paleozoic strata were formerly extensively distributed in this central Asiatic region, but the early Mesozoic or mid-Mesozoic epochs of diastrophism and erosion wrought such havoc that now only a few remnants are preserved (Fig. 4).

These rocks are all closely folded, and, although considerably deformed, the fossil content is fairly well preserved. The strike is nearly east and west, conforming in this respect to the average structural trend of the other elements of the ancient floor. Nowhere have we seen the exact relations between this series and the Jurassic above or the graywackes below. But the relative position in the scale can be inferred, and

the general nature of the relation is reasonably well determined by differences of structural habit and physical condition. There is clearly an important break indicated between the Paleozoic sediments and the Jurassic series, since these strata are marine, whereas the Jurassic beds are strictly continental.

It is particularly disappointing that these Paleozoic beds have not been seen in direct sedimentary contact with the graywacke-slate series beneath. This leaves some uncertainty about structural relation and relative age. It is clear that the graywackes are older, and, in view of the fact that they are unfossiliferous, somewhat more metamorphosed and of an entirely different petrographic habit, we are inclined to believe that the graywackes are much older and are probably separated from the Paleozoic strata by an unconformity as pronounced as either of those above. There is abundant evidence that the Great Mongolian Bathylith, described as the next unit under the following heading, is later than the graywacke series, and is very much older than the Jurassic sediments, which in some places lie on an erosion floor of granite (Fig. 3). But it is not entirely clear, from any relation yet observed, whether the Paleozoic sediments are younger or older than the maximum invasion stage of the bathylith. All the early and mid-Paleozoic strata are missing, so that there are no representatives yet found from Cambrian to Mississippian time. Apparently the Paleozoic era is the most defective one, as indicated by the few sedimentary remnants still preserved. The Paleozoic rocks mark a transient marine history between two very long epochs of continental control.

The Great Mongolian Bathylith

Between the sedimentary series just described and the older ones to follow, there developed in central Asia a great granite bathylith, exposures of which can be seen at various places over a very large territory. The formations existing at that time, including the Archæan crystalline rocks and the graywacke-slate series, are invaded by the granite, and at many places where subsequent erosion has been deep enough, remnants of these earlier formations are preserved as roof pendants. The granite appears as large areas of massive rock, and also as smaller intrusive masses, even dikes, which cut all the formations up to and including the graywackes. It is not so clear what its relations are to the Paleozoic series, but in one place the granite appeared to be faulted against the Paleozoic strata (Fig. 4, Oshigo Ola). As the Permian beds near the contact are not metamorphosed, and as no granite dikes are seen

cutting them, it seems fair to infer that these Permian sediments are younger than the granite.

It is possible, of course, that even the later intrusives, such as those which cut the Jurassic series, are products of the same great bathylithic magma, but if so, they belong to a much later stage in its own development than that represented by the great areas of true granite. That stage, the stage of massive granite solidification which was also the stage of maximum invasion, is probably pre-Pennsylvanian, and certainly later than the Khangai graywacke. It is entirely possible that every igneous unit in the region, no matter what its age, is genetically connected with this immense bathylith. Its early developmental stages may have been responsible for the injection phenomena of the ancient gneisses; its maximum encroachment was attained in Paleozoic time, and its old age rejuvenations may in this view be recorded in the outbreaks of later periods (Fig. 7).

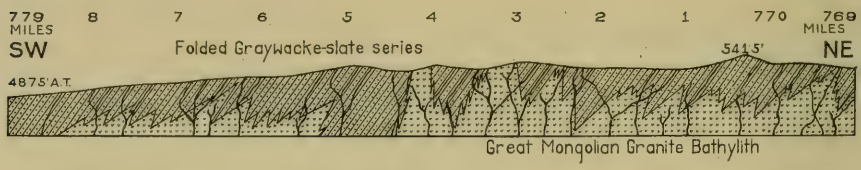

Fig. 5. Typical section of the Khangai graywacke series. This section is from Five-Antelope Camp, 100 miles southwest of Urga.

The simply folded graywacke-slate series is undercut and penetrated by the Great Mongolian Bathylith, and locally metamorphosed by contact influence over a very wide territory. This section reproduces a ten-mile stretch along the route followed by the Expedition within the northern mountain area.

These granites show considerable variety of composition and minor habit, but the dominant type is a biotite granite of medium coarse texture and massive structure. It has produced an extraordinary variety of end-product effects, and considerable contact metamorphism. Its relations and distribution and special features are made the subject of a separate paper already published.[1]

The Khangai Graywacke Series

A very extensive series of graywacke sandstones and interbedded shale or slate rocks is widely distributed in Mongolia. This series forms the major composition of the mountains of the Arctic divide, and constitutes the country rock of the Urga-Tola River-Tsetsenwan region, as well as the Khangai mountain range through the province of Sain Noin

[1]Berkey, Charles P., and Morris, Frederick K. 1924. "The Great Bathylith of Central Mongolia." Amer. Mus. Novitates, No. 119.

toward Uliassutai. These rocks are particularly well exhibited in the Gurbun Saikhan and in the small mountain tract 20 miles east of the Mt. Uskuk block, as well as in the Ude region along the Urga trail. Representatives of the same formation are found in many other areas.

In the Tola River region and at Tsetsenwan and westward, graywackes dominate, whereas southward and eastward a greater proportion of shales is interbedded. Neither the top nor the bottom of the series has been determined, but it is certain that it is of very great thickness,—probably at least 20,000 feet.

As far as observed, these strata are unfossiliferous throughout. Diligent search was made for possible fossil content, and, in the general Uskuk region, slates were found with obscure markings that are believed to represent imprints of some simple organic form, probably algæ. A striking thing, of course, is the unfossiliferous nature of these rocks in spite of their simple sedimentation structure, in strong contrast to the richly fossiliferous habit of the Upper Paleozoic strata. It is not believed possible that these graywackes and slates, with their splendid bedding structure and abundance of original shales, could be of Paleozoic age without bearing better evidence in the form of fossil content.

Siliceous limestones, of dark gray to blue color, are found associated with slates in some localities, and these also are quite without fossils so far as we have seen. Probably these limestones represent incursions of a shallow sea, and the very fact that they lack fossils so completely suggests that they are pre-Cambrian. The graywackes are probably non-marine and of the same age, and, especially in the Khangai Mountains and the region about Urga, where limestones are quite lacking, it is believed that this great series is essentially continental.

Everywhere the series is folded. In places where it is made up largely of original shales, there is much internal deformation, so that typical slates have been formed; but wherever the much more massive graywackes make up the formation, simple folding is more common, with very little internal deformation or metá-structure.

The series was invaded by the granite bathylith subsequent to its folding, and in many places over extensive areas this rock now forms the only roof. Great numbers of dikes cut through the series, and the bathylith itself is uneven enough, so that with later erosion patches of granite are exposed, alternating with patches of graywacke. In places where the granite lies close beneath, there is considerable contact metamorphic effect produced on certain qualities of the graywacke-slate series. In some places a crystalline condition and moderately schistose

structure are thus produced, whereas normally the rock is eminently granular and not schistose at all (Fig. 5).

Other observers have noted graywacke series in regions beyond the reach of the traverse of the Third Asiatic Expedition, especially in districts to the north. Some Russian geologists have classified graywackes in Siberia as of Devonian age. It does not appear, however, that there is sufficient reason to follow this classification for the Khangai series of Mongolia. A graywacke found north of Urga by J. Morgan Clements[1] is regarded by him as of pre-Cambrian age. This may correlate with the Khangai series of the Third Asiatic Expedition. Graywackes and slates also are mentioned in the region very far to the south by other observers, and again with suggestion of different age, but it is not certain, of course, that the same formation is referred to.

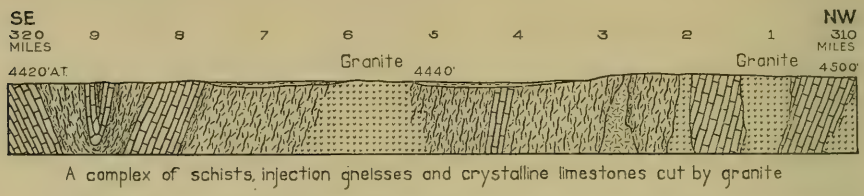

Fig. 6. Reproduction of ten miles of structure section from the geologist's field notebook, 9 to 19 miles northwest of Sair Usu on the Uliassutai trail.

The figure shows pre-Cambrian rocks of very complex structure. These have been peneplaned and two shallow basins of the later sediments overlie them. The peneplane is very well shown.

The Ancient Crystalline Complex

Clearly older than the graywacke series, as indicated not only by their structural relations but also by the much greater metamorphic modification, is a great group of formations which doubtless includes several separable series, but which together may be conveniently referred to as the ancient crystalline complex (Fig. 6). The simplest of the rocks of this class are slates, phyllites, schists, limestones and conglomerates that are clearly derived from some ancient sedimentary series, of much more variable habit and somewhat different origin from that of the overlying graywacke series. They stand everywhere on edge; they are repeatedly exposed in many places as widely separated as are the observations of the Expedition. The tracts are extensive, however, at but few places, and there are but few of these where many of the members are exposed together.

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[1]Clements, J. Morgan. 1922. "Gold Placer Area in Mongolia, China." Department of Commerce, Trade Information Bulletin No. 4, Far Eastern Division.

LATE MEZOZOIC + TERTIARY	Basin sediments, Lower Cretaceous to Recent, unconformable upon the OLDROCK FLOOR
MIDDLE MEZOZOIC	Mezozoic porphyries and surface flows, tuffs and ashes Jurassic series of continental sediments cut by porphyries
LATE PALEOZOIC	Paleozoic series of marine sediments, shales, limestones, and sandstones, cut by dikes. All later intrusive rocks may possibly be derived from the bathylith, by rejuvenation and differentiation in its deeper parts
EARLY PALEOZOIC	The Great Mongolian Bathylith — a subjacent body, whose depth and differentiation are suggested by the right-hand portion of the diagram
LATE PROTEROZOIC (Sinian of Grabau)	Khangai series of graywackes and slates, jaspers, quartzites
EARLY PROTEROZOIC	The Wu Tai system, phyllites, schists, greenstones and crystalline limestones
ARCHÆOZOIC	The Tai Shan complex — gneisses, schists and crystalline limestones, cut and saturated and even replaced by intrusives

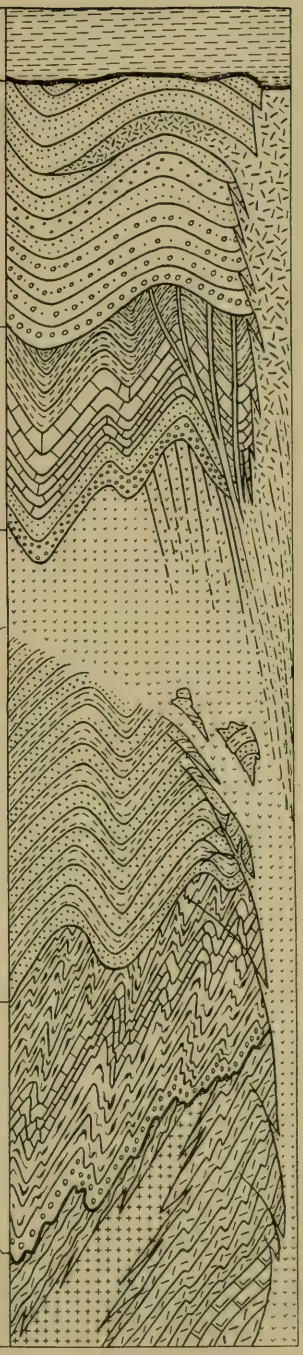

Fig. 7.

The Wu T'ai System

Because of the fact that in certain places conglomerates are found in the midst of these series, and on account also of an observed difference in the degree of metamorphic complexity of certain members, we think the evidence favors the recognition of at least two great systems of pre-Cambrian rocks, older than the rocks of the Khangai graywacke series.

If we are right in regarding the graywackes as pre-Cambrian, they must be late pre-Cambrian, and as such they should correspond approximately to the Nan K'ou series of von Richthofen and Bailey Willis, in China, or the Sinian system of Grabau. Our next older series in Mongolia may include the greenish chloritic schists in the Artsa Bogdo range of the Altai Mountains. There is also a vast series of greenstones and chloritic phyllites in the mountains east of Ardyn Obo, which may be of igneous origin, and perhaps represent ash beds and surface flows that have undergone thorough reorganization. More data bearing on this problem may be expected when these rocks are studied with the microscope. Thin beds of limestone were found in the greenstone area. Mica schists and mica phyllites were seen on the Kalgan-Urga trail north of P'ang Kiang, and crystalline limestones are associated with these. The phyllite-schist-limestone-greenstone group occurs at many places, yet is nowhere as thoroughly pierced and saturated by invading igneous material as is the group of rocks next to be described. No better guide for these still older rocks is available than that of Bailey Willis as given in his "Research in China," where he classifies a series of phyllites, limestones, quartzites, schists and greenstones under the Wu T'ai system, and places this system as Early Proterozoic. We see no better classification for these very similar rocks in the Gobi region.

The T'ai Shan Complex

Still more complexly modified rocks are found in the Gobi region. They are largely gneisses and associated schists and crystalline limestones. The gneisses range from granitic to dioritic in general composition, but they are not simply granites and diorites. They represent a complex in which the original rock probably was a schist. This original rock has been invaded by igneous material which has penetrated and saturated the original, following in the main the structural lines of the schist. The magma has replaced as well as penetrated the host rock, so that now the igneous matter is a streaked gneiss because it has inherited the structure of the schist which it has largely destroyed and replaced. Where the

These two divisions of rock formations were recognized by earlier explorers	Overlying sediments, not hitherto subdivided	Geologic Column as worked out by The Third Asiatic Expedition	Twelve definite sedimentary formations, distinguishable on structural or paleontologic grounds, and ranging in age from Lower Cretaceous to Pleistocene time, are represented in the sediment on the ancient floor.			
		Mesozoic	The Great Mesozoic Unconformity			
			All Rocks Below this Line are Folded			
		Mesozoic: Early Mesozoic	Jurassic	A great series of conglomerates, sandstones and shales, with associated lava flows, tuffs and ashes, carrying obscure plant remains and locally coal, the whole about 20,000 feet thick. Apparently corresponds to Lower Jurassic of northern China.		
		Unconformity				
	A floor of ancient formations, not hitherto subdivided or correlated	Paleozoic: Late Paleozoic	Permian	Limestones, Shales, Sandstones	A series of limestones, shales and sandstones with characteristic invertebrate fossils	
			Carboniferous	Slates, Quartzites, Conglomerates		
		Unconformity Covering Early Paleozoic Time				
		Great Bathylithic Invasion			Mongolian granite bathylith	
		Proterozoic: Late	Nan K'ou System of von Richthofen and Willis	Sinian System of Grabau	Khangai Series	Tola River graywackes and slates without fossils
		Proterozoic: Early	Wu T'ai System as used by Willis in China			Schists, phyllites, limestones, dolomites, quartzites, greenstones
		Archæozoic: Archæan	T'ai Shan Complex as used by Willis in China			Crystalline limestones, schists and complex injection-gneisses

igneous streaks are less predominant, the rocks may still be classed as schists, and among these the commonest type is a coarse-grained muscovite-biotite schist, streaked with lenses and thin sheets of granite or pegmatite. The limestones are white to blue or gray crystalline marble.

Such rocks were especially noted in the block mountain south of Tsetsenwan; in another block mountain 40 miles southwest of Tsetsenwan, and north of Kalgan on the road to the pass, as well as at many other places.

Because of the greater complexity of structural habit, these rocks are regarded as still older than those we have referred to the Wu T'ai system, and, again following the usage established by Willis in China, we have chosen to regard these oldest of the formations yet seen in the Gobi as Archæozoic and equivalent to the T'ai Shan of China.

TECTONIC LINES

All these crystalline rocks, both those of the Wu T'ai system and those of the T'ai Shan complex, are folded and sheared, and usually are found standing almost on edge with the major trend or structure running nearly east and west. Very rarely have there been great deviations from this trend, although in a minor way there is a good deal of variation. The average is about south 80° east and north 80° west. All the very ancient structural lines belong to this trend, and this is so fundamental in the floor structure that it affects even the later mountain ranges down to and including those of Jurassic time.

MISSING PARTS OF THE COLUMN

Undoubtedly there are great breaks between the principal members of the pre-Cambrian series. It is believed that the conglomerates seen on the Urga trail in the midst of these formations, and the conglomerates seen also on the Tsetsenwan-Sain Noin trail 300 miles west of Urga, mark some of these important breaks, but even without these there is sufficient evidence in the differences of the rocks themselves to warrant such subdivision as has been made, and such age differences as are indicated in the tabulation. Doubtless very much greater detail of formational make-up is actually exhibited than has been determined as yet, but the major elements of the ancient rock floor and the major characters of the individual unit series are reasonably satisfactorily represented as a working basis by the accompanying table (page 15).

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THE PENEPLANES OF MONGOLIA[1]

BY CHARLES P. BERKEY AND FREDERICK K. MORRIS

This paper is another of the brief announcements that have been issued from time to time by the geologists of the Third Asiatic Expedition. A larger chapter on the Physiography of Mongolia is in preparation; but, as references are being made in other connections to the "Gobi Peneplane," the "Mongolian Peneplane," etc., it seems desirable at this time to define these baselevel surfaces, even though adequate discussion,

Fig. 1. Generalized map of Mongolia.

Mountainous areas are shaded in slanting lines. Lowlands are white, and the deeper depressions are stippled. The Arctic divide is shown by a line of round dots. The routes of the Expedition are shown by heavy broken lines. Index letters along the route of the Expedition indicate the following places mentioned in the text: K (northwest of Peking), Kalgan; PK, P'ang Kiang; IM, Irdin Manha; AO, Ardyn Obo; OS, Ondai Sair. Sain Noin Khan is in the Khangai Mountains, on a river that lies south of the Arctic divide, about midway between the Ondai Sair and M of Mts. Uskuk Mountain, not shown on this map, is just west of Ondai Sair.

especially of the problems of their mode of origin, must await the publication of the larger report.

THE MONGOLIAN PENEPLANE.—A clearly defined ancient erosion surface bevels all the mountainous areas of Mongolia. Remnants of an

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 30.

older unreduced upland rise above it as monadnocks, and the valleys carved out below the peneplane represent so mature a dissection that by far the major part of the old erosion plane has been destroyed. Provisionally, this old surface of mature erosion has been called the Mongolian peneplane, because of its very widespread distribution in Mongolia (Fig. 2).

Fig. 2. The maturely dissected Mongolian peneplane in southern Mongolia, on the Kalgan-Urga trail.

The picture is drawn from a panoramic photograph, taken at the upland level, looking south and southwest.

It is possible that this peneplane is the surface which passes underneath the Cretaceous sediments, which undoubtedly rest upon a mature surface of erosion.[1] This matter will be discussed in another paragraph.

The peneplane was first observed in the granite mountains of southern Mongolia, at an altitude of 5,300 feet (1,600 meters). But as we climbed toward the Arctic divide, at about 6,000 feet (1,830 meters) south of Urga, an old mature surface was again seen beveling the schists

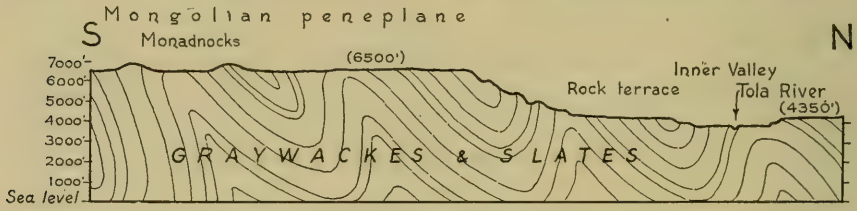

Fig. 3. Diagrammatic section across the Tola River at Urga.

The figure shows: (1) monadnocks rising above the peneplane; (2) the peneplane; (3) the broad rock terrace; (4) the inner valley cut below the rock terrace.

and the younger graywackes. Northwestward, other higher ranges could be seen, and probably the faulted ranges of Transbaikalia are beveled by a peneplane, which in the faulting has been lifted to unequal heights and tilted at somewhat unlike angles in the several fault blocks.

At the Tola River, near Urga, the following topographic elements were observed: (1) monadnocks rising above the peneplane; (2) the

[1]Berkey, C. P., and Morris, F. K. 1924. "Basin Structures in Mongolia." Bull. Amer. Mus. Nat. Hist., LI, p. 109.

peneplane; (3) a broad rock shelf or terrace within the valleys of the Tola and its tributaries; (4) an inner valley, sunk gorgelike below the rock terrace yet having a mature floor upon which the river meanders. These relations are graphically expressed in figure 3.

THE KHANGAI PENEPLANE.—When we climbed into the Khangai Mountains north of the great lamasery of Sain Noin Khan, we saw again an ancient mature upland, carved by streams and, in the highest parts,

Fig. 4. Distant view of the Khangai peneplane.

The figure is part of a large field sketch made near Sain Noin Khan, looking northward over two intervening mountain ridges to the Arctic divide, which forms the skyline. The peneplane is a broad, gently rolling surface, above which rise low monadnocks. Several glacial cirques are seen, but the glaciation was not severe.

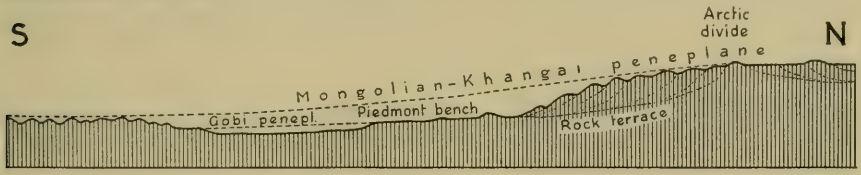

Fig. 5. Diagram showing the Khangai peneplane at the north, warped downward so as to form the Mongolian peneplane in the south.

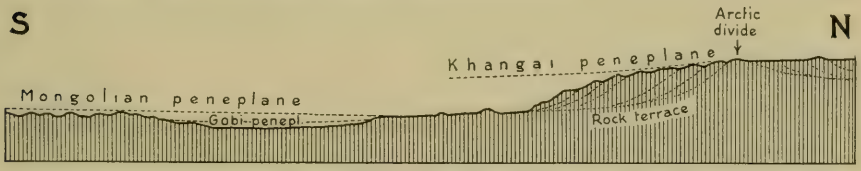

Fig. 6. Diagram showing the Khangai peneplane as an independent, older surface than the Mongolian peneplane.

by former glaciers. Above this peneplane rise notable monadnocks. The physiographic unconformity between the valleys and the ancient upland surface is very clearly seen in this region (Fig. 4). We were not wholly sure of the identity of this upland with the Mongolian peneplane, and so called it provisionally the Khangai peneplane. It stands at about 10,000 feet (3,000 meters), at the place where we observed it, and so should be older than the Mongolian peneplane, unless these two erosion surfaces

can be shown to be identical. There is a shoulder or high rock terrace bordering the valleys.

Descending from the Khangai Mountains and coming southward, we followed the peneplane as carefully as possible, to test its relations with the Mongolian peneplane. The valleys broaden southward, and the rock benches within the valleys tend to coalesce, so that remnant hills or outliers of the Khangai Mountains are cut off from the long spurs and lie

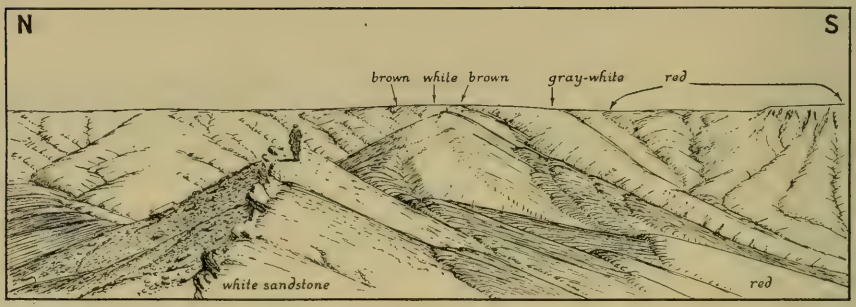

Fig. 7. Field sketch showing the dissected Gobi peneplane at a point about 30 miles north of Baga Bogdo.

The skyline represents the peneplane beveling upturned Tertiary sediments. The upland is extraordinarily smooth, but in the badlands formed by dissection of the Gobi peneplane, the tilted beds develop varying topographic expression, according to their hardness. Many of the gullies have asymmetrical cross section, the southward sloping wall being the longer. A lens of cemented white sandstone forms a small hogback, near the center of the foreground.

Fig. 8. Field sketch of the Gobi peneplane at Ardyn Obo, looking eastward.

The sketch shows: (1) the remarkably level surface of the Gobi peneplane, beveling strata that are sensibly horizontal; (2) the lowland of the P'ang Kiang stage at the left; (3) the badland bluffs descending about 300 feet from the Gobi upland to the P'ang Kiang level; (4) the remarkable shortness of the gullies of the dissected zone, in contrast to the great area of the P'ang Kiang lowland (see figure 11).

isolated, surrounded by the erosion lowland. Looking southward from such border fringes of the Khangai hills, it seemed that the new, lower beveling continues southward over the tops of the ranges there. Lacking adequate maps or surveys, it is very difficult to be wholly sure of such a correlation; but if our observation was not at fault, it would support the inference that there are two peneplane levels beveling the hard-rock structures of Mongolia: an older baselevel, the Khangai peneplane, and the younger and lower Mongolian peneplane (Fig. 6). This matter will be discussed more fully in a later paragraph of this paper.

The Gobi Peneplane.—At altitudes lower than the Mongolian peneplane, we observed a surface of extraordinary smoothness developed upon the relatively soft basin sediments. It is a peneplane, not a deposition surface, as shown by the following considerations: (1) it bevels tilted and faulted strata; this was notably observed in the Altai piedmont regions at Eastern Badlands (Fig. 7); (2) it is underlain by sediments of widely different age; for example, by the Eocene rocks at Irdin Manha, and by the Oligocene sediments of Houldjin, less than 10 miles north of Irdin Manha; (3) even where the strata were sensibly horizontal (Fig. 8), the plateau upland cannot be a depositional surface, for it is impossible that surfaces of Eocene, Oligocene and Pliocene deposition should to-day all be in the same stage of incipient dissection.

It seems to us to be demonstrated that the Gobi upland surface is indeed a baselevel of erosion, or true peneplane; but whether it is of æolian origin or is the work of water in a past cycle of more humid conditions, is one of the most difficult and unsettled problems of the region.

The P'ang Kiang Lowland.—The Gobi peneplane is interrupted by innumerable undrained hollows, which range in size from about 200 yards to tens of miles in length, and from 20 feet to 400 feet deep. The larger hollows have relatively flat floors, though they are never so perfectly level as the Gobi upland, and in almost all cases contain several shallow playas. Because the important telegraph station at P'ang Kiang lies in a large hollow of this type, we have assigned all these hollows to the "P'ang Kiang stage" of dissection (Fig. 8).

We have thus four levels to consider—the Khangai, the Mongolian, the Gobi and the P'ang Kiang levels. At least three of these levels are clearly separate, but it is not certain that all four are separate or are of wholly different age. The brief space allotted to this paper permits us to do little more than state the problems.

Relations of the Khangai and Mongolian Peneplanes.—The question of the possible identity of the Khangai and Mongolian peneplanes is given graphically in the diagrams, figures 5 and 6.

In figure 5 the significant events may be summarized as follows: (1) there was a folded and complex mountainous oldland; (2) this mountainous country was peneplaned,—leaving residual monadnocks; (3) the peneplane was warped and locally faulted, especially in the Altai and Zabaikal regions, and was deeply dissected. In the Khangai Mountains the uplift was a very broad, gently sloped anticlinal warp, which was much higher than some of the other upward areas farther south.

Figure 6 records the following stages: (1) there was a complex and folded mountainous oldland; (2) this oldland was reduced to a baselevel or peneplane, above which stood low residual elevations or monadnocks: this is the Khangai peneplane; (3) the region was uplifted; (4) it was then subjected to erosion so prolonged that the Khangai peneplane was wholly destroyed over a broad area, and a new baselevel was achieved, south of the Khangai region. This is the Mongolian peneplane, above which the Khangai is itself a monadnock unit.

The crux of this problem lies in the question of the age of the Mongolian peneplane. The oldest basin sediments are of late Mesozoic, probably Lower Cretaceous age. They rest upon a peneplane which has been carved upon the oldrocks since the last mountain-folding. If this folding took place, as we believe, in Middle Jurassic time, these mountains must have been reduced virtually to baselevel by the beginning of the Lower Cretaceous (Comanchean). It seems very improbable that two major peneplanes, the Khangai and the Mongolian, could

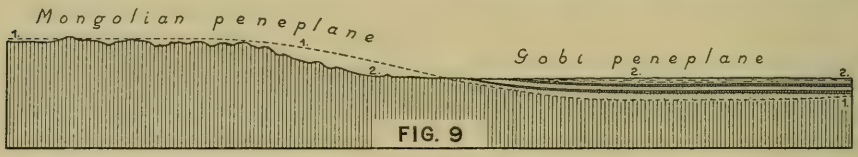

Fig. 9. Diagram illustrating the thesis that the warped Mongolian peneplane is the surface upon which the basin sediments rest.

have been developed in this interval. If then the Mongolian peneplane is the surface on which the oldest Gobi sediments rest (Fig. 9), we should consider this an argument in favor of regarding the Khangai and Mongolian peneplanes as one and the same warped surface. But if the Mongolian be a much younger surface than the pre-Cretaceous peneplane, as suggested in figure 10, the question of the identity of the Khangai and Mongolian peneplanes would be reopened. Even in that case, the following considerations are opposed to their being two separate stages: (1) the Mongolian peneplane is as elaborately dissected as is the Khangai upland; if it were so much younger, it should be less dissected; (2) it can be shown that very much warping and faulting have taken place in Mongolia, so that an old upland peneplane might be expected to lie at very different levels in different parts of the country; (3) it seems to us that it is not logical to expect a great upland peneplane like the Khangai to survive the removal of the enormous quantities of hard rock, together with the long period of very slow decay and removal that must

come in the later stages of post-mature dissection, involved in the carving of a new peneplane, several thousand feet lower than the Khangai, over a large part of Mongolia.

At first sight, this interpretation might seem comparable to the conclusions of Marius R. Campbell[1] in the Front Range, where he finds the Flat Top peneplane as an older, and the Rocky Mountain peneplane as a younger and lower level, both beveling the same hard rocks. But the Flat Top peneplane is almost wholly destroyed by erosion, while the Rocky Mountain level is the most striking and widespread landform of the Front Range; this contrast in degree of dissection and destruction of the two peneplanes seems to be lacking in the case of the Khangai and Mongolian peneplanes. It would be stretching Dr. Campbell's interpretation beyond reason, we think, to cite it as a case quite parallel to that of the Khangai and Mongolian peneplanes. A further discussion of the problem involves the relation of the Mongolian to the Gobi peneplanes.

Relations of the Gobi and Mongolian Peneplanes.—The Mongolian peneplane always lies higher than the Gobi peneplane that bevels the basin-sediments. There is no doubt that the Mongolian base-level is much the older of the two. The questions to be solved are the following: Is the surface that underlies the gobi basins the downwarped Mongolian peneplane (Fig. 9)? If not, at what date was the Mongolian peneplane completed?

In some instances the peneplane now exposed in the field can be shown to be a morvan, that is, a once-buried peneplane which has been laid bare by the stripping of the sediments which formerly covered it. This is the case in the peneplane at Uskuk Mountain, where early Tertiary sediments, and possibly Cretaceous beds as well, once covered what is now the top of the mountain block.[2]

It is a possible interpretation, therefore, that the Mongolian peneplane is the surface upon which the earliest basin sediments were laid down, and this was indeed the theory with which we at first worked in the field.

As we obtained increasing evidence of the widely different periods of basin-warping, however, it was judged that the entire history was more complex than it seemed at first. The following considerations are some of the elements of the problem: Buried peneplanes or unconformities and disconformities are numerous and imply long gaps in the sedimentary

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[1]Campbell, M. R. 1922. "The Peneplanes of the Rocky Mountain Region." U. S. Geol. Survey, Bull. No. 730.

[2]Berkey, C. P., and Morris, F. K. 1924. "Basin Structures in Mongolia." Bull. Amer. Mus. Nat. Hist., LI, p. 114, Fig. 10.

record. Thus in the Altai region the section includes: (1) early Lower Cretaceous shales and sands, disturbed by tilting and faulting; (2) early Tertiary conglomerates, sands and clays, whose upper beds carry a Lower Oligocene fauna; (3) Lower Miocene clays, and (4) Upper Pliocene sands and gravels. Clearly there are gaps in the sedimentary record, and at least two of these gaps represent peneplanations—one at the base of the Cretaceous, and the other at the base of the Tertiary, when the faulted and tilted Mesozoic rocks were reduced to baselevel.

The relatively thin fills of sediment, deposited at great intervals of time, seem to indicate that during each of these long periods in which no deposit was made, erosion might well have baseleveled the very moderately uplifted land from which the preceding sedimentary fill had been

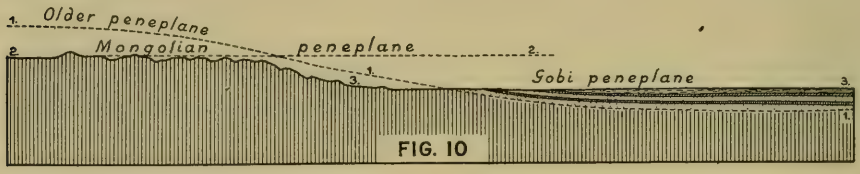

Fig. 10. Diagram illustrating the thesis that the basin sediments rest upon an older surface than the Mongolian peneplane.

The stages of development indicated in this diagram are: (1) an ancient peneplane, probably pre Cretaceous. This was warped to form basins, and sediments were deposited in these basins; (2) the warped region was peneplaned, forming the Mongolian peneplane; (3) a new level surface, the Gobi peneplane, was beveled across the soft rocks of the basins, and, to some extent, the upstanding hard-rock masses have been girdled by a rock bench which is continuous with the Gobi peneplane.

washed. It seems to us that, in a region where one alternation of slight warping and quiescence followed another all through the late Mesozoic and Tertiary, a peneplane like the Mongolian might be made pari-passu with the deposition of sediment. Hence, the Mongolian peneplane may not be of pre-Cretaceous age, but may have been finished at a much later time, say in the Middle Tertiary, and may have been finished at different times in different parts of the country.

The absence of Miocene sediments over most of the region studied by the Expedition[1] and over all or nearly all of Northern China[2] as well, rather suggests the Miocene as a period of very widespread erosion, in which the closing stages of peneplanation were completed. The great post-Oligocene disconformity, which is very striking everywhere except at the Hsanda Gol, where the break between beds of Lower Oligocene and

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[1]Berkey, C. P., and Morris, F. K., *loc. cit.*, p. 126.
[2]Andersson, J. G. 1923. "Essays on the Cenozoic of Northern China." Mem. Geol. Surv. China, Ser. A, No. 3.

those of Lower Miocene age is inconspicuous, may correspond to the Mongolian peneplane developed on the hard rocks.

Summarizing these relations, it seems possible that the Mongolian peneplane may prove to be the surface upon which the oldest Lower Cretaceous sediments were laid down (Fig. 9); but if so, it could not be the surface upon which were deposited such sediments as the Ardyn Obo formation (Oligocene) and the P'ang Kiang formation (Miocene or later). But it seems more likely to us that the pre-Cretaceous peneplane has been destroyed everywhere, except (1) where it is still covered by basin sediments (Fig. 10), or (2) where it has been re-exposed, in comparatively recent time, by the removal of its sediments. In this case the Mongolian peneplane would be much younger than the pre-Cretaceous, and might have been completed in Tertiary time, perhaps in the Miocene.

The conditions under which the Gobi peneplane was formed, and the date of its completion are questions of some difficulty. Since late Pliocene beds are beveled by this surface at Hung Kureh, the peneplane must have been formed during the Pleistocene. Its recency is also attested by its extraordinarily smooth surface, undissected save for the hollows that represent the P'ang Kiang stage of erosion. Part of the difficulty lies in the question, how such widespread peneplanation could have been accomplished in a region as uplifted as the interior of Asia must have been during the Pleistocene, which was undoubtedly a period of mountain growth. East of Uskuk Mountain in the piedmont region north of the Altai, the Gobi peneplane is domed or arched, and is carved into an intricate network of gullies that in some places are well-developed badlands. Clearly the Gobi peneplane is here being destroyed, not formed, at the present time. The fresh badland bluffs bordering the P'ang Kiang lowlands in so many parts of Mongolia show that everywhere the Gobi peneplane is being destroyed rather than made in the present cycle, and that both wind and running water are agents of its destruction.

Relation between the Gobi Peneplane and the Lowlands of the P'ang Kiang Stage.—As there is no doubt that the P'ang Kiang hollows are younger than the Gobi peneplane, the only problem is their mode of origin. A paper on this subject will be offered shortly, and it must suffice here to give only a brief description.

The hollows never were the beds of large lakes, though small shallow playa basins lie scattered on their broad floors. There is commonly a shelf or terrace in the hollow, but no sign of beaches, bars, wave-cut cliffs or delta terraces that might indicate the former presence of large lakes. The bluffs that form the descent from Gobi upland to P'ang Kiang

floor may be fairly smooth, or may be carved into badlands by innumerable short gullies, and these two contrasting conditions may be present on the same bluff within a few miles. We believe that the hollows are the result of the combined action of wind and running water. According to this view, the first stage of development was a deflation hollow, or blowout, made by the wind. But when it became deep enough to reach moisture that might encourage vegetation, the rate of deepening by wind was decreased, while erosion of the surrounding bluffs that walled in the hollow was carried on, intermittently, in the rainier seasons, by short

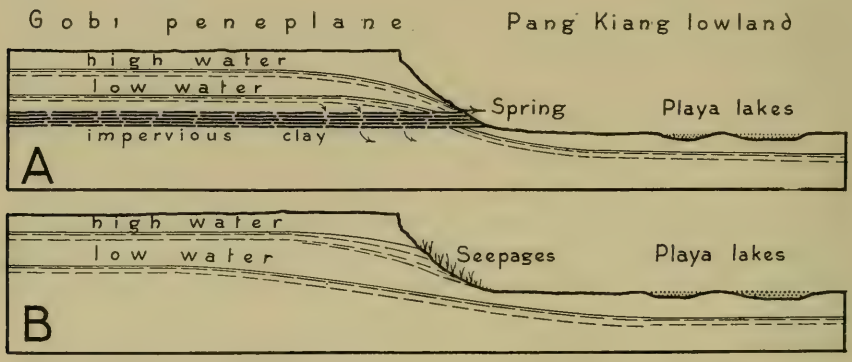

Fig. 11. Two diagrams illustrating the distribution of ground water in the sediment basins.

The vast gravelly surface of the Gobi peneplane absorbs water readily into the porous sediments. In time of high groundwater level, a series of springs or seepages, or both, appears at the cliff front to reinforce whatever rainwash there is. Thus a series of short, steep gullies is developed, as shown in figure 8. The sediment washed out of these gullies is spread over the bottom of the hollow and, when dried, is largely carried away by the wind.

streams supported by springs and seepages. The vast area of the Gobi upland, with its gravel surface, readily absorbs the rain and melting snow, while the broad shallow fill of porous sediments acts as a reservoir of groundwater. When seasons of exceptional rainfall raise the water-table, dissection of the cliff-front becomes active through the escape of spring waters (Fig. 11). The washed-out material is spread in thin sheets upon the floor of the hollow, where, through the long dry season, it is subject to the work of powerful winds. The upland near the hollows, especially on the southern and eastern sides, is in many instances covered with sheets of dune sand. We believe that water is the chief agent of erosion of the cliff, while wind is the chief agent of complete removal of loose material from the floor of the hollows.

Comparison with Other Regions.—As yet, data are not available to us to show whether the Russian geologists have published papers

dealing with the peneplanes of the northern country. In China, the classic work of Bailey Willis[1] and the more recent studies by Andersson[2] offer means of comparison, though as yet it is too early to seek an actual correlation in physiographic stages. We offer for brevity's sake the stages recognized by Bailey Willis as revised in part by Andersson:

1. The Pei T'ai stage.—Early Tertiary—"We take this broad flat form to represent a stage of erosion to advanced old age, the nearest approximation to a peneplain which we have found in the course of our journey."[3]

2. "T'ang Hsien stage (Pliocene).—Deposition of gravels and clays with the Hipparion fauna. Landforms of advanced maturity.

3. "Fen Ho stage (Early Pleistocene).—Earth movements and subsequent revival of vertical erosion.

4. "Ma Lan stage (Middle Pleistocene).—Cold arid climate. Deposition of valley gravels and æolian loess with *Elephas* sp.

5. "Pan Chiao stage (Late Pleistocene).—Climate semiarid, abundant summer rains. Dissection of the valley gravels and primary loess. Formation of redeposited gravels and loess, with *Bos* sp., *Ovis* sp. and *Cervus* sp."[4]

These may tentatively be compared with the stages recognized in Mongolia, as follows, placing the oldest stages at the bottom of the column:

	China	Mongolia
8	Modern dissection	Modern dissection
7	Pan Chiao dissection	P'ang Kiang dissection
6	Ma Lan, loess stage	Gobi peneplane
5	San Men,[5] pluvial epoch (valley gravels)	Gobi peneplane
4	Fen Ho uplift	Warping and uplift
3	T'ang Hsien, partial peneplanation	Rock terraces
2	Pei T'ai peneplane	Mongolian peneplane Khangai peneplane ?
1	Monadnocks	Monadnocks

ADDENDUM

After this paper had been sent to press, the authors read V. A. Obruchev's essay "The Gateway to China,"[6] in which the great Russian geologist describes a very perfect upland peneplane beveling the mountains of western Dzungaria. Several photographs of this ancient surface are figured.

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[1]Willis, Bailey, Blackwelder, Eliot, and Sargent, R. H. 1907. "Research in China." Carnegie Instn. Wash., Pub. 54.

[2]Andersson, J. G. 1920, quoted by Yih, L. F. 1920. "Geology of the Western Hills of Peking." Mem. Geol. Surv. China, I, pp. 65–77.

[3]Willis, B., *loc. cit.*, p. 237, and Pls. XXXII, XXXIII, XXXV and Atlas sheet E I.

[4]Andersson, J. G. 1920, quoted by Yih, L. F. 1920. "Geology of the Western Hills of Peking." Mem. Geol. Surv. China, I, p. 74.

[5]Ting, V. K. 1923, quoted by Andersson, J. G. 1923. "Essays on the Cenozoic of Northern China." Mem. Geol. Surv. China, Ser. A, No. 3, p. 117.

[6]Obruchev, V. A. 1915. "Votora v'Kitai. Geographicheski i geologicheski ocherk pogranichnoi Dzungari." ("The Gateway to China. Geographical and geological sketch of the boundary of Dzungaria). Izvestia Imp. Russ. Geogr. Soc., LI, No. 5, pp. 277–322, with teotonic map and 5 plates. (St. Petersburg.)

AMERICAN MUSEUM NOVITATES

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THREE NEW THEROPODA, PROTOCERATOPS ZONE, CENTRAL MONGOLIA[1]

BY HENRY FAIRFIELD OSBORN

In 1923, in the red Djadochta sandstone at Shabarakh Usu, were discovered three remarkable new types of small dinosaurs related to the Theropoda. All three types are approximately of the same geologic age, namely, the life zone which we now regard as near the beginning of Upper Cretaceous time. The skulls are entirely dissimilar and extraordinarily interesting.

The first (Fig. 1) of the typical megalosaurian type, although of small size, seems to have been an alert, swift-moving carnivorous dinosaur to which the generic name *Velociraptor* is applied.

The second (Figs. 3, 4), although megalosaurian and provided with a row of teeth, was at first mistaken for the skull of a bird, owing to its long slender rostrum; it may prove to have avian relationships; hence we name it *Saurornithoides*, the "birdlike theropod."

The third (Figs. 6, 7) is a short skull, entirely toothless like the Ornithomimidæ, which was found lying directly over a nest of dinosaur eggs, separated only by four inches of friable sandstone; hence we name it *Oviraptor*, the "egg seizer." The fore limb found with this skull is clearly related to the Ornithomimidæ.

The actual proportions of these three skulls are well displayed in the accompanying figures (Figs. 1, 3, 6 and 7) to a one-half scale.

Velociraptor mongoliensis, new genus and species

TYPE.—Amer. Mus. 6515, skull and jaws, one front claw and adjoining phalanges. Djadochta beds at Shabarakh Usu, August 11, 1923, Field No. 377, collector P. C. Kaisen.

GENERIC CHARACTERS.—Skull and jaws of diminutive megalosaurian type. Cranium abbreviated; orbits greatly enlarged; face elongated; four fenestræ in the side of the cranium, one fenestra in the jaw. Teeth recurved, serrate on one or both borders, alternating in replacement; 3 ? + in premaxillaries, 9 ? + in maxillaries, 14 in dentaries.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 32.

SPECIFIC CHARACTERS.—Ungual phalanges very large, laterally compressed, strongly recurved, super-raptorial in type.

This skull was found in the soft sandstone matrix lying alongside a skull of *Protoceratops andrewsi*. Although slender and diminutive, it is none the less of typical megalosaurian or theropod type, suggesting a family relationship to the Megalosauridæ. The ten or twelve sharply recurved teeth are strongly serrate on the posterior border, less serrate on the anterior; thirteen to fourteen in number in each jaw, somewhat homodont or similar in form, although differing in size, recurvature and serration; irregular or alternating in replacement, so that the wide gaps between the recurved crowns are perfectly adapted to the sudden seizure of light and swift-moving prey; sharply compressed, strongly recurved phalanges facilitating the holding of the prey; the long rostrum and wide gape of the jaws indicate that the prey was not only living but of considerable size.

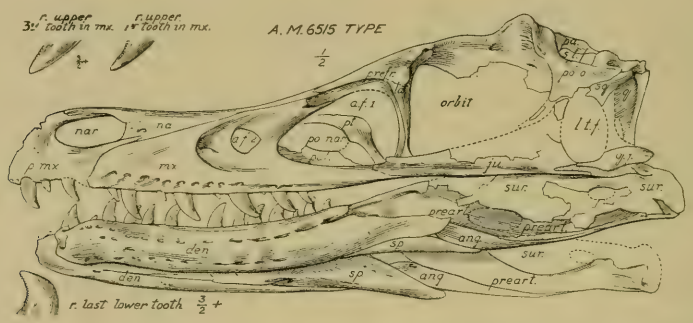

Fig. 1. Type skull and jaws of *Velociraptor mongoliensis* (Amer. Mus. 6515).
From the Djadochta formation, Protoceratops zone, central Mongolia. One-half natural size.
Enlarged maxillary and mandibular teeth: (Above) first tooth in maxilla, double serration; third tooth in maxilla, single serration. (Below) posterior tooth in dentary, single serration. $\frac{3}{2}$ + natural size.

MEASUREMENTS

Skull, length over all, occiput to premaxillaries	176 mm., est.
Facial length, anterior border of orbits to premaxillaries	111
Cranial length, anterior border of orbits to occiput	65
Faciocranial index	170%
Mandibular length, tip of dentaries to back of surangular	175

These measurements indicate that the face is relatively much longer (index 1.70) than the cranium, that the postorbital region of the cranium is extremely abbreviated, that the jaws are excessively long and slender. The post-temporal region is of the typical diapsid type with two fenestræ, supratemporal (s.t.f.) and laterotemporal (l.t.f.). There is a

very large antorbital fenestra (a.f.1) and a smaller antorbital fenestra (a.f.2). With the aid of Prof. W. K. Gregory, the following cranial elements have been made out: quadrate, quadratojugal, squamosal, parietal, postorbital, jugal, prefrontal, lachrymal, palatine, nasal, maxillary, premaxillary; in the jaw, surangular, prearticular, angular, splenial, dentary.

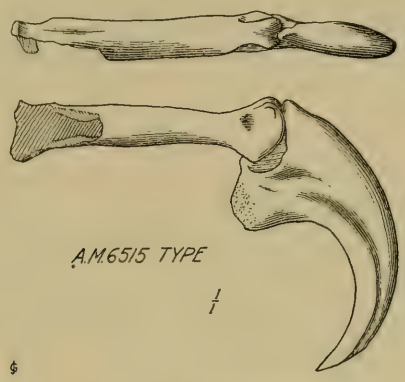

Fig. 2. Phalanges of *Velociraptor mongoliensis* associated with type skull and jaws (Amer. Mus. 6515). Natural size.

By comparison with *Allosaurus* (cf. Gilmore, 1915), these phalanges probably belong to the enlarged Digit I of the manus, namely, 1 ph., 2 ph. (Upper) viewed from above. (Lower) viewed from the side.

Saurornithoides mongoliensis, new genus and species

Type.—Amer. Mus. 6516, skull and jaws found in a concretion lying on the surface with bone and teeth exposed and much weatherworn; nearby in another concretion a series of vertebræ with pelvis, parts of hind limb and pes which may belong to the same individual as the skull. Collected by the Chinese assistant, Chih, July 9, 1923, Field No. 256, Djadochta beds at Shabarakh Usu.

Generic Characters.—A diapsid and probably theropod reptile with five craniofacial fenestrations and one mandibular fenestration; nineteen maxillo-premaxillary teeth, practically homodont, fairly uniform in dental replacement; not of active raptorial type; teeth serrate only on posterior borders.

Specific Characters.—Teeth flattened, serrate on posterior borders only, diminishing in size from the first to the fourth premaxillary tooth, increasing in size from the first to the tenth maxillary tooth; uniform in replacement, closely compacted below; crowns recurved, subacutely pointed.

When first discovered, the type skull (Fig. 3) was partly covered with sand and largely worn by the action of the drifting sand. Its long pointed rostrum strongly suggested the skull of one of the toothed birds, but it has since proved to be on the reptilian or megalosaurian side. The name *Saurornithoides* is assigned, signifying the "saurian with birdlike rostrum." For avian character, one naturally examines the quadrate

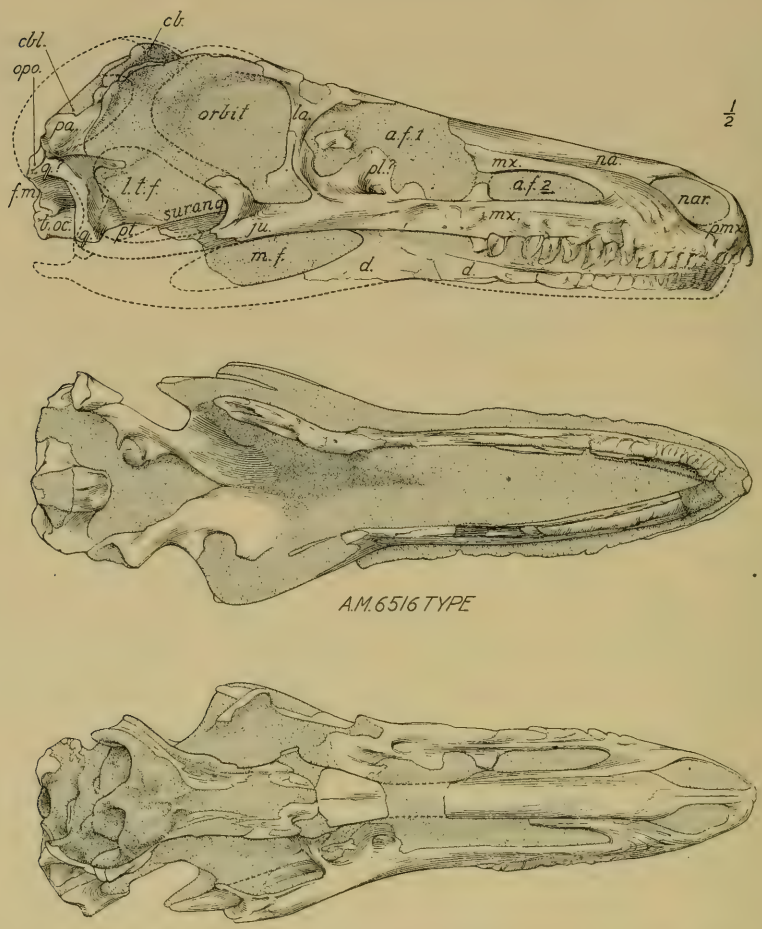

Fig. 3. Type cranium and jaws of *Saurornithoides mongoliensis* (Amer. Mus. 6516), Protoceratops andrewsi zone, Djadochta formation, collection of 1923. All figures one-half natural size.

(Upper) right lateral view of cranium and jaws as embedded in the Djadochta sandstone indicated by dots.

(Middle) palatal view of cranium, showing inferior view of dentaries, palatines, pterygoids, posterior nares and basioccipitals.

(Lower) top view of cranium as embedded in the sandstone. The walls of the brain case, including the cerebrum and cerebellum region, are clearly indicated.

which appears to have movable articular surfaces with the parietal above and quadratojugal below; but this point awaits confirmation. The fenestration of the skull is of the diapsid type, resembling in its five openings on each side the typical megalosaurian *Velociraptor* described above, namely, the supratemporal, laterotemporal (l.t.f.), antorbital

(a.f.1), second antorbital (a.f.2), narial (nar.); it has also apparently a large mandibular fenestra (m.f.) behind the dentaries. With the exception of the fairly free borders of the quadrate (q.), the bony sutures seem to be chiefly closed and the following elements are made out mainly by their anatomical position: parietal (pa.), quadrate (q.), basioccipital (b.oc.), pterygoid (pt.), jugal (ju.), lachrymal (la.), palatine (pl.?), maxillaries (mx.), premaxillaries (pmx.), dentaries (d.). Above the parietals is observed an imperfect cast of the cerebrum (cb.) and of the cerebellum (cbl.).

Fig. 4. Diagram of seven anterior maxillary teeth of the left side of *Saurornithoides mongoliensis* type, beneath the anterior nares (nar.) and the antorbital fenestra (a.f.2), showing deep serrations on the posterior border. Three times natural size.

Dentition.—The teeth are subhomodont or of similar shape but differ widely from those of *Velociraptor* in their uniform replacement, the summits of the fifteen crowns of the maxillary teeth being approximately on the same level. It is difficult to determine the exact number or characters of the teeth, owing to the severe attrition of the dental series. There are apparently four premaxillary and fifteen maxillary teeth, nineteen superior teeth in all. This indicates that *Saurornithoides* had different feeding habits from *Velociraptor;* it was less adapted to seizing alert, swift-moving prey; it may possibly have been an egg feeder, namely, ovivorous. We must await the evidence afforded by the limbs.

The inferior view of the skull apparently displays the surface of the partly damaged jaws, the dentaries and the wide closure of the posterior nares by the union of the pterygoid plates. The backward extension of the posterior nares and the union of the pterygoid are frequently an adaptation to aquatic life; it is possible, therefore, that *Saurornithoides* may have had an aquatic habitat, a point to which the limbs might bear testimony. The fragment of hind limb and left pes (Fig. 5) found in a concretion near the type skull is of cursorial and raptorial type. Although much fractured and weathered, the four digits exhibit the following characters: D.I, 2 ph., partly compressed; D.II, 3 ph., partly compressed; terminal claw 30 mm., recurved; D.III enlarged, 3+ ph.,

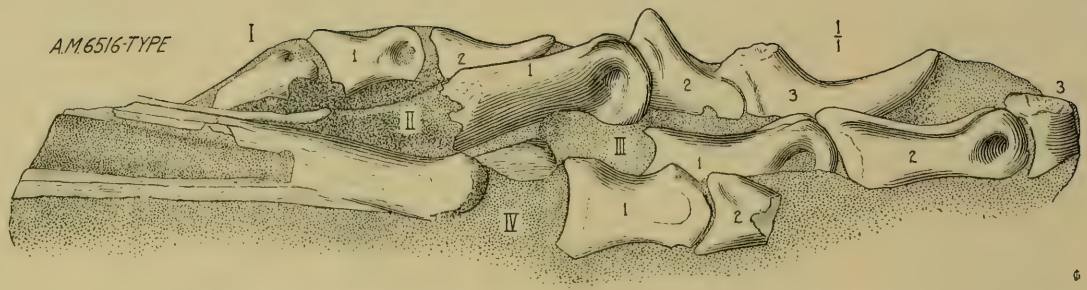

Fig. 5. Type of *Saurornithoides mongoliensis* (Amer. Mus. 6516). Portion of left pes lying supine. Natural size.

Found with pelvis and hind limb in a concretion lying near the concretion containing the type skull of *S. mongoliensis* and probably belonging to the same individual.

terminal wanting; D.IV, 2+ ph., two terminals wanting; D.III apparently the largest. These appear to be of typical megalosaurian type. Weatherworn vertebræ in concretion are of cursorial not aquatic adaptation.

MEASUREMENTS

Length of skull, basioccipital to premaxillaries	192 mm.
Length of skull, occipital to anterior border of orbits	67
Length of face, anterior border of orbits to tip of premaxillaries	125
Faciocranial index	187%
Space occupied by dental series	73

From the above measurements it appears that the proportions of the face to cranium (187%) are approximately similar to those of *Velociraptor* (170%). The cranium as a whole is greatly elongated and the rostrum depressed toward the extremity. The apparent tapering and shallowness of the anterior part of the cranium are partly due to the fact that the lower jaws are thrust in between the upper, thus concealing the dental border and all the inferior teeth.

CONCLUSION.—Our conclusion, from the imperfectly preserved type skull and associated type hind limb, is that *Saurornithoides mongoliensis*, despite its elongate rostrum and flattened teeth, was a small cursorial theropod, more sluggish than *Velociraptor*, which was swift and raptorial in habit, but remotely related to it.

Oviraptor philoceratops, new genus and species

TYPE AND LOCALITY.—Djadochta beds at Shabarakh Usu, skull, jaws, cervical vertebræ and one fore limb, collected by George Olsen, July 13, 1923, Field No. 268 (Amer. Mus. 6517).

GENERIC CHARACTERS.—A diapsid reptile with eight craniofacial and mandibular fenestrations. Cranium exceeding facial region in length; entirely edentulous; probably related to the edentulous Ornithomimidæ. Skull extremely abbreviate; orbit and fenestrations exceptionally large. A large interclavicle. Manus tridactyl; metacarpals abbreviated; digits irregularly elongated as in the Ornithomimidæ; elements of digits not compressed laterally.

SPECIFIC CHARACTERS.—Faciocranial index 70%. Lower jaw with greatly elevated mandibular border and two mandibular fenestræ; prominent bony eminence above the rostrum. Scapula extremely elongate. Humerus, ulna and radius subequal. Digit II extremely elongate, D.I and III relatively abbreviate.

The unique toothless cranium, which forms the type of *Oviraptor philoceratops*, was found by Mr. George Olsen embedded in a nodule of reddish sand, which after careful preparation in the American Museum laboratory yielded the shattered appearance illustrated in figure 6. The upper figure shows the left side of the shattered type cranium of *Oviraptor;* the lower figure shows the right side of this shattered

Fig. 6. Right and left aspects of type skull of *Oviraptor philoceratops* (Amer. Mus. 6517) exactly as it lay in the matrix, the shattered and widely separated condition of the bones as they appear embedded in the sandstone indicated by dots. One-half natural size.

cranium. Both figures correspond exactly with the type as it now appears in the matrix. Through very careful comparison of the bony elements represented on the right and left sides respectively, it proved possible to make the complete restoration of the right side of the cranium shown in figure 7. This cranium exhibits the following openings or fenestræ: (1) Supratemporal fenestra, exposing the parietal (pa.). (2) Latero-temporal fenestra, between the squamosal and jugal arches (l.t.f.). (3) Orbit, of large size, in mid-cranial region. (4) Antorbital fenestra (a.o.f.1); antorbital fenestra (a.o.f.2). (5) Anterior nares (nar.). (6) Mandibular fenestra (md.f.1); mandibular fenestra (md.f.2).

Characters.—This eight-fenestrated cranium is a marvel of lightly arched skull structure; the sutures are mostly closed; consequently the determination of the following cranial components by Professor Gregory is largely according to position and not according to sutures, namely: parietal, squamosal, opisthotic, quadratojugal, jugal, postorbital, frontal, maxillary, nasal. Sutural separation is indicated between the typical components of the lower jaw. The most remarkable feature, next to fenestration, lightness of the cranial arches and absence of cranial sutures, is the form of the skull and jaw. The cranium, vertically deep posteriorly, is shallow anteriorly to admit the elevated dentary portion of the jaw; the jaw, very shallow posteriorly, is vertically deep anteriorly, thus rising to oppose the shallow portion of the cranium.

Habits.—The generic and specific names of this animal, *Oviraptor*, signifying the "egg seizer," *philoceratops*, signifying "fondness for ceratopsian eggs," may entirely mislead us as to its feeding habits and belie its character. The names are given because the type skull (Amer. Mus. 6517) was found lying directly over a nest of dinosaur eggs, the one photographed being actually separated from the eggs by only four inches of matrix. This immediately put the animal under suspicion of having been overtaken by a sandstorm in the very act of robbing the dinosaur egg nest.

This animal differs as widely as possible from *Velociraptor* and *Saurornithoides*, first, in the extreme abbreviation and depth of its skull, second, in its relatively long cranial and facial region, third, in the extraordinary fenestration of the side of the skull and jaws, there being eight fenestræ or openings in all, and, fourth and most important, the entire absence of teeth. The latter character removes it from the Megalosauridæ, to which we might refer the two skulls previously described, and relates it to the Ornithomimidæ, the toothless dinosaurs, although it differs generically from either *Ornithomimus* or *Struthiomimus*.

MEASUREMENTS

Length of skull, opisthotics to maxillaries	179 mm.
Length of cranial region, opisthotics to antorbital bar	111
Length of facial region, antorbital bar to premaxillaries	78
Faciocranial index	70%
Depth of skull, summit of parietals to angulars	112

These measurements and proportions present the widest possible contrast to those of the typical megalosaurian skull. The abbreviation of the facial region is especially distinctive. It is probable that the

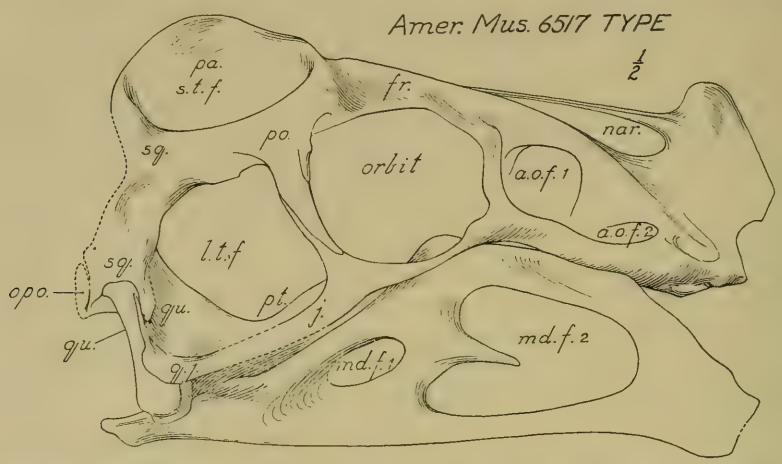

Fig. 7. *Oviraptor philoceratops* skull (Amer. Mus. 6517) reconstructed from right and left sides of original specimen as shown in Fig. 6. One-half natural size.

rostrum was sheathed in a horny beak, but there is no evidence of a predentary. Were it not for the evidence afforded by the fore limb and vertebræ, we should be completely at a loss to determine the relationships of this animal.

FORE LIMB.—Fortunately there was found associated with the skull the anterior portion of the skeleton (Fig. 8), including cervical vertebræ (C.V.), thoracic ribs (R), interclavicle (Ic.), the greater part of the left fore limb and supine right manus and portion of the prone left manus. So far as at present excavated from the rock, these are shown in figure 8. The interclavicle (Ic.) lies near its union with the extremely long and slender scapula (Sc.). The right manus lies supine, showing the palmar surface of Mtc. I (I) with the elongate first phalanx (1) and extremely long laterally compressed phalangeal claw (2); next lies Mtc. II (II) with three elongated phalanges (1, 2, 3), the terminal claw showing just

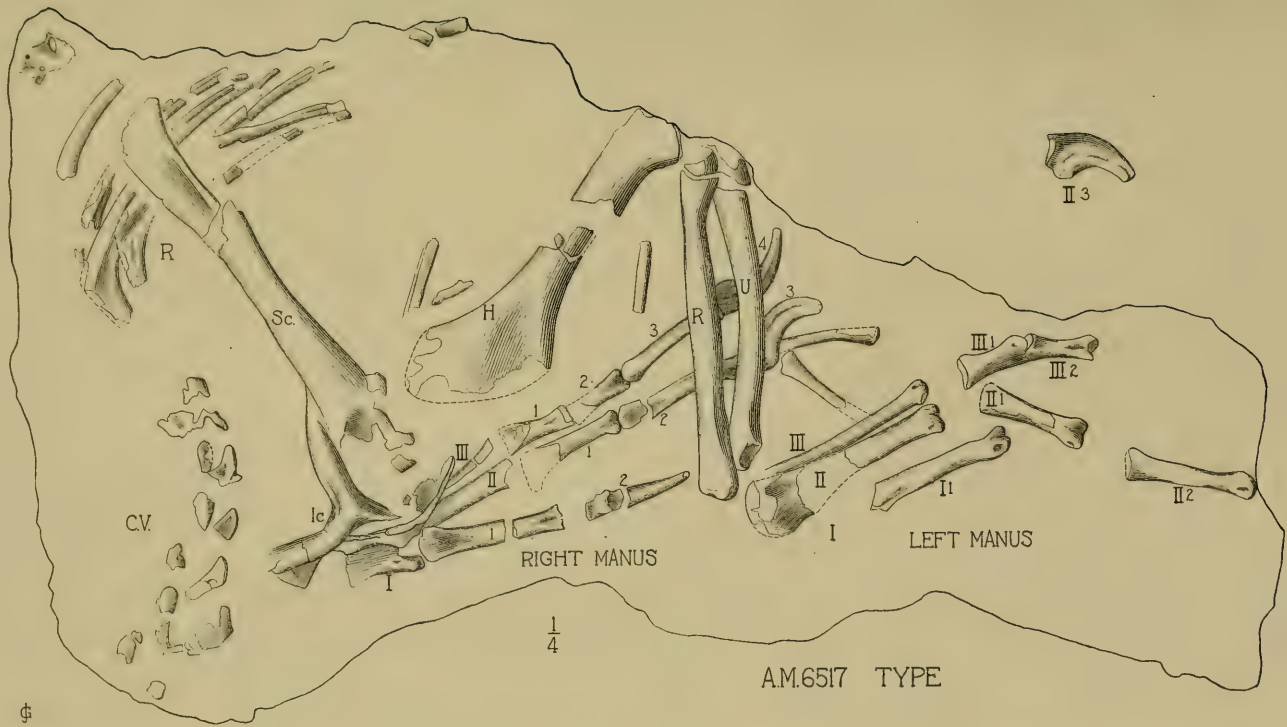

Fig. 8. Portions of left fore limb, also left and right manus of *Oviraptor philoceratops*. One-fourth natural size.
Ic. =interclavicle. Sc. =scapula. H =humerus. I, II, III, =right manus with phalanges supine; left manus with phalanges prone.

beneath the ulna; next is the more slender Mtc. III (III) with four phalanges (1, 2, 3, 4). Fortunately in the more scattered left manus, which lies prone showing the dorsal surface, the second enlarged metacarpal (II) is preserved, also the reduced third metacarpal (III); what is presumed to be the third phalanx of the third digit (III, 3) was exposed at the edge of the block; the isolated claw (II, 3) was entirely weathered out and lying among the eggshell fragments on the surface.

Comparing this manus with that of *Ornitholestes* Osborn, of *Struthiomimus altus* Osborn, and of *Chirostenotes* Gilmore, as figured by Gilmore (1924, pp. 4 and 5), the extremely elongate second digit (II) of *Oviraptor* is analogous to that of *Ornitholestes* and of *Chirostenotes* rather than to that of the more symmetrical digits of *Struthiomimus*. On the contrary, the metacarpals and phalanges of *Oviraptor* are relatively broad, as in *Struthiomimus*, rather than extremely compressed laterally, as in *Ornitholestes* and *Chirostenotes*.

CONCLUSIONS

The discovery of these three new Theropoda in central Mongolia is extremely interesting and important. It tends to establish the theory that Mongolia was a highly fertile center of terrestrial dinosaur life in Lower Cretaceous times, as well as of mammalian life in Lower Tertiary times.

The three small carnivorous dinosaurs above described may be classified as follows:

Family Megalosauridæ:

Velociraptor mongoliensis, super-raptorial, certainly carnivorous; maxillodentary teeth $\frac{14}{14}$; teeth serrate on both borders.

Saurornithoides mongoliensis, raptorial, carnivorous or ovivorous; rostrum elongate; maxillodentary teeth $\frac{19}{19}$; teeth compressed, serrate on posterior borders only.

Family Ornithomimidæ:

Oviraptor philoceratops, herbivorous or ovivorous; cranium abbreviate; maxillodentary borders edentulous; manus tridactyl, attenuate.

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EUDINOCERAS, UPPER EOCENE AMBLYPOD OF MONGOLIA[1]

By Henry Fairfield Osborn

One of the most surprising and welcome discoveries of the season of 1923 was that of two superior premolar teeth which demonstrate the presence of archaic ungulates of the order Amblypoda in Upper Eocene time in Mongolia, serving as a new link with America. No Amblypoda have hitherto been found in Eurasia, excepting *Coryphodon* of the Lower Eocene of France and England.

In the Uinta B beds of northern Utah, the last surviving Upper Eocene members of the Amblypoda referable to the genus *Uintatherium* Leidy or *Eobasileus* (=*Loxolophodon*) Cope occur in the same beds with titanotheres of the genera *Dolichorhinus*, *Manteoceras* and *Metarhinus*. The Irdin Manha formation of Mongolia is more recent in age than the Uinta B beds of Utah; it is uppermost Eocene, or Uinta C.

In the Irdin Manha formation the presence of Amblypoda in the Mongolian fauna is demonstrated by the two superior premolar teeth. They belong to a new genus distinct from any of the known American or European Eocene forms hitherto described. Consequently we apply the new generic name *Eudinoceras*, the prefix "eu" signifying that the superior premolar teeth are more progressive than those of Marsh's *Dinoceras* (=*Uintatherium*), or of Cope's *Loxolophodon*, in the possession of a prominent internal cone, no trace of which is observed in the Upper Eocene American genera.

Discovery.—The first tooth (Fig. 2A, Amer. Mus. 20101) was discovered by Leader Andrews June 1, 1923, on a bench of the Irdin Manha formation, about two miles south of camp. On September 15, 1923, the author joined the party and, expressing the most lively interest in this tooth, agreed with the other paleontologists that it was undoubtedly one of the Amblypoda and that it established the presence of this order in Mongolia. It was at first compared with the Lower Eocene *Coryphodon*, but its closer resemblance to the Upper Eocene amblypods soon became apparent. The discovery was so important that Leader

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 33.

Andrews was photographed on September 17 on the spot where the first tooth was picked up (Fig. 1).

The author had a strong presentiment that he must stop, at a point eight miles to the south of Andrews's find, and examine a small exposure of the Irdin Manha. He said to Mr. Andrews, "I am going to find another *Coryphodon* tooth"; he walked to the bluff a hundred yards distant, traversed about seventy-five feet of the middle of the exposure, and there at his feet lay a second tooth of exactly the same character (Fig. 2B, Amer. Mus. 20102), belonging to an animal of the same size but from the opposite side of the upper jaw! This led to the author's being photographed (Fig. 1). Thus double confirmation was obtained of the presence of the Amblypoda in Mongolia; the explanation of this remarkable telepathic coincidence is left to the psychologist.

Eudinoceras mongoliensis, new genus and species

Type.—A third or fourth superior premolar of the right side (Amer. Mus. 20101), collected by Roy C. Andrews, June 1, 1923.

Paratype.—A third or fourth superior premolar of the left side (Amer. Mus. 20102), collected by Henry F. Osborn, September 17, 1923.

Horizon.—Irdin Manha formation, Protitanotherium mongoliense zone, southeastern Mongolia.

Both these specimens are from the Irdin Manha formation, Upper Eocene.

Generic Characters.—*Eudinoceras,* from the Greek εὐ, intensive, δεινός, terrible, κέρας, horn. The superior premolars are intermediate in structure between the *Coryphodon* and the *Dinoceras* (= *Uintatherium*) premolars, namely, with a prominent internal cone which is present in *Coryphodon* and entirely lacking in *Dinoceras.* Main portion of crown yoke-crested, as in *Coryphodon* and *Uintatherium;* broad anterior and posterior cingula.

Specific Characters.—Type (Amer. Mus. 20101), ap. 26 mm., tr. 36 mm., transverse exceeding anteroposterior diameter. Length-breadth index .72. Paratype (Amer. Mus. 20102), ap. 27 mm. est, tr. 41 mm. Length-breadth index .66 est. This may be expressed as follows:

Eudinoceras mongoliensis type: r.p^3, ap. 26 mm., tr. 36 mm., index .72.

Eudinoceras mongoliensis paratype: l.p^3, ap. 27 mm. est., tr. 41 mm., index .66 est.

The length-breadth indices of these premolar crowns, namely, .72 and .66, as compared with the index of p^4 of *Dinoceras mirabile* type, ap. 23 mm., tr. 30 mm., index .77, indicate that in *Eudinoceras* the premolars are relatively shorter and broader than in *Dinoceras mirabile.* Accordingly we anticipate that in *Eudinoceras* the skull will be found to be shorter than in *Dinoceras.* This suggests the possible relationship of *Eudinoceras* to the genus *Bathyopsis* Cope in which the jaw is relatively

Fig. 1. Discovery of *Eudinoceras mongoliensis* teeth.

(Above) Roy C. Andrews standing on the spot where the type was found, June 1, 1923.

(Below) Henry F. Osborn kneeling on the spot where the paratype tooth was found, September 17, 1923.

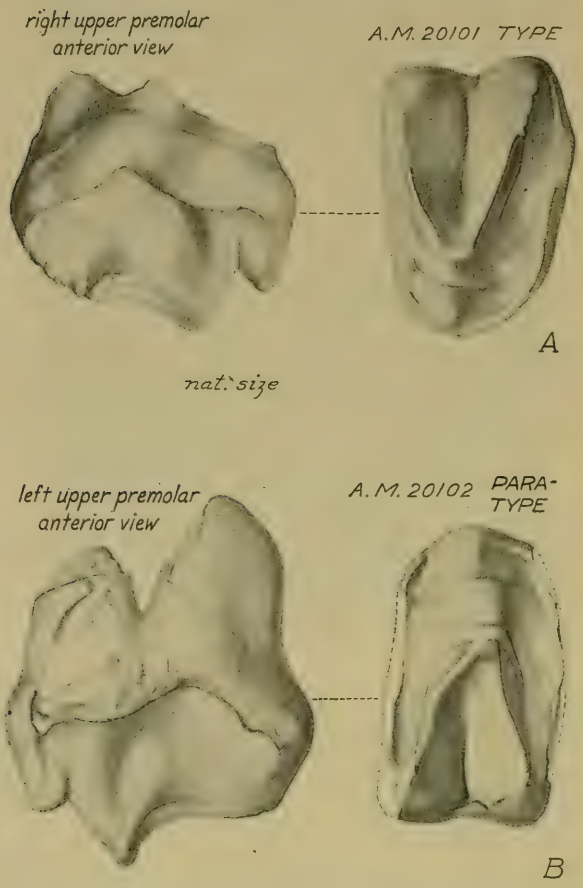

Fig. 2. A, Type of *Eudinoceras mongoliensis* (Amer. Mus. 20101), a third or fourth superior premolar of the right side: crown view (right), anterior view (left). Natural size.

B, Paratype (Amer. Mus. 20102), a third or fourth left superior premolar: crown view (right), anterior view (left). Natural size.

short and deep; the name *Bathyopsis* is derived from the Greek βαθύς, deep, ὄψις, face, signifying deep-faced. We must, however, await the discovery of a cranium of *Eudinoceras* before we can determine whether it has a short-faced, bathyopic, cranium, harmonic with its relatively short and broad teeth.

Meanwhile we may observe that none of the Upper Eocene Dinocerata we have hitherto known, namely, *Uintatherium*, *Dinoceras*, *Eoba-*

sileus (=*Loxolophodon*), possesses the prominent internal cone of the premolars characteristic of *Eudinoceras*. The homologue of this cone is apparently a tritocone or anterointernal premolar cusp, as is observed, for example, in the Lower Eocene *Coryphodon testis* $p^{2\text{-}4}$ (Osborn, 1898, p. 204, Fig. 22).

The above type and paratype figures, reproduced precisely natural size, represent the characters of this opposite pair of teeth. The paratype (tr. 41 mm.) is little broader than the type (tr. 36 mm.) and may represent either a larger individual, or the two teeth may be successive instead of directly opposite, namely, the type may represent a p^3 of the right side, while the paratype may represent a p^4 of the left side.

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ANDREWSARCHUS, GIANT MESONYCHID OF MONGOLIA[1]

By Henry Fairfield Osborn

Dedicated to the leader of the Third Asiatic Expedition, Mr. Roy Chapman Andrews, are the name and description of this giant omnivorous carnivore of the Upper Eocene of the Irdin Manha formation of Mongolia. When first discovered by Mr. George Olsen, it was hailed by Mr. Andrews as a carnivore, a supposition which proved to be correct.

Later, its surpassing size led to the view that it was a member of the giant pig family represented by *Entelodon* in Europe and by the Entelodontidæ in North America,—giant omnivorous pigs with elongate skulls; in fact, the cranial and facial proportions of *Andrewsarchus* are remarkably similar to those of *Entelodon* of the Oligocene and of *Dinohyus* of the Lower Miocene of North America, doubtless because of similar omnivorous feeding habits.

An outline sketch of the skull was sent in a letter to the Museum, from which Dr. W. D. Matthew immediately observed its real affinity to the primitive Creodonta of the family Mesonychidæ. When the specimen reached the laboratory, it was compared with the giant *Mesonyx* (*Harpagolestes*) *uintensis* of the Upper Eocene of Wyoming (Osborn, 1895.98, p. 79, Fig. 4).

Andrewsarchus, new genus

Derived from surname "Andrews" and from ἀρχός, a leader, chief or commander. Giant mesonychid with greatly elongated facial region. Zygomata broadly expanded; face contracted behind muzzle; full eutherian dentition, thus differing from *Mesonyx* (*Harpagolestes*) in which m^3 is absent; fourth premolar, p^4, molariform, triangular, with prominent tritocone.

Andrewsarchus mongoliensis, new species

Genotypic species of *Andrewsarchus*. Type cranium (Amer. Mus. 20135), Irdin Manha formation, Mongolia. Breadth-length index of cranium, .67; faciocranial index, 1.50; basicranial length, condyles to

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 34.

tips of premaxillaries, 834 mm.; zygomatic width, 560 mm.; m^3 with metacone greatly reduced, ectoloph consisting mainly of paracone.

This is the largest terrestrial carnivore which has thus far been discovered in any part of the world. The cranium far surpasses in size that of the Alaskan brown bear (*Ursus gyas*), the largest living carnivore, which, when full-grown, weighs 1,500 lbs.; in length and breadth of skull, *A. mongoliensis* is double *Ursus gyas* and treble the American wolf (*Canis occidentalis*). It is also treble the size of its American relative

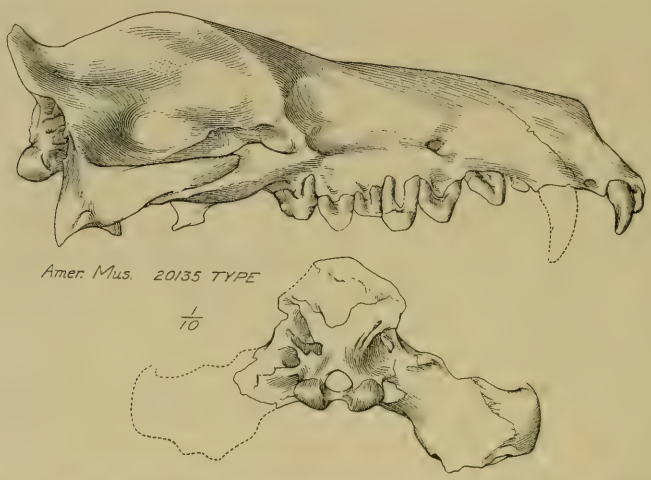

Fig. 1. Type skull of *Andrewsarchus mongoliensis* (Amer. Mus. 20135), Irdin Manha formation of Mongolia. Lateral and occipital views. One-tenth natural size.

Mesonyx obtusidens from the Middle Eocene of Wyoming and double that of *Mesonyx* (*Harpagolestes*) *uintensis* (Fig. 3) from the Upper Eocene of northern Utah, Uinta B.

Cranial Characters.—A comparison of the palate (Fig. 2) and occiput (Fig. 1) of *A. mongoliensis* (one-tenth scale) with the palate of *Harpagolestes uintensis* (Fig. 3), reproduced to one-fourth scale, brings out: (1) the great difference in size, and (2) the difference in generic and specific characters. The comparative measurements are as follows:

	Harpagolestes uintensis	*Andrewsarchus mongoliensis*
Total basal length of cranium	429 mm.	834 mm.
Width of zygomatic arches	270	560
Facial length, distance from i^1 to m^3	206	500
Cranial length, distance from m^3 to condyles	223	334

	Harpagolestes uintensis	*Andrewsarchus mongoliensis*
Zygomatic width across occipital condyles.....	71 mm.	117 mm.
Faciocranial index.....	92%	150%
Cephalic, or breadth-length index.....	63%	67%

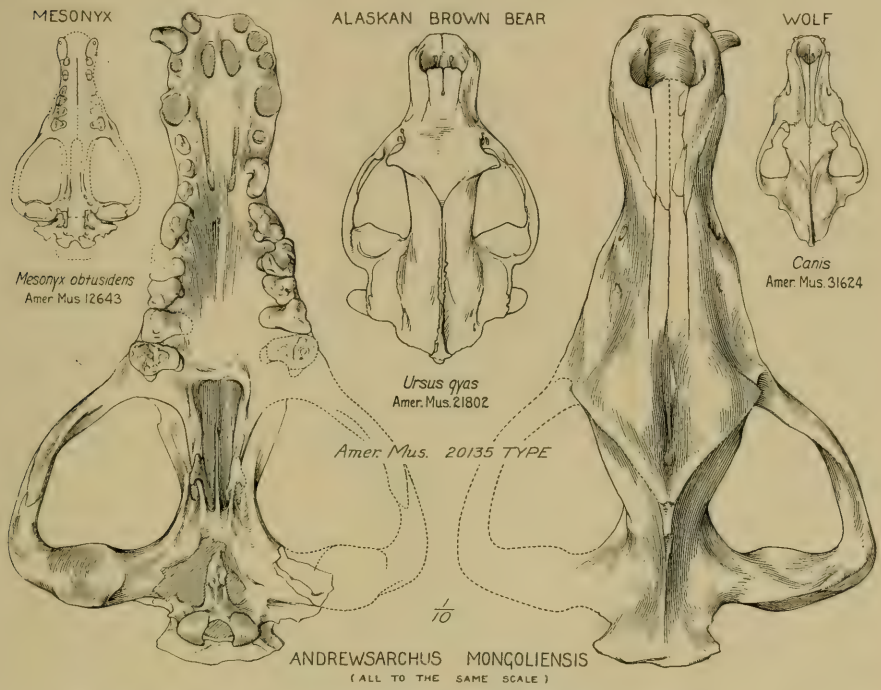

Fig. 2. Comparison of *Andrewsarchus* with *Mesonyx*, *Ursus* and *Canis*. Type cranium of *Andrewsarchus mongoliensis* (Amer. Mus. 20135). Palatal and superior views. All figures one-tenth natural size.

Cranium of *Mesonyx obtusidens* (Amer. Mus. 12643).

Cranium of Alaskan Brown Bear (*Ursus gyas*) (Amer. Mus. 21802).

Cranium of Wolf (*Canis occidentalis*) (Amer. Mus. 31624).

Dental Characters.—Type characters of *A. mongoliensis* which may prove to be of generic or specific value are the following (Figs. 1, 2):

I^2 greatly enlarged; i^3 much smaller.

Canines, superior, not preserved, of enormous size.

P^1 small, with single fang and cone.

P^2 bifanged, with single cone; ap. 46 mm., tr. 21 mm.

P^3 with rudimentary third fang, double cone, prominent protocone, no deuterocone; ap. 59 mm., tr. 37 mm.

P^4 enlarged, molariform, with prominent tritocone, three fangs; ap. 51 mm., tr. 43 mm.

M^1 somewhat smaller in size, three fangs; ap. 39 mm., tr. 42 mm.

M^2 broadly triangular, large internal fang, with prominent proto- and tritocones, deuterocone worn off; ap. 44 mm., tr. 61 mm.

M^3 prominent proto- and tritocones, rudimentary deuterocone; ap. 50 mm., tr. 66 mm.

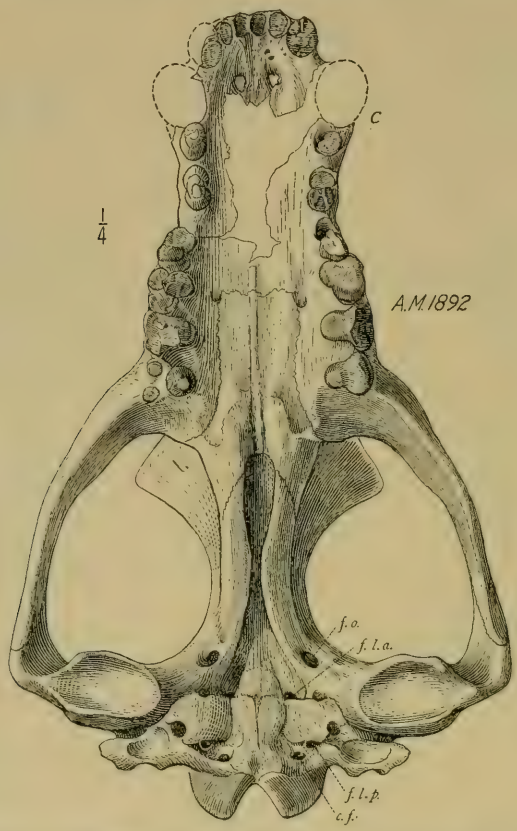

Fig. 3. Palate of *Mesonyx uintensis* S. & O. ref. (Amer. Mus. 1892), Uinta B, Utah, Dolichorhinus cornutus level. One-fourth natural size. For comparison with palate of *Andrewsarchus mongoliensis* (Fig. 2).

These measurements show that the cranium of *Andrewsarchus* (834 mm.) is nearly twice as long as that of *Harpagolestes* (429 mm.), that the zygomatic arches are twice as broad and that the facial length of *Andrewsarchus* (500 mm.) is 150% as compared with that of *Harpagolestes* (206 mm.), 92%. The face of *Andrewsarchus* is 150% of the cranium, whereas the face of *Harpagolestes* is 92% of the cranium, supporting the statement that in *Andrewsarchus* the face is relatively elongate.

Comparison with Harpagolestes.—While in nearly all dimensions double the size of its American contemporary *Harpagolestes*, *Andrewsarchus* differs also in other characters:

	Harpagolestes	*Andrewsarchus*
Incisive series	Transverse in position.	Anteroposterior in position.
Faciocranial proportions	Equal.	Face greatly exceeds cranium.
Posterior nares	Tubular alisphenoids.	Widely open alisphenoids.
Third molar	Absent.	Present.

RESTORATION

According to Scott (1913, pp. 558–560), the Mesonychidæ, prevailingly a North American family, ranged from the Paleocene to the Upper Eocene, in adaptation an analogue of the Hyænodontidæ among the Carnivora. Skeletal restorations are those of Scott (1887, Journ. Acad. Nat. Sci. Phila., IX, Pl. v, *Mesonyx obtusidens*) and of Wortman (1901, Amer. Journ. Sci., XII, Pl. viii, *Dromocyon vorax*). From these restorations the following comparisons may be made:

	Dromocyon vorax	*Mesonyx obtusidens*
Incisive teeth to back of pelvis	1272 mm. (4 ft. 2 in.)	1278 mm. (4 ft. 4 in.)
Height of shoulder above the ground	672 mm. (2 ft. 2½ in.)	576 mm. (1 ft. 10½ in.)
Basal length of cranium	318 mm.	279 mm.

Length of Body.—As the length of the cranium of *Mesonyx obtusidens* (279 mm.) is to the total body length (1278 mm.), so is the length of the cranium of *Andrewsarchus* (834 mm.) to its total body length, namely, 3820 mm. (=3 m. 82 cm. or 12 ft. 6½ in.).

Height of Body.—As the length of the skull of *M. obtusidens* (279 mm.) is to the height of the vertebræ (576 mm.), so is the length of the skull of *Andrewsarchus* (834 mm.) to the height of the vertebræ, namely, 1890 mm. (=1 m. 89 cm. or 6 ft. 2 in.).

If *Andrewsarchus mongoliensis* was proportioned in the same manner as *Mesonyx obtusidens*, it had a length from the snout to the back of the pelvis of 12 ft. 6½ in. and a height from the ground to the shoulder or middle of the back of 6 ft. 2 in. Thus in round numbers it was three times the size of *Dromocyon vorax* or of *Mesonyx obtusidens* of the Middle Eocene of Wyoming, Bridger formation.

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CADURCOTHERIUM ARDYNENSE, OLIGOCENE, MONGOLIA[1]

By Henry Fairfield Osborn

Cadurcotherium ardynense appears in the Ardyn Obo formation[2] associated with animals of Lower Oligocene age, referred to *Cynodictis*, *Schizotherium* and *Aceratherium*. In the preliminary description of *Cadurcotherium ardynense*,[3] written before the cranial characters were revealed as shown in the present paper, the generic and specific characters were vaguely stated. A restatement is now made of both the generic and specific characters of this animal.

Cadurcotherium ardynense Osborn, 1923

Type.—Amer. Mus. 19154, aged skull with complete upper dentition.

Paratypes.—(1) Amer. Mus. 20441, adult lower jaw of slightly younger age than the type. (2) Amer. Mus. 19155, cranium with complete premolar-molar dentition, of younger age, m^3 not yet in place. (3) Amer. Mus. 20444, palate with molars, old individual. (4) Amer. Mus. 20443, juvenile jaw and milk dentition. (5) Amer. Mus. 20442, limb and foot bones of other individuals; all found close together in the same quarry. According to Granger, the six or seven individual specimens, with remains of limbs, were found on the same level, in one pit, and undoubtedly belong to the same species.

Horizon.—Ardyn Obo formation, Lower Oligocene, Mongolia.

Specific Characters of *C. ardynense*.—Animals of small size, long and powerful upper and lower tusks, suboval in section; canine tusks suboval in section; incisors rudimentary or absent; lower premolars reduced to $\frac{3}{2}$; inferior molars with longitudinal greatly exceeding transverse diameter; superior molars with transverse exceeding or equaling longitudinal diameter. Facial region deep, greatly abbreviated.

As shown in the aged type (Figs. 1, 2), the skull is abbreviated, the face especially so; facial and premolar abbreviation together with great enlargement of superior and inferior tusks, a distinctive family feature of the Amynodontidæ; principal measurements of the type skull (Amer. Mus. 19154) and of the paratype skull (Amer. Mus. 19155) as follows:

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[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 35.

[2]Named and defined by Berkey and Granger in American Museum Novitates, No. 77, p. 12.

[3]Osborn, H. F. 1923. "*Cadurcotherium* from Mongolia." Amer. Mus. Novitates, No. 92, pp. 1, 2.

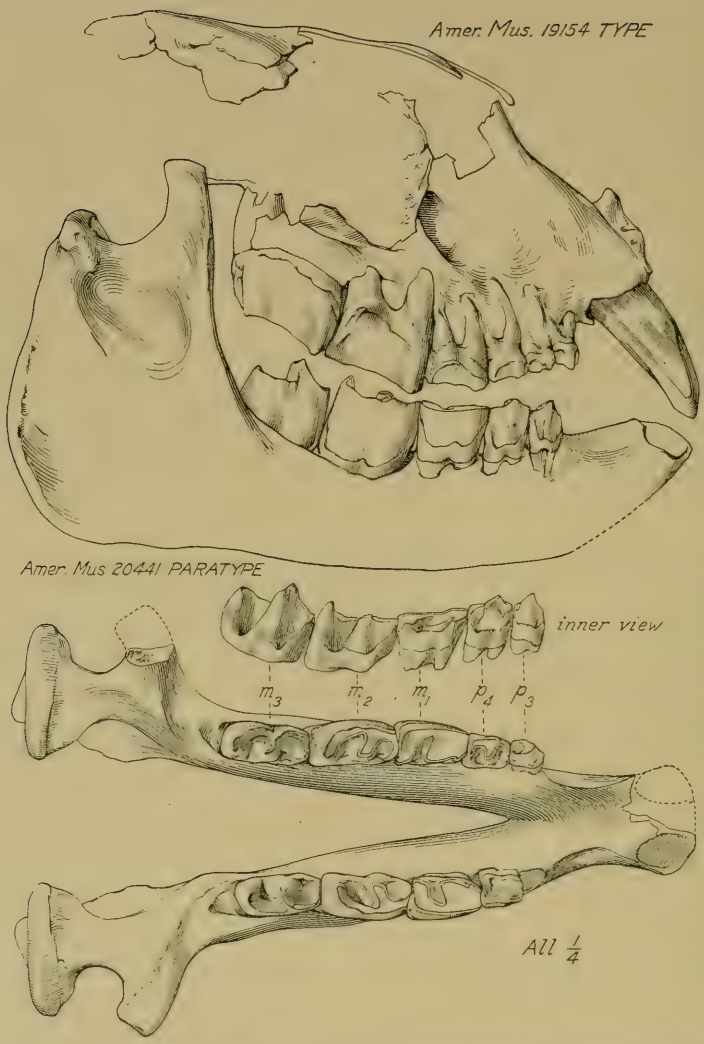

Fig. 1. (Upper figure) type skull of *Cadurcotherium ardynense* (Amer. Mus. 19154). (Lower figure) paratype jaw of same (Amer. Mus. 20441). Both figures one-fourth natural size.

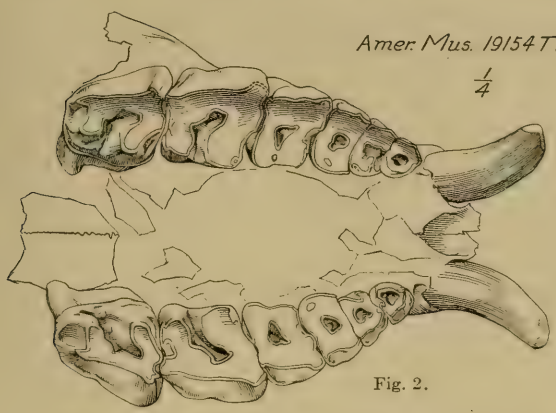

Fig. 2.

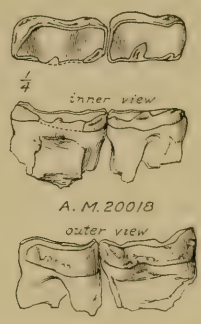

Fig. 3.

Fig. 2. Palate of type cranium of *Cadurcotherium ardynense* (Amer. Mus. 19154). One-fourth natural size.

Fig. 3. *Cadurcotherium* ? sp. (Amer. Mus. 20018), l. m_2, m_3. One-fourth natural size. These teeth are in the Barnum Brown collection of 1922, found on the Irrawaddy River, Burma, and they correspond with the species described by Pilgrim.

	Type Amer. Mus. 19154 mm.	Paratype Amer. Mus. 19155 mm.
Total length of cranium and face	....	370[1]
Length from orbit to premaxilla	123[1]	153[1]
Total depth of cranium, third molar tooth	175	165[1]
Length of lower jaw, angle to symphysis	363	....
Superior premolar-molar series	183	183[1]
Inferior premolar-molar series (A. M. 20441)	....	164
Superior premolars, p^{2-4}	56	56
Superior molars, m^{1-3}	137	132
Height of ectoloph, m^3	....	59
Height of ectoloph, m_3	55[1]	....

Fortunately the younger cranium (Amer. Mus. 19155) supplements the aged type (Amer. Mus. 19154) and gives us the complete characters of the superior and inferior dentition. In the deeply worn premolars of the type (Fig. 2), the proto- and ectoloph unite internally; in the younger cranium, when unworn, p^4 shows a separate proto- and ectoloph.

Dentition.—In the juvenile paratype jaw (Amer. Mus. 20443) the dental formula is: $Di_{\overline{1}}$ $Dc_{\overline{1}}$ $Dp_{\overline{3}}$ $M_{\overline{1}+}$. In the adult jaw (Amer. Mus. 20441) and type skull (Amer. Mus. 19154) the formula is: $I\,{}^{?}_{?}{}^{0}_{0}$ C^{1}_{1} P^{3}_{2} M^{3}_{3}.

[1]Estimated.

Thus in the young there is one pair of lower milk incisors. In the adult the evidence is doubtful; there may have been a temporary pair of incisors. The superior and inferior canines equally large, the lower tusks being rounder, the upper tusks oval anteroposteriorly; ap. 31 mm., tr. 22 mm., length 81 mm. The premolars are reduced to two lower and three upper, the formula being: $P\frac{3}{2}$; p_3 is a simple, laterally compressed crown; p_4 is submolariform; p^{2-3} have rudimentary internal crests.

The laterally compressed, extremely hypsodont crowns of the inferior molars, m_{1-3}, are generic characters of *Cadurcotherium*. In m^1 the transverse diameter (46 mm.) greatly exceeds the anteroposterior (32 mm.). In m^2 the anteroposterior diameter (46 mm.) equals approximately the transverse (56 mm.). In m^3 the anteroposterior diameter (56 mm.) equals the transverse (56 mm.). We are therefore able to define this Mongolian species with considerable accuracy.

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SERRIDENTINUS AND *BALUCHITHERIUM*, LOH FORMATION, MONGOLIA[1]

By Henry Fairfield Osborn

In a thin deposit of olive-colored clays and light gray sandstone resting on the red-banded beds of the Hsanda Gol formation at Loh, and believed to be of Lower Miocene age, were found two highly characteristic fossils:

1) Proboscidean. A fragmentary series of lower mastodont teeth (Amer. Mus. 19152) which first reveals the presence of an undoubted *Serridentinus* in Mongolia, which we name *Serridentinus mongoliensis.*

Serridentinus probably marks the arrival of a proboscidean related to the *M. angustidens* of the Lower Miocene of Europe. Osborn has recently (1923) separated the generic phylum *Serridentinus* as a medium-jawed trilophodont readily distinguished from the true *Trilophodon angustidens* phylum by the trefoil conules arising from the side of the external cones (protoconids) in the lower molars and from the side of the internal cones (protocones) in the upper molars. This trefoil characteristic is clearly displayed in the crown view of r.m_{2-3} (Fig. 1). In the true *Trilophodon angustidens,* as in *Phiomia*, the trefoil conules are directly in the center of the crown. Thus distinguished, *Serridentinus* forms a phylum parallel with *Trilophodon*, which together migrated from Eurasia into North America. Species of *Serridentinus* appear to characterize forested and swampy habitats; they are never found in exactly the same areas as species of *Trilophodon.* We conclude that *Serridentinus* had a different adaptive radiation from *Trilophodon.*

2) Rhinocerotine. The facial portion of a skull (Amer. Mus. 19185) containing three grinding teeth and perfectly preserved nasals, which we name *Baluchitherium mongoliense.*

Serridentinus mongoliensis, new species

Type.—Amer. Mus. 19152. A series of right inferior grinding teeth, p_4 (dp_4), m_2, m_3; also one left grinder, m_1 (reversed in drawing); in juvenile condition, dp_4 greatly worn, m_1 partly worn, m_{2-3} embedded in the jaw.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 36.

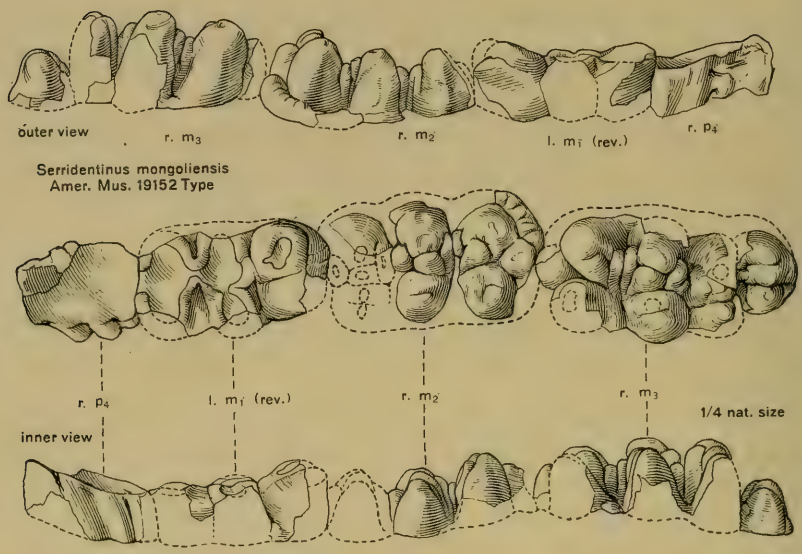

Fig. 1. Type of *Serridentinus mongoliensis* (Amer. Mus. 19152), four lower grinding teeth, p_4 (dp_4)-m_3, Loh formation, ? Lower Miocene, Mongolia.

(Upper) external view. (Middle) crown view. (Lower) internal view. All one-fourth natural size. The teeth are from the right side, except the first lower molar, l. m1 (rev.), which is from the left side.

Horizon.—Loh formation, ? Lower Miocene, Mongolia.

Locality.—Loh, near camp. Upper olive clays. Found by J. B. Shackelford, July 15, 1922, Field No. 71 (Amer. Mus. 19152).

This is one of the most welcome discoveries of the 1922 expedition, because it serves to demonstrate the arrival of what appears to be a true species of trilophodont mastodon of the phylum *Serridentinus*.

The type specimen was found in an extremely fractured condition and was restored, as shown in figure 1. It required great skill in reconstruction; the restored parts are indicated by dotted lines. The principal measurements in millimeters, all estimated, and indices (I.) are:

p_4 (dp_4)–m_3 inc. =	420e
p_4 (dp_4), much worn,	ap. 65, tr. 51, I. .78
m_1, left,	ap. 99, tr. 58, I. .59
m_2, right,	ap. 108, tr. 59, I. .55
m_3, right,	ap. 138, tr. 63, I. .46

Comparing these measurements and indices with those of the type of *Serridentinus* (*Mastodon*) *productus* Cope from the Upper Miocene of Texas, we observe the following:

	p_4 (dp_4)			m_1			m_2			m_3		
	ap.	tr.	I.	ap.	tr.	I.	ap.	tr.	I.	ap.	tr.	I.
Upper Miocene												
Serridentinus productus												
type, and referred m^3	55	43	78	93	63	68	138	75+	54	163[1]	76[1]	46[1]
?Lower Miocene												
Serridentinus mongoliensis												
type,	65[1]	51[1]	78[1]	99[1]	58[1]	59[1]	108[1]	59[1]	55[1]	138[1]	63[1]	46[1]

As compared with *S. productus*, the type of *S. mongoliensis* is a smaller animal, m_{1-3} measuring 340 mm. *S. mongoliensis* is also less progressive, each loph consisting of four conelets (by reduplication of the two primary cones, corresponding with the protoconid and metaconid in each loph), and two large trefoil conules on each side of the external cones (corresponding with the protoconid). More in detail: the crown of dp_4 is entirely worn off; the crown of left m_1 is largely worn off; in the crown of m_2 the protolophid is wanting; the metalophid has the typical structure described above, namely, four conelets, two trefoil conules; in the tritolophid the cones are less distinctly paired into conelets, there is a small anterior trefoil conule and a large posterior. In the right m_3, the protolophid has a very large anterior trefoil conule, a small posterior; the metalophid is typical, consisting of four symmetrical conelets and two symmetrical trefoil conules; the tritolophid is less progressive; the tetartolophid is depressed and consists of three main conelets. These specific characters may be verified by applying the magnifying lens to figure 1.

As shown in the comparative table above, the tooth proportions of *S. mongoliensis* are very similar to those of *S. productus;* we may thus readily designate the specific stage.

Specific Characters.—Ridgecrest formula of *S. mongoliensis:* $Dp4_{?\overline{2}}$ $M1_{\overline{3}}$ $M2_{\overline{3}}$ $M3_{\overline{4}}$. In each typical ridgecrest (e.g., the metalophid) three conelets and two trefoil conules attached to the external cones. Molar proportions as in *S. productus*.

Baluchitherium mongoliense, new species

Type.—Amer. Mus. 19185. Anterior portion of skull including right zygoma, complete orbit, frontals, nasals and portions of four grinding teeth, p^4–m^3. The type fortunately preserves the long, smooth and beautifully arched nasal bones, which, with the relatively complete smooth frontals, indicate the entire absence of horns. In profile view the facial region is similar to that of the type of *Baluchitherium grangeri*[2] except that the nasals are more prominently arched and exhibit a lateral flange not

[1]Estimated.

[2]Osborn, H. F. 1923. "*Baluchitherium grangeri*, a Giant Hornless Rhinoceros from Mongolia." Amer. Mus. Novitates, No. 78. Contribution No. 8, Asiatic Expeditions of The American Museum of Natural History.

observed in the former species. The type skull of *B. mongoliense* indicates an animal little more than half the size of the type skull of *B. grangeri*, the actual proportions being clearly indicated in the following comparative measurements:

	Baluchitherium grangeri mm.	*Baluchitherium mongoliense* mm.
Length, fourth superior premolar to third molar, p^4-m^3	288	163[1]
Fourth superior premolar, p^4, anteroposterior	52	32
Fourth superior premolar, p^4, transverse	92	42
Nasals, length from tip of nasals to maxillary suture	334[1]	224
Facial height above orbit	430	220

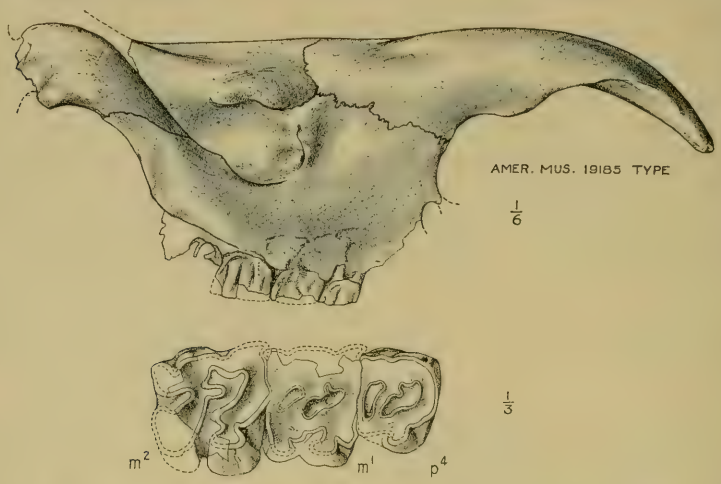

Fig. 2. Type of *Baluchitherium mongoliense* (Amer. Mus. 19185), anterior portion of skull, Loh formation, ? Lower Miocene, Mongolia. Skull one-sixth natural size. Crown, p^4-m^2, one-third natural size.

Horizon.—Loh formation, ? Lower Miocene, Mongolia.

Locality.—Loh, upper light gray sandstone, approximately the same level as hind foot of ?*Rhinoceros* (Amer. Mus. 19151). Found by R. C. Andrews, July 1, 1922, Field No. 67.

Description.—These measurements indicate that *B. grangeri* is not far from double the size of *B. mongoliense*. Size, however, is not a reliable specific character. A very marked specific distinction is found in the progressive condition of the protoloph and metaloph in the fourth superior premolar, p^4, of *B. mongoliense;* the protocone is constricted as in m^1; the metaloph is elongate and develops a crista; thus the fourth premolar of *B. mongoliense* is much more progressive than the fourth premolar

[1]Estimated.

of *B. grangeri* (compare Osborn, *op. cit.*, Fig. 4C) in which the protoloph extends into a broad simple loop around the inner side of the abbreviated metaloph, as in Oligocene aceratheres generally. An additional character is the apparent hypsodonty of the molar teeth, the crown of m^2 showing the following measurements: ap. 45 mm., tr. 44 mm., index .98; height of ectoloph 39 mm.; protocones strongly constricted in m^{1-2}; prominent postcrochet on the metaloph.

Specific Characters.—Nasals strongly arched with lateral flange. P^4 submolariform with constricted protocone, a metaloph and crochet. Molars subhypsodont with constricted protocone, antecrochet and crochet. Type cranium about half the size of the type skull of *B. grangeri*.

REFERRED RHINOCEROTINE PES

In the same horizon with the type skull of *B. mongoliense* and in the upper olive clays, Loh formation, was found the pes labeled "?*Rhinoceros*, hind foot, found by J. B. Shackelford, Field No. 50, Amer. Mus. 19151, June 27, 1922." This pes certainly belongs to a different individual and probably to a different species. It includes the astragalus, calcaneum, cuboid, navicular, ectocuneiform, mesocuneiform and metatarsalia II, III, IV. Unfortunately, the metatarsals are incomplete below, so that we cannot estimate their length, although it would not appear from Mts. IV that the metapodial was extremely elongate as in *B. grangeri*. The foot is undoubtedly rhinocerotine.

Notes by W. D. Matthew (October 3), "I regard the above descriptions as erroneous in two points:

1. The distinction that you draw between teeth of your *Serridentinus* and *Trilophodon* phyla appears to me non-existent, as both *Trilophodon* and *Phiomia* have the cusp construction that you ascribe to *Serridentinus* alone.

2. The molars of "*Baluchitherium*" *mongoliense* are so widely different from *B. grangeri* that I cannot believe there is any near relationship. On the other hand, both molars and premolars show a marked approach to the Cœlodonta group in the hypsodont wavy ectoloph and in many other details. Of course I am fully aware of the superficial resemblance to *Baluchitherium* in the nasals, but would rather expect to see some such construction in a hornless member of the Cœlodonta group."

Fossils in the Ondai Sair Formation, Mongolia

By T. D. A. Cockerell

BULLETIN

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Fig. 1. Map of the Gobi region.

The mountainous areas are shaded with slanting lines; the lowlands are white; the deeper depressions are stippled.

Ondai Sair is indicated by the index letters OS, south of the letters MTS of KHANGAI MTS. Ust Balei is not marked on the map, but it lies on the large river that leads northwestward out of Lake Baikal, near the prong of mountain-country that projects toward this river from the Sayan ranges.

56(117:51.7)

Article VI.—FOSSILS IN THE ONDAI SAIR FORMATION, MONGOLIA[1]

BY T. D. A. COCKERELL

INTRODUCTION

I am indebted to The American Museum of Natural History for the opportunity to study a most interesting collection of fossils in the paper shales of the Ondai Sair formation of the Gobi Desert. These were collected by Messrs. Charles P. Berkey and F. K. Morris, on the Third Asiatic Expedition of the Museum. Messrs. Berkey and Granger (American Museum Novitates, No. 77) discuss the Ondai Sair formation, and state that it is "at least as old as the Cretaceous, perhaps the Lower Cretaceous or Comanchean, rather than the Upper Cretaceous. In this locality, at Mt. Uskuk, the series is sharply delimited by an unconformity, above which no fossils of this type are to be found; and it is limited also below by a much greater unconformity, beneath which lie folded strata with coal beds, conglomerates and intrusives, all judged to be of Jurassic age, as well as many still older formations."

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 37.

Mr. Frederick K. Morris has been good enough to write me at considerable length, summarizing the observations and conclusions of the investigators. I venture to quote the following:

"We found the fish-bearing paper shales associated with sandstones in which were sauropod reptiles at Ondai Sair. At the Oshih (Ashile) basin we searched the paper shales this year again for fossils, but found only the remains of a few plants, too badly macerated prior to deposition to be identified. The paper shales of the Oshih basin carry gypsum crystals, which perhaps points to bitter waters in which the fauna of Ondai Sair could not live. The Oshih and Ondai Sair basins are very probably continuous and form one basin. Sauropods and primitive predentates are found in each locality, although perhaps there is a slight difference between the two faunas. At Oshih the paper shales lie far higher in the series, not less than five hundred feet above the chief sauropod beds; but a few large sauropod vertebræ were seen only one hundred feet below a horizon which, on other grounds, we believe is correlated with the paper shales. At Ondai Sair, as I have said, the sauropods are found close to the paper shales and essentially of the same age.

"Fish-bearing shales are found in North China and have been called Jurassic, on the assumption that the fishes were indeed the *Lycoptera middendorffi* described by Reis. Paper shales were seen by us on the main road to Urga, between Ude and Tuerin, but our brief search of them did not reveal any fossils. We think this basin may be of the same age as the fish shales of Ondai Sair.

"The Oshih-Ondai Sair basin is the oldest true basin found by us in Mongolia; its sandstones rest directly upon the strongly disturbed old rocks that have passed through one or more mountain-bearing revolutions. At Ondai Sair the basement was chiefly pre-Cambrian rocks—graywackes and slates invaded by granites. At Oshih less is seen of the basement, but we found an inlier of crystalline limestone, cut by syenite and granite; also other inliers of the old graywacke series of which the Altai range to the south is principally composed; and a younger chain of strongly folded porphyries, which may be what Doctor Berkey and I judged to be Jurassic in other localities last year. Clearly, there is a great unconformity beneath the Oshih and Ondai Sair and, so far as we know, these basins, which carry the paper shales, date the beginning of the basin or gobi sedimentation; that is, the beginning of deposition of shallow masses of continental sediments—alluvial fans, flood-plains, deltas, playa lake deposits and, locally, deposits in shallow but more permanent lakes. These deposits are but little disturbed and it is in them that all the vertebrate fossils are found.

"The accurate dating of the oldest of these basin deposits is of great importance, not only for paleontology but for the dating of the last great disturbance prior to the Altai uplift.

"We found marine beds of Permian age involved in the older mountain-folding. Apparently younger than these, is a vast series of shales, sandstones, conglomerates and surface volcanic rocks—ash, tuffs and flows of rhyolite, trachyte and basalt which are strongly folded. After folding, these rocks had been eroded to a peneplane. This latter series is wholly non-marine and carries obscure plant remains and, locally, coal. We named these rocks the Tsetsenwan series.

"South of Mongolia the Lower Jurassic in northern China carries coal and is strongly folded, even slaty in places, and has porphyries very like those in the Mongolian series just mentioned. In northern China, therefore, a folding took place sometime between Middle Jurassic and late Jurassic time. In view of the physical similarity between the Lower Jurassic rocks of the Western Hills and the Tsetsenwan series in Mongolia, and because in China also the fish-bearing shales are not severely disturbed, it has seemed to us that for reasons of structural geology it is likely that the earliest basin lands are possibly of Comanchean age. The "Upper Jurassic or Lower Cretaceous" of Reis may well be what we call in America, Comanchean.

"The significance of the Ondai Sair fauna is increased when we consider that there is apparently a chain of basins extending from Siberia across Mongolia into China; if the fauna proves to be the same or of nearly the same age in all, this fact would correlate the entire column of post-mountain-folding, continental sediments in the three regions."

ONDAI SAIR BIOTA

The following species were obtained by the Expedition in the Ondai Sair formation:

Reptilia: *Protiguanodon mongoliense* Osborn, Amer. Mus. Novitates, No. 95, 1923.

Pisces: *Lycoptera middendorffi* Johannes Müller, 1848. Exceedingly abundant in the paper shales (Pl. II, fig. 1). The specimens agree with *L. middendorffi* in the proportions of the fins, rather than with *L. sinensis* A. S. Woodward, from the Lower Jurassic (?) of the Province of Shantung, China. These fishes will be discussed more fully in a later contribution; they form a new family, **Lycopteridæ**, apparently

ancestral to the Cyprinidæ, and have scales scarcely differing from those of the European minnow.

Crustacea: *Estheria middendorffi* T. R. Jones, 1862. Exceedingly abundant in the paper shales (Pl. II, fig. 2).

Insecta: *Ephemeropsis trisetalis* Eichwald, 1864
Ephemeropsis melanurus, new species
Cymatophlebia (?) *mongolica*, new species
Trichopterella torta, new species
Indusia reisi, new species
Chironomopsis gobiensis, new species
Coleoptera, spp. incert.

Plants: *Baiera furcata* (Lindley and Hutton)
Phyllocladites (?) *morrisi*, new species
Czekanowskia sp.
Equisetaceæ (?) fragments

Concerning this biota, we have to ask, (a) does it appear, taken as it stands, to be Upper Jurassic or Lower Cretaceous? (b) is it identical, or nearly identical, with that of the supposed Upper Jurassic fish shales of the Transbaikal country directly north of the Gobi Desert?

With regard to the first question:

(1) The dinosaur, I learn from Dr. W. D. Matthew, is provisionally referred to the Cretaceous, but it is not of itself decisive as to age.

(2) The fish is singularly modern in aspect and affinities, but it belongs to a type always considered Jurassic.

(3) The *Estheria*, as an organism, is of no value in determining age, except within very wide limits. Similar species are living today.

(4) The insects do not clearly indicate age; they are on the whole of modern type, but such forms are known to occur in the Jurassic.

(5) The plants appear to represent a Jurassic flora, but similar forms have been found in the Cretaceous. Thus the contemplation of this biota apparently leaves us where we were before, in uncertainty as to whether it is Upper Jurassic or Lower Cretaceous.

Turning now to the second question, it must evidently be answered in the affirmative. The Transbaikal fish shales are found in several places, for instance: Turga, about 60 miles north of Mongolia, directly north of the Gobi Desert; Konduevskoe or Konduyewskaya, about 90 miles due east of Turga; Nertchinsk or Nertstschinsk, 100 miles north-northwest of Turga.

These shales are, just as those from Ondai Sair, full of *Lycoptera middendorffi*, *Estheria middendorffi* and *Ephemeropsis trisetalis;* they also

carry plants which appear to be *Baiera* and *Czekanowskia*. It does not appear possible that such an association could occur in two deposits of very different age. I have not had access to the important paper by O. Reis, "Die Binnenfauna der Fischschiefer in Transbaikalien," Explor. Géolog. chem. de fer Sibérie (Petrograd, 1910), but Mr. Morris has sent me photographs of the plates, with explanations, and a brief statement of Reis's position. The beds have always been considered Upper Jurassic but Reis confessed to finding in the fauna puzzling affinities ranging from early Tertiary to Jurassic, although the strongest bonds appeared to be with the Upper Jurassic or Lower Cretaceous.

As Reis records a number of organisms not yet found in the Ondai Sair, it will be well to review the more significant of them:

(1) Some additional fish remains are too fragmentary to be of much value. One of these, based on some fins, is called *Stichopterus woodwardi*. The generic name is new and has been omitted from Jordan's Classification of Fishes and Genera of Fishes. The genus is, however, probably unrecognizable.

(2) There is a series of Mollusca, referred to *Lymnæa*, *Paludina*, *Cerithium* and *Cyrena*. *Lymnæa obrutschewi* Reis is closely similar to *L. accelerata* White, from the Comanchean near Cañon City, Colorado, except that it is smaller. *Paludina pura* Eichwald very closely resembles *Lioplacodes veternus* Meek and Hayden, from the American Jurassic, but is also smaller. It is a shell with much the aspect of the modern *Bythinia tentaculata* Linné, but I think it is safe to call it *Lioplacodes purus*.[1] *Cyrena pusilla*[2] Reis is a very small species but characteristic of the genus and having the general form of Cretaceous species. *Cerithium gerassimowi* Reis is not closely related to anything known to me, but the approximately similar types belong to later epochs.

(3) The additional insects are of no consequence. One beetle is named *Carabites latecostatus*, but its family position is uncertain.

(4) Numerous ostracods are recorded by Joseph Georg Egger, with a plate of figures. They are referred to described species, but distinctive characters are few and I do not know what reliance can be placed on them. Our confidence in the determinations is not increased by finding one of the species referred to *Cypris faba*, the common ostracod of the Miocene at Wangen (Œningen) in Baden.

(5) The additional fragmentary plants convey little information. *Pinus witimi*, based on a winged seed, suggests a much later epoch; but

[1]Comparison may also be made with the genus *Baikalia* Martens, living today in Lake Baikal.

[2]The name *Cyrena pusilla* is preoccupied by *Cyrena pusilla* "Parreyss," Phil., Abbild. II. 78. Cyrena, Tab. 1, f. 7 (February 1846), from the Nile. The fossil species described by Reis may be known as **C. reisi**, new name.

there is no reason why this should not be called *Pityospermum witimi.* The genus *Pityospermum* of Nathorst includes winged seeds resembling *Pinus,* found in the Jurassic. Another Siberian species, *Pityospermum maackianum,* was described by Heer as *Pinus maackiana.*[1]

UST BALEI BIOTA

There remains one other method of attacking our problem, by comparison with the biota of the Ust Balei beds, north of Irkutsk and west of Lake Baikal. These beds were first mentioned by Trautschold in 1867, and since then have proved fruitful of plants and insects. They are universally recognized as Jurassic and generally ascribed to the Middle or "Brown Jura," more or less equivalent to the Lower Oölite. Since those who consider the *Lycoptera* shales Jurassic, agree in placing them in the Upper Jurassic, it is not to be expected that they should carry the same biota as the Ust Balei; but there might be some similarity.

The Ust Balei insects, as recorded, number about 25 species, as follows:

Blattoidea: *Ophismoblatta sibirica* (B., R. and G.)[2]; *O. maculata* (B., R. and G.). The first is a wing, the second a nymph.

Mantoidea: *Pseudohumbertiella grandis* (B., R. and G.). Based on half a wing; was supposed to be a mantid, but Handlirsch thinks it may better be referred to the locustoids.

Dermaptera: *Baseopsis* (?) *sibirica* B., R. and G. Based on the anterior half of an insect; was supposed to be an earwig, but Handlirsch regards it as unrecognizable, perhaps a beetle larva.

Orthoptera: *Parapleurites gracilis* B., R. and G. A good tegmen, referred by Handlirsch to his family Locustopsidæ.

Panorpatæ: *Mesopanorpa hartungi* (B., R. and G.). Referred to the family Orthophlebidæ.

Plecoptera: *Mesonemura maacki* B., R. and G. (imago); *Mesoleuctra gracilis* B., R. and G. (larva); *Platyperla platypoda* B., R. and G (larva).

Ephemeroidea: *Mesobaëtis sibirica* B. R. and G.; *Mesoneta antiqua* B., R. and G. These are May-fly nymphs of

[1]This is spelled *maakiana* in the books, but it was named after Maack, the celebrated Siberian explorer.

[2]Brauer, Redtenbacher and Ganglbauer (1889).

ordinary size, quite unlike the giant forms of the fish shales.

Odonata: *Palæophlebia synlestoides* B., R. and G. (an imperfect wing). *Samarura gigantea, minor, pulla, angustata* and *rotundata,* all of B., R. and G. (nymphs).

Coleoptera: *Carabocera prisca* B., R. and G.; *Timarchopsis czekanowskii* B., R. and G.; *Doggeria sibirica* Handl.; *Memptus braueri* Handl.; *M. redtenbacheri* Handl. Five beetles of rather doubtful affinities. *Elaterites sibiricus* Heer is said to come from Irkutsk.

Diptera: *Mesopsychoda dasyptera* B., R. and G.

Lepidoptera or Homoptera: *Phragmatœcites damesi* Oppenheim; *Palæocossus jurassicus* Oppenheim; two remarkable insects considered by Handlirsch to be primitive Lepidoptera, but Tillyard has recently given apparently conclusive reasons for referring the Palæontinidæ to the Homoptera. They are recorded from East Siberia, and were, I presume, from Ust Balei.

These insects show no affinity with those of the fish shales, and since they constitute an analogous fresh-water and lake-side fauna, the absence of the large ephemerids is especially noteworthy. The number of species (especially in view of the fragmentary condition of many) is too small to permit any very decisive conclusions, and it is much to be desired that the locality should be explored again for additional material. We can, however, state that the Ust Balei fauna is not that of the fish shales.

Heer described a number of plants from Ust Balei, but as Seward has shown, his work needs radical revision. So far as we know it, the flora does not seem to correspond with that of the fish shales.

We must then conclude that the fish shales of Ondai Sair and the Transbaikal contain a fairly homogeneous biota, which must be approximately of one age. This biota is quite distinct from that of the Ust Balei beds, and presumably much later. It may be Upper Jurassic, but there is no proof that it is not Lower Cretaceous. Actually, it presumably belongs to a period near the beginning of the Lower Cretaceous and its classification as Jurassic or Cretaceous may be merely a matter of arbitrary definition. In any event, this biota, which represents an early stage in

the development of a number of groups still surviving, is of great interest and well merits further investigation.

INSECTS

EPHEMERIDA

(PLECTOPTERA)

The May flies were well developed as early as the Permian, with many genera. Numerous species are known from the lithographic stone of Bavaria (Jurassic), and a series of nymphs or larvæ has been obtained from the Jurassic rocks of Siberia. The Permian species, constituting a family, Protereismatidæ, are remarkable for having the hind wings as large, or nearly as large, as the upper. Nevertheless the venation is singularly modern, as can be seen by comparing the Permian *Prodromites*[1] *rectus* (Sellards) with such a genus as the living *Ameletus*. Thus it may be said that at least some of the Permian wings approach the modern Siphlonuridæ in structure and it is therefore perhaps less surprising to find apparently genuine siphlonurids in the Jurassic. The genus *Pædephemera* of Handlirsch, with four species in the lithographic stone of Bavaria, scarcely differs at all in the wings from *Siphlonurus*, except that the hind wings are appreciably larger. The gigantic May-fly nymphs from the fish shales of Siberia have also the characters of the Siphlonuridæ, but differ from *Siphlonurus* in having more double abdominal gills, herein agreeing better with Bengtsson's genus *Siphlurella*. The venation of the adult, as shown by the Mongolian material, is more like that of *Ephemerella*, but also shows distinct affinity with the Permian *Prodromites*. The modern siphlonurids will then constitute a subfamily Siphlonurinæ, in contrast with the gigantic Mesozoic Ephemeropsinæ.

EPHEMEROPSIS Eichwald

Eichwald in 1864 founded the genus on an unfigured nymph from Siberia, which he called *E. trisetalis*. It came from the shales of the Transbaikal country, in the vicinity of Nertchinsk, north of the Gobi Desert. In 1868 the same author obtained a larger specimen from the same formation and vicinity and set it forth, with a figure, as *E. orientalis*. As Handlirsch remarks, this is very probably the same as *E. trisetalis*. Considerably earlier, in 1848, Müller had figured the tail of one of these nymphs in Middendorff's "Reise," the locality being Byrka, Siberia. Handlirsch bases his *E. middendorffi* on this figure but, except that the caudal appendages are said to be only about 15 mm. long (instead of 20

[1]**Prodromites**, new name for *Prodromus* Sellards, 1907 (not Distant, 1904).

mm. or over), there is nothing to distinguish it. In 1889, Brauer, Redtenbacher and Ganglbauer figured a nymph from Turga, Siberia, which they considered to be *Ephemeropsis orientalis*. Handlirsch, on their account, founds a new generic name, *Phacelobranchus*, calling the species *P. braueri*. The genus is founded on the fact that the tracheal gills are beset with fine hairs, as in the siphlonurid genus *Chirotonetes* Walker, which, however, has quite differently shaped gills. These hairs are seen only with difficulty and I cannot doubt that they exist in true *Ephemeropsis* as well. O. Reis (1910), in describing the fauna of the fish shales of the Transbaikal, figures *Ephemeropsis orientalis* with six pairs of double gills, the outer portion ciliated. The figure represents a "restoration" and in some details is not very accurate. Without having the original types, it is difficult to be positive about the actual characters of the four supposed species, but my present opinion is that they are all synonymous, and accordingly to be designated *Ephemeropsis trisetalis* Eichwald. Furthermore, I am not at present able to discern that the Ondai Sair species is separable from Eichwald's.

Ephemeropsis trisetalis Eichwald

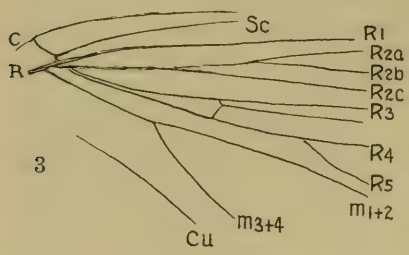
Plate I, Figures 1 to 9; Text Figures 2, 3, 4

Nymph.—The one nearly complete Ondai Sair specimen is about 40 mm. long from front of thorax to base of caudal appendages (Pl. I, fig. 1). The thorax is about 13 mm. wide, thus considerably broader than in the Reis restoration, the body distinctly tapering posteriorly as in the figure of *Phacelobranchus*. I believe the last two pairs of gills are not double, but it is difficult to be sure that the inner lobe is not concealed beneath the abdomen (Pl. I, figs. 1, 2). The outer tapering lobe, resembling a slender knife blade in form, is about 5 mm. long, as described for *E. trisetalis* (Pl. I, fig. 3). The hind margins of the last two abdominal segments are laterally produced and pointed, as in the modern *Siphlonurus*. This feature is not brought out by Reis, but it is better indicated in the figure of *Phacelobranchus*, though even here the projections of the last segment are not nearly long enough. The lateral caudal appendages are 23.5 mm. long; the middle one is evidently shorter, but my best specimen does not show the extreme tip (Pl. I, figs. 4, 5). I have been fortunate in finding nymphal wing pads, with venation as shown in the figures (Fig. 2 and Pl. I, figs. 6, 7). The drawing, figure 2, shows the branching of the radius (radial sector), about 6 mm. from base and 5 from apex of wing, and what looks like a faint cross vein from the lower branch to the vein below.

Fig. 2. Nymphal wing of *Ephemeropsis*.

Wings.—Part of the adult wing has been preserved in one instance (Figs. 3, 4, and Pl. I, figs. 8, 9). It has the following characters: costa strongly arched at base, the strong oblique vein ending in the highest part (basad of this in *Ephemera*); sub-

costa normal, but at oblique vein very close to radius; radius (R_1) stout, practically parallel with subcosta; radial sector branching early, but not widely spreading, the upper branch forking about 7.5 mm. from its origin, the fork thus formed very narrow, its lower branch not elbowed, but doubling of cells beginning after the fourth; R_3 eventually widely divergent from R_4 (following Tillyard's nomenclature),[1] leaving a large open reticulated area, with some supplementary longitudinal veins; R_{4+5} (M_{3+4} of Miss Anne Morgan) forking about 7.7 mm. from base of wing, the fork very wide, the lower branch most divergent but not elbowed at base, several supplementary longitudinal veins between the branches; first cubitus close to second, with no place for oblique veins to margin.



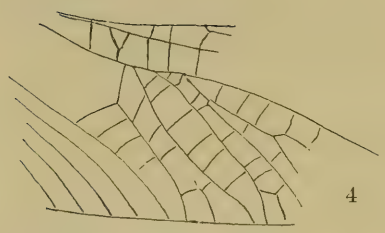


Fig. 3. Venation of the basal part of adult wing of *Ephemeropsis:* an analysis of the photograph, Plate I, Fig. 10.

C, costa; Sc, subcosta; R, radius; R1, 2, 3, 4, 5, branches of radius; Media, with branches m_{1+2}, $_{3+4}$; Cu, cubitus.

Fig. 4. Venation of part of the wing of *Ephemeropsis.* Compare with Plate I, Fig. 11.

The above description is based on the supposition that the wide fork so conspicuous in the specimen is actually the last radial fork of Tillyard, the medial fork of other authors. Difficulty arises, however, when we attempt an analysis of the radial branches, unfortunately somewhat disturbed by breakage. Leaving the wide fork out of the question, the radial branches lie close together, forking at extremely acute angles. The main branch of the sector is thicker and darker than the others and divides early, its upper branch again forking as described above. From the base of the main sector below appear to arise two branches, the one at the extreme base being the stem of the wide fork (supposed above to be R_{4+5}); the other, a little (1.3 mm.) farther along, is resolved on close inspection into two rather weak veins, practically contiguous, but after about 3 mm. gradually diverging, as shown in the figure. The uppermost of these veins again divides 4 mm. farther on, but the lower section is angulated basally, meeting a cross vein. The second or lower of these veins diverges widely apicad from the supposed R_4 and about 8 mm. from its origin branches again with a wide fork, the lower portion being so

[1]Tillyard, 1923. Trans. New Zealand Institute, LIV, p. 227.

delicate as to appear like a supplementary vein. Now, if we assume that the conspicuous wide fork represents Tillyard's media (cubitus of Miss Morgan), then the weak fork above it and more apicad, although appearing doubtfully to belong to the primary venation, is the last fork of the radial sector, usually conspicuous in May-fly wings. On this basis, the veins above are all branches or divisions of R_2, except the lowermost, which is R_3. It then appears that R_3 arises from the sector at practically the same point as R_{4+5}, contrary to what we might expect, and contrary also to the condition in the Permian *Prodromites*. It is possible, however, to maintain that the closely adjacent veins arising from near the base of the sector are actually R_4 and R_5, separate to base, the vein R_3 being placed as usual.

Very competent authors who have intensively studied the venation of May flies have already given us three quite different interpretations, so perhaps we may be excused if we hesitate to dogmatize about the homologies in *Ephemeropsis*. If the vein R_2 can present so many ramifications, other veins may also show unexpected complexity, and the determination of the basic scheme of venation becomes difficult. Certainly the wing pad of *Ephemeropsis* does not suggest that the complexities of the adult wing are directly derived from the primary veins.

It is proper to state that we have no absolute proof that the wing described belongs to the same species as the nymphs; but as it occurs with them and is of suitable size, I cannot doubt that it is identical.

Horizon and Locality.—Ondai Sair formation (paper shales), Ondai Sair, Mongolia. The wing and wing pads were in the field parcel No. 79. The nearly entire nymph is in field parcel No. 64, but pieces of the same nymphs are also from parcel No. 79.

Ephemeropsis melanurus, new species

Plate I, Figure 10

Specific Characters.—Abdominal gills 4.3 mm. long, double, both parts sharply pointed; the outer slender, curved below the middle; the inner broad, its width about 1.4 mm., caudal appendages fringed as in *E. trisetalis*, but much smaller, probably about 10 mm. long (about 8 mm. preserved), the appendages and their fringes black (fringes pale in *E. trisetalis*). The median tail at base is only about half a millimeter wide, while that of *E. trisetalis* is a full millimeter; but nevertheless at 7 mm. from base the tail with fringes is 2.5 mm. across, the fringes being very long.

Horizon and Locality.—Ondai Sair formation (paper shales), Ondai Sair, Mongolia.

Although this specimen shows only the structures described, it is certainly a distinct species. Both the caudal appendages and the gills are sufficiently characteristic for recognition.

Odonata

Æshnidæ

Cymatophlebiinæ (Cymatophlebiina Handlirsch)

Cymatophlebia Deichmüller

This genus was based on a species from the lithographic stone of Solnhofen in Bavaria. A new figure was given by Needham (1907) in Bull. Amer. Mus. Nat. Hist., XXIII, p. 141. The Mongolian fossil is too incomplete for certain generic reference, but what there is agrees sufficiently with *Cymatophlebia.*

Cymatophlebia (?) mongolica, new species

Plate II, Figures 3, 4, 5

Costa and radius very stout; cells between costa and subcosta before nodus broader than high, thus much broader than in *C. longialata* (Germar); cells between subcosta and radius in same region similarly broad; radius in this region nearer to media than to subcosta; nodus as in *Cordulegaster;* costal cells beyond nodus broader than high; media branching at lower end of the very oblique subnodus; M_2 bent near base as if by a cross vein to R_5, but I think this is merely a distortion. These characters are from the type, in parcel No. 64.

Horizon and Locality.—Ondai Sair formation (paper shales), Ondai Sair, Mongolia.

Another specimen (also with No. 64) shows the nodus and part of the region just beyond. It is so much distorted that it looks like another species, M_1 being under the radius, and the end of the subcosta thrust upward. It is of value only as showing an early duplication of cells between M_1 and M_2, a character of *Cymatophlebia*, only whereas in the latter the paired cells are about equal, in our fossil the first few paired cells show the upper one very large and the lower very small, hardly a fifth the size of the upper. More apicad, the cells rapidly become subequal. Still another specimen (field label No. 79) shows part of the sub-basal region of wing and indicates the presence of high narrow cells in the hind wing, the lower portion folded over and much confused.

Trichoptera

Trichopterella, new genus

Generic Characters.—Size medium; wings broad; costal margin very gently arched, slightly concave near base; radius (R_1) straight to R_1-R_2 cross vein, then arched upward, resuming a direct course at a higher level; radial sector arising near base of wing, branching to form a long discoidal cell, the base of which is more acute than the base of the first fork; cross vein at end of discoidal cell somewhat oblique; separation of R_2 from R_3 a short distance before end of discoidal cell, of

R_4 and R_5 just beyond discoidal cell; no R-M cross vein; media apparently with only two branches, but the ends of these are obliterated and it is not impossible that they forked near the apical margin; fork of media at about same level as fork of R_4 and R_5; M-Cu cross vein obliquely arising from media a little before the fork and joining the cubitus at the fork or very slightly before it; first anal straight to end, parallel with and remote from second; postcosta or second anal forming with the others the usual pointed cell, enclosing a smaller cell toward base. Only the anterior wing is known.

Trichopterella torta, new species

Figure 5

Specific Characters.—Anterior wing 15.5 mm. long, 6 mm. wide; veins pale brown, no markings preserved; discoidal cell 3.8 mm. long; R_5 branching 5.7 mm. from base of wing; long anal cell ending 5 mm. from base of wing; length of cubital fork 4 mm.

Horizon and Locality.—Ondai Sair formation (paper shales), Ondai Sair, Mongolia. In parcel No. 64.

Fig. 5. Discoidal cell of wing of *Trichopterella torta.*

The numerous Trichoptera from the Lias are all small, the anterior wings ranging from 3.2 to 9 mm. long, only one species exceeding 5 mm. Two of the Lias genera, also represented by small species, occur in the Jurassic. The entirely separate and parallel-running first anal of *Trichopterella* is equally seen among the Lias genera, such as *Necrotaulius*, *Mesotrichopteridium* and *Pseudorthophlebia*. All these insects, however, have the characteristic anal cells, which are lacking in Tillyard's Mesopsychidæ (four genera) from the Upper Triassic of Queensland.

On the other hand, *Trichopterella* seems to be specialized, after the manner of the Tertiary and modern *Setodes*, in the reduction of the media to two simple branches; but it is not impossible that these were forked near the margin. The media and cubitus of *Trichopterella* separate very early, at the same level as the origin of the radial sector, hence the cellula thyridii is very long, nearly twice as long as the discoidal.

There is a rather wide crack in the rock across the middle of the wing, but this does not obscure the venation.

There is one Jurassic genus, *Mesotaulius* of Handlirsch, from the lithographic stone of Bavaria, which has the anterior wings 31 mm. long. It has little affinity with *Trichopterella*.

The living genus *Alepomyia* Banks from Newfoundland has a two-branched media, but is otherwise quite distinct from *Trichopterella*.

Reis recorded a trichopterous larva case from the fish shales of the Transbaikal. A similar or identical species occurs in the Ondai Sair shales, as follows:

Indusia reisi, new species

Plate II, Figure 10, on the stem of *Phyllocladites*

Specific Characters.—A larva case was found contiguous with the base of a specimen of *Phyllocladites morrisi*. It is cylindrical, straight, very broad, composed of grains of sand, and similar to that of the modern genus *Stenophylax*. On the east side of the main draw, half way between Uskuk and Hsanda Gol, F. K. Morris found a heavy slab, about 15 mm. thick, showing numerous specimens of *Estheria middendorffi* and a few caddis cases on one side, and on the other very numerous caddis cases. From this additional material it can be determined that *Indusia reisi* cases are sometimes as much as 22 mm. long, very slightly curved, 2 mm. diameter at the little end, 3.7 at the larger. The distinct pebbles are mainly at the larger end, the choice of materials varying with age, as in *Stenophylax*. The case figured by Reis was ornamented with ostracods.

Horizon and Locality.—Ondai Sair formation (paper shales), Ondai Sair, Mongolia.

Diptera

Chironomidæ

Chironomopsis Handlirsch

This genus was based on *Chironomus arrogans* Giebel, a name founded on Brodie's figure of a supposed *Chironomus* from the English Purbeck. It shows no distinct generic characters and I have used the name only in a general sense, as applicable to fossil Chironomidæ of uncertain status.

Chironomopsis gobiensis, new species

Plate II, Figures 6, 7

Specific Characters.—Female. Length about 7 mm.; head small, with large eyes; antennæ long and slender, with cylindrical joints, longer than broad, not visibly hairy; palpi extended, about half as long as antennæ; thorax elevated, gibbous anteriorly; legs long, tibiæ apparently longer than femora, hind tibiæ about or nearly 3 mm. long. Color as preserved, brown, evidently dark brown or blackish in life.

Horizon and Locality.—Ondai Sair formation (paper shales), Ondai Sair, Mongolia. In parcel No. 79.

Several specimens, apparently referable to a single species, have been found. So far as visible, the antennæ and mouth parts strongly suggest the bloodsucking *Culicoides* group, but it would be going too far to affirm distinctly that this is a bloodsucking form. It is possible that

the bloodsucking habit among Diptera arose without reference to the Mammalia, as *Simulium* is known to attack young fish and Culicidæ have been seen to prey an cold-blooded vertebrates, reptiles and amphibians. Thus the opportunities for the development of such habits presumably existed before there were any Diptera.

C. gobiensis is evidently the species reported as "mosquitoes," but I think it is practically certain that it does not belong to the Culicidæ. It is very different from *Mesopsychoda dasyptera* Brauer, Redtenbacher and Ganglbauer, from the Jurassic of Ust Balei, Siberia.

Coleoptera

There are two or three species of beetles in the Ondai Sair collection, but their preservation is so poor that I do not venture to describe them (Pl. II, fig. 8). The *Carabites latecostatus* of Reis is certainly not represented.

PLANTS

Ginkgoales?

Baiera furcata (Lindley and Hutton)

Plate II, Figure 9

The plant remains in the Ondai Sair shales are fragmentary and not readily referable to particular species. There is, however, one specimen which, so far as it goes, appears to agree exactly with *Baiera furcata* (Lindley and Hutton) Braun, which Seward calls *B. lindleyana* (Schimper), disregarding priority. This *B. furcata*, or fossils indistinguishable from it, may be either Jurassic or Lower Cretaceous. Seward states that it is known from the Middle Jurassic of Chinese Dzungaria; he is also disposed to refer to it the plant from the Lower Cretaceous of the Black Hills, which Fontaine recorded as *Czekanowskia nervosa* Heer. *Baiera* is in general highly characteristic of the Jurassic but rare in the Lower Cretaceous.

From the Siberian Jurassic, Heer recorded a *Trichopitys setacea*. The genus *Trichopitys* of Saporta, with *Baiera*-like foliage, was originally based on a plant from the Permian, which appears to be related to the Ginkgoales. Seward has suggested that *T. setacea* does not belong to the Permian genus, but is to be compared with *Baiera lindleyana*.

In the Ondai Sair shales are robust shoots bearing stalked obpyriform bodies more or less comparable with the fruits of *Trichopitys heteromorpha* as figured by Zeiller. In one specimen, at least, there is a distinct seedlike impression at the base, and on closer analysis there seems to be

nothing to separate the species from *Phyllocladites* Heer (*Drepanolepis* Nathorst), which occurs in the Jurassic of Spitzbergen. Seward defines the genus as consisting of strobili of open habit with single-seeded sporophylls, of uncertain systematic position but probably gymnospermous. The general resemblance to the fruiting shoots of the Ginkgoales is sufficiently close to suggest a possibility that these are after all the fruits of *Baiera furcata*, or at least belong with the foliage which cannot be separated from the latter species. There is, however, some indication of possible narrow bract scales, suggesting remote affinity with *Larix*. It seems desirable to give this organism a name, so it may be introduced as follows:

Phyllocladites (?) **morrisi**, new species

Plate II, Figures 10, 11; Text Figure 6

Specific Characters.—Stout erect shoots, at least two inches long, the straight stiff stem about 2 mm. wide about 35 mm. from apex; sporophylls on short stout stalks about 2 mm. long. Sporophylls 6 to 7 mm. long, about 3.5 wide near base, obpyriform, with very obtuse apex. Ovules or seeds circular.

Horizon and Locality.—Ondai Sair formation (paper shales), Ondai Sair, Mongolia. In parcel No. 64.

Named after Mr. Frederick K. Morris, who collected the material.

Fig. 6. *Phyllocladites morrisi.*

I sent a sketch of this plant to Dr. E. W. Berry; he kindly replied that he was not able to place it with any species known to him.

Czekanowskia species

Four contiguous broad-linear (1.5 mm. diameter) leaves, the portion preserved 56 mm. long, resemble pine needles, but apparently belong to *Czekanowskia*. It is impossible to refer them to any particular species.

Ondai Sair formation, "No. 64, Ondai Sair."

Reis has figured similar leaves, but apparently more slender, from Turga. He referred them to *Czekanowskia* sp. The genus is characteristic of Jurassic strata, but is reported from the North American Cretaceous.

PLATES I AND II

Plate I

Figs. 1–9. *Ephemeropsis trisetalis* Eichwald.

Fig. 1. Nearly complete nymph about 40 mm. long.

Fig. 2. Part of a nymph, showing legs and abdominal gills.

Fig. 3. Abdominal gills, detached from the nymph.

Figs. 4, 5. Caudal appendages of nymph.

Figs. 6, 7. Nymphal wing pads.

Figs. 8, 9. Adult wing, basal portion.

Fig. 10. *Ephemeropsis melanurus*, new species. Detached gills and caudal appendages.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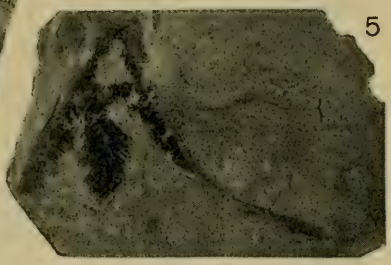
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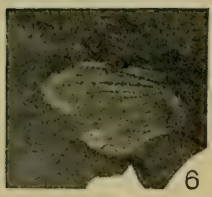
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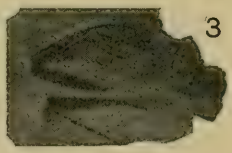
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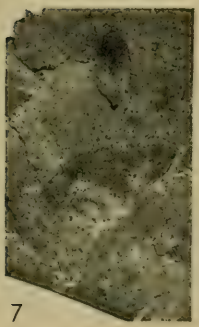
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Plate II

Fig. 1. *Lycoptera middendorffi* Johannes Müller.

Fig. 2. *Estheria middendorffi* T. R. Jones.

Figs. 3, 4. 5. *Cymatophlebia* (?) *mongolica*, new species. Details of wing.

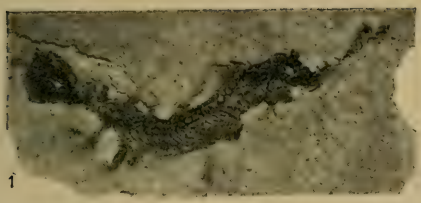
Figs. 6, 7. *Chironomopsis gobiensis*, new species.

Fig. 8. Beetle, undetermined.

Fig. 9. *Baiera*.

Figs. 10, 11. *Phyllocladites* (?) *morrisi*, new species. Near the base of Fig. 10 specimen is the caddis case of *Indusia reisi*, new species, touching the stem of *Phyllocladites*.

Fig. 12. Plant, undetermined.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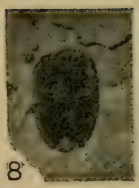
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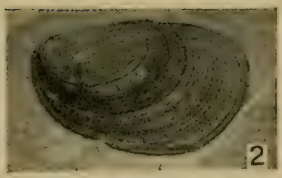
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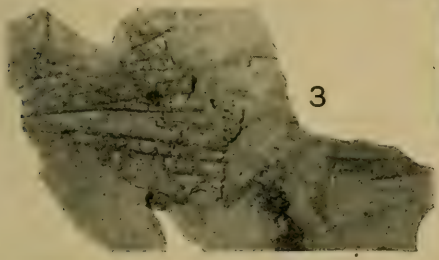
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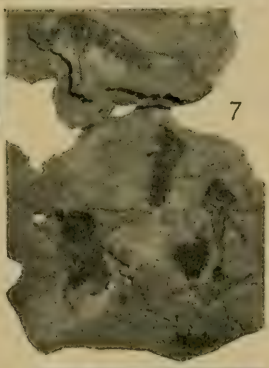
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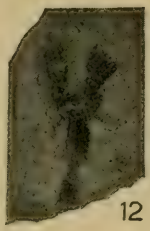
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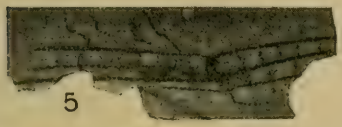
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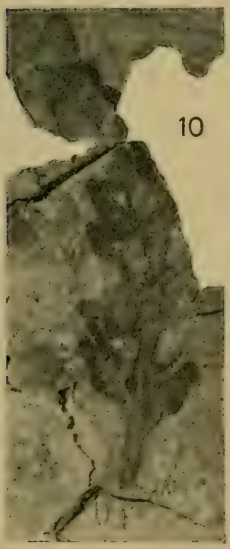
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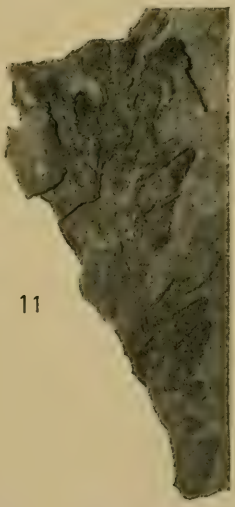
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Some Fishes Collected by the Third Asiatic Expedition in China

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Article VII.—SOME FISHES COLLECTED BY THE THIRD ASIATIC EXPEDITION IN CHINA[1]

By Henry W. Fowler[2]

The fishes reported in this paper were sent to The American Museum of Natural History by its Third Asiatic Expedition. They are represented by several lots, chiefly from Hsing Lung Shan (Eastern Tombs region, Chihli Province, North China) and vicinity in August 1921 and Ningkwo in the Province of An-hwei Central China during September and October of the same year. All from these two localities were collected by Mr. Clifford H. Pope. Preliminary notices have been given of two new species.[3]

The specimens embraced in this study of the Third Asiatic Expedition's material number 1103, of which the majority are cyprinids. Descriptions are given of seventeen species of special interest, as imperfectly or little known. The other species are noticed with condensed computations of their variation, often supplemented with discussion. I have also included several notes on types or rare species in the Academy of Natural Sciences of Philadelphia and used several series in their collections of both Chinese and Japanese specimens in comparison. Figures illustrating two new cyprinids that I have previously described, a little-known loach, and some of the salient color-variants of the Chinese *Cobitis tænia* are given.

Acknowledgment is due to Mr. John T. Nichols and The American Museum of Natural History for the loan of this material for study and the reservation of a set of the duplicate specimens for the museum of the Academy of Natural Sciences of Philadelphia.

Engraulidæ

Mystus nasus (Schlegel)

Head contained 6⅖ to 6⅘ times in length to base of caudal; depth, 6 to 6¼. Dorsal III, 11, I; anal II, 92 to 107; pectoral VI, 11 or 12; ventral I, 6. Scales 72 to 76 in lateral line to caudal base, and 3 more on latter; 12 or 13 scales transversely between dorsal and ventral origins; 18 to 23 predorsal scales; abdominal scutes 19 or 20 to ventral origin, 28 to 33 following. Head width 2⅔ to 3 times in its length; snout 4½ to 5½; eye 5⅓ to 6; maxillary ⅗ to 1⅕; interorbital 3⅛ to 3⅖; first branched dorsal ray 1 1/10 to 1⅕; length of caudal 1⅘ to 1⅚; pectoral 1⅓ to 1⅖; ventral 2⅛ to 2¼.

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[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 38.

[2]Of the Academy of Natural Sciences of Philadelphia.

[3]American Museum Novitates, No. 38, May 25, 1922, pp. 1–2; and No. 83, July 25, 1923, pp. 1–2.

Body strongly compressed, deepest at dorsal and ventral origins, predorsal edge convex and postdorsal with only slight median keel.

Head acuminate, strongly compressed, flattened sides but slightly approximate below. Snout protrudes rather obtusely, length $\frac{3}{5}$ its width. Eye without distinct lid, adipose tissue covering over; center about first fourth in head, slightly more backward in smaller example. Mouth large, narrow, mandible tip midway in snout length. Maxillary very long, extends beyond angle of preopercle, though not quite to gill-opening in younger example and to below gill-opening and slightly beyond pectoral origin in larger example. Teeth in jaws or along maxillary its entire length, and in mandible edges uniserial; small patch each side of vomer and another moderate uniserial row on each palatine. Tongue small free knob, advanced, edentulous. Nostrils together, front one at last third in snout, and hind one much the larger. Interorbital broadly convex. Opercles smooth.

Gill-opening extends forward opposite hind eye edge, connecting membranes moderate. Gill-rakers 18 or 19+22, fine, lanceolate, equal in length to gill-filaments, which are as long as eye. Pseudobranchiæ $\frac{1}{4}$ the length of gill-filaments. Isthmus a long, slender, trenchant keel.

Scales caducous, thin, rather narrowly imbricated, cycloid. Row of broad scales extends over greater part of anal basally, also some small scales on caudal base. Scaly flap in ventral axil $\frac{2}{5}$ length of fin. Scales with 1 or 2 basal radiating striæ; circuli basally 114 to 120; apical striæ 9 or 10, fine, largely reticulate. Abdominal scutes sharply pointed.

Dorsal inserted slightly behind ventral origin, first branched ray longest and depressed backward farther than others. Anal low, mostly uniform, begins at first $\frac{2}{5}$ in combined head and trunk, excluding caudal, slightly behind middle in smaller example. Caudal continuous with anal, median upper rays longest, forming a point. Pectoral without filaments, reaches slightly beyond ventral; longest filaments reach midway in combined head and trunk, without caudal, to a distance contained $2\frac{1}{4}$ times in head and trunk, in smaller example, though in all cases at least to anal origin. Ventral reaches $\frac{1}{4}$ the distance to anal, nearly $\frac{1}{3}$ in young. Vent close before anal.

Color in alcohol, faded pale brown, sides and lower surface very pale. Slight neutral-brown tint at predorsal. Iris pale slaty (doubtless silvery white in life). Fins pale, slightly dotted with pale dusky on dorsal basally.

Length 283 to 310 mm.

Five examples from Ningkwo.

Kreyenberg and Pappenheim[1] discuss the variation of the length of the maxillary, contending for *Coilia brachygnathos* that "unsere sämtlichen Exemplare grosse wie kleine, zeigen nur das obige Verhalten." It seems quite likely, therefore, that smaller or younger examples usually, if not always, have shorter maxillaries.

Flutidæ

Fluta alba (Ziuew)

Eleven from Ningkwo, 335 to 533 mm. All gray-brown, paler below. Sides and above variously though finely reticulate, spotted or marbled

[1]1909, Abh. Ber. Mus. Magdeburg, II, Heft 1, p. 10.

with dusky-brown. Often a dark median lateral line more or less complete. In some examples dark mottling extends more or less completely over belly and under surface, sometimes only for short space behind gill-opening. Again, dark specks on back obsolete or absent and usually three dark median parallel lines down back. Some examples may have spots very fine or absent so back uniform grayish in appearance and belly pale.

MASTACEMBELIDÆ

Mastacembelus sinensis (Bleeker)

Head contained 6 to 6⅘ times in length to base of caudal; depth 10⅗ to 12. Dorsal spines XXXIV, vary XXXI to XXXV; anal spines III. Snout 3½ to 3⅗ times in head; eye 8 to 8⅕; mouth cleft 3⅘ to 4⅛; interorbital 8 to 9.

Body well compressed, deepest just before vent. Head width 3 to 3⅔ times in its length. Snout conic, compressed, ends in a fleshy tip, width 2 to 2⅛ in its length. Eye center at about first third in head; diameter 2⅛ to 2⅕ in snout, little greater than interorbital. Jaws slender, lower shorter, inferior. Maxillary nearly reaches opposite eye. Teeth small, conic, in narrow bands in jaws. Lips fleshy, moderate. Nostrils appear as a pair of short fleshy tubes each side of snout tip; hind nostril a simple pore at last sixth in snout. Interorbital nearly level. Preorbital spine strong, below front of eye. Tail 1½ to 1⅗ times in combined head and trunk. Pectoral 4 times in head; caudal 2½ to 3.

Color in alcohol brownish generally, under surface of head and belly paler to creamy. Broad dark or dusky-brown lateral band, starting as line from snout tip across side of head, then broadening over greater part of side to caudal base. This band sometimes entirely uniform, speckled, dotted irregularly, or with 40 or more narrow pale vertical lines. Back with dusky reticulations, also lower side of abdomen. Some may extend well over basal portions of soft vertical fins. Often basal portions of last more or less dark or neutral and edges narrowly pale. Belly often immaculate white, sometimes finely reticulated with brownish. Some examples largely uniform or with markings very faint. Often a distinct pale streak runs along upper side of back delimiting upper border of dark lateral band and this with more or less regular indentures to form pale transverse lines.

Length 126 to 228 mm.

Seventeen from Ningkwo.

CATOSTOMIDÆ

Myxocyprinus asiaticus (Bleeker)

Head contained 4⅖ times in length to base of caudal; depth 2⅓. Dorsal v, 48, 1; anal iv, 10, 1; pectoral 1, 17; ventral 1, 10. Scales 50 in lateral line to caudal base and 3 more on latter; 13 scales above lateral line, 8 below; 19 predorsal scales. Head width 1½ times in its length; snout 2 1/10; eye 6; least depth of caudal peduncle 2½; first branched dorsal ray 2⅕; first branched anal ray 1 1/10; lower caudal lobe 3¾; pectoral 4⅛; ventral 4½.

Body strongly compressed; back greatly compressed, elevated and its front profile strongly inclined, edge but slightly keeled; greatest depth at origin of dorsal. Caudal peduncle strongly compressed, long as deep.

Head small, moderately compressed sides but little flattened and scarcely approximated below. Snout obtuse, convex over surface, length $\frac{7}{8}$ its width. Eye small, midway in head length; diameter $2\frac{1}{3}$ in snout, 3 in interorbital. Mouth small, inferior. Premaxillaries protractile downward. Lips moderately small, fleshy, plaited. Nostrils small, together; front one pore-like, with cutaneous rim, at last fourth in snout; hind one a crescentic slit. Interorbital broadly convex. Suborbitals rather narrow.

Gill-opening extends forward to opposite last fourth of head. Gill-rakers 13+19, flexible, lanceolate, contained $2\frac{1}{2}$ times in gill-filaments, which equal eye in length. Pseudobranchiæ rather small, about $\frac{2}{5}$ the length of gill-filaments.

Scales in even longitudinal series; breast and belly covered with small scales; row of smaller basal scales on anal and several rows on caudal; head naked and a narrow naked median predorsal strip; no scaly axillary flaps. Scales with 22 to 33 basal radiating striæ; basal circuli 61 to 66; apical radiating striæ 13 to 15. Lateral line complete, midway along side from suprascapula to caudal base; tubes slender, simple and well exposed over each scale exposure to its hind edge.

Dorsal very long basally, inserted slightly nearer pectoral origin than ventral; front lobe of fin $1\frac{2}{3}$ its length, rounded. Anal begins well posteriorly, much nearer caudal base than ventral origin; depressed fin reaching about $\frac{1}{3}$ in caudal; first branched ray longest. Caudal deeply forked, lower lobe a little the longer. Pectoral broad, not quite reaching ventral. Ventral like pectoral, reaches $\frac{2}{3}$ to anal. Vent close before anal.

Color in alcohol, deep dusky-brown, center of each scale with darker shade to form slightly darker longitudinal streaks. Neutral-slaty on cheek and below eye, also upper hind side of head, and on all fins. Upper caudal lobe, lips, chin and under surface of head pale or whitish.

Length 288 mm.

One example, bought twenty miles from Ningkwo, in Ching Tsui Ho on way to Wuhu.

Cyprinidæ

Cyprininæ

Carassius auratus (Linnæus)

Head contained $2\frac{1}{2}$ to $3\frac{1}{5}$ times in length to caudal base; depth $2\frac{1}{4}$ to $2\frac{1}{2}$. Dorsal II, I, 16, 1 to 18, 1; anal II, I, 5, 1. Scales 26 to 28 in lateral line to caudal base and 2 or 3 more on latter; 7 scales above lateral line, 6 below; 13 predorsal scales. Snout $3\frac{1}{8}$ to $3\frac{2}{3}$ times in head; eye $3\frac{1}{8}$ to 5; maxillary $3\frac{1}{3}$ to $3\frac{2}{3}$; interorbital $2\frac{1}{3}$ to $2\frac{3}{5}$.

Color in alcohol dull brownish generally above, below little paler. Fins grayish, sometimes ends of paired ones a little darker.

Length 115 to 153 mm.

From Hsing Lung Shan August 7, 1921, 93 examples; from twenty-six miles south of Hsing Lung Shan, August 12, 1921, 83 examples; Ningkwo, 3 examples.

Barbinæ

Hemibarbus labeo (Pallas)

Head contained 3¼ to 3½ times in length to caudal base; depth 4 to 5. Dorsal III, 7, 1; anal III, 6, 1. Scales 40 to 48 in lateral line to caudal base, and 3 more on latter; 6 or 7 scales above lateral line, 5 or 6 below; 11 to 13 predorsal scales. Snout 2⅛ to 2⅖ times in head; eye 3¼ to 4⅔; maxillary 2⅗ to 3; interorbital 3½ to 4; first branched dorsal ray 1 1/10 to 1⅛; first branched anal ray 1⅗ to 1¾; caudal 1⅛ to 1⅕; pectoral 1⅖ to 1½; ventral 1¾ to 2. Pharyngeal teeth 1, 3, 5—5, 3, 1, hooked, compressed, with well-developed grinding surfaces. Scales with 15 to 19 obsolete weak apical striæ; circuli moderate, finer basally.

Color in alcohol with row of 8 or 9 deep brown spots close along and above lateral line, most distinct or contrasted in young. On back and sides base of each scale with dark spot. Dorsal and caudal with several rows of dusky spots on outer portions.

Length of largest 244 mm.

Two from Hsing Lung Shan, August 7, 1921; six from Ningkwo, September 15 to October 15, 1921.

For comparison only a few young examples in the Academy from the Iwaii River at Ichinoseki, Japan, representing the nominal *Gobio barbus* Schlegel, which appears in every way the same, as admitted by Berg. These examples show:

Head contained 3⅕ to 3⅓ times in length to base of caudal; depth 4 to 4¾. Dorsal I, I, 7, 1; anal III, 6, 1, rarely III, 7, 1. Scales 40 to 42 in lateral line, occasionally 39 or 44, to caudal base and 2 or 3 more on latter; 8 scales, often 7, above lateral line; 6 scales below lateral line, seldom 5; 13 to 17 predorsal scales. Snout 2⅖ to 2⅘ times in head; eye 2⅞ to 3⅘; maxillary 3⅛ to 3⅓; interorbital 4 to 4½. Pharyngeal teeth 1, 3, 5—5, 3, 1, seldom 1, 2, 5—5, 2, 1 or 1, 2, 5—5, 3, 1.

Length 54 to 62 mm.

Oshima says that *Hemibarbus maculatus*[1] from China differs only in color. In alcohol the nominal *Hemibarbus joiteni* Jordan and Starks is said to be "pinkish yellow, with a longitudinal series of eight large spots above the lateral line; smaller spots irregularly placed on back and sides; dorsal and caudal with similar black spots; other fins without markings. Although faint dark spots are present in the young specimen of *Hemibarbus labeo*, they are not permanent; the color of the adult is always uniform grayish-brown." My examples show traces of all these markings, though now apparently greatly faded.

Gobioninæ

Gobio gobio (Linnæus)

Head contained 3¼ to 3½ times in length to base of caudal; depth 4¼ to 4¾. Dorsal II, 7, 1; anal II, 6, 1. Scales 38 in lateral line to caudal base and 2 more on latter; 6 scales above lateral line, 5 below; 14 to 18 predorsal scales. Snout 2⅗

[1] 1919, Ann. Carnegie Mus., XII, Nos. 2–4, p. 212.

to $2\frac{7}{8}$ in head length; eye $3\frac{4}{5}$ to $5\frac{1}{5}$; maxillary $3\frac{1}{3}$ to $3\frac{1}{2}$; interorbital $3\frac{2}{5}$ to 4. Pharyngeal teeth, 3, 5—5, 3, hooked, with well-developed grinding-surfaces. Scales with 13 to 18 apical radiating striæ; superior and inferior circuli coarse, basal very fine.

Color in alcohol brownish-olive above, with row of 6 to 10 median lateral blackish blotches, usually closer behind, and lower whitish surface strongly contrasted. On back, following scale courses longitudinally, there are rows of dusky spots, mostly appearing as longitudinal lines. Dusky streak from side of snout below nostrils to eyes. Dorsal and caudal grayish with 5 to 7 transverse rows of blackish spots, on latter more as lines. Blackish blotch in pectoral axil. Lower fins and barbels whitish.

Length 48 to 100 mm.

Forty-three from Hsing Lung Shan, August 7, 1921; one from Ning-kwo with the depth of the body contained $6\frac{1}{5}$ in the length to the caudal base, and lips and lower front surfaces of the barbels strongly papillose, sides also with five dark blotches.

A comparison of the European material in the Academy shows:

Head contained $3\frac{1}{4}$ to 4 times in length to base of caudal; depth $3\frac{3}{5}$ to $4\frac{4}{5}$. Dorsal III, 7, I; anal III, 6, I. Scales 34 to 40 in lateral line to caudal base and 2 or 3 more on latter; 5 to 7 scales above lateral line, usually 6; 4 or 5 scales below lateral line; 14 to 17 predorsal scales. Snout $2\frac{1}{8}$ to $2\frac{4}{5}$ times in length of head; eye $3\frac{1}{8}$ to $4\frac{7}{8}$; maxillary $2\frac{7}{8}$ to $3\frac{1}{2}$; interorbital $3\frac{1}{5}$ to $4\frac{1}{8}$. Pharyngeal teeth 3, 5—5, 3.

Length 70 to 172 mm.

These examples from Nürnberg, Germany; Leyden, Holland; Lake Lucerne, Switzerland; Arno River, Italy.

Several little-known species have been described from China. *Gobio argentatus* Sauvage and De Thiersant[1] differs in many respects from *Gobio gobio*, as the presence of seven branched anal rays, two rows of scales between the lateral line and the base of the ventral fin; and the color-pattern and fins without spots, though a bluish lateral band is present. Kreyenberg and Pappenheim identify examples with *Gobio argentatus*,[2] but they give the head as contained 4 to $4\frac{1}{5}$ times in the body and $3\frac{1}{2}$ to 4 scales below the lateral line. In most every other way their specimens appear to agree with mine.

Gobio nitens Günther[3] is described with five scales below the lateral line, though with but two rows between the lateral line and the base of the ventral fin. It is, however, without barbels, in which it agrees with *Gobio imberbis* Sauvage and De Thiersant,[4] which in turn differs.

Gobio nigripinnis Günther[5] is another species without barbels but, as its specific name indicates, is with blackish fins.

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[1]1875, Ann. Sci. Nat., (6) I, Zool., p. 9. Yang-tze Kiang.
[2]1908, Sitzs. Ges. Naturf. Freund. Berlin, 1908, p. 97. Tuntingsee, Hankau.
[3]1873, Ann. Mag. Nat. Hist., (4) XII, p. 246. Shanghai.
[4]1875, Ann. Sci. Nat., (6) I, Zool., p. 9. Yenkiatsoun (S. Shen-si).
[5]1873, Ann. Mag. Nat. Hist., (4) XII, p. 246. Shanghai.

Gobio nummifer Boulenger[1] does not seem to differ from *Gobio gobio*. It is described with six round black spots along the body and tail above the lateral line.

Gobio wolterstorffi Regan

Head contained $2\frac{3}{5}$ to $3\frac{1}{4}$ times in length to base of caudal; depth 4 to 5. Dorsal III, 7, I; anal III, 6, I. Scales 34 in lateral line to caudal base and 2 more on latter; 5 scales above lateral line, 4 below; 12 predorsal scales. Snout $3\frac{1}{3}$ to $3\frac{1}{2}$ times in length of head; eye $3\frac{1}{8}$ to $3\frac{1}{5}$; maxillary 3 to $3\frac{1}{4}$; interorbital 3 to $3\frac{1}{5}$. Pharyngeal teeth 2, 5—5, 3, hooked, some of upper broadly compressed, with broad grinding surfaces. Scales with 15 to 18 apical radiating striæ; circuli above and below moderate, converging finely basally.

Color in alcohol pale brownish above, with olive tinge on back, which mottled coarsely with blackish spots very irregularly. Sides and under surface whitish, with silvery reflections on sides of head. Each tube of lateral line with black spot close above and below. Iris silvery. Fins all pale, lower whitish.

Length 20 to 93 mm.

From Hsing Lung Shan, August 7, 1921, 2 examples; from twenty-six miles south of Hsing Lung Shan, August 12, 1921, 25 examples.

Pseudogobio rivularis (Basilewsky)

Head contained $3\frac{2}{5}$ times in length to base of caudal; depth $4\frac{4}{5}$ to $5\frac{1}{4}$. Dorsal II, 6, I or II, 7, I; anal II, 5, I. Scales 31 to 35 in lateral line to caudal base and 2 more on latter; 5 or 6 scales above lateral line, 4 below; 11 or 12 predorsal scales. Snout $2\frac{1}{8}$ to $2\frac{1}{6}$ times in length of head; eye $3\frac{7}{8}$ to $4\frac{1}{10}$; maxillary $3\frac{2}{5}$ to $3\frac{3}{4}$; interorbital $3\frac{1}{3}$ to $3\frac{1}{2}$. Pharyngeal teeth 2, 4—4, 2, hooked, with narrow grinding-surfaces. Scales with 7 to 10 apical radiating striæ; circuli coarse above and below, converging finely basally.

Color in alcohol pale brownish on back, mottled obscurely with darker. Back with 5 broad dark saddles, each a little narrower than interspaces. Sides with about 7 very pale or obscure round blotches made up of minute grayish dots, more or less uniform in size and about equal to eye-diameter, distributed along middle of side or on line of vertebral axis. Dusky line from side of snout to eye and narrower less defined line from snout tip to above nostrils. Fins pale. Dorsal with 4 series of dusky spots, each dark blotch on rays only. Caudal only with 4 transverse dark bands, each inclined backward, and a small conspicuous median black spot, much less in diameter than half of pupil, at caudal base. Other fins all pale to whitish, though each with pale to obscure dusky median blotch or shade.

Length 43 to 56 mm.

From twenty-six miles south of Hsing Lung Shan, August 7, 1921, 3 examples.

Günther notes under *Pseudogobio sinensis* that the black caudal spot disappears with age.[2]

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[1] 1901, Proc. Zoöl. Soc. London, I, p. 269, Pl. XXIII, fig. 2. Ningpo.
[2] 1873, Ann. Mag. Nat. Hist., (4) XII, p. 247.

Saurogobio dabryi Bleeker

Head contained $3\frac{2}{3}$ to $4\frac{4}{5}$ times in length to base of caudal; depth $4\frac{3}{5}$ to $8\frac{1}{4}$. Dorsal III, 8, I, once III, 7, I; anal III, 6, I. Scales 36 to 47 in lateral line to caudal base and 2 more on latter; 4 to 6 scales above lateral line, 3 or 4 below; 11 to 13 predorsal scales. Snout contained 2 to 3 times in length of head; eye $3\frac{3}{5}$ to 5; maxillary $3\frac{1}{8}$ to $3\frac{1}{4}$; interorbital $3\frac{1}{2}$ to $4\frac{1}{8}$.

Body moderately compressed, slender, long, deepest at dorsal origin. Caudal peduncle well compressed; its least depth contained $2\frac{1}{3}$ to $2\frac{2}{5}$ times in its length, $2\frac{7}{8}$ to $4\frac{1}{3}$ in head.

Head moderate, slightly compressed, with flattened sides scarcely constricted below, width $1\frac{3}{4}$ to $1\frac{1}{5}$ in its length. Snout conic, upper profile with a slight depression just behind its tip, as long as broad; with age its width is contained $1\frac{1}{5}$ times in its length. Eye elevated, its center midway in length of head; its length contained $1\frac{1}{5}$ to 2 times in length of snout, $1\frac{1}{5}$ in interorbital, except that the latter is less than the eye in young. Mouth small, inferior, mandible depressed. Maxillary concealed, reaches front nostril, and with a fleshy barbel from subterminal outer face, $1\frac{1}{2}$ to $1\frac{4}{5}$ in eye. Lips narrow, soft, fleshy, coarsely papillose. Nostrils together, within last fourth of snout; hind one much the larger and mostly concealed by posterior cutaneous flap of front one. Interorbital broadly concave. Suborbitals narrow, preorbital longer than eye. Occipital fontanel as long as eye.

Gill-opening extends forward opposite hind eye edge. Gill-rakers 2+14, short, low, compressed papillæ, greatly less than gill-filaments, which contained $1\frac{3}{4}$ in eye. Pseudobranchiæ $\frac{2}{3}$ of gill-filaments. Inside of pharynx coarsely papillose. Pharyngeal teeth small, compressed, or pointed without terminal hooks or grinding-surfaces.

Scales with 8 to 56 slightly waved apical striæ, about 8 to 34 in young; apical circuli 35 to 38, imperfect. Scales firmly adherent, in even longitudinal rows, well exposed; few scales on caudal base; breast, anterior part of belly medially and head naked. Scaly pointed flap in ventral axil, $2\frac{2}{5}$ in fin. Lateral line slopes a little low at first, then runs midway over ventral and along side of caudal peduncle to caudal base. Tubes in lateral line slender, simple, half way over each scale exposure.

Dorsal origin midway between snout tip and anal origin, upper fin edge slightly concave; depressed fin contained $1\frac{3}{5}$ to $1\frac{3}{4}$ in the distance to caudal base; first branched ray $1\frac{1}{6}$ to $1\frac{1}{3}$ in head. Anal origin a little nearer caudal base than last dorsal ray base; depressed fin contained $1\frac{2}{5}$ to $1\frac{3}{4}$ times in the distance to caudal base; first anal ray $1\frac{1}{2}$ to $2\frac{1}{8}$ in head. Caudal deeply forked, pointed lobes equal, $4\frac{1}{4}$ to $4\frac{2}{5}$ in combined head and trunk. Pectoral reaches $1\frac{1}{6}$ to $1\frac{1}{3}$ to ventral, length $1\frac{1}{10}$ to $1\frac{1}{4}$ in head. Ventral inserted below third to fifth dorsal ray bases, depressed fin contained 2 to $2\frac{1}{8}$ times in distance to anal origin; fin contained $1\frac{1}{4}$ to $1\frac{2}{3}$ in head.

Color in alcohol pale olivaceous-brown, edge of each scale broadly and slightly darker. Grayish median lateral streak close along and above lateral line, with about 10 to 14 obscure darker spots. Dorsal and caudal grayish terminally, other fins whitish. Iris brownish.

Length 26 to 252 mm.

From Hsing Lung Shan, August 7, 1921, 6 examples; twenty-six miles south of Hsing Lung Shan, August 12, 1921, 8 examples; Ningkwo, An-hwei Province, 14 examples.

Longurio athymius Jordan and Starks[1] is synonymous. It is shown, apparently erroneously, with the breast and chest scaled.

Paraleucogobio notacanthus Berg

Head contained $3\frac{2}{5}$ to $3\frac{2}{3}$ times in length to base of caudal; depth $3\frac{1}{2}$ to $3\frac{3}{4}$. Dorsal III, 7, I; anal III, 6, I. Scales 35 to 36 in lateral line to caudal base and 2 or 3 more on latter; 5 scales above lateral line, 4 below; 12 or 13 predorsal scales. Snout $3\frac{1}{3}$ to $3\frac{2}{5}$ times in its length; eye 4 to $4\frac{2}{5}$; maxillary $3\frac{1}{3}$ to $3\frac{3}{5}$; interorbital $2\frac{3}{4}$ to $2\frac{9}{10}$. Pharyngeal teeth, 3, 4—5, 3, hooked, with grinding-surfaces. Scales with 10 to 20 basal radiating striæ; circuli moderate, finely convergent basally.

Color in alcohol, back olivaceous, each row of scales marked with a longitudinal dusky band, made up of blackish dots. Along middle of side longitudinal blackish band, little less in width than eye. Dorsal grayish, with blackish blotch above forward. Caudal grayish, with dusky clouding basally in center. Other fins all more or less whitish.

Length 68 to 90 mm.

From Hsing Lung Shan, August 7, 1921, 27 examples.

Sarcocheilichthys lacustris (Dybowski)

Head contained $4\frac{1}{5}$ to $4\frac{2}{5}$ times in length to base of caudal; depth $3\frac{1}{5}$ to $3\frac{1}{3}$. Dorsal III, 7, I; anal III, 6, I. Scales 38 to 40 in lateral line to caudal base and 3 or 4 more on latter; 6 or 7 scales above lateral line, 5 or 6 below; 14 to 16 predorsal scales. Snout $2\frac{3}{5}$ to $2\frac{3}{4}$ in head length; eye $4\frac{2}{5}$ to $4\frac{1}{2}$; maxillary $3\frac{3}{4}$ to $4\frac{1}{4}$; interorbital $2\frac{1}{5}$ to $2\frac{1}{2}$.

Body compressed, moderately robust, deepest at dorsal origin and edges all convexly rounded. Caudal peduncle well compressed, its least depth $1\frac{1}{5}$ to $1\frac{1}{3}$ in its length or $1\frac{1}{2}$ to $1\frac{2}{3}$ in length of head.

Head small, compressed, flattened sides not convergent especially above or below, lower profile a little more inclined; width $1\frac{2}{5}$ to $1\frac{3}{4}$ in its length. Snout obtusely convex, length $\frac{3}{4}$ to $\frac{4}{5}$ its width. Eye with hind pupil edge midway in length of head; $1\frac{1}{3}$ to $1\frac{3}{4}$ in snout, 2 to $2\frac{1}{8}$ in interorbital. Mouth inferior, small. Maxillary concealed, reaches opposite hind nostril. Small barbel on maxillary above near end of expansion. Lips smooth, fleshy, not extending across mandible, folded deeply at each side. Mandible spatulate, horny, firm and firm bony median surface opposite in middle of upper jaw. Nostrils together, in last third of snout; front one a simple pore with broad marginal posterior flap, exposing hind one in a crescent. Interorbital broadly convex.

Gill-opening extends forward opposite last third of head, not to eye. Gill-rakers 2+4, short rudimentary tubercles. Gill-filaments as long as eye. Pseudobranchiæ $\frac{3}{5}$ the length of gill-filaments. Pharyngeal teeth, 2, 5—5, 2, compressed, hook at end of each and grinding-surfaces moderate.

Scales with 38 to 40 apical radiating striæ; 48 basal circuli. Scales firmly adherent in even longitudinal rows, all well exposed; caudal base scaled; small scales cover breast; axillary ventral scale $\frac{2}{5}$ the length of fin. Lateral line slopes slightly

[1]1905, Proc. U. S. Nat. Mus., XXVIII, p. 197, Fig. 3. Chemulpo.

at first until midway in depth; tubes simple, small, each one exposed over basal third of scale. Row of few tubercle scars around border of upper jaw above lip, also few below nostril and front of eye below.

Dorsal origin much nearer snout tip than caudal base, upper edge of fin concave; length of fin contained $2\frac{1}{8}$ to $2\frac{1}{5}$ times in the distance to caudal base; first branched dorsal ray 4 to $4\frac{1}{3}$ in combined head and trunk. Anal inserted close behind depressed dorsal tip, or a little nearer caudal base than dorsal origin; length of depressed fin $1\frac{1}{4}$ to $1\frac{1}{2}$ in the distance to caudal base; first branched anal ray $1\frac{1}{3}$ to $1\frac{2}{5}$ in head. Caudal deeply forked, lobes broad, even; length of fin contained $3\frac{3}{5}$ to $3\frac{2}{3}$ times in combined head and trunk. Pectoral reaches $\frac{3}{4}$ to $\frac{4}{5}$ to ventral; length of fin 1 to $1\frac{1}{8}$ in head. Ventral inserted slightly behind dorsal origin, depressed fin reaches $\frac{3}{4}$ to $\frac{4}{5}$ to anal; length of fin $1\frac{1}{4}$ to $1\frac{1}{3}$ in head.

Color in alcohol deep brown generally, each row of scales longitudinally with deeper or median dusky streak. Fins all with neutral-slaty or dusky, especially terminally and edges narrowly whitish. Bases of all fins narrowly whitish. Under surface of head and belly somewhat pale.

Length 150 to 179 mm.

Fifteen examples from Ningkwo.

Pseudorasbora parva (Schlegel)

Head contained $3\frac{1}{4}$ to $3\frac{7}{8}$ times in length to base of caudal; depth $3\frac{1}{3}$ to $4\frac{3}{5}$. Dorsal III, 7, I; anal III, 6, I. Scales 33 to 35 in lateral line to caudal base and 2 more on latter; 5 or 6 scales above lateral line, 4 to 6 below; 13 to 15 predorsal scales. Snout 3 to $3\frac{2}{5}$ in head; eye $3\frac{1}{8}$ to 5; maxillary $3\frac{7}{8}$ to 4; interorbital $2\frac{2}{5}$ to $2\frac{4}{5}$. Pharyngeal teeth 5—5, hooked, with grinding-surfaces; bones quite small. Scales with 2, 3 or 4 apical radiating striæ; circuli moderate.

Color in alcohol brownish generally, on back and upper sides each scale as if with median brownish blotch. All fins with more or less grayish to dusky terminally. Sometimes dark pigment spots concentrated along lateral line to form median lateral dark streak, resolving in dark spot just before caudal base. One example shows terminal portions of all fins, caudal broadly bordered so behind, with dusky to blackish, also sort of transverse or horizontal basal blackish band, as if made up of black pigment dots. Length 28 to 91 mm.

Hsing Lung Shan, August 7, 1921, 110 examples, and south of Hsing Lung Shan, August 12, 27 examples.

In the very young the front dorsal edge is blackish and there is a narrow blackish lateral band from side of snout to caudal base. It also has the lateral line very incomplete, only on the first few anterior scales. One young example is without mandibles, its jaws abortive, though both nostrils still in front of the eyes; or in profile what remains of the snout is less than half the eye.

For comparison with the Japanese specimens in the Academy, there is a series represented by many specimens from Yodo River in Osaka, Lake Biwa at Matsubara, Iwai River at Ichinoseki and near Nagoya in Owara. These show the following.

Head contained $3\frac{1}{8}$ to $4\frac{1}{8}$ times in length to base of caudal; depth $3\frac{1}{4}$ to 4. Dorsal III, 7, I; anal III, 6, I. Scales 29 to 36 in lateral line to caudal base and 2 or 3 more on latter; 5 or 6 scales above lateral line, 4 below; 12 to 15 predorsal scales. Snout $3\frac{1}{10}$ to $3\frac{1}{3}$ in head; eye $3\frac{2}{3}$ to $4\frac{3}{4}$; maxillary $3\frac{1}{5}$ to $4\frac{2}{3}$; interorbital $2\frac{1}{4}$ to $2\frac{1}{2}$. Pharyngeal teeth 5—5, rarely 1, 5—6.

Length 38 to 90 mm.

Rasborinæ

Aphyocypris chinensis Günther

Figure 1

Head contained $3\frac{7}{8}$ times in length to base of caudal; depth $3\frac{7}{8}$. Dorsal III, 7, I; anal III, 6, I. Scales 33 in lateral line to caudal base and 2 more on latter; 6 scales above lateral line, 4 below; 13 predorsal scales. Snout 3 times in head measured from upper jaw tip; eye 4; mouth width $3\frac{1}{3}$; interorbital $2\frac{1}{3}$.

Body compressed, fusiform, deepest at dorsal origin, edges convexly rounded. Caudal peduncle strongly compressed, least depth $1\frac{2}{3}$ times in its length or 2 in total length of head.

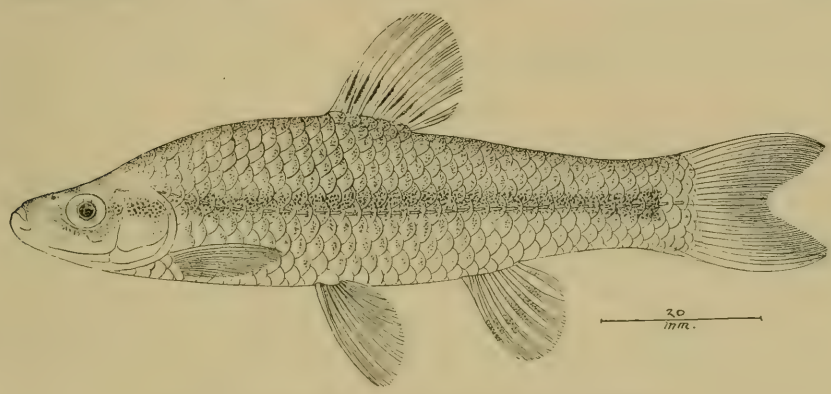

Fig. 1. *Aphyocypris chinensis* Günther. Ningkwo.

Head conic, upper profile slightly concave, flattened sides but little constricted below; width $1\frac{7}{8}$ in its total length. Snout conic, little depressed above, length $\frac{2}{3}$ its width. Eye with hind pupil edge midway in total head length; $1\frac{1}{3}$ times in snout, $1\frac{3}{4}$ in interorbital. Mouth superiorly terminal, greatly inclined, with short gape, mandible well protruded. Maxillary concealed, not reaching opposite nostril. Lips firmly coriaceous, lower broad and trenchant. Nostrils together, within last third of snout; front one a pore, with broad hind cutaneous flap exposing posterior nostril in crescent. Interorbital broadly convex. Suborbitals moderate, invade little over half of cheek to preopercle ridge. Opercle smooth.

Gill-opening extends forward to opposite last third of head. Gill-rakers 4+12, short points, rudimentary, greatly less than gill-filaments, which nearly equal eye. Pseudobranchiæ $\frac{2}{5}$ of gill-filaments. Pharyngeal teeth 3, 5—5, 3, hooked and with broad grinding-surfaces.

Scales with 33 to 36 waved radiating striæ apically; 32 to 36 basal circuli. Scales firmly adherent, in even longitudinal series, all well exposed, scarcely smaller on breast and caudal peduncle; axillary ventral scale ¼ the length of fin. Head naked. Lateral line extends along middle of side, complete; tubes extend over half of each scale exposure, slender, simple.

Dorsal origin midway between snout tip and caudal base, upper edge of fin convex; depressed fin reaches half way to caudal base. Anal inserted a little behind dorsal base, lower edge of fin convex; depressed fin reaches a distance contained 1¾ times in that to caudal base. Caudal deeply emarginate; lobes broad and pointed. Pectoral low, reaches ⅚ to ventral. Ventral inserted slightly before dorsal origin, reaches ⅞ to anal. Vent close before anal.

Color in alcohol, back dull olive-brown, each scale with darker submarginal blotch. Dusky streak from snout tip back from eye and along middle of side to caudal base, where expanded, much broader. Its entire course made up of dusky specks or dots. Lower surface of head and trunk whitish. Dorsal pale, a little below its middle, a short dusky bar close behind each ray. Median portion of each anal ray with slight gray-dusky shade. Caudal pale gray. Paired fins whitish. Iris silvery-white.

Length 100 mm.

One example from Ningkwo.

Xenocypridinæ

Xenocypris davidi Bleeker

Head contained 4¼ to 4½ times in length to base of caudal; depth 3⅔ to 3⅘. Dorsal III, 7, 1; anal III, 10, 1 or 11, 1; pectoral 1, 16 or 17; ventral 1, 8. Scales 60 to 64 in lateral line to caudal base and 3 more on latter; 12 scales above lateral line, 7 below; 26 to 29 predorsal scales. Head width 2 to 2 1/10 in its length; head depth 1⅓ to 1⅗; snout 3⅓ to 3½; eye 3⅘ to 4; maxillary 4¾; interorbital 2¾ to 3.

Body elongately ovoid, strongly compressed, deepest at dorsal origin, and edges all convexly rounded. Caudal peduncle strongly compressed, least depth 1⅖ in its length, or 2 to 2⅙ in head.

Head well compressed, flattened sides slightly approximated below, upper profile nearly straight to slightly convex, and lower profile similar to slightly more inclined. Snout convex, rather obtuse, length ¾ to ⅞ its width. Eye moderate, hind edge slightly nearer gill-opening than snout tip; 1⅛ in snout, 1½ in interorbital. Mouth small, inferiorly terminal, width 1⅛ to 1¼ in eye. Maxillary largely concealed by preorbital, at least its expansion, which 4 in eye, reaches opposite front nostril. Lips moderate, entire. Edge of upper jaw firmly coriaceous. Nostrils together, front one at about last third in snout, pore-like, and hind one a crescentic slit close behind, formed by cutaneous marginal flap of anterior. Interorbital broadly and evenly convex. Suborbital chain moderate; preorbital depth about ⅘ its length which 1¼ in eye. Opercle finely striate.

Gill-opening extends forward to opposite hind eye edge. Gill-rakers 12+40, short, thin, compressed, triangular, ⅓ the length of gill-filaments, which 1⅖ in eye. No pseudobranchiæ. Pharyngeal teeth 2, 4, 6—6, 4, 2, strongly compressed, without hooks, and all with grinding-surfaces, outer quite broad. Some teeth deciduous, as several loose ones of outer set to each base.

Scales with 12 apical radiating striæ, often 0 to 3 apical marginal auxiliaries; basal circuli 55 to 60. Scales in even longitudinal series parallel with lateral line, scarcely smaller on predorsal; slightly smaller scales on breast, belly and caudal base; pointed scaly flap in ventral axil $\frac{2}{5}$ the length of fin. Head naked. Lateral line complete, well decurved, passes lower $\frac{2}{5}$ in depth at ventrals and ascends along side of caudal peduncle to caudal base medially; tubes simple, extend over each scale about midway to $\frac{3}{4}$ of exposure.

Dorsal origin midway between snout tip and caudal base, first 3 rays spine-like, osseous, compressed and third greatly longest; first branched dorsal ray $1\frac{1}{8}$ to $1\frac{1}{6}$ in head; depressed fin reaches a distance contained $2\frac{1}{4}$ to $2\frac{1}{3}$ times in that to caudal base. Anal begins well behind depressed dorsal tip, first branched ray highest and forms apex of slight anterior lobe; first branched anal ray $1\frac{7}{8}$ to 2 in head. Caudal strongly forked, lobes sharply pointed, slender, equal, little longer than head. Pectoral reaches a distance contained $1\frac{1}{2}$ to $1\frac{2}{3}$ times in that to ventral, contained $1\frac{1}{4}$ in head. Ventral inserted opposite dorsal origin, reaches a distance contained $1\frac{3}{4}$ to $1\frac{4}{5}$ times in that to anal; $1\frac{2}{5}$ to $1\frac{1}{2}$ in head. Vent close before anal.

Color in alcohol with back tinged with pale olive, sides and lower surface pale to whitish. Dorsal and caudal pale olivaceous, lower fins whitish. Iris slaty and whitish.

Length 173 to 228 mm.

Six examples from Ningkwo.

Rhodeinæ

Acanthorhodeus guichenoti Bleeker

Head contained $3\frac{3}{4}$ to 4 times in length to base of caudal; depth 2 to $2\frac{1}{6}$. Dorsal III, 16, 1 to 18, 1; anal II, 11, 1 to 14, 1. Scales 34 or 35 in lateral line to caudal base and 3 or 4 more on latter; 6 or 7 scales above lateral line, 5 or 6 below; 14 or 15 predorsal scales. Snout $3\frac{1}{5}$ to $3\frac{1}{3}$ in head; eye $3\frac{2}{5}$ to $3\frac{1}{2}$; maxillary $3\frac{3}{4}$ to 4; interorbital 3.

Body strongly compressed, deeply ovoid, predorsal scarcely trenchant and all other edges rounded convexly; greatest depth at dorsal origin. Caudal peduncle well compressed, its least depth 1 to $1\frac{1}{8}$ in its length or 2 to $2\frac{1}{10}$ in head.

Head small, strongly compressed, sides flattened and scarcely approximated below; profiles similar; head width 2 to $2\frac{1}{8}$ in its length. Snout conic, short, obtuse, length $\frac{7}{8}$ its width. Eye advanced, hind pupil edge slightly before center in head length; diameter equals snout, $1\frac{1}{6}$ to $1\frac{1}{3}$ in interorbital; very narrow border of adipose tissue all around eye. Mouth slightly inclined, lower jaw a little the shorter. Maxillary largely concealed, reaches opposite hind nostril, and with short terminal barbel, not over $\frac{1}{3}$ of pupil in length. Edges of jaw firmly coriaceous and lips narrow. Nostrils together, within last fourth of snout; front one a simple pore, its hind cutaneous flap exposes hind nostril in crescent. Interorbital widely convex. Suborbital chain moderate; posterior infraorbital largely covering cheek.

Gill-opening extends forward to opposite hind edge of eye. Gill-rakers 2+5 short points, about $\frac{1}{6}$ the length of gill-filaments, which $1\frac{1}{4}$ in eye. Pseudobranchiæ $1\frac{1}{2}$ in gill-filaments. Pharyngeal teeth 5—5, compressed, each with slight terminal hook and lower face with strong crenulations, these more or less obsolete in smaller examples; each also with broad entire inner grinding-surface.

Scales with 55 to 61 fine waved weak apical marginal striæ; circuli fine, all basal. Scales closely adherent on trunk, thin, in longitudinal series, deepest medianly and

rows slightly convergent anteriorly and posteriorly; scales much smaller on breast. Basal scaly sheaths to dorsal and anal moderate and caudal base covered with moderate scales. Pointed axillary ventral scale $2\frac{1}{2}$ in fin. Lateral line complete, curves slightly inferiorly along side to caudal base medianly; tubes slender, simple, well exposed or at least half way in scale exposure. Male with front half of snout before nostrils with thick-set pits, evidently tubercle scars and not present in female.

Dorsal origin little nearer snout tip than caudal base; first 3 rays strongly osseous, compressed, though third with flexible tip; length of first branched ray $1\frac{1}{8}$ to $1\frac{1}{6}$ in head. Anal origin midway between gill-opening and caudal base, in younger specimens, a little advanced or midway between hind eye edge and caudal base; first 2 rays similarly osseous to those of dorsal and last soft rays greatly shorter in both, than front ones; first branched anal ray $1\frac{1}{5}$ to $1\frac{2}{5}$ in head. Caudal deeply forked, lobes pointed, equal; lower lobe $3\frac{1}{4}$ to $3\frac{3}{5}$ in combined head and trunk. Pectoral low, nearly or quite reaching ventral, $1\frac{1}{4}$ to $1\frac{2}{5}$ in head. Ventral inserted little before dorsal origin; depressed fin reaching $\frac{4}{5}$ to $\frac{7}{8}$ to anal; fin $1\frac{2}{5}$ to $1\frac{1}{2}$ in head. Vent opposite middle of depressed anal and anal papilla moderate in female, not extending beyond end of depressed ventral tips.

Color in alcohol pale brownish generally, back with slight grayish tinge. Close above lateral line about 4 to 6 scales each with an obsolete pale dusky spot, and along side of caudal peduncle a narrow slaty streak, also above lateral line and horizontally median in position. Fins all pale, dorsal, anal and caudal with 3 or 4 rows of obscure grayish spots. Pectoral and ventral uniform. Iris whitish.

Length 105 to 170 mm.

Fourteen examples from Ningkwo.

Acanthorhodeus hypselonotus Bleeker[1] apparently differs in its much deeper body, larger scales, fewer dorsal rays and the absence of barbels.

Abramidinæ

Chanodichthys bramula (Valenciennes)

Head contained 4 times in body to caudal base; depth $2\frac{1}{8}$. Dorsal III, 7, 1; anal III, 28, 1. Scales 50 in lateral line to caudal base and 3 more on latter; 12 scales above lateral line, 9 below; 28 predorsal scales. Snout $3\frac{1}{2}$ in head; eye $4\frac{1}{2}$; maxillary $3\frac{2}{3}$; interorbital $2\frac{1}{3}$.

Body strongly compressed, deeply ovate, predorsal slightly trenchant and postventral with distinct keel over which scales not passing; greatest depth at dorsal origin. Caudal peduncle strongly compressed, its length $\frac{3}{4}$ its least depth, which 2 in head.

Head small, profiles alike, that of occiput curving up suddenly and convexly to dorsal fin; flattened sides but slightly constricted below; width of head 2 in its length. Snout broad, conic, its length $\frac{2}{3}$ its width. Eye with center slightly behind first third of head; its diameter $1\frac{1}{5}$ in snout, 2 in interorbital. Mouth broad, with short gape, and closed jaws even. Maxillary concealed, reaches opposite hind nostril. No barbels. Both jaws with strong, trenchant, cartilaginous edges. Lips firm. Nostrils together, within last third of snout; hind one twice size of front one and exposed in crescent, due to hind cutaneous flap of front one. Interorbital broadly convex. Suborbital

[1] 1871, Verhandel. Kon. Akad. Wet. (Amsterdam), XII, (No. 2), p. 43, Pl. XI, fig. 2.

chain narrow, extends only over upper fourth of cheek. Opercle with finely radiating striæ.

Gill-opening extends forward opposite last $\frac{2}{5}$ in head. Gill-rakers 5+10, slender points, $\frac{1}{4}$ the length of gill-filaments, which $1\frac{1}{8}$ in that of eye. Pseudobranchiæ half length of gill-filaments. Pharyngeal teeth, 2, 4, 4—5, 4, 2, compressed, tips slightly hooked, grinding-surfaces slight and entire.

Scales with 21 to 29 apical striæ; basal circuli fine, 67. Scales closely adherent, thin, in even longitudinal series all more or less well exposed, but slightly larger about body edges and on breast; caudal base with little smaller scales. Ventral with pointed axillary scale, $\frac{1}{3}$ the length of fin. Lateral line slightly decurved, becomes median at caudal base; tubes simple, extend over half of each scale exposure.

Dorsal origin a little nearer caudal base than snout tip, first 3 rays osseous, entire, and third with flexible tip; depressed fin reaches a distance $1\frac{7}{8}$ in that to caudal base; first branched dorsal ray $1\frac{9}{10}$ in head. Anal origin opposite base of last dorsal ray, 3 times length of last; first branched ray $1\frac{9}{10}$ in head. Caudal deeply forked, lower lobe slightly longer, or $3\frac{1}{4}$ in combined head and trunk. Pectoral low, not quite reaching ventral, $1\frac{1}{4}$ in head. Ventral inserted well before dorsal origin, reaches vent, which close before anal; ventral $1\frac{2}{5}$ in head.

Color in alcohol with back pale olivaceous, sides and below paler. Each row of scales with median white streak. Fins pale, all slightly grayish submarginally, vertical ones with slight dusky edges.

Length 185 mm.

One from Ningkwo.

Culter erythropterus Basilewsky

Head contained $3\frac{3}{4}$ to $3\frac{4}{5}$ times in body to caudal base; depth $3\frac{3}{4}$ to $4\frac{2}{5}$. Dorsal III, 7, 1; anal III, 20, 1 to 25, 1; pectoral 1, 14 or 15; ventral 1, 8. Scales 62 to 70 in lateral line to caudal base and 4 or 5 more on latter; 14 to 16 scales above lateral line, 8 or 9 below; 44 or 45 predorsal scales. Snout $3\frac{1}{4}$ to 4 in head measured from upper jaw tip; eye $4\frac{1}{5}$ to $5\frac{3}{5}$; maxillary 3 to $3\frac{1}{8}$; interorbital $3\frac{1}{2}$ to $4\frac{1}{8}$.

Body elongately ovoid, strongly compressed, deepest at dorsal origin, edges all convexly rounded, except slight median postventral keel. Caudal peduncle strongly compressed, least depth $1\frac{1}{4}$ to $1\frac{1}{2}$ in its length or $2\frac{1}{2}$ to $2\frac{4}{5}$ in head.

Head well compressed, flattened sides sloping evenly above and below, upper profile slightly concave from snout to occiput; width of head $2\frac{1}{4}$ to $2\frac{3}{5}$ in its length, depth $1\frac{1}{2}$ to $1\frac{4}{5}$. Snout convex, profile slightly convex in front, its length $\frac{7}{8}$ its width. Eye moderate, hind edge about midway in total head length; diameter 1 to $1\frac{1}{2}$ in snout, $1\frac{1}{8}$ to $1\frac{3}{4}$ in interorbital. Mouth moderate, well inclined, lower jaw well protruding. Maxillary largely concealed above by preorbital, reaches eye, expansion $1\frac{2}{3}$ to $1\frac{3}{4}$ in eye. Lips firm, fleshy, lower much broader laterally. Nostrils together; front one about at last third of snout, a simple pore; hind one a crescentic slit close behind, bounded by cutaneous marginal flap of front one. Interorbital broadly convex. Suborbital chain moderate; preorbital little deeper than long and its length slightly greater than eye.

Gill-opening extends forward opposite eye center. Gill-rakers 5+16, lanceolate, equal gill-filaments in length, or $1\frac{2}{3}$ in that of eye. Pseudobranchiæ half length of gill-filaments. Pharyngeal teeth, 2, 4, 5—4, 4, 2, hooked and with slight narrow grinding-surfaces.

Scales with 6 to 8 apical radiating striæ and 10 or 11 marginal auxiliaries; basal circuli 91 to 96. Scales in even longitudinal series parallel with lateral line, slightly crowded and smaller on predorsal, belly, breast and caudal base. Pointed scaly flap in ventral axil about ¼ the length of fin. Lateral line complete, decurved moderately, passes ventral at lowest third in body depth and ascends caudal base medianly; tubes simple, slender, extend over each scale about midway in its exposure.

Dorsal origin a little nearer caudal base than snout tip, first 2 rays spine-like, osseous, and third greatly longest; depressed fin 2⅓ in distance to caudal base; first branched ray 1¼ to 1⅖ in head. Anal begins slightly before depressed dorsal tip, first branched ray highest and forms apex of moderate anterior lobe; 2 1/10 to 2⅔ in head. Caudal strongly forked, lobes sharply pointed, slender and equal; lower lobe equals or little more than head. Pectoral reaches ⅔ to ventral, 9/10 in smaller examples; length 1¼ to 1⅔ in head. Ventral inserted slightly before dorsal origin, reaches ⅔ to ⅞ to anal; length 1⅖ to 1⅞ in head. Vent close before anal.

Color in alcohol, back tinged with pale olive, sides and lower surface pale to whitish. Dorsal and caudal pale olivaceous, lower fins whitish. Iris slaty to whitish.

Length 226 to 266 mm.

Two examples from Ningkwo.

Leuciscinæ

Leuciscus brandti (Dybowski)

Head contained 3¼ to 3¾ times in length to base of caudal; depth 4½ to 5¼. Dorsal II, 7, I; anal III, 7, I. Scales 80 to 90 in lateral line to caudal base and 1 to 4 more on latter; 16 to 20 scales above lateral line, 10 to 16 below; 52 to 60 predorsal scales. Snout 3¼ to 3⅞ in head; eye 3¼ to 5; maxillary 2¾ to 3⅛; interorbital 3 to 3¾. Pharyngeal teeth 2, 5—4, 2, latter rarely 5, 2, slender, slightly hooked, with grinding-surfaces.

Color in alcohol with back deep dusky brownish generally, with lower and under surfaces pale to whitish. An inconspicuous blackish horizontal line from just above origin of lateral line backward, but obsolete behind dorsal and marking dark color of back. Along middle of side, from about level with eye, broad band little narrower and becoming conspicuously black after dorsal and ventral to middle of caudal. Caudal base with conspicuous and prominent black blotch size of pupil, midway at caudal base and distinctly separated from dark lateral band. Whole side of body sprinkled with variably dusky to black dots, specks and spots. Dorsal and caudal pale brownish, also pectoral with slight tinge of same. Ventral and anal whitish. On head dark band as obsolete or slightly reflected.

Length 34 to 163 mm.

Sixty-five examples from Hsing Lung Shan, August 7, 1921. In three very young examples the lateral line is present only on a few anterior scales. Two also have the eye slightly greater in diameter than the snout length, while one has the breast finely scaled.

The short diagnosis of *Telestes brandtii*[1] Dybowski gives the developed anal rays as 8, a condition I find in only one specimen in my series.

[1] 1912, Faune Russie, Pisc., III (1), p. 155, Fig. 6.

Berg shows an example from the lower Amur region. In his diagnosis of the species he repeats Dybowski's formula, though his figure shows certainly nine branched anal rays. It also does not show the dark median lateral band, the conspicuous detached black basal caudal spot and the speckled or dusted pattern of dark dots, so conspicuous in my examples.

Phoxinus lagowskii Dybowski

Head contained 3½ to 3¾ times in length to base of caudal; depth 4¼ to 4⅞. Dorsal II, 7, I; anal III, 7, I. Scales 71 to 73 in lateral line to caudal base and 3 or 4 more on latter; 16 to 19 scales above lateral line, 11 or 12 below; 46 or 47 predorsal scales. Snout 3⅕ to 3¼ in head; eye 5 to 5⅖; maxillary 3 to 3⅛; interorbital 3 1/10 to 3¼. Pharyngeal teeth 2, 5—4, 1, compressed, ends hooked and grinding-surfaces present. Scales with 30 radiating marginal striæ, of which 18 or 19 basal; circuli coarse.

Color in alcohol dusky-brown on back and upper surfaces, finely speckled or mottled irregularly with dusky to blackish, though in no place forming a dark lateral band. Vertical blackish line, less than eye, at caudal base. Upper inner border of gill-opening blackish. Lips pale. Iris dull slaty. Dorsal and caudal grayish-brown, other fins paler to whitish.

Length 106 mm.

Two examples from Hsing Lung Shan, August 7, 1921.

My examples agree largely with the figure and account by Berg[1] as *Phoxinus lagowskii variegatus* (Günther). This Berg admitted to subspecific rank as the southern and Chinese representative of *Phoxinus lagowskii*. I find nothing, aside from the alleged deeper caudal peduncle of *variegatus*, to distinguish it.

A comparison of the four types of *Leuciscus costatus* Fowler,[2] shows them to be synonymous. A further study of them shows the following details.

Head contained 3⅗ to 3 9/10 times in length to base of caudal; depth 4 1/10 to 4⅘. Dorsal II, 7, I; anal III, 7, I. Scales 71 to 73 in lateral line to caudal base and 2 to 4 more on latter; 14 to 16 scales above lateral line, 8 or 9 below; 44 to 48 predorsal scales. Snout 3 to 3⅖ in head; eye 3⅗ to 4⅓; maxillary 3 to 3¼; interorbital 2⅔ to 2⅞. Pharyngeal teeth 2, 5—5, 2, grinding-surfaces little developed. In all, as in the Hsing Lung Shan specimens, the lateral line is complete. There is also a faint trace of the dark or blackish vertical basal caudal bar as in Berg's figure of *Phoxinus lagowskii*.[3]

Idus waleckii Dybowski

Head contained 3⅔ to 4 1/10 times in length to base of caudal; depth 3⅗ to 4. Dorsal III, 8, I; anal III, 10, I. Scales 44 to 47 in lateral line to caudal base and 2 or 3

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[1]1912, Faune Russie, Pisc., III, (1), p. 231, Fig. 13.
[2]1899, Proc. Acad. Nat. Sci. Phila., 1899, p. 180. Tan Lan Ho, tributary Shu Lan Ho, Sungari Basin in Eastern Mongolia.
[3]1912, Faune Russ., Pisc., III, (1) p. 228, Pl. I, fig. 8.

more on latter; 9 or 10 scales above lateral line, 5 below; 23? to 26 predorsal scales. Snout $3\frac{2}{5}$ in head; eye $4\frac{1}{5}$ to 5; maxillary 3 to $3\frac{3}{5}$; interorbital 3 to $3\frac{1}{5}$.

Body elongate, rather slender. Head width 2 in its length, scarcely constricted below. Snout rather short, convex, length $\frac{3}{5}$ its width. Eye at first $\frac{3}{8}$ of head. Mouth very oblique. Maxillary greatly inclined, reaches about to eye. Interorbital broadly crescentic. Gill-rakers 3+6 short points, about $\frac{1}{4}$ of gill-filaments, which $1\frac{1}{5}$ in eye. Pharyngeal teeth 3, 5—5, 3, hooked, with narrow grinding-surfaces. Scales with 4 or 5 apical radiating striæ; circuli fine, though doubly so basally. Scales on breast and preventral but little smaller than others. Lateral line complete, well decurved. Dorsal origin midway between eye center and caudal base. Anal origin well behind base of last dorsal ray. Caudal emarginate. Pectoral contained $1\frac{2}{5}$ times in head. Ventral inserted a trifle before dorsal origin; fin $1\frac{3}{4}$ in head.

Color in alcohol faded dull dusky-brown on back, with olive tinge. Sides and lower surface dull brassy. Under surface more or less uniform. Iris brownish, also fins.

Length 168 to 215 mm.

Described from the type of *Leuciscus farnumi* Fowler, in the Acad. Nat. Sci. Philadelphia from the Tore River, and two paratypes from Dalai Nor, all obtained in 1897.[1]

Opsariichthys uncirostris (Schlegel)

Head contained $3\frac{1}{4}$ to $3\frac{1}{3}$ times in length to caudal base; depth 4 to $4\frac{2}{5}$. Dorsal III, 7, I; anal III, 9, I. Scales 41 to 45 in lateral line to caudal base and 3 more on latter; 9 scales above lateral line, 5 below; 20 or 21 predorsal scales. Snout $3\frac{1}{3}$ to $3\frac{2}{3}$ in head; eye 3 to 5; maxillary 2 to $2\frac{1}{4}$; interorbital 3 to $3\frac{2}{5}$. Pharyngeal teeth with broad grinding-surfaces and small terminal hooks. Scales with 5 to 12 apical radiating striæ; circuli moderate, fine apically. Lateral line only on about 7 anterior scales in young.

Color in alcohol silvery white. Dorsal and caudal grayish, lower fins whitish. Jaws and lower side of head pale, like belly.

Length 32 to 134 mm.

Fifteen examples, from twenty-six miles south of the Hsing Lung Shan, August 12 , 1921.

For comparison there are in the Academy two from the Tore River in Eastern Mongolia, and a series of Japanese specimens from the Yodo River in Osaka. They show:

Head contained $3\frac{1}{5}$ to $3\frac{1}{3}$ times in length to caudal base; depth 4 to 5. Dorsal III, 7, I; anal III, 9, I. Scales 40 to 48 in lateral line to caudal base and 2 or 3 more on latter; 8 to 10 scales above lateral line, 4 or 5 below; snout $3\frac{1}{8}$ to 4 in head; eye $3\frac{1}{8}$ to 4; maxillary 2 to $2\frac{1}{2}$; interorbital $3\frac{1}{8}$ to $4\frac{1}{8}$; pharyngeal teeth 2, 3, 5—5, 3, 2, vary 2, 3, 5—4, 3, 2 or 1, 4, 4—5, 4, 1 or 1, 4, 4—4, 4, 1.

Length 50 to 135 mm.

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[1]1899, Proc. Acad. Nat. Sci., Phila., 1899, p. 179.

Zacco platypus (Schlegel)

Head contained 3¼ to 3⅚ times in length to caudal base; depth 4 to 5. Dorsal II, 7, I; anal III, 9, I. Scales 41 to 43 in lateral line to caudal base and 3 more on latter; 7 or 8 scales above lateral line, 3 or 4 below; 16 to 18 predorsal scales. Snout 3 to 3⅔ in head; eye 3 to 4; maxillary 2⅘ to 3; interorbital 2½ to 3. Pharyngeal teeth 2, 4, 4—4, 4, 2, hooked, with grinding-surfaces. Scales with 11 to 20 apical radiating striæ; circuli largely coarse apically, become fine basally. Pearl organs of male, a row of small ones from nostrils to antero-supraorbital; row around front edge of snout, slightly doubled on each side; then a continuous series of 4 horizontally on preorbital; on suborbital chain, a row close below eye to postorbital inferiorly; a series of 7 on lower ridge of preopercle; scattered tubercles on upper part of opercle and along its front edge vertically; a double row along lower side of each mandibular; second, third and fourth anal rays each with row of small tubercles along outer face.

Color in alcohol largely dull olivaceous above, edge of each scale slightly darker. Muzzle, upper surface of head and chin largely with dusky-slate to blackish, pale in female or non-ornamented male. Male with dusky-slate broad lateral band, interrupted by a number of pale lines or bars extending up and intersecting with whitish color of belly. Membranes of dorsal and anal dusky to blackish. Caudal largely with dusky tinge, especially on outer median portion. Other examples, tuberculate, and with but slight dusky on fins, show pale or orange tinge on middle of front dorsal edge and upper part of pectoral medianly. Same on ventral fin and front half of anal.

Length 34 to 130 mm.

From Hsing Lung Shan, August 7, 1921, 114 examples; twenty-six miles to south of Hsing Lung Shan, August 12, 1921, 105 examples.

For comparison I examined the following series of Japanese examples in the Academy: Kinu River at Utsonomiya, Yodo River in Osaka, Chilongo River in Kurume, Yabe River at Funayado, Kawatana near Nagasaki and Tsuruga. They show:

Head contained 3½ to 4 times in length to caudal base; depth 3½ to 4¼. Dorsal II, 7, I; anal III, 8, I to 10, I. Scales 36 to 46 in lateral line to caudal base, and 2 or more on latter; 8 scales above lateral line, rarely 7, 4 below; 15 to 17 predorsal scales. Snout 3 to 3⅓ in head; eye 2¾ to 4½; maxillary 2½ to 2⅞; interorbital 2¾ to 3⅛. Pharyngeal teeth 2, 4, 5—5, 4, 2, vary 1, 4, 5—5, 4, 1 or 2, 4, 4—5, 4, 2 or 2, 4, 5—4, 4, 2 or 1, 4, 5—4, 4, 1 or 2, 4, 4—4, 3, 1.

Length 57 to 144 mm.

Zacco platypus has not before been reported from Northeast Mongolia. In the American Museum series another more progressively ornamented male shows the series of lateral snout pearl-organs and those on the lower preopercle ridge fused as a ridge. The latter are greatly similar to Boulenger's figure of *Opsariichthys acanthogenys*. Further, there are small scattered pearl-organs on the scales along the anal base and under surface of the caudal peduncle. The lower rudimentary caudal rays are much covered with adipose tissue, abruptly ending forward and like basal portions of lower caudal rays also finely studded with tubercles.

Tubercles on the anal fin are present on the anterior or rudimentary rays, basal tubercle of fourth, fifth and sixth anal rays enlarged and at tips of fifth, sixth and seventh two or three small terminal tubercles on each side.

Pseudaspius leptocephalus (Pallas)

Head contained 3⅙ times in length to caudal base; depth 4¾. Dorsal III, 7, 1; anal III, 9, 1. Scales 91 in lateral line to caudal base and 6 more on latter; 16 scales above lateral line, 10 below; 52 predorsal scales. Snout 3⅖ in head measured from upper jaw tip; eye 6½; maxillary 3⅖; interorbital 4⅔.

Body elongate, well compressed, edges rounded, deepest at dorsal origin. Caudal peduncle compressed, least depth 3 in total head length. Head attenuate, compressed, flattened sides not convergent; width 2¾ in its length. Snout broadly convex, depressed, a trifle longer than wide. Eye slightly before first third in head length. Premaxillaries protractile forward. Maxillary not quite reaching to eye or but a trifle behind posterior nostril. Mandible depressed, protrudes, 2½ in total head length. Nostrils at last third of snout, superior. Interorbital broadly convex. Preorbital 1⅔ in snout, width 1⅘ its length. Postorbital equals eye. Gill-rakers 3+6, short strong firm points, 2¾ in length of gill-filaments, latter 1½ in eye. Pharyngeal teeth 2, 5—?, ?, with slight grinding-surfaces. Scales small, reduced and crowded on median preventral and breast, little smaller on median predorsal and caudal base. Pointed adnate scaly flap in ventral axil. Lateral line well decurved.

Dorsal origin midway between hind eye edge and caudal base, fin reaches half way to caudal base, first branched dorsal ray longest, 1⅔ in head. Anal a little behind dorsal base, first branched ray 2 in head. Caudal deeply forked, pointed lobes evidently subequal, upper lobe 1¼ in head. Pectoral 3 in head. Ventral inserted a little before dorsal, nearer anal origin than pectoral origin, 2 in head.

Color in alcohol, dull uniform brownish, paler below. Fins and iris plain brown.

Length 247 mm.

Described above from an example in the Academy obtained in the Tore River, a tributary of the Sungari.

Chela nicholsi Fowler

Figure 2

Head contained 4⅔ times in length to caudal base; depth 4⅔. Dorsal III, 7, 1; anal III, 22, 1; pectoral I, 14; ventral I, 8. Scales 58 in lateral line to caudal base and 4 more on latter; 10 scales above lateral line, 3 below; 40 predorsal scales. Snout 3⅔ in head measured from upper jaw tip; eye 3¾; maxillary 3; interorbital 4⅓.

Length 152 mm.

Type in the American Museum and paratype noted above in the Acad. Nat. Sci. Philadelphia. These are the only examples known.

Pseudobrama dumerili Bleeker

Head contained 4½ times in length to caudal base; depth 3¼. Dorsal III, 7, 1; anal III, 9, 1; pectoral I, 14; ventral I, 8. Scales 44 in lateral line to caudal base and 3 more on latter; 9 scales above lateral line, 4 below to ventral origin, 6 below to anal origin; 20 predorsal scales. Snout 4 in head; eye 3½; maxillary 5⅓; interorbital 2⅘.

Body moderately ovoid, strongly compressed, deepest at dorsal origin, postventral with slight median keel over which scales not passing and other edges all convexly rounded. Caudal peduncle strongly compressed, least depth 1⅕ in its length or 1⅞ in head.

Head well compressed, flattened sides slightly approximated below, upper profile slightly convex, lower more so; width 2 in its length, depth 1¼. Snout convex, rather obtuse, length ⅗ its width. Eye rather large, hind edge midway in head length, diameter 1 in snout, 1¼ in interorbital. Mouth small, inferiorly terminal, width 1⅓ in eye. Maxillary largely concealed by preorbital, at least its expansion, which 3⅘ in eye, or reaches opposite front nostril. Lips moderate, entire. Edges of jaws firmly coriaceous. Nostrils together, front one at last third in snout, pore-like, and hind one a crescentic slit close behind, formed by cutaneous marginal flap of anterior. Interorbital broadly and evenly convex. Suborbital chain moderate, preorbital depth ⅘ its length, which 1⅓ in eye. Opercle smooth.

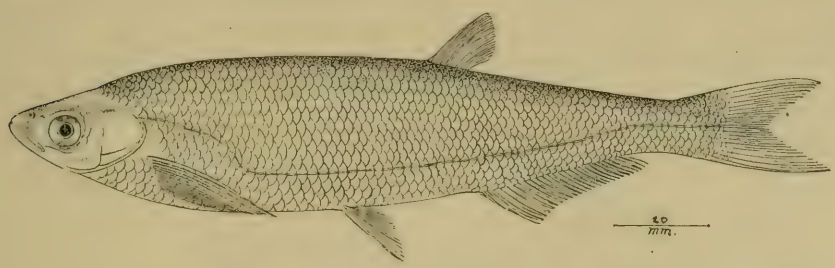

Fig. 2. *Chela nicholsi* Fowler. Type.

Gill-opening extends forward about opposite hind edge of eye. Gill-rakers 38+91, short, fine, slender, close-set, 2⅛ in length of gill-filaments, which 1½ in eye. No pseudobranchiæ. Pharyngeal teeth 6—7, strongly compressed, all with broad grinding-surfaces, and pointed but without hooks.

Scales with 16 to 19 apical radiating striæ, also 7 or 8 auxiliary marginals; basal circuli 45 to 60. Scales in even longitudinal series parallel with lateral line, scarcely smaller on breast and caudal base. Pointed scaly flap in ventral axil, about ⅖ length of fin. Lateral line complete, deeply decurved, passes lower ⅖ in body length at ventrals and ascends along side of caudal peduncle to caudal base medianly. Tubes simple, extend over each scale about midway of exposure.

Dorsal origin midway between snout tip and caudal base, first 3 rays spine-like, osseous, compressed, third greatly longest; first branched dorsal ray 1 in head. Anal begins well behind depressed dorsal, first branched ray highest and forms apex of slight anterior lobe, 2 in head. Caudal strongly forked, lobes sharply pointed, slender, equal, little longer than head. Pectoral reaches a distance contained 1¼ in that to ventral, 1⅕ in head. Ventral inserted slightly before dorsal origin, reaches a distance contained 1⅞ in that to anal, 1⅖ in head. Vent close before anal.

Color in alcohol with back tinged pale olive, sides and lower surface pale to whitish. Dorsal and caudal pale olivaceous, lower fins whitish. Iris slaty and whitish.

Length 170 mm.

One from Ningkwo.

Ochetobius elongatus (Kner)

Head contained $4\frac{3}{5}$ to $4\frac{7}{8}$ times in length to caudal base; depth $5\frac{1}{2}$ to $6\frac{2}{3}$. Dorsal III, 9, I; anal III, 9, I. Scales 63 to 65 in lateral line to caudal base and 3 more on latter; 10 or 11 scales above lateral line, 5 or 6 below; 28 to 30 predorsal scales. Snout $3\frac{2}{5}$ in head; eye $5\frac{1}{4}$ to 6; maxillary $3\frac{3}{5}$ to $3\frac{3}{4}$; interorbital $3\frac{1}{4}$ to $3\frac{2}{5}$.

Body greatly elongate, fusiform, compressed, deepest at dorsal origin, edges all convexly rounded. Caudal peduncle well compressed, its least depth 2 to $2\frac{1}{5}$ in its length or $2\frac{7}{8}$ to $3\frac{1}{10}$ in head.

Head small, compressed, its flattened sides slightly approximated below, upper profile nearly straight and much less inclined than lower; width of head $2\frac{1}{8}$ to $2\frac{1}{4}$ in its length. Snout conic, its length $\frac{7}{8}$ to 1 in its width. Eye center at first third in head; eye diameter $1\frac{2}{5}$ to $1\frac{3}{5}$ in snout, $1\frac{4}{5}$ in interorbital; adipose-lid moderate, invades a little more of eye behind than in front. Mouth oblique, closed jaws even in front. Maxillary reaches opposite hind nostril, largely concealed. Jaws firm and their edges rather trenchant. Nostrils together, within last fourth of snout; front one a pore, with hind cutaneous flap exposing posterior nostril in crescent. Interorbital broadly convex. Suborbitals narrow, cover but little of cheek, less than $\frac{1}{3}$ to preopercle ridge.

Gill-opening extends forward opposite hind eye edge. Gill-rakers 8+25, lanceolate, slender, contained $1\frac{1}{4}$ in the length of gill-filaments, or $1\frac{3}{5}$ in eye. Pseudobranchiæ about half the length of gill-filaments. Pharyngeal teeth 2, 3, 5—5, 3, 2, with broad smooth grinding-surfaces but without terminal hooks.

Scales with 23 to 30 apical slightly waved radiating striæ; basal circuli fine. Scales largely adherent, thin, in even longitudinal series, largely uniform; scales a little smaller on breast and but slightly smaller on caudal base than on body. Ventral axillary scale $2\frac{1}{4}$ in the length of the fin. Lateral line complete, decurved slightly along side, and becomes median at caudal base. Tubes simple and extend about half way over scale exposure.

Dorsal origin slightly nearer snout tip than caudal base, first branched ray depressed reaches a little beyond tip of others, or is contained $1\frac{2}{5}$ to $1\frac{1}{2}$ in head; length of depressed fin contained $3\frac{1}{8}$ to $3\frac{1}{3}$ times in length to caudal base. Anal origin a little nearer last dorsal ray base than caudal base, first branched ray tip shorter than last when depressed, or $2\frac{1}{8}$ to $2\frac{1}{4}$ in head; depressed fin $1\frac{4}{5}$ to $1\frac{7}{8}$ times in distance to caudal base. Caudal deeply forked, lobes sharply pointed, alike, $4\frac{2}{5}$ to $4\frac{3}{4}$ in combined head and trunk. Pectoral reaches a distance contained $1\frac{9}{10}$ to $2\frac{1}{8}$ in that to ventral, $1\frac{1}{2}$ to $1\frac{3}{5}$ in head. Ventral inserted slightly before dorsal origin, $2\frac{1}{4}$ to $2\frac{1}{3}$ in distance to anal origin, $1\frac{2}{3}$ to $1\frac{3}{4}$ in head.

Color in alcohol with back olivaceous, sides and below pale brownish, with traces of whitish. Eye and under surface of head silvery-white. Dorsal and caudal pale brownish, paired fins and anal whitish.

Length 235 to 270 mm.

Five from Ningkwo.

COBITIDÆ

Misgurnus anguillicaudatus (Cantor)

Head contained 5 to $6\frac{1}{3}$ times in length to caudal base; depth $7\frac{3}{4}$ to 9. Dorsal II, 7, I; anal II, 6, I. Scales 138 to 170 in lateral line to caudal base. Snout $2\frac{2}{3}$ to

$2\frac{7}{8}$ in head; eye $5\frac{1}{5}$ to $7\frac{1}{5}$; maxillary $3\frac{3}{4}$ to 4; interorbital $4\frac{7}{8}$ to $5\frac{1}{4}$. Scales with 36 to 38 radiating striæ in young, adult with 68 to 70; circuli fine.

Color in alcohol dull brownish, back darker and color of upper surface rather abruptly distinct from that of lower surface. Back and upper surface more or less distinctly spotted with darker everywhere, though spots more pronounced posteriorly, or above anal and on caudal peduncle. Spots on back and sides often arranged as 2 longitudinal dark lines. Dorsal pale brown, with about 4 horizontal bands of dusky spots. Caudal with about 10 transverse vertical dusky spots and black blotch at base above nearly large as eye. Anal pale, also with few dusky spots.

Length 66 to 206 mm.

Eighty examples from Hsing Lung Shan and two from twenty-six miles south of Hsing Lung Shan, latter August 12, 1921. Besides these I have also included three from Tan lan Ho, in the Academy.

The color is variable, though always with a black spot at the bases of the upper caudal rays. Head and trunk always with scattered spots, specks or dots, variously close-set or more or less scattered. Sometimes only large scattered blotches to several times size of eye present, or larger blotches may occur only above lateral line. None show so great development of adipose-like rudimentary caudal rays as in the next species.

Misgurnus decemcirrosus (Basilewsky)

Figure 3

Head contained 5 to $5\frac{3}{4}$ times in length to base of caudal; depth 6 to $6\frac{7}{8}$. Dorsal II, 7, I, sometimes 8, I; anal II, 6, I, sometimes 5, I. Scales 95 to 127 in lateral line to caudal base. Snout $2\frac{1}{2}$ to $2\frac{3}{5}$ in head; eye 5 to $7\frac{1}{4}$; maxillary 4 to $4\frac{1}{3}$; interorbital $3\frac{3}{4}$ to $6\frac{3}{4}$. Scales with 36 to 44 radiating striæ in young, with circuli about 70 rows; adults with 77 to 80 radiating striæ.

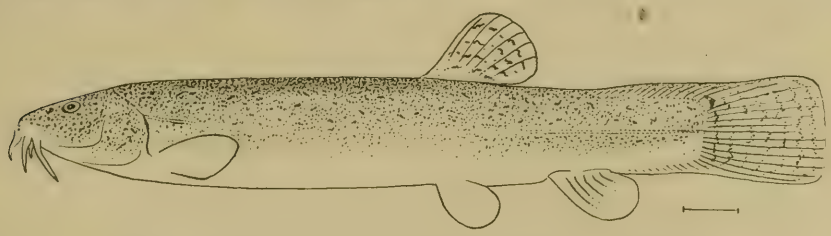

Fig. 3. *Misgurnus decemcirrosus* (Basilewsky). Tien Tsen.

Color in alcohol dull brown, finely specked or dotted with dusky on back and upper surface. Obscure dusky or blackish spot at bases of upper caudal rays not much larger than pupil.

Length 132 to 196 mm.

Six from Ningkwo. Also twenty-one from the Pietto River at Tien Tsen collected by N. F. Drake, in the Academy.

The Ningkwo examples are all with very great development of the rudimentary caudal rays, starting close behind the dorsal base in most cases and joining behind with the caudal. Lower rudimentary caudal rays likewise greatly developed, begin close behind anal base and fused posteriorly with caudal.

Color pattern also very variable, as some with large scattered dusky to blackish spots on head and trunk, though none much larger than eye. Body similarly finely sprinkled with dark dots, specks or small spots as in *Misgurnus anguillicaudatus*.

Misgurnus crossochilus Sauvage is doubtless a synonym. The details set forth in the original description do not show any characters worthy of specific value and agree so far as given with my materials of the present species.

Nemacheilus toni (Dybowski)

Head contained 4 to 4⅖ times in length to caudal base; depth 6⅞ to 8¾. Dorsal II, 7, I or 8, I; anal II, 5. Scales quite minute, about half a millimeter in size and 128 to 140 estimated in lateral count; each with 30 radiating marginal striæ; circuli moderately fine. Snout 2⅕ to 2⅖ in head; eye 5⅗ to 6⅞; maxillary 3¼ to 4⅕; interorbital 4½ to 5¾.

Color in alcohol pale olive-gray on back to paler or whitish below, side and back with many large dull dusky blotches, rather irregular and most much larger than eye. Obscure dusky streak from side of snout to nostrils. Dorsal with about 4 and caudal with 5 or 6 cross bands made up of dusky blotches, fins otherwise pale to whitish. Several grayish blotches on pectoral medianly and anal terminally. In young example color-pattern much more contrasted. The markings appear variable in preserved examples as in the one in best condition they are as a row of large blackish blotches above and another below lateral line.

Length 60 to 99 mm.

Three from Hsing Lung Shan.

The type of *Nemachilus pechiliensis* Fowler, in the Academy, is now in such poor preservation that it is useless for examination. The original description, however, shows that it is clearly a synonym.

Orthrias oreas Jordan and Fowler[1] is also in agreement and is another synonym.

Lefua andrewsi Fowler

Figure 4

Known only from the type in the American Museum.

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[1]1903, Proc. U. S. Nat. Mus., XXVI, p. 796, Fig. 2.

Fig. 4. *Lefua andrewsi* Fowler. Type.

Lefua costata (Kessler)

Head contained 4 to 4⅖ times in length to caudal base; depth 6⅙ to 6½. Dorsal II, 6, I; anal II, 5, I. Scales 93 to 102 in median lateral series. Snout 2⅞ to 3⅛ in head; eye 4⅖ to 6¼; maxillary 3¾ to 4⅕; interorbital 3 to 3⅓. Scales with 38 to 43 radiating marginal striæ (30 to 36 in type of *Nemachilus dixoni*); circuli rather fine, moderate.

Color in alcohol brownish generally, with slight olive tint. Back and sides with very obscure scattered moderate spots of small size. Dorsal and caudal finely and obscurely spotted with gray-brown, though latter fin always with distinct round black spot at middle of base, not larger than pupil. Iris dull slaty, lips and jaws all pale or dull. Dark median lateral streak not very distinct and largely evident only after ventral.

Length 40 to 73 mm.

Six from Hsing Lung Shan.

In the Academy the type of *Nemachilus dixoni*, a synonym of the present species, is included above.

Elxis nikkonis Jordan and Fowler[1] is certainly closely related, though the alleged larger scales, given as about fity-six, would seem to warrant specific distinction. It is, however, otherwise closely related, as the black basal caudal spot suggests.

Lefua echigonia Jordan and Richardson[2] is based on three young examples only 38 to 45 mm. long. It is represented with four barbels in profile, showing it doubtless had eight. Its coloration greatly suggests *Misgurnus decemcirrosus* (Basilewsky).

Nemachilus variegatus (Dabry) Sauvage and de Thiersant[3] is probably a *Lefua*. It is described as having large brownish cloudings formed into a series of somewhat undulate bands and a black band at caudal and dorsal base.

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[1]1903, Proc. U. S. Nat. Mus., XXVI, p. 768, Fig. 1.
[2]1908, Proc. U. S. Nat. Mus., XXXIII, p. 263, Fig. 1.
[3]1874, Ann. Sci. Nat. Zool., I (2), p. 14.

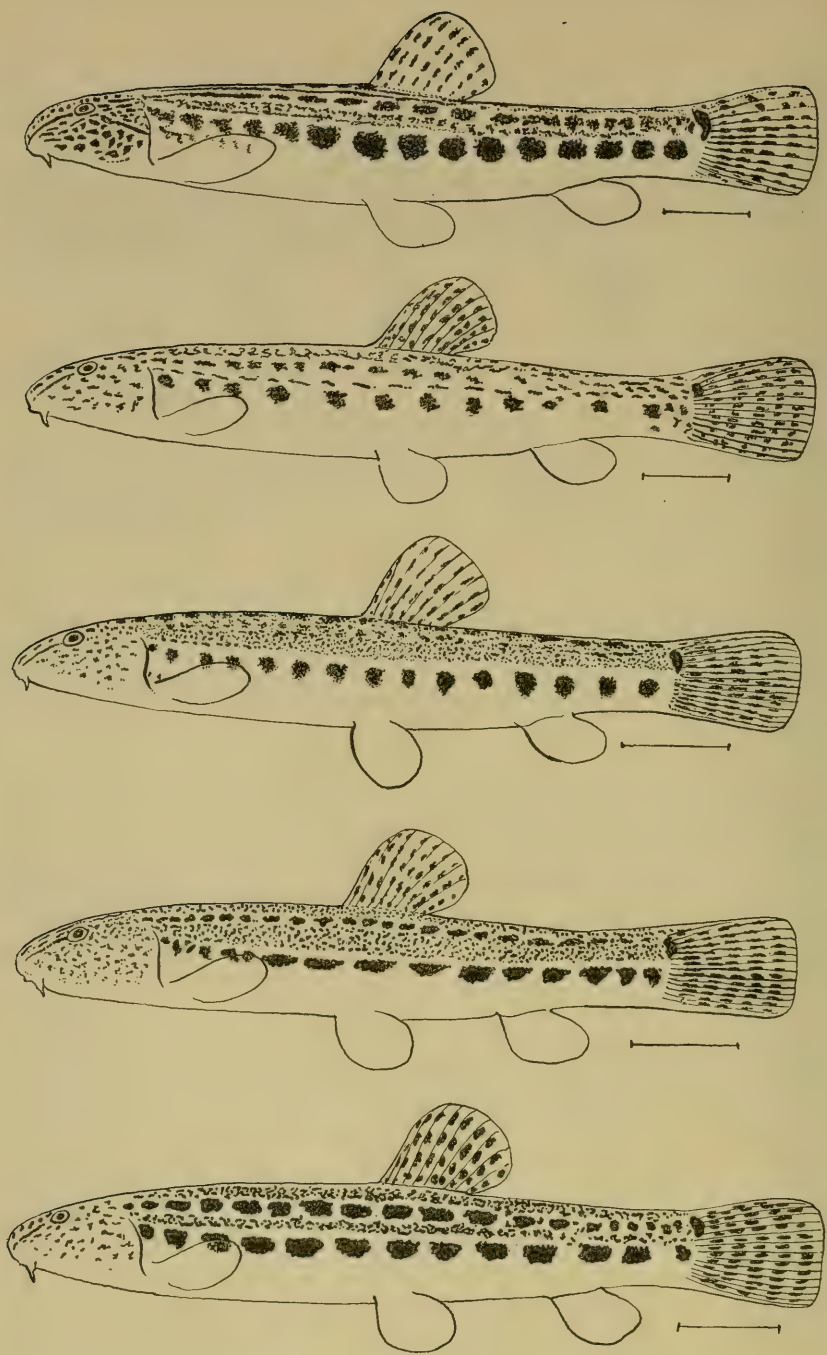

Fig. 5. *Cobitis tænia* Linnæus. Variation in color-pattern.

Cobitis tænia Linnæus

Figure 5

Head contained $4\frac{3}{4}$ to $5\frac{7}{8}$ times in length to caudal base; depth $6\frac{1}{3}$ to $7\frac{3}{4}$. Dorsal II, 6, 1 to 8, 1; anal III, 4, 1 to 6, 1. Snout $2\frac{1}{4}$ to $2\frac{3}{5}$ in head; eye $5\frac{1}{3}$ to $6\frac{1}{3}$; maxillary $3\frac{1}{3}$ to $4\frac{1}{3}$; interorbital 8 to $8\frac{2}{3}$.

Length 55 to 98 mm.

From Hsing Lung Shan, August 7, 1921, 83 examples.

In the Academy a series of 20 examples from Europe, the Italian Lakes and Sweden. These show the following.

Head contained $4\frac{3}{4}$ to $5\frac{1}{3}$ times in length to caudal base; depth $5\frac{7}{8}$ to $7\frac{1}{4}$. Dorsal II, 7, 1; anal III, 5, 1 or 6, 1. Snout $2\frac{1}{4}$ to $2\frac{3}{4}$ in head; eye $4\frac{3}{4}$ to 6; maxillary $3\frac{7}{8}$ to $4\frac{1}{4}$; interorbital $7\frac{3}{4}$ to 9.

Length 48 to 95 mm.

The scales are most striate in the largest European examples, the radiating marginal striæ showing 38 to 48 and circuli in the largest in about 25 series. In a Japanese example, representative of the nominal *Cobitis biwæ* Jordan and Snyder, from Kiroshina, and in all the above Chinese examples examined, besides one I reported from the Academy collection as the nominal *Cobitis sinensis* Sauvage and De Thiersant taken in the Tan Lan Ho, the marginal radiating striæ are 28 to 31. In no way do they differ from the other Chinese examples examined.

Considerable variation in the color-pattern is noticed in this species, and for comparison I have placed a drawing of the largest European example at the top of the accompanying figure, the others representing the extremes found in the Hsing Lung Shan series.

From the description of *Cobitis dolichorhynchus* Nichols[1] I am inclined to consider it a variant. It is said to be more elongate than *Cobitis tænia*, though its depth is given as only 5.8. From the above details this depth is within the range of my European examples. The alleged longer snout also appears variable. I fail to find any other characters on which to separate the Futsing specimens.

Four examples also obtained at Ningkwo, 137 to 165 mm.

SILURIDÆ

Parasilurus asotus (Pallas)

Head contained $3\frac{4}{5}$ to $4\frac{3}{4}$ times in length to caudal base; depth $5\frac{4}{5}$ to $6\frac{1}{5}$. Dorsal I, 5; anal II to V, 68 to 77. Snout $2\frac{7}{8}$ to $3\frac{1}{6}$ in head measured from tip of upper jaw; eye $4\frac{1}{2}$ to 9; maxillary $2\frac{1}{2}$ to $3\frac{1}{8}$; interorbital $2\frac{1}{5}$ to $2\frac{1}{4}$. Lower jaw well protruded. In young maxillary barbel extends back to middle of depressed dorsal, or well beyond depressed pectoral.

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[1]1916, Proc. Biol. Soc. Wash., XXXI, p. 16. Futsing, Fu-kien.

Color in alcohol nearly deep mouse-gray above, becoming deep olive-buff on under surface of head and belly, sides below all with pale smutty dusted appearance. About 17 or 18 vertical rows of very inconspicuous pale small spots on back, transversely down till level with lateral line. Also few similar pale spots on upper surface of head. Pectoral and ventral pale. Iris slaty. Maxillary barbel dusky above, pale below. Mental barbels pale, like chin.

Length 58 to 332 mm.

Eleven from Hsing Lung Shan, August 7, 1921 and two from Ningkwo.

PORCIDÆ

Pseudobagrus macropterus (Bleeker)

Head contained 4½ times in length to caudal base; depth 8⅔. Dorsal I, 7; anal v, 10; pectoral I, 9; ventral I, 5. Snout 2¾ in head; eye 7; maxillary 3; interorbital 3⅔; mouth width 2½.

Body slender, depressed forward, strongly compressed behind, deepest about middle of depressed pectoral. Caudal peduncle little free, strongly compressed, least depth about 2¼ in its length or 2⅖ in head.

Head broadly depressed, flattened medianly above, sides convex, width 1⅓ in its length, depth 2⅙. Snout broadly depressed, length ⅗ its width as measured across at front of eyes. Eye center falls about first ⅖ in length of head, elevated, lids free; 2⅔ in snout, 2 in interorbital. Mouth broadly transverse, lower jaw much the shorter. Teeth in broad villiform bands in jaws and continuous across vomer and palatines. Lips thick, fleshy, plicated. Maxillary barbel long, reaches dorsal origin; hind nasal barbel longer than eye, 1⅘ in snout; outer mental barbel reaches gill-opening or ¾ to pectoral origin; inner mental 3 in head. Nostrils separated; front one with low cutaneous rim, closer to hind one than to snout edge; hind nostril about ⅖ in snout profile. Interorbital level.

Gill-opening extends forward opposite eye center. Gill-rakers 8+13, lanceolate, 1⅙ in gill-filaments, which 1⅛ in eye. Isthmus wide, depressed, broadly triangular.

Skin smooth. Lateral line distinct, midway along side.

Dorsal origin about first third in combined head and trunk, third ray longest and edges of membranes slightly emarginate. Dorsal spine 2 in head. Adipose dorsal very long 2⅙ in combined head and trunk. Anal small, first branched ray highest, inserted a little nearer caudal base than pectoral origin; first branched ray 2⅖ in head. Caudal deeply forked, lobes rounded, hind edge deeply emarginate and lower lobe 1⅖ in upper; length 1 1/10 in head. Pectoral rounded, reaches a distance contained 1⅘ in that to ventral; spine 1⅞ in head, flattened, 14 teeth along hind edge. Ventral insertion nearer snout tip than caudal base or close behind base of last dorsal ray, fin reaches a distance contained 1½ in that to anal, length 1⅞ in head.

Color in alcohol pale slaty-gray above, with obscure slightly darker slaty dots scattered about, also on dorsals and caudal. Under surface of body pale to whitish. Maxillary and nasal barbels slaty, others whitish. Iris slaty.

Length 345 mm.

One from Ningkwo.

Pseudobagrus fulvi-draco (Richardson)

Head contained 2¾ to 3¾ times in length to caudal base; depth 3 to 3¾. Dorsal I, 7, I; anal, v, 15 or 16. Snout 3 in head; eye 4 to 7; maxillary 2¾ to 3; interorbital 2⅕ to 2½. Maxillary barbel extends back but little beyond head, though sometimes quite a little shorter. Serræ on hind edge of pectoral spine 14 to 16 and much more developed than the fine and more numerous even small denticles along front edge of spine. Dorsal spine often with very obsolete similar armature, or the denticles or spinules absent.

Color in alcohol slaty-brown above, with about 3 large obsolete blotches on side, well contrasted from same color of back above. In many color faded more or less brownish. All fins with more or less blackish blotch terminally, though on caudal in middle of each lobe. In young color-pattern greatly contrasted as blackish and very pale brownish.

Length 27 to 170 mm.

Ten from Hsing Lung Shan, August 7.

Pseudobagrus emarginatus Sowerby[1] is based on an example 413 mm. long without caudal. Sowerby says it is very much more elongate than *Pseudobagrus ussuriensis* (Dybowski), and closely resembles it except in its emarginate caudal. *Pseudobagrus ussuriensis* is said in the original description to reach 1000 mm., and to have a rounded caudal. Possibly this may be a condition with advanced age.

OPHICEPHALIDÆ

Ophicephalus argus Cantor

Head contained 2⅔ to 3 times in length to caudal base; depth 5 to 5⅔. Dorsal 48 to 51; anal 32 or 33. Scales 59 to 62 in lateral line to caudal base and 3 or 4 more on latter; 8 to 10 scales above lateral line, 13 to 15 below; 29 to 30 predorsal scales. Snout 5⅞ to 6 in head measured from upper jaw tip; eye 5⅕ to 7⅕; maxillary 2⅖ to 2⅗; interorbital 4⅕ to 5½.

Body moderately long, compressed. Least depth of caudal peduncle 3⅖ to 3⅘ in total head length.

Head width 2⅙ to 2⅓ in its length. Hind pupil edge at first fourth in head; hind eye edge about first third in head in young; diameter 1 to 1¼ in snout, 1⅙ to 1⅓ in interorbital. Mouth large, lower jaw protruding. Maxillary extends well beyond eye, but slightly beyond in young. Teeth finely conic, in narrow bands in jaws; inner row along each side of mandible and row on vomer and palatines enlarged. Front nostril in short tube at first ⅖ in snout; hind one a simple pore close above and before front eye edge. Interorbital depressed, level.

Gill-rakers 3+6, short low tubercles, largest slightly less than gill-filaments, which 2 in eye.

Scales with 9 to 18 basal marginal radiating striæ, 12 to 15 apical circuli, other circuli fine. Head with muzzle and jaws naked; 12 to 15 scales on cheek to preopercle edge; occipital scales scarcely larger than those on sides of head; small scales on

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[1]1921, Proc. U. S. Nat. Mus., LX, p. 1, Yalu River, Southern Manchuria.

breast and caudal basally. Lateral line a little high at first, drops 2 scales a little behind pectoral, then median to caudal base; tubes narrow and simple.

Median dorsal rays $3\frac{3}{5}$ to $3\frac{2}{3}$ in head; median anal rays $3\frac{1}{4}$ to $3\frac{3}{4}$; caudal rounded, $1\frac{3}{5}$ to $1\frac{2}{3}$; pectoral $2\frac{1}{2}$ to $3\frac{1}{2}$ (?); ventral $3\frac{1}{8}$ to $3\frac{1}{4}$.

Color in alcohol brown, paler below to whitish on under surface of head. Brown streak from side of snout to eye, then back along upper side of head to shoulder; another parallel from lower eye edge to pectoral base. Jaws and lower side of head with some pale brown spots. Pores along preopercle flange and mandible dusky. Trunk with row of 11 dark large rings, beginning at shoulder and continued above median axis to caudal base. Below median axis nearly equal number of less regular dark blotches, some angular or giving off slight oblique bars below, but all similarly with more or less dark bordering line. Vertical fins dusky terminally, with dark blotches. Pectoral pale brown, with dusky spot less than eye at bases of upper rays. Ventral whitish. Iris brown.

Length 98 to 222 mm.

Seven from Ningkwo.

Channa ocellata Peters

Head contained $3\frac{1}{6}$ to $3\frac{2}{3}$ times in length to caudal base; depth $4\frac{2}{3}$ to $5\frac{7}{8}$. Dorsal 43 to 48; anal 27 to 32. Scales 55 to 60 in lateral line to caudal base; 7 or 8 scales above lateral line, 14 or 15 below; 20 to 28 predorsal scales. Snout $3\frac{1}{4}$ to $4\frac{3}{4}$ in head measured from upper jaw tip; eye $5\frac{1}{3}$ to $7\frac{1}{8}$; maxillary $2\frac{1}{4}$ to $2\frac{1}{2}$; interorbital $3\frac{3}{5}$ to $3\frac{3}{4}$.

Body elongate, compressed. Least depth of caudal peduncle $2\frac{3}{4}$ to 3 in total head length.

Head width $1\frac{3}{5}$ to $1\frac{4}{5}$ in its length. Snout depressed, its length $\frac{2}{5}$ to $\frac{1}{2}$ its width. Eye center at first fourth in head, a little backward in young; diameter 1 to $1\frac{1}{2}$ in snout, $1\frac{1}{3}$ to $2\frac{1}{5}$ in interorbital. Mouth large, lower jaw slightly protruding. Mouth extends a little beyond eye, to hind eye edge in young. Teeth fine, simple, conic, in bands in jaws and on vomer and palatine; inner series of teeth in lower jaw enlarged, widely spaced. Lips fleshy, rather narrow. Front nostril in short tube on side of snout, $1\frac{1}{5}$ in eye; hind nostril elevated, opposite upper front eye edge. Interorbital broadly convex.

Gill-rakers as 5 tubercles, lower longer, all much shorter than gill-filaments, which $1\frac{2}{3}$ in eye.

Scales with 19 to 30 basal parallel striæ; apical circuli 10, giving place with age to about 35 irregular marginal striæ. Front half of snout, mandible and branchiostegal region naked, and scales on top of head largest, much larger than those on cheek; 9 rows of scales across cheek to preopercle edge. Most of pectoral and caudal finely scaled. Lateral line high anteriorly, after seventeenth scale dropping 2 scales, when midway to caudal base; tubes simple, small and with small pore.

Median dorsal rays 2 to $2\frac{1}{5}$ in total head length; median anal rays $2\frac{7}{8}$ to $3\frac{1}{2}$; caudal rounded behind, $1\frac{1}{8}$ to $1\frac{1}{4}$; pectoral $1\frac{3}{5}$ to $1\frac{3}{4}$, reaches a distance contained $1\frac{1}{5}$ to $1\frac{1}{3}$ in that to vent.

Color in alcohol brown on back, paler to livid whitish on under surface of head and trunk. Dark streak from upper hind eye edge back toward middle of opercle, lower one from lower hind eye edge back toward pectoral base. Lower jaw neutral tint, with dusky line on and along upper maxillary edge and another on side of

mandible close along edge of lower lip. In young, lower side of head more or less distinctly spotted with brown. Trunk with 10 dusky to blackish large median blotches. First as large black round spot above pectoral axil and last as larger round black spot at caudal base, which mostly above lateral line and its edge narrowly pale. With age most of entire body finely spotted with pale or whitish, sometimes 2 spots on 1 scale. Dorsal and anal neutral-dusky, former usually with scattered small whitish spots. Pectoral and caudal brownish.

Length 93 to 255 mm.

Thirteen from Ningkwo.

SERRANIDÆ

Siniperca chuatsi (Basilewsky)

Head contained $2\frac{1}{4}$ to $2\frac{2}{3}$ times in length to caudal base; depth $2\frac{7}{8}$ to $3\frac{2}{3}$. Dorsal XII, 12 to 14; anal III, 8 to 10. Scales 128 to 130 counted along lateral line to caudal base; pores 115 in lateral line to caudal base; 20 scales above highest arch of lateral line to spinous dorsal base, 38 below to spinous anal origin; 33 ? predorsal scales. Snout $3\frac{1}{8}$ to 4 in head measured from upper jaw tip; eye 5 to $5\frac{1}{2}$; maxillary 2 to $2\frac{1}{6}$; interorbital $5\frac{2}{3}$ to 7.

Body elongately fusiform, well compressed. Least depth of caudal peduncle $1\frac{1}{5}$ to $1\frac{1}{3}$ in its length to $3\frac{1}{2}$ to $4\frac{1}{5}$ in total head length.

Head width $2\frac{1}{2}$ to $3\frac{3}{4}$ in its length, much more attenuated in young. Snout conic, width $1\frac{1}{8}$ to $1\frac{1}{6}$ in its length. Hind edge of eye midway in length of head, diameter $1\frac{1}{8}$ to $1\frac{2}{3}$ in snout, $\frac{3}{5}$ to 1 in interorbital. Mouth moderate, mandible protruding, greatly so in young. Maxillary extends slightly beyond hind eye edge, opposite hind pupil edge in young; expansion $1\frac{2}{3}$ in eye. Teeth moderately fine, conic, 4 or 5 series in front above narrowing in 1 series on side posteriorly, 2 or 3 innermost each side of median line largest and directed inward; mandibulars 5 or 6 rows in front, narrowing to single outer low series with large inner row of 4 on each side; patch of small conic teeth on vomer and each palatine, none on tongue. Nostrils together, within last fourth of snout. Interorbital broadly depressed, level in young. Hind preopercle edge denticulate and 3 large denticles at angle, much larger in young.

Gill-rakers 1+3, lanceolate, $1\frac{1}{3}$ in gill-filaments, which $1\frac{2}{5}$ in eye.

Scales with 9 basal parallel striæ marginally; circuli 7 to 14 apically.

Fifth dorsal spine $2\frac{2}{3}$ to 4 in total length of head; eighth dorsal ray $2\frac{3}{4}$ to 3; second anal spine $3\frac{1}{6}$ to $3\frac{7}{8}$; second anal ray $2\frac{2}{5}$ to 3; caudal rounded behind, $1\frac{9}{10}$ to 2; pectoral $2\frac{1}{8}$ to $2\frac{2}{5}$; ventral $2\frac{1}{8}$ to $2\frac{1}{5}$.

Color in alcohol brown generally, little paler below. Trunk and head with more or less rounded close-set darker to dusky blotches or spots, some ring-like and small spots, dots, bars or short lines in paler areas. On head usually dark underlaid streak from behind eye back across postocular and another from lower hind eye edge. Jaws usually with obscure brownish blotches. In young markings on trunk usually reduced to large dark blotches, in very young forming about 6 dark vertical transverse bands, much wider than pale interspaces. Vertical fins pale, finely spotted with dark brown, spots fewer and larger in young, absent or little evident in very young. Pectoral pale. Ventral pale basally, little dusky sub-terminally.

Length 72 to 225 mm.

Nine from Ningkwo.

Gobiidæ

Eleotris potamophila Günther

Head contained $2\frac{3}{5}$ times in length to caudal base; depth $4\frac{1}{8}$ to $4\frac{2}{3}$. Dorsal VI to VIII—I, 8, 1 or 9, 1; anal I, 7, 1. Scales 40 to 45 in median lateral series to caudal base and 4 or 5 more on latter; transversely at soft dorsal origin 13 to 15 scales; 30 to 35 predorsal scales. Snout $3\frac{3}{4}$ to $4\frac{1}{4}$ in head measured from upper jaw tip; eye $5\frac{2}{5}$ to $7\frac{2}{5}$; maxillary $2\frac{1}{3}$ to $2\frac{1}{2}$; interorbital $3\frac{1}{5}$ to $5\frac{1}{3}$.

Body robust, subcylindrical, trunk more or less compressed posteriorly, deepest about dorsal origin. Caudal peduncle well compressed, least depth $1\frac{3}{4}$ to $1\frac{4}{5}$ its length or $3\frac{1}{10}$ to $3\frac{1}{4}$ in total head length.

Head robust, depressed, width $1\frac{3}{5}$ to 2 in its length. Snout broad, surface convex, length $\frac{3}{5}$ to $\frac{3}{4}$ its width. Eye slightly impinging on upper profile, center at first third in head; front pupil edge about first third in young; diameter $1\frac{1}{3}$ to 2 in snout, 1 to $2\frac{1}{5}$ in interorbital. Mouth large, wide, mandible well protruded. Maxillary reaches opposite hind pupil edge, about to eye center in young; expansion $1\frac{1}{4}$ to 2 in eye. Lips firm. Teeth simple, conic, moderate, large, in bands of 3 or 4 irregular series in jaws; none on vomer, palatines or tongue. Tongue broad, slightly convex along entire front edge. Front nostril in small short tube, at last $\frac{2}{5}$ in snout; hind nostril a simple pore, midway between front nostril and eye. Interorbital broadly and slightly depressed concavely. Preopercle entire, without spine.

Gill-rakers 3+8 or 9, spinescent tubercles, greatly shorter than gill-filaments, which equal eye.

Scales with 10 to 25 basal radiating striæ; apical denticles 65 to 70, and 2 or 3 series transversely; circuli fine. Jaws, snout, preorbital and under surface of head naked. Supraorbital with row of fine papillæ and above short series opposite nostrils; another row from close below eye up over postocular and suprascapula; double row along preopercle edge and continued forward along lower face of mandible to symphysis; small cluster of papillæ above maxillary on snout edge, also above front of supraorbital row; another cluster just below nostrils; infraorbital row begins just below hind nostril, slopes down toward maxillary, then abruptly up toward hind eye edge, where forking sends horizontal row back across cheek; below and parallel another midway on cheek, also small bar between posteriorly and anteriorly downward extension above upper maxillary edge; row down along front part of opercle closely parallel with preopercle edge. Breast and belly covered with small cycloid scales; about 17 scales across cheek to preopercle edge; caudal and pectoral bases finely scaly.

Third dorsal spine $2\frac{4}{5}$ to 3 in total length of head; third dorsal ray $2\frac{1}{4}$ to $2\frac{2}{5}$; second anal ray $2\frac{1}{2}$ to $2\frac{3}{5}$; caudal rounded behind, $1\frac{1}{3}$ to $1\frac{2}{5}$; pectoral $1\frac{1}{2}$ to $1\frac{2}{3}$; ventral $2\frac{1}{10}$ to $2\frac{1}{5}$. Anal papilla moderate.

Color in alcohol with back largely burnt umber, with 3 dark to blackish saddles, broadening as blotches above median lateral axis. First saddle includes most of spinous dorsal, second from hind half of soft dorsal base and third not crossing caudal peduncle, but invading caudal base. Dusky loup across occiput. Under surface of head and belly pale, with dusky or smutty-brown spots. Dusky blotch before, below and behind eye. Soft dorsal and caudal gray-brown, with 6 or more blackish cross-lines. Pectoral pale brownish, with 6 transverse lines of deep brown. Two dusky-black spots at pectoral base, both externally and in axil. Ventral whitish, with median dusky blotches.

Length 72 to 165 mm.

Twelve from Ningkwo.

TETRODONTIDÆ

Spheroides rubripes (Schlegel)

Head contained $3\frac{1}{8}$ times in length to caudal base; depth $2\frac{3}{4}$. Dorsal IV, 12 to 15; anal IV, 8 to 10; pectoral I, 17 or 18. Snout $2\frac{1}{4}$ to $2\frac{1}{2}$ in head; eye 6 to 7; mouth width $3\frac{3}{5}$ to 4; interorbital $1\frac{5}{6}$ to $2\frac{1}{6}$.

Body robust, moderately long, deepest about pectoral base and back broadly convex. Caudal peduncle conic, least depth $1\frac{4}{5}$ its length or $3\frac{3}{4}$ in head.

Head about as wide as deep, upper profile evenly convex; width $1\frac{1}{8}$ to $1\frac{1}{5}$ in its length. Snout broad, convex over surface and in profile, length $\frac{2}{3}$ to $\frac{3}{4}$ its width at front of eyes. Eye small, elevated, hind edge midway in head; diameter $2\frac{1}{3}$ in snout, $3\frac{2}{5}$ to $4\frac{1}{3}$ in interorbital. Mouth moderately wide, terminally inferior. Lips thick, fleshy, with striate papillæ, which also extend over most of lower jaw or mandible. Teeth with entire edges, median groove well defined above and below. Nostrils lateral in oval cutaneous sac, outer slit much the larger; falls just before last fourth in snout profile. Interorbital widely convex.

Gill-opening 4 to $4\frac{1}{4}$ in head. Line of lateral mucous system encircles eyes, then follows along upper side of back well above pectoral back to middle of caudal base; branch below nasal sac, another above pectoral origin upward and finally one from junction behind eye downward. Predorsal, interorbital, postorbital, breast and abdomen with prickles, slightly larger on abdomen, variably more or less meeting behind depressed pectoral.

Dorsal begins a little nearer caudal base than pectoral origin, rounded or median rays longest; fourth ray $2\frac{1}{8}$ to $2\frac{1}{5}$ in head. Anal similar and opposite dorsal; fourth ray 2 to $2\frac{1}{10}$ in head. Caudal convex behind, $1\frac{1}{3}$ to $1\frac{3}{4}$ in head. Pectoral broad, hind edge convex, reaches $\frac{2}{5}$ to $\frac{1}{2}$ to anal, 2 to $2\frac{1}{6}$ in head.

Color in alcohol dark neutral-gray on back, below whitish. Blackish blotch opposite hind half of depressed pectoral and another at dorsal base both with line of pale to whitish boundary. Four or 5 similar pale lines cross back, often broken or variably incomplete. Fins pale, often dark spot at pectoral base. Iris pale slaty.

Length 116 to 143 mm.

Eleven from Ningkwo.

A very interesting species, quite strikingly marked and not rare in China and Japan. Not previously reported from Chinese fresh-waters.

The Affinities of the Fish Lycoptera Middendorffi

By T. D. A. Cockerell

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Article VIII.—THE AFFINITIES OF THE FISH *LYCOPTERA MIDDENDORFFI*[1]

By T. D. A. Cockerell

Plate III; Text Figure 1

Among the interesting fossils obtained by the Third Asiatic Expedition of The American Museum of Natural History in 1922 were numerous fishes from the Ondai Sair formation of Mongolia, ascribed to the Lower Cretaceous. These appear on examination to be old and young of a single species, *Lycoptera middendorffi*, described by Johannes Müller in 1848 from shales supposed to be of Jurassic age, occurring in the Transbaikal region of Siberia. The problem of stratigraphy and correlation has been discussed as fully as circumstances permit in another paper, and it remains only to give a fuller account of the fish remains, which are of quite unusual interest.

Lycoptera is referred by Doctor A. S. Woodward to the family Leptolepidæ, of which he writes:[2]

> The Leptolepidæ differ from the two preceding families [Pholidophoridæ and Oligopleuridæ] in the absence of fulcra on the fins [whereby they agree with all living Isospondylous fishes], and are remarkable as being the earliest family in which intermuscular bones occur. These elements, forming so conspicuous a feature among modern fishes, appear to be arranged here only in a single series above the vertebral column in the abdominal region; though there may perhaps be traces of them sometimes also in the lower half of the caudal region. The vertebral centra of *Leptolepis* itself exhibit interesting gradations in the degree of development according to the geological age of the species, these centra never being more than delicate constricted rings or cylinders in the Upper Lias, and always strengthened by secondary peripheral calcifications in the Oxfordian [Middle Jurassic] and upwards. In *Thrissops*, which ranges as far at least as the Lower Cretaceous, the vertebral centra are still more robust. These fishes, it will be noticed, approach very closely the Clupeidæ, among which they are sometimes included; but they are distinguished by the meeting of the parietal bones in the median line, by the non-fusion of the hæmal spines at the base of the tail, and by the presence of a thin film of ganoine on the scales. [Remarks in brackets are mine.]

Jordan and Branner[3] say of the Leptolepidæ:

> This family stands almost intermediate between the Ganoids and the Isospondyli. It has the general fin arrangement of the latter, but the scales are more or less diamond-shaped and ganoid on their exposed parts, and the last vertebræ are more or less turned upward, although the tail is usually or always forked. The orbital plates cover the cheek as in the Elopidæ, but there is no gular plate, so far as known.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 39.
[2]1895, 'Catalogue of Fossil Fishes in the British Museum (Natural History),' III, p. xxi.
[3]1908, Smithsonian Miscellaneous Collections, LII, Part 1, p. 13.

However, a gular plate is clearly shown in Reis's figure of *Lycoptera middendorffi.*

Boulenger[1] separates the Leptolepidæ from other malacopterygian families only by the perforation of the vertebral centra, at least so far as his table shows. He recognizes that the coating of the scales with ganoin is not a family character.

We may readily gather from all this that the Leptolepidæ, beginning in the Upper Lias, represent the line of development which first points distinctly to the modern dominant isospondylous and related fishes. It is a group which therefore deserves minute analysis to determine what characters were evolving and in what manner. Gregory[2] has recently remarked: "The Jurassic Leptolepidæ are the earliest known true teleosts, with their cycloid scales, vertebral centra nearly complete, no fin fulcra, intermuscular bones present, and head and jaws remarkably like those of primitive Clupeidæ. The homocercal tail sometimes develops hypural bones of primitive teleost type." He here refers to Woodward's figure of tail of *Leptolepis dubius.*

An analysis of the above statements and of the known characters of the fishes serves only to bring out more clearly the relationship to existing families. The supposed family character of more or less ganoid scales breaks down entirely, as Gregory has indicated. As regards the vertebral centra, in some forms at least they appear to be well ossified, and *Lycoptera* during its lifetime goes through about the same stages described by Woodward as existing in successive species of *Leptolepis.* The distinct elevation of the end of the vertebral column corresponds to the condition found in the young of *Salmo* and other fishes.

I am particularly fortunate in being able to present some enlarged figures of the scales of *Leptolepis* and *Thrissops*, photographed by Mr. Herring under the direction of Doctor A. S. Woodward at the British Museum. The type of *Leptolepis* is *L. coryphænoides* (Bronn)[3] from the Upper Lias. It may be that *L. dubius* (Blainville) from the Lithographic Stone of Bavaria is not strictly congeneric, in which case *Ascalabos* Munster may be available in a subgeneric sense. A photograph of the scales of *L. dubius* (which may possibly differ somewhat from those of the type of the genus and family) shows the following characters: scales cycloid, broader than long, apex very broadly rounded, base truncate, laterobasal angles obtuse; nucleus central; circuli fine and distinct,

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[1]1904, 'Cambridge Natural History,' VII, p. 544.
[2]1923, Bull. Amer. Mus. Nat. Hist., XLVIII, p. 241.
[3]*Cyprinus coryphænoides* Bronn, 1830; *Leptolepis bronnii* Agassiz, 1832.

concentric; no radii. The laterobasal circuli cut the more central ones somewhat as indicated in Geinitz's figure of *Kymatolepis*, but about halfway between nucleus and margin. A distinct ridge on each side passes from the region of the nucleus to the laterobasal corner.

Now it is singular that the features of this scale, even to the interference of the circuli laterally and the indication of ridges from the nucleus to the laterobasal corners, are very nearly those of the living *Caranx hippos* (Linnæus), or *Carangus hippos* as Jordan has it. The ridges, however, are just as well seen in certain salmonoid scales, such as *Leucichthys nigripinnis* (Gill). The fish *Leptolepis dubius* is of course quite distinct from the Salmonidæ, and still more so from the Carangidæ, but I believe that the scale-structure may be regarded as prophetic. That is to say, the scale type of the modern fishes was acquired earlier than many of the other structures, and hence when found in a fossil may be used to indicate the line of development initiated by the latter. If this generalization is valid, it affords us a very important clue to the evolution of fishes. In the case of *Thrissops*, I am fortunate in having a photograph of the scales of the type species, *T. formosus* Agassiz, from the Lithographic Stone of Bavaria. The scales are extremely broad and very different from those of *Leptolepis*. They may be described as follows: scales transverse, very much broader than long; apical margin simple, broadly rounded or slightly angular; some distance below the margin, but well above the nucleus, is usually a more or less irregular or wavy band, interpreted as an annulus; occasional feeble rudiments of apical radii, but distinct basal radii of the type seen in *Ichthyodectes;* circuli extremely fine, concentric.

These scales much resemble those of the Cretaceous *Hypsodon*, lacking, however, the prominent tuberculation of the apical area. There is a superficial, but probably not significant, resemblance to the scales of the modern Hemirhamphidæ and Exocœtidæ.

Coming now to *Lycoptera middendorffi*, we find still another quite diverse type of scale (Fig. 1). The scales are minute, about 1.2 mm. across, cycloid, transversely broad oval, without corners; nucleus central; circuli fine and concentric; apical and basal radii, the basal (about 14) extending up the sides nearly to meet the apical; apical radii about 13 but weaker and shorter, irregular. In some scales the radii are less developed or evanescent.

This scale is practically identical with that of the European minnow, *Phoxinus phoxinus*. I am unable to point out any difference which could be called generic. *Lycoptera* has so much the aspect of a

cyprinid that Egerton long ago proposed to place it in the cyprinid genus *Aspius*. It is a freshwater fish, and in it I think we must see the ancestor of the Cyprinidæ and their allies.

That it is not a cyprinid is shown by the following characters.

1.—Teeth are present on the premaxilla, maxilla, and dentary, though extremely small. I could not demonstrate these teeth in my material and for a time believed them absent, but in one specimen I was able to see small sockets, and a specimen from the original (Siberian) lot in the British Museum clearly shows the teeth. Through the kindness of Doctor A. S. Woodward, I am able to present an enlarged figure of this specimen.

2.—As shown by Reis, there is a gular plate resembling that of *Amia*.

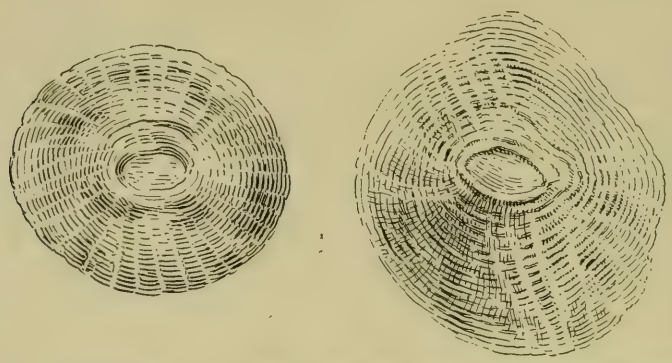


Fig. 1. Two scales of *Lycoptera* from the Ondai Sair shales, showing their general character.

3.—The end of the vertebral column turns upward, though the caudal fin is bifurcated and entirely like that of a cyprinid in appearance.

4.—The anterior vertebræ are not modified.

Characters 2 and 3 suggest a certain affinity with *Amia*, but the scales are wholly different. The dorsal fin is far posterior, about opposite the anal, as in the cyprinid genus *Engraulicypris*. In the adult the vertebral centra are solid, yet apparently always with a central canal for the notochord.

Doctor A. S. Woodward has described a second *Lycoptera*, *L. sinensis*, from the Lower Jurassic (?) of the Province of Shantung, China. Our specimens are, however, referable to *L. middendorffi*.

I think it is now evident that the Leptolepidæ of authors must be subdivided, at least to the following extent.

1.—Leptolepidæ. Marine (or sometimes brackish water ?) fishes, definable as indicated above,

a.—Leptolepinæ, new subfamily. Type *Leptolepis*, with scales as described above. (For other characters of these genera see Woodward.)

b.—Thrissopsinæ, new subfamily. Type *Thrissops*, with broad scales as described above. From the position of the dorsal fin opposite the anal, we might infer affinity with *Lycoptera*, but the scales are entirely different; so also the *Coryphæna*-like caudal fin.

2.—Lycopteridæ. Freshwater fishes, with scales resembling those of *Phoxinus*. *Lycoptera*, two species, or three if we include *Prolebias davidi* of Sauvage, 1880, from the supposed Tertiary of northern China.

Other genera referred to Leptolepidæ will have to be left in a rather uncertain position until their scales can be critically examined, but there is no indication that any one of them belongs to Lycopteridæ. In the Kimmeridge shale at Ringstead, Dorset, England, I collected circular or subcircular scales, 3 to 4 mm. diameter, with concentric circuli, strong annuli, and no radii. Doctor A. S. Woodward believes they must belong to Leptolepidæ, but they seem to represent a genus distinct from *Leptolepis dubius*.

Plate III

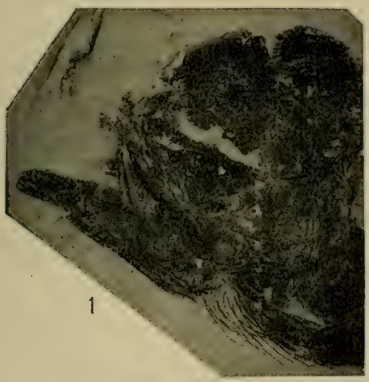
Fig. 1. Enlarged figure of head of *Lycoptera middendorffi*. British Museum, P. 1841.

Fig. 2. Median dorsal scales of *Thrissops formosus*. Lithographic Stone, Solnhofen, Bavaria. British Museum, P. 913a.

Fig. 3. Anterior dorsal scales of *Leptolepis dubius*. Lithographic Stone, Solnhofen, Bavaria. British Museum, P. 924.

Figs. 4–8. *Lycoptera middendorffi*, from Ondai Sair.

Fig. 4. General view of a small specimen.
Fig. 5. A larger specimen that preserves the head and pelvic fins fairly well.
Fig. 6. A large fish, in which the pectoral pelvic and anal fins are well preserved. The scales, shown in text figure 1, are drawn from the specimen.
Fig. 7. Well-preserved anal and part of a dorsal fin.
Fig. 8. A good caudal fin.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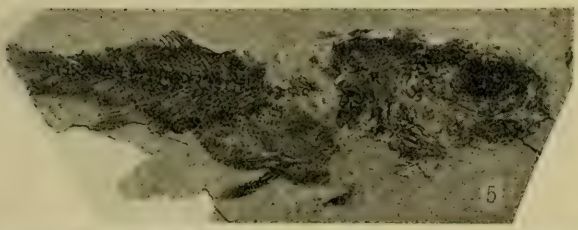
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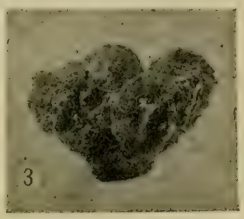
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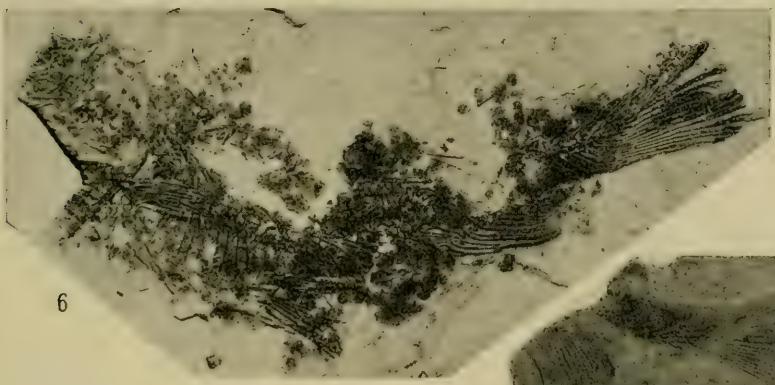
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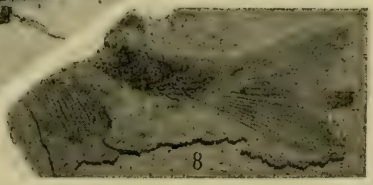
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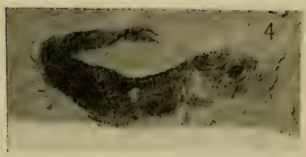
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AMERICAN MUSEUM NOVITATES

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56.81,9P(117:51.7)

ON *PROTOCERATOPS*, A PRIMITIVE CERATOPSIAN DINOSAUR FROM THE LOWER CRETACEOUS OF MONGOLIA[1]

By William K. Gregory and Charles C. Mook

One of the most interesting of the many remarkable discoveries of the American Museum Third Asiatic Expedition is a small predentate dinosaur from the lower Cretaceous of Mongolia, which has been named *Protoceratops andrewsi* by Granger and Gregory. The type skull, which was received and worked out of the matrix some time before the rest of the seventy-odd specimens of the form arrived at the Museum, proves to be that of a young animal with an estimated extreme skull length of less than ten inches, while the largest skull of *Protoceratops* measures twenty-three inches in length.

Except for the absence of horns, the whole configuration of the skull conforms to the general ceratopsian type: the parietals and squamosals are produced into a perfectly formed, fenestrated occipital frill; the enlarged squamosal enters the side of the frill and is in contact below with the jugal; the mandible and the crowns of the teeth are much like those of later ceratopsians. On the other hand, many primitive features are retained which were lost or disguised in the typical ceratopsians. Thus, in half-grown specimens the "frill" is seen to be merely an enlarged scaffolding for the powerful jaw and neck muscles; there are no epoccipital bones, and the lateral and superior temporal fenestræ are instantly recognizable as such, whereas in later Ceratopsia, through the continued growth of the frill, their original character is largely concealed. The opposite prefrontals and "postfrontals" (postorbitals) remain in their primitive positions and do not form a secondary roof above the frontals as they do in the typical Ceratopsia; hence there is no median "pseudo-pineal" or postfrontal foramen. Freely articulating palpebral bones are attached to the anterosuperior corner of the orbits, as in *Psittacosaurus*. The premaxillæ each bear two fairly long, cylindrical teeth, instead of being edentulous as in the later Ceratopsia, and the very deep beak, in contrast to the anteroposteriorly elongate beak of *Triceratops*, also re-

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 40.

calls that of such relatively primitive predentates as *Psittacosaurus*. The anterior nares are simple ovals and the premaxillæ lack all the peculiar specializations of the later ceratopsians. The cheek teeth succeed each other in a closely appressed vertical series, including not more than two rows, in contrast with the numerous rows of the later Ceratopsia. The roots are single, not cleft buccolingually. The orbits are relatively much larger than in typical ceratopsians, especially in the young skulls. The preorbital fossæ are very large depressions, instead of being narrow slits, and the lachrymal bones are of considerable size. The well-developed parietal fontanelles are transversely oval, instead of being produced anteroposteriorly as in typical ceratopsians.

Many very primitive features are also retained in the postcranial skeleton. The first three cervical vertebræ, although appressed, are not coalesced, and the spine of the axis is not produced backward as it is in the typical Ceratopsia. The scapula is already elongate to aid in supporting the large head, but the fore limb as a whole is not nearly so large in proportion to the hind limb as it is in typical Ceratopsia; the small manus also is much smaller than the pes, the middle digit of the manus being much shorter than the middle digit of the pes, whereas in typical ceratopsians it is as large or larger.

The pelvis is in many respects remarkably primitive: the dorsal border of the ilium is vertical in position, whereas in later Ceratopsia (except *Leptoceratops*) it is more or less reflected outward and finally forms a wide shelf above the femur. The prepubic process of the pubis, instead of being a very large, vertically-extended process, as in later Ceratopsia, is relatively small and but little extended vertically; the postpubic process is relatively much less reduced than in the later types. The sacral complex includes seven to eight vertebræ, in contrast with the ten of *Triceratops*. The femur retains a large fourth trochanter and is slightly shorter than the tibia, while in typical Ceratopsia the fourth trochanter is reduced and the femur is longer than the tibia. The hind foot is remarkably long and slender for a ceratopsian, and is in fact more like that of *Psittacosaurus* than like that of *Triceratops* or *Monoclonius*. In short, the whole proportions and configuration of the skeleton indicate that *Protoceratops* was not far removed from the ancestral bipedal ornithischian, the former existence of which was long since inferred by Dollo (1905) after a brilliant analysis of the various types of dinosaurian pelves. The tail vertebræ have very long neural spines, while in *Triceratops* the neural spines are much shortened. The feet and tail of *Protoceratops* possibly indicate partly aquatic habits.

Fig. 1. *Protoceratops andrewsi.* Small, young adult skull, possibly a female. A. M. No. 6408. Viewed from above. Two-fifths natural size.

The occipital frill is composed exclusively of the expanded parietals. There is no good evidence of a separate interparietal or fused dermosupraoccipitals. The squamosals are limited to the anteroexternal border of the frill. There being no horns on the postorbitals, there is no secondary skull roof above the frontals and consequently no "pseudopineal" opening.

The definition of the family Protoceratopsidæ, proposed by Granger and Gregory, may now be extended as follows:

Primitive small ceratopsians, with a hornless skull, without either secondary skull roof or pseudopineal foramen above the frontals, no epoccipital bones; with simple oval anterior nares and unspecialized premaxillæ. A well-developed occipital frill, with large transversely oval parietal fontanelles. Freely articulating palpebral bones (supraorbitals) attached to the anterosuperior corner of the orbits. Premaxillaries with teeth. Cheek teeth arranged in a vertical series of not more than two developed at one time; roots simple (not bifid). Fore limb slender, manus much smaller and shorter than pes, the latter elongate, compressed. Sacral complex of seven or eight vertebræ. Ilium with blade but slightly inclined outward to the sagittal plane, not reflected or produced laterally above the femur. Prepubic process relatively small, not expanded vertically; postpubic process but little reduced. Femur with large fourth trochanter, femur shorter than tibia. Midcaudal vertebræ with very long spines.

The genus *Leptoceratops* of Brown (1914) is a little-modified survivor in the Edmonton formation in North America, of the Protoceratopsidæ. It agrees with *Protoceratops* in the following characters.

(1.) The roots of the cheek teeth are simple, not bifid.

(2.) The nasals are hornless.

(3.) The parietal frill has a long, high, sagittal crest.

(4.) The mandible is short and deep, in contrast with the elongate proportions of the mandible in *Triceratops*.

(5.) The femur has a large fourth trochanter.

(6.) The tibia is longer than the femur.

(7.) The medial surface of the ilium is not reflected or produced outwardly over the femur, the whole ilium being extremely like that of *Protoceratops*.

(8.) The ischium is long, not shortened as in the typical ceratopsians.

(9.) The neural spines of the caudal vertebræ are extremely high in proportion to the anteroposterior extent of the centrum, in contrast with the very low spines of *Triceratops*.

On the other hand, *Leptoceratops* has progressed toward the typical ceratopsian in (1) the reduction of the parietal fontanelles, (2) the coalescence of the anterior three cervical vertebræ, (3) the backward prolongation of the spine of the axis above the third cervical vertebra, (4) the shortening of the metacarpals and especially of the metatarsals.

The genus *Brachyceratops* Gilmore, from the Belly River formation of the upper Cretaceous, clearly belongs with the Ceratopsidæ, of which it represents a young individual and a very primitive stage. Thus it shows: (1) an early stage in the development of the horns, (2) the beginning of the lateral reflection of the iliac blade, (3) the incipient shortening

of the tibia as compared with the femur, (4) the lack of coalescence of the two halves of the secondary skull roof above the frontals.

Of the typical Ceratopsidæ, the genus *Ceratops* (*Chasmosaurus*) represents a stage in which the frill has become produced backwardly,

Fig. 2. *Protoceratops andrewsi.* Side view of supposed old male skull. A. M. No. 6414. One-fourth natural size.

Although considerably distorted by the lens, this view shows well the great depth of the beak, which recalls that of *Psittacosaurus*, the shortness and depth of the lower jaw, the height and prominence of the sagittal crest of the parietal, the relatively small size of the orbit as compared with that of the younger skull, etc. The great development of the occipital frill and of the jugal is obviously not primarily for the protection of the neck but for the support of the robust muscles necessary to operate the great beak and grinding apparatus. The cheek teeth are not shown in this specimen. One-fourth natural size.

elongating the parietal fontanelles so that their longitudinal much exceeds their transverse diameter. The nasal and supraorbital horns are still small. *Torosaurus*, with its highly fenestrated frill, would be the logical outcome of this line of development.

Styracosaurus would seem to be an aberrant offshoot of a primitive *Ceratops*. In all these the parietal crest is produced far behind the squamosals.

Monoclonius may well be a direct descendant of *Protoceratops*, in which the nasal convexity has grown up into a long horn, and the frill, acquiring epoccipital bones, has been produced at the upper end into the erratic processes of *Centrosaurus*.

Anchiceratops may be regarded as one of the *Monoclonius* group, with a secondary tendency for the closure of the fontanelles.

The *Triceratops-Diceratops* group may also be derived from *Protoceratops*, perhaps by way of a form related to *Leptoceratops*, which already shows a strong tendency toward the secondary closure of the parietal fontanelles and a transverse widening of the crest.

Although most of the *Protoceratops* material has still to be cleaned up, a series of skulls has been worked out, starting with an extremely young stage not long out of the egg, and ending with a very old stage with a wide frill 511 mm. wide. In one of the younger stages, with a total skull length of 283 mm., the frill is not much wider than the skull itself, but is already produced behind the occipital condyle. The parietal fontanelles are large, broad ovals. The orbits are relatively very large and the snout is short. As growth proceeds the crest becomes relatively larger and much wider, and the orbits become relatively smaller, the snout more compressed and the lateral temporal fenestræ smaller. There seem to be two kinds of skulls, a long and a very broad kind, possibly representing females and males. Specific differences have not yet been worked out.

In conclusion, *Protoceratops* affords decisive evidence for Dollo's inference that the gigantic quadrupedal Ceratopsia have been derived from some small bipedal predentates. In skull characters it is already in a primitive ceratopsian stage, but its postcranial skeleton retains much of the bipedal heritage, especially in the pelvis and hind limbs, which was lost by its gigantic graviportal descendants.

When compared with the small bipedal predentates *Psittacosaurus* and *Protiguanodon*, also of the Cretaceous of Mongolia, *Protoceratops* exhibits such a great number of significant agreements in the skull, dentition, vertebræ, and limbs, that the existence of an earlier common ancestral stock is virtually demonstrated, *Psittacosaurus* retaining much the greater number of primitive characters. More precisely, some pre-Wealden bipedal predentate closely allied to *Hypsilophodon* appears to be indicated as the common ancestral stock, not only for the camptosaurs,

Fig. 3. *Protoceratops andrewsi.* Under side of a nearly complete skeleton. A. M. No. 6417. One-tenth natural size.

Note the large size of the hind limb and foot, as compared with the forearm and hand; the elongation of the metatarsus as in bipedal Ornithischia. The dorsal border of the ilium is not reflected outward above the acetabulum. The prepubic process of the pubis, while stout, is not nearly as long or as much expanded vertically as it is in later Ceratopsia, and the postpubic process is not so much reduced. The long ischia are concave on the lower border but lack an obturator process. The spines of the caudal vertebræ are very long and slender.

iguanodons, trachodons, and corythosaurs, but also for the variously specialized psittacosaurs, troödons, acanthopholids, nodosaurs or ankylosaurs, and ceratopsians. The stegosaurs of the Comanchean, retaining a relatively unspecialized skull and pelvis, are on the whole an older branch usually recognized as derived from the Liassic *Scelidosaurus*.

The *Protoceratops* material is also of interest as affording strong evidence for the older view that the middle part of the ceratopsian frill is formed from the parietals, as maintained by Marsh, Hatcher, Lull, and Lambe, in opposition to the newer view of Hay, von Huene, and Gilmore that it is formed from the enlarged dermosupraoccipitals. These originally paired elements are unknown in any other group of dinosaurs and, aside from doubtful vestiges in Crocodilia, appear to be limited to the Permian orders of reptiles.

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59.81(51.7)

NEW REPTILES AND A NEW SALAMANDER FROM CHINA[1]

By Karl Patterson Schmidt[2]

The collections of the several expeditions to China of The American Museum of Natural History contain a number of new species of reptiles. In addition to these I include here a preliminary notice of a new salamander presented to the Field Museum of Natural History by Mr. Robert B. Ekvall. More extended descriptions of the following species will be included in a forthcoming detailed report on the collections of reptiles thus far accumulated by Mr. Clifford H. Pope and other members of the Third Asiatic Expedition under the leadership of Mr. Roy Chapman Andrews.

Testudinata

Geoclemys grangeri,[3] new species

Type.—A. M. N. H. No. 23481; Yenchingkau, Wanhsien, Szechwan, 1500 feet altitude; November, 1921; Walter Granger.

Diagnosis.—Differs from *Geoclemys reevesii* in having the axillary shield larger than the inguinal; the small occipital shields much smaller than in *reevesii;* and the spots of the plastral shields much smaller and more sharply defined. The gular suture more than twice that of the humerals; first marginal broadest; bridge a little longer than the posterior lobe of the plastron.

Sauria

Sphenomorphus leveretti,[4] new species

Type.—A. M. N. H. No. 30201; ♂; mountains south of Nodoa, Hainan; July 30, 1923; Clifford H. Pope.

Diagnosis.—Allied to *Sphenomorphus indicus*, from which it may be distinguished by its more elongate snout; the longer and more pointed frontal; the greater extension of the rostral shield on the upper surface of the snout; the longer dorsal and nuchal scales; twenty-two sharply keeled lamellæ beneath the fourth toe; and a more spotted pattern, the lateral black band of *indicus* being represented only by more numerous black spots, while the mid-dorsal area is heavily spotted with black, without the median black line occasionally found in *indicus*.

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[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 41.

[2]Of the Field Museum of Natural History.

[3]Named for Mr. Walter Granger, Chief Paleontologist of the Third Asiatic Expedition.

[4]Named for Rev. William J. Leverett of the American Presbyterian Mission, Nodoa, Hainan, in recognition of his invaluable aid to the work of the Expedition.

Leiolopisma septentrionalis, new species

Type.—A. M. N. H. No. 21451; Hsing Lung Shan, Eastern Tombs, Chihli Province, China; August 1 to 15, 1921; Clifford H. Pope.

Diagnosis.—Body elongate, limbs failing to meet by half the length of the arm; digits five; head wider than the neck; an undivided transparent shield in the lower eyelid; no supranasals; ear opening without denticles; dorsal scales smooth, in twenty-eight rows around the body; a pair of enlarged preanals; anterior loreal smaller than the second; fifteen lamellæ beneath the fourth toe; sides dark brown, back light metallic brown, the dorso-lateral line where the two colors meet not straight, regularly scalloped; throat with brown spots.

Leiolopisma monticola, new species

Type.—A. M. N. H. No. 20998; Snow Mountain Village, 9000 feet altitude, Likiang, Province of Yunnan, China; November, 1916; R. C. Andrews and Edmund Heller.

Diagnosis.—Body elongate, limbs weak, separated when adpressed by the length of the arm; digits 5; head wider than the neck; an undivided transparent shield in the lower eyelid; no supranasals; ear opening without denticles; dorsal scales smooth, slightly larger than the ventrals, in twenty-four rows around the body; a pair of enlarged preanals; anterior loreal longest; frontal in contact with the anterior two supraoculars; fronto-parietals larger than the interparietal; 12 lamellæ beneath the fourth toe; back light brown with rows of darker spots; sides dark brown; venter very dark gray.

Lygosaurus salsburyi,[1] new species

Type.—A. M. N. H. No. 30198; ♂; Nodoa, Hainan, China; January-July, 1923; Clifford H. Pope.

Diagnosis.—Very closely allied to *Lygosaurus sowerbyi* Stejneger, recently described from Fukien Province, from which it may be distinguished by the greater number of subdigital lamellæ. *L. salsburyi* has from nineteen to twenty-one smooth lamellæ beneath the fourth toe, as compared with fifteen or sixteen in *sowerbyi*.

Serpentes

Sibynophis hainanensis, new species

Type.—A. M. N. H. No. 27788; ♂; Nodoa, Hainan, China; December 1922–July 1923; Clifford H. Pope.

Diagnosis.—Closely allied to *Sibynophis collaris;* maxillary teeth 40; rostral just visible from above; upper labials 8; parietals in contact with the lower postocular on each side; ventral plates 167; caudals 115.

Natrix andrewsi,[2] new species

Type.—A. M. N. H. No. 28255; ♂; mountains south of Nodoa, Hainan, China; July 30, 1923; Clifford H. Pope.

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[1]Named for Dr. Clarence G. Salsbury of the American Presbyterian Mission, Nodoa, Hainan, who also rendered important aid to the work of the Expedition.

[2]Named for Mr. Roy Chapman Andrews, Leader of the Third Asiatic Expedition.

DIAGNOSIS.—Subgenus *Macropophis* Boulenger; maxillary teeth 37, uniform in front, the last gradually enlarged; body very slender; eye large; all the scales strongly keeled, in nineteen rows; ventral plates 164; caudals 118; anal divided; prominent vertical white bars in front of and behind the eyes.

Natrix helleri,[1] new species

TYPE.—A. M. N. H. No. 20149; ♀; Tengyueh, 5500 feet altitude, Province of Yunnan, China; April 24, 1917; R. C. Andrews and Edmund Heller.

DIAGNOSIS.—Closely allied to *Natrix subminiata* of Java and southeastern Asia, from which it is distinguished by a higher number of ventral scales, 163–172, compared with 132–157 in *subminiata* as here restricted.

Dorsal scale rows 19, the outer smooth, the median rows sharply keeled; ventrals 163–172; anal divided; caudals 75–86; upper labials 7–9, three entering the eye; a single preocular; three postoculars; temporals 2–2; general color uniform olive, with reddish markings on the neck, chiefly confined to the skin between the scales.

Natrix nivalis, new species

TYPE.—A. M. N. H. No. 21021; ♀; Snow Mountain Village, 9000 feet altitude, Likiang, Province of Yunnan, China; November, 1916; R. C. Andrews and Edmund Heller.

DIAGNOSIS.—Directly derived from *Natrix nuchalis,* from which it is distinguished by the lower number of ventral plates, and a proportionately broad and short frontal. Dorsal scales weakly keeled, in 17 rows; ventrals 150–152; anal divided; caudals 43–54; upper labials 6, the fifth very large; one preocular; postoculars 1–3; temporals 1–1 or 1–2; general color dark olive-brown, without markings at the base of the scales; venter dark gray, the median part black.

Natrix popei,[2] new species

TYPE.—A. M. N. H. No. R 27763; ♂; Nodoa, Hainan, China; December 1922–July 1923; Clifford H. Pope.

DIAGNOSIS.—Closely allied to *Natrix vibakari* and to *Natrix sauteri* of Formosa; maxillary teeth 20, the last gradually enlarged; anal divided; scales in nineteen rows; one or two anterior temporals; eight upper labials; fourth and fifth entering the eye; ventral plates 130–137; subcaudals 78–86; apical pits very faint, small, absent on most scales.

Elaphe osborni,[3] new species

TYPE.—A. M. N. H. No. 21073; ♀; Tengyueh, Province of Yunnan, China; May 10, 1916; R. C. Andrews and Edmund Heller.

DIAGNOSIS.—Most closely allied to *Elaphe hodgsoni* (Günther) and *Elaphe tæniura* Cope.

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[1]Named for Mr. Edmund Heller, Assistant Curator of Mammals, Field Museum of Natural History.

[2]Named for Mr. Clifford H. Pope, Assistant in Zoölogy, Third Asiatic Expedition.

[3]Named for Professor Henry Fairfield Osborn, President of The American Museum of Natural History, whose personal interest in the Museum's Asiatic Expeditions has greatly furthered their work.

Body form not specialized, ventrals not angulate, head distinct from neck; dorsal scales faintly but sharply keeled, in twenty-one rows; ventrals 215–225; anal divided; caudals 77-79; supralabials 8, 4th and 5th entering the eye; preoculars 2; postoculars 2; temporals 2-3; color fawn, with black transverse bars anteriorly and longitudinal lines posteriorly; no black line through the eye.

Gonyosoma caldwelli,[1] new species

Type.—A. M. N. H. No. 21010; ♂; Yenping, Fukien Province, China; 1916; H. R. Caldwell.

Diagnosis.—Very closely allied to *Gonyosoma melli* (Vogt) from Kwangtung and to *Gonyosoma frenata* Günther of the Khasi Hills.

Head and body elongate, body compressed; ventrals sharply angulate; snout obliquely truncate, projecting; dorsal scales very faintly keeled, in nineteen rows; ventrals 223; anal divided; caudals 108 (? +); supralabials 8, 3rd, 4th, and 5th entering the eye; no loreal; one preocular; two postoculars; temporals 1-2; uniform green above and below, with a black stripe through the eye.

Boiga sinensis, new species

Type.—A. M. N. H. No. 23495; ♂; Fukien Province, China; 1921; H. R. Caldwell.

Diagnosis.—Head short and broad, the snout longer than the diameter of the eye; body compressed, tail long; ventrals not angulate; anterior palatine teeth slightly enlarged; posterior pair of chin shields much smaller than the anterior; dorsal scales smooth, oblique, in twenty-one rows, the mid-dorsal row not enlarged; ventrals 230; anal divided; caudals 127; preoculars 3; postoculars 2-3; temporals very small, 4 to 6 in the first row, 6 to 7 in the second, not regularly arranged; ground color light reddish brown, with three series of darker brown spots.

Trimeresurus stejnegeri,[2] new species

Type.—A. M. N. H. No. 21054; ♂; Shaowu, Fukien Province, China; 1916; R. C. Andrews and Edmund Heller.

Diagnosis.—Differs from the widespread *Trimeresurus gramineus*, with which it has hitherto been confounded, in the very small shields between the chin shields and the first ventral plate, the smaller and more widely separated supranasals, the distinct first labial (which in south Chinese *gramineus* is frequently fused with the nasal), and the usual uniform green coloration of the side of the head.

Trimeresurus yunnanensis, new species

Type.—A. M. N. H. No. 21058; ♂; Tengyueh, Yunnan Province, China; May 18, 1917; R. C. Andrews and Edmund Heller.

Diagnosis.—Closely allied to the preceding species, and distinguished from *T. gramineus* by the same characters. It is distinguished by having only nineteen rows of

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[1]Named for Mr. Harry R. Caldwell, who is largely responsible for the Expedition's Fukien collections.

[2]Named for Dr. Leonhard Stejneger, Head Curator of Biology, United States National Museum, as a small tribute to his invaluable contributions to Oriental herpetology.

dorsal scales at mid-body, and twenty-one on the neck, compared with twenty-one at mid-body and 23-25 on the neck in *T. stejnegeri.* The average number of ventral plates, 155-160, is perhaps somewhat lower in *T. yunnanensis.*

CAUDATA

Batrachuperus tibetanus, new species

TYPE.—F. M. N. H. No. 5900; adult female; near the Tibetan border of Kansu, southwest of Titao, 9000 feet altitude, in Hwang Ho drainage; December, 1923; Robert B. Ekvall.

DIAGNOSIS.—Closely allied to *Batrachuperus sinensis,* from which it may be distinguished by the more posteriorly situated vomerine teeth; the more depressed head; the fourteen costal grooves; the absence of horny covering on the palms and soles, only the tips of the digits having a horny epidermis; the somewhat longer tail, .49-.52 of the total length; and the much lighter coloration.

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59.9,32(51.7)

JERBOAS FROM MONGOLIA[1]

By Glover M. Allen

A very beautiful series of jerboas from several localities in the Gobi Desert was secured by the Asiatic Expeditions of The American Museum of Natural History under the leadership of Mr. Roy Chapman Andrews. Although the species represented are few, they are of unusual interest, for they include a very interesting new *Allactaga*, the five-toed jerboa, and a striking new genus related to *Dipus*, the three-toed jerboa. The series of *Allactaga mongolica* may be considered as typical and shows, on comparison with specimens of the species from Chili, China, that the latter is subspecifically distinct and may bear the name *annulata* given many years ago by Milne-Edwards, but latterly placed in synonymy.

Allactaga mongolica (Radde)

Dipus jaculus mongolica Radde, 1862, 'Reisen im Suden von Ost-Sibirien,' I, p. 170, Pl. viii, figs. 3*a*-3*b*.

A five-toed, long-eared jerboa, buffy gray above, clear white below; the tail-tip with a flattened tuft, white at its base, black in its middle three-fourths, and white terminally.

This characteristic desert species was found in abundance by the Expeditions of 1922 and 1923, and a fine series was secured at localities in the central Gobi, namely, Turin, Artsa Bogdo, Tsagan Nor, Hurum Tu, Gun Burte, Sain Noin Khan, Ussuk, Loh, near Tze-Tsen Wang, twenty miles southwest of Urga, and on the Tola River, eighty miles west of that city, as well as in the vicinity of Erhlien, Sair Usu, and east as far as Iren Dabasu. Among the specimens taken during May and early June there is a very striking preponderance of males. Thus, of the one hundred and seventeen skins taken in May, all but fifteen were males, indicating some difference in habits in the earlier part of the season; for in August the proportion is just reversed, with only five males to fourteen females. The type locality of this species is Tarei Nor, whence Radde had fourteen specimens on which his description was based.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 42.

Allactaga mongolica annulata (Milne-Edwards)

Dipus annulatus MILNE-EDWARDS, 1867, Ann. des. Sci. Nat., (5) VII, p. 376.

Milne-Edwards' name is currently regarded as a synonym of *A. mongolica*. The original specimens were obtained by Père A. David at or near the southwestern border of the Mongolian plateau and others were noted by him at Swenhoafu, Chili Province. Comparison of a skin from two hundred kilometers northeast of Shehol in that province reveals the fact that the latter is different from true *mongolica* in its darker muzzle and forehead, contrasting sharply with the white cheeks; the much darker back, which is nearly solid brown in the specimen; and the dark outer sides of the tibiæ. The black band of the tail-tuft is also somewhat shorter than in true *mongolica* of the Gobi Desert. The skull of the Chili animal differs in its narrower interpterygoid fossa and in having the small palatal vacuities narrowed to mere slits instead of being broadly elliptical. It also averages slightly larger, its greatest length being 40–40.5 instead of 37–39 mm., as in the series from the Gobi. These differences come out in Milne-Edwards' plates ('Recherches,' 1868–1874, Pls. x, x*a*, fig. 3-3f) of *Dipus annulatus*, so that his name may be considered applicable in a subspecific sense to the southeastern darker form of this jerboa. The exact type locality is not stated but was probably not very far west of Peking.

Allactaga bullata, new species

TYPE.—Adult male, skin and skull, No. 58723, A. M. N. H., from Tsagan Nor, Mongolia. July 5, 1922. Third Asiatic Expedition.

DESCRIPTION.—Externally similar to *A. mongolica* but slightly smaller. Skull smaller, with more nearly vertical upper incisors and very much larger bullæ that nearly meet at their anterior ends.

Color and pattern indistinguishable from those of *A. mongolica*. Dorsal surface of head, ears, body, and outer sides of thighs, grayish buff, brighter on the sides of the face below the ears and on the back and thighs; grayer on the muzzle, forehead, and sides of body. The individual hairs are slaty at base with a short buffy, subterminal ring, and a black tip, sometimes minute, sometimes half the length of the buffy ring. Mixed with these on the back are scattered longer black hairs. An indistinct spot above the eye, paler gray, and at the posterior base of each ear, a spot of pure white. Lower side of body, forearms, feet, and a prominent hip-stripe pure white to the roots of the hairs. Tail white all around for about 8 mm. at base, then pale ochraceous above to the beginning of the terminal tuft which is white for about 10 mm. at its base, slightly darkened by black hairs among the white; then follows the main part of the tuft which is distichous, blackish for about 45 mm. in the median line, with short white tip measuring 20 mm. in the median line. The ventral side of the tail is white except that the black portion of the tuft is penetrated by a narrow extension of the white medially. The hind feet are dark brownish in a narrow line

along the sole, with a larger blackish area beneath the basal phalanges. Median toe of hind foot exceeding the lateral toes by about 5 mm. Incisors white.

SKULL.—The skull differs notably from that of *A. mongolica* in its smaller size, in having its upper incisors very much less thrown forward, in its more abruptly expanded braincase behind the interorbital constriction, and most strikingly in the very much larger audital bullæ. These are about three times the volume of those in the larger species and are so closely approximated medially that the basioccipital is one-half as broad as in the latter, while their extreme tips anteriorly are nearly in contact. The interparietal differs in having its anterior edge bracket-shaped, with the median point anteriormost. The cheek teeth show no difference except in size.

MEASUREMENTS.—The type was measured by the collector as follows: head and body, 105 mm.; tail, 188; hind foot, 70; ear, 40. In the dry skin the hind foot now measures 65 mm. The skull measures: occipito-nasal length, 34 mm.; condylobasal length, 31; palatal length, 21; diastema, 10.5; incisive foramina, 6; nasals, 12.6; interorbital constriction, 10.5; zygomatic width, 24; mastoid width, 22.3; greatest diameters of bullæ, 10.3×7.6; upper cheek teeth, 6.5; lower cheek teeth, 6.3.

So similar is this species to *A. mongolica* in details of external appearance that the two are not distinguishable except by the slightly larger size of the latter, as seen especially in its somewhat longer ears. The skull, however, with its very much larger bullæ, is at once strikingly different. The new species does not seem to show relationship with any of those so far described, and forms a fine addition to the known fauna of the Gobi. It is apparently less common than *A. mongolica*. The series at hand is from the following localities in the central Gobi: Tsagan Nor, Sair Usu, fifty miles west and one hundred and sixty miles southeast of Sair Usu, and twenty-three miles south of Erhlien.

Dipus sowerbyi Thomas

Dipus sowerbyi THOMAS, 1908, Ann. Mag. Nat. Hist., (8) II, p. 307.

A jerboa with but three toes on the hind foot, the upper incisors orange and grooved; color, buffy above, white below, the flattened tuft at the tip of the tail black, with the end white.

A splendid series of this bright-buffy jerboa was secured from various localities in the Gobi Desert, including Iren Dabasu on the east, Erhlien, Loh, Turin, Artsa Bogdo to Tsagan Nor on the west. The type locality is Yulinfu, in Shensi province, at the southern edge of the Ordos desert, but although the only topotype available is much brighter buff or ochraceous than the average of the Mongolian series, there are occasional specimens that match it in every detail, so that for the present these latter are best considered *D. sowerbyi*. It seems likely from a careful comparison of descriptions that this should be regarded as a subspecies of *D. sagitta* typical in eastern Russia. According to Thomas its muzzle is broader and color slightly brighter, but there seem to be few other appreciable differences.

Stylodipus, new genus

Structurally resembling *Dipus* in external characters, but the hind foot proportionally shorter, and the flattened tail tuft not so strictly terminal, but beginning at about half-way on the length of the tail and gradually increasing in width distally. Hind foot with but three toes. Skull in general like that of *Dipus*, but the bullæ much larger, their mastoid portion produced some 2 mm. behind the occipital bone, whereas in *Dipus* they do not quite reach that level. Palate with a pair of small oval foramina as in *Dipus*, and in addition a second minute pair just back of the last molars. Incisors white, the upper pair grooved. The minute upper premolar more reduced than in *Dipus*, a mere spicule, not reaching the crown level of the molars; the latter with the reëntrant enamel folds much more nearly of equal depth on the inner and the outer sides, resulting in an approximately figure-eight pattern, with slight wear.

The genotype and only referred species is the following.

Stylodipus andrewsi, new species

Type.—Adult male, skin and skull, No. 58549, A. M. N. H., from Ussuk, Mongolia. June 22, 1922. Third Asiatic Expedition.

Description.—Externally like *Dipus*, but the hind feet proportionally shorter, the tail pen-shaped, thick, and with the terminal half distichous, gradually increasing in width to the tip (Fig. 1).

Entire dorsal surface, including head, body, outer side of ears, the arms and thighs as far as wrist and ankle, sandy colored or pale buff, evenly darkened by black hairs or black-tipped hairs. The hairs of the back are "deep neutral gray" (Ridgway, 1912) at base, with a tip of "light ochraceous buff" and a minute black point. An indistinct whitish spot is present above the eye and a slightly paler area below it. A small tuft of silky white hairs clothes the inside of the ear at its base and there is a distinct postauricular white patch. The fore feet, backs of hind feet, a prominent stripe running forward across the back of the hip, and the entire ventral surface of the body are pure white to the roots of the hairs. The soles of the hind feet are "dusky drab," the long hairs under the toes much shorter and softer than in *Dipus sowerbyi*. The tail is white all around in a narrow ring at the extreme base. Its middle third is apparently somewhat thicker than the base or the tip; in color it is like the back except that toward the end the dusky tips of the hairs are long, with pale bases, giving a smoky tint to the expanded, pen-shaped terminal portion. Below, the short hairs are very pale buffy along the median line, the terminal half of the tail with a buffy lateral border and dusky edge. Just below the tip the whitish bases of the long hairs form an indistinct pale area.

Skull (Figs. 2, 3).—The great enlargement of the upper portion of the audital bullæ results in a corresponding compression of the interparietal, so that it becomes nearly triangular in outline as compared with the faintly pentagonal one of *Dipus* (*sowerbyi*). The lacrymal is reduced also as compared with the latter, but the breadth of the vertical portion of the zygomatic plate is much the same in both. Interesting is the great reduction of the small anterior upper premolar, which is a minute spicule reaching about half-way to the crown of the first molar. The reëntrant enamel folds of the upper molars are nearly equal on both inner and outer sides, and nearly or quite touch at the center of the tooth, the outer fold, however,

slightly more posterior than the inner. The lower posterior molar lacks a reëntrant from the inner side. The incisors are white instead of yellow, the upper ones with a median groove.

MEASUREMENTS.—In proportions the ears, tail, and hind foot seem rather shorter than in the species of *Allactaga* and *Dipus* found living in the same region. The collector's measurements are: head and body, 128 mm.; tail, 150; hind foot, 55; ear, 16. The skull measures: greatest length, 33 mm.; condylobasal length, 30.5;

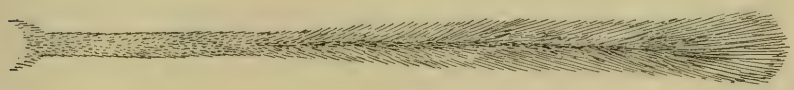

Fig. 1.

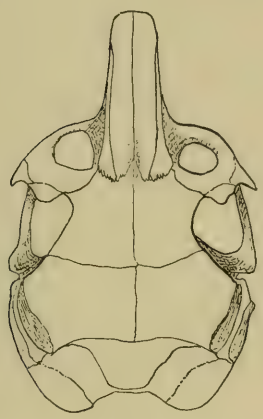

Fig. 2.

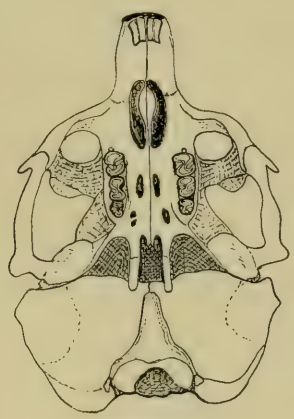

Fig. 3.

Fig. 1. *Stylodipus andrewsi*, new species. Dorsal aspect of the distichous tail. ×4/7.

Fig. 2. *Stylodipus andrewsi*, new species. Outline of cranium from above. ×3/2. The type, No. 58549.

Fig. 3. The same in ventral aspect. × 3/2. (Outlines with camera lucida.)

palatal length, 19; diastema, 8.2; incisive foramina, 6; zygomatic breadth, 22.8; interorbital breadth, 10.0; breadth across auditory openings, 22; diameters of bulla (ventral aspect), 10.2×9.8; vertical depth of bulla, 13; width across first upper molars, 7.4; upper cheek teeth, 6; length of mandible, 22; lower cheek teeth, 6.

This very interesting new jerboa is obviously related to *Dipus*, but shows a greater inflation of the auditory region and a consequent change in the shape of the surrounding bones. The tendency to reduction of the small first upper premolar is carried farther, and there is an approach to equality in the development of the enamel folds on inner and outer

sides of the molars. The shape of the tail is more like that of *Pygeretmus*, pen-like instead of having merely a terminal tuft or expansion.

This is a species of the Gobi Desert. The small series obtained is from Ussuk, Tsagan Nor, Loh, and near Erhlien. It seems fitting that the name of the able leader of the Asiatic Expeditions, Mr. Roy Chapman Andrews, should be associated with this handsome jerboa.

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SQUIRRELS COLLECTED BY THE AMERICAN MUSEUM ASIATIC EXPEDITIONS[1]

By Glover M. Allen

The squirrel-like rodents hitherto brought back by the Asiatic Expeditions of The American Museum of Natural History amount to some 750 specimens from a wide range of territory, chiefly southwestern Yunnan, the southeast coast of China including the island of Hainan, and from the region of Peking and central Mongolia. This fine series of well-prepared skins has helped to make clearer the distribution and relationships of many species. Noteworthy are: the extension of range of certain spermophiles described from Kansu and Ala Shan and now found by Mr. Roy Chapman Andrews in central Mongolia; the tracing of the coniferous-forest types in their southward extension into Mongolia; the discovery of two flying squirrels in Hainan where none had previously been reported; and the evidences of intergradation between various subspecies of the widely distributed red-bellied squirrel (*Callosciurus erythræus*). The list of species collected is here given.

Sciuridæ

Citellus dauricus (Brandt)

Spermophilus dauricus Brandt, 1843, Bull. Acad. Imp. des Sci., St. Pétersbourg, cl. phys.-math., II, p. 379.

A single specimen, taken twenty miles southwest of Urga, is undoubtedly referable to this species. It was first brought to the attention of naturalists by Pallas who obtained it near Tarei Nor. Radde in 1856 secured additional examples and, in his report published in 1862, gave a careful account with colored figures of the animal. Like his, the present specimen, though taken May 19, is still in winter pelage. Its lips, sides of neck, flanks, feet, and entire under side of body are white, and a dull white line runs from the muzzle to the base of the ear. The top of the nose is pinkish (vinaceous-buff), the rest of the upper side pale buff finely lined with black hairs evenly distributed. The tail is short, 59

[1] Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 43.

mm., buff above and below, its terminal half above and its terminal third below bordered with black and fringed with white. This is evidently closely related to *C. mongolicus*, differing only in its slightly more pallid coloring, and perhaps in slightly larger skull. The latter should therefore stand as a subspecies.

Citellus dauricus mongolicus (A. Milne-Edwards)

Spermophilus mongolicus A. Milne-Edwards, 1867, Ann. des Sci. Nat., Zool., (5) VII, p. 376.

The type-locality of this spermophile is "la Mongolie chinoise et dans le voisinage de Pékin." Specimens obtained by Mr. Andrews near Peking are therefore topotypes, and a careful comparison of these with a series from Taboul, 100 miles northwest of Kalgan (on the edge of the Mongolian plateau), fails to reveal any tangible difference. Evidently, therefore, the name *umbratus*, given by Mr. Oldfield Thomas to Taboul specimens, must be regarded as a synonym of *mongolicus*. He compared the latter with pale specimens from northwestern Shensi and Ordos desert but was misled by supposing the latter were typical of *mongolicus*. As compared with *dauricus*, this is less pallid and decidedly more pinkish above, with a yellowish belly in winter pelage. The summer coat is not assumed until fairly late, about the first of July. Specimens from Tsinanfu are grizzled pinkish buff and black above, washed with pale yellow on sides, limbs, and belly. The very short tail, 60 mm. or less, is distinctive.

Citellus obscurus (Buechner)

Spermophilus obscurus Buechner, 1888, 'Przewalski Exp., Mamm.,' p. 17.

The type locality is Kansu, north of Tchagryn-gol, whence Buechner had two August skins and a third taken in May that still retained part of the paler winter pelage. A series taken by Mr. Andrews at Artsa Bogdo, Mongolia, in August, 1922, agrees closely with his description and figure and is provisionally referred to the same species. The general color above is an evenly grizzled mixture of dull buffy and black, producing a dark sandy appearance; sides and belly dull whitish, washed with buffy. It lacks the decidedly ruddy tinge of *mongolicus* and, even in a specimen still partly in winter dress, seems to lack the pinkish-buff patch on the nose of the latter. A distinguishing point noticed by Buechner is that the black subterminal border of the tail is more or less obscured on the ventral side by long rusty hairs. The dark brown bases of the hairs on back and belly are also more conspicuous, and the basal half of

the tail is less distichous, more cylindrical. In the dry plains country of Shansi this species is represented by a paler, more pinkish form, two specimens of which are in the Museum of Comparative Zoölogy. It may be described as follows.

Citellus obscurus siccus, new subspecies

TYPE.—Adult female, skin and skull, No. 19924, Museum of Comparative Zoölogy, from ten miles west of Taiyuanfu, Shansi, China. August, 1921. F. R. Wulsin.

DESCRIPTION.—In summer pelage, paler, more vinaceous buff above than *C. obscurus;* slightly paler and with longer tail than *C. d. mongolicus.*

Forehead, sides of face, entire back and base of tail "vinaceous-cinnamon" evenly grizzled with fine black hairs. End of the muzzle clearer, "pinkish-cinnamon"; white eye-ring, indistinctly continued to the end of the nose and to the ear as a whitish line. Sides of neck, the fore limbs and feet, the flanks, front of hind leg, and the hind feet, pale buffy ("pinkish buff"). Below, white washed with buffy. On the chin and upper throat, fore arms and lower part of hind leg, the hair is practically white to the base, but elsewhere, on throat and belly the dark fuscous bases show through everywhere. The tail is distichous in its terminal half, which is pale rusty ("cinnamon") in the middle, bordered by black and fringed with buff. The lower side is entirely pale rusty, with the subterminal black border partly obscured by rusty hairs. The soles of the hind feet are hairy as far as the palmar tubercles.

The skull is not distinguishable from that of specimens from Artsa Bogdo, Mongolia, referred to *C. obscurus* except that the nasals equal the intermaxillaries in backward extension instead of falling short of them. Compared with that of *mongolicus* the skull is a trifling amount smaller.

MEASUREMENTS.—The type skin is about 210 mm. in length of head and body, the tail 76, hind foot 38. The skull measures: greatest length, 45.5 mm.; basal length, 41.7; palatal length, 24; diastema, 10; nasals, 16.5; zygomatic width, 29; width across molar rows, 13; upper cheek teeth, 10.5; mandible, 29; lower cheek teeth, 9.4.

This is apparently the representative of *C. obscurus* occurring in Shansi, and may at once be distinguished from *mongolicus* by its longer tail and paler, more pinkish, tint. I have seen no specimens of the shorter-tailed animal from Shansi, although Thomas has recorded *mongolicus* from that province, contrasting it, however, with darker Taboul specimens.

Citellus pallidicauda (Satunin)

Spermophilus pallidicauda SATUNIN, 1903, Annuaire Mus. Zool. St. Pétersbourg, VII, p. 551.

A rather large species, at once distinguished by its large feet with naked palms and the tail, which is dull ochraceous at the base above, paling elsewhere to whitish or pale buffy, and so quite lacking the sub-

terminal black border of other Chinese species. This was apparently common on the Gobi Desert, whence series were secured at Ude and Ussuk as well as one each from Loh and Gun Burte. Although referred to *pallidicauda* on geographical grounds (type locality, Lake Chulmu Nor, Gobi-Altai), this is unquestionably very closely related to *C. alaschanicus* Buechner from southern Mongolia, if not identical with it.

Citellus eversmanni jacutensis (Brandt)

Spermophilus jacutensis Brandt, 1843, Bull. Acad. Imp. des Sci., St. Pétersbourg, cl. phys.-math., II, p. 379.

A large, long-tailed species with the back thickly speckled with whitish. In winter pelage the sides and belly are white with a faint buffy wash, and the back is dull buffy, slightly darkened with scattered black hairs and marked with small white spots through the close juxtaposition of several of the white bands of the longer hairs. In summer coat, the back is very much darker, while the forehead, sides of the head and neck, the flanks, limbs, and belly are ochraceous. Compared with a series from the Altai Mountains representing typical *eversmanni*, the back in the present series from Mongolia is slightly duller, less clear black-and-white speckled, while the ochraceous tint of sides and belly is more intense. Pallas long ago remarked these differences in Yakutsk specimens and Brandt in 1843 gave the provisional name *jacutensis*, which is probably worth recognition in a subspecific sense.

This is the common spermophile of the open, wooded country of northern Mongolia, where its southern limit is probably conterminous with that of the evergreen forest. A large series from Sain Noin Khan in the early part of June is just beginning to change from winter to summer dress. In one taken June 4, the new and contrastingly ochraceous hair of the muzzle, eye, and ear region has just appeared, while in others taken June 10 and 11, the new coat is coming in on the shoulders as well. A large series taken in mid-July forty-five miles northeast of Urga has fully assumed the summer pelage.

Marmota bobak sibirica (Radde)

Arctomys bobac var. *sibirica* Radde, 1862, 'Reise im Süden v. Ost-sibirien,' I, p. 159.

A pale-buffy marmot, with short dark-brown tail. A large series was secured from localities between eighty miles southeast of Urga and forty-five miles northeast of the same center; others were taken in the region about Tzetsenwan, Mongolia. There is some variation in color, tending to a darkening of the buffy hair-tips to brown. Several very small young were captured in mid-June.

Eutamias asiaticus (Gmelin)

Sciurus asiaticus GMELIN, 1788, Linné's 'Syst. Nat.,' 13th Ed., I, pt. 1, p. 150.

This small ground squirrel with its five sharply defined, black stripes on an olive or khaki-colored ground, and with a pure white belly, seems to show very little geographic variation in color. It was met with in sparsely wooded country near Urga (fifteen and forty-five miles northeast) and to the southwest at Sain Noin Khan, but seemingly it does not penetrate into the grass-lands or the more desert parts of the Gobi. Specimens from the above localities seem identical with others from Gichiga on the Sea of Okhotsk; nor am I able to distinguish them from *E. a. altaicus*, described as being less brightly colored than the typical form.

Eutamias senescens Miller

Eutamias senescens MILLER, 1898, Proc. Acad. Nat. Sci., Philadelphia, p. 330.

Jacobi is undoubtedly correct in regarding this as a species distinct from *E. asiaticus*, as originally described. It differs in its slightly larger hind foot, shaggier, coarser fur and in having the rump rusty instead of olivaceous; in addition, the two lateral pairs of black stripes are much mixed with ochraceous and merge with the reddish of the rump, whereas in *E. asiaticus* the five black stripes are all clear and distinct, the two inner lateral ones continuing to the root of the tail. The belly of *E. senescens* is faintly washed with yellowish, but the throat is contrastingly white, while in *E. asiaticus* the belly is clear white. The skull of the former is more slender, the rostrum longer. By these criteria, *orientalis* and *albogularis* are subspecies of *senescens*, rather than of *asiaticus* as suggested by Jacobi.

Four skins from Tungling and the Eastern Tombs in Chili Province were secured by Mr. Andrews.

Eutamias senescens intercessor Thomas

Eutamias asiaticus intercessor THOMAS, 1908, Abstr. Proc. Zoöl. Soc. London, December, p. 44.

Shansi specimens are a very little paler than the typical form, with less dark hairs on the forehead, and with the rusty and ochraceous of rump and flanks less intense. Skins from Kweihwating and from forty-five miles east of Paotow are referred to this subspecies.

Tamiops macclellandi swinhoei (A. Milne-Edwards)

Sciurus macclellandii var. *swinhoei* A. MILNE-EDWARDS, 1868–1874, 'Recherches Hist. Nat. Mamm.,' p. 308.

Of these striped tree-squirrels with white-tufted ears a series of four representing this subspecies was taken at Mucheng on the Salween drainage, 6500 to 7000 feet altitude. The light lateral stripes are clear ochraceous, the top of the head is strongly suffused with the same, the belly lightly so. February skins have the three black dorsal stripes well defined. This series probably marks nearly the southern limit of the subspecies, described originally from Moupin.

Tamiops macclellandi forresti Thomas

Tamiops maritimus forresti THOMAS, 1920, Ann. Mag. Nat. Hist., (9) V, p. 305.

General color (winter) olive, the median black stripe alone distinct, the four other dark stripes faintly rusty, the white stripes washed with buffy; cheek stripes and belly white. On the isolated Lichiang range this local form has developed, and is well marked through its nearly uniform buffy-olive ground color. Four specimens were secured at an elevation of 10,000 feet near the summit of Pei Shui.

Tamiops macclellandi vestitus Miller

Tamiops vestitus MILLER, 1915, Proc. Biol. Soc. Washington, XXVIII, p. 155.

This is a much more grayish race than any of the others. The summer and winter pelages differ slightly. In summer three black dorsal stripes are clearly shown, whereas in winter the two lateral of the three are brown, and the intermediate area is more buffy. The crown is sometimes distinctly russet. This was first described as a species but Jacobi is doubtless correct in regarding it as a subspecies of *macclellandi*. Mr. Andrews secured specimens from Tungling and from the vicinity of the Eastern Tombs, Chili Province.

Tamiops macclellandi monticola (Bonhote)

Sciurus macclellandi monticolus BONHOTE, 1900, Ann. Mag. Nat. Hist., (7) V, p. 52.

A darker race of the Fukien highlands. Summer skins show five prominent dorsal stripes on a grayish-brown ground, the two outermost enclosing a white stripe with a decided ochraceous tinge. In winter the four lateral black stripes are rusty brown. A series from Yenping in the mountains of Fukien comes from very near the type locality. The bright buffy facial stripes are conspicuous but cannot be traced continuously across the shoulder to the light body-stripe as they can, for example, in *vestitus*.

Tamiops macclellandi maritimus (Bonhote)

Sciurus macclellandi maritimus Bonhote, 1900, Ann. Mag. Nat. Hist., (7) V, p. 51.

A somewhat grayer race with narrower and paler whitish lateral stripe than in the preceding race. This is a slightly marked form of the low coastal area of Fukien. A small series was secured at Yuki by Rev. Harry R. Caldwell.

Tamiops macclellandi hainanus J. A. Allen

Tamiops macclellandi hainanus J. A. Allen, 1906, Bull. Amer. Mus. Nat. Hist., XXII, p. 476.

Very similar to *maritimus* but the light side-stripes are more buffy and the foot is smaller, more delicate. A fine series was secured by Mr. Clifford Pope at Nodoa, on the island of Hainan. He writes that it is common there, living in patches of jungle, prickly bamboos, in large bushes, or in isolated groups of trees. A favorite place is a mass of vines covering a dead tree. It is extremely quick and agile in its movements and easily alarmed. He never saw it descend to the ground.

Tamiops barbei (Blyth)

Sciurus barbei Blyth, 1847, Journ. Asiatic Soc. Bengal, XVI, p. 875.

This is undoubtedly a species distinct from *macclellandi*, which it replaces in the lower country of Burma and the Malay peninsula. It is distinguished: (1) by the more conspicuous outer pale stripe, which is broadly continuous across the shoulder with the cheek stripe; (2) by the smaller hind foot, usually less than 30 mm.; (3) by the much narrower tail; and (4) by the ochraceous instead of pale yellow or whitish under surface. The skull is very slightly smaller, the cheek teeth noticeably so, with the outer anterior corner of p^4 less developed so that the anterior outline of the tooth is slightly convex instead of concave. A series of twelve specimens was taken near Mengting at the Burmese border of Yunnan, and two others on the Salween drainage at Mucheng (5000 feet). There it must be close to its northern limit in Yunnan, and meets the range of *T. macclellandi swinhoei*, specimens of which were secured at the slightly higher altitude of 7000 feet near the same place. Careful comparison with specimens of typical *barbei* from Tenasserim, kindly loaned by the U. S. National Museum, fails to reveal any important difference between the two series, although in the latter the hair of the lower surface is shorter and with slightly less conspicuous dark bases.

Rupestes forresti Thomas

Rupestes forresti THOMAS, 1922, Ann. Mag. Nat. Hist., (9) X, p. 399.

A medium-sized squirrel, grizzled black and ochraceous above, merging into nearly clear ochraceous on sides of head, throat and flanks. There is a narrow whitish stripe on each side of the body, and the belly is pale ochraceous. Of this rare squirrel a single flat skin was obtained at Lichiang. The type was from the Mekong-Yangtze divide at 7000–9000 feet.

Funambulus tristriatus (Waterhouse)

Sciurus tristriatus WATERHOUSE, 1837, Charlesworth's Mag. Nat. Hist., I, p. 499.

Three skins from the Faunthorpe-Vernay Expedition to India show stages in molt from the russet winter pelage to the black-backed summer coat.

Sciurotamias davidanus (A. Milne-Edwards)

Sciurus davidanus A. MILNE-EDWARDS, 1867, Rev. et Mag. de Zool., (2) XIX, p. 196.

A grizzled black, gray and buff squirrel, with a white eye-ring and white streak at the posterior base of the ear. The long hair of the tail is white-tipped, the belly white, washed with buffy. The pelage is rather coarse, almost shaggy. A series from Tungling and the Eastern Tombs is typical and three skins from He-shuin, Shansi, seem to represent the same squirrel, here perhaps near its western limit.

Sciurotamias davidanus owstoni J. A. Allen

Sciurotamias owstoni J. A. ALLEN, 1909, Bull. Amer. Mus. Nat. Hist., XXVI, p. 428.

This is a much more richly colored race, in which the buffy of the typical form is replaced by ochraceous, with a heavy wash of the same on the lower side. The eye-ring and the postauricular patches, however, remain whitish. The type locality is Tai Pei Shan, the mountain range of central Shensi. The Third Asiatic Expedition secured specimens along the base of these mountains, as well as forty-five miles southwest of Fengsiangfu in the same Province.

Dremomys pyrrhomerus (Thomas)

Sciurus pyrrhomerus THOMAS, 1895, Ann. Mag. Nat. Hist., (6) XVI, p. 242.

A medium-sized squirrel, grizzled buffy and black above, white below, and at once distinguished by its ochraceous cheeks, and the bright

ferruginous thigh-patch and under side of the tail. Its range seems somewhat circumscribed in the middle Yangtze basin. The type was from Ichang and the Third Asiatic Expedition secured a series at Wanhsien, in eastern Szechwan, collected by Mr. Walter Granger.

Dremomys pernyi howelli Thomas

Dremomys pernyi howelli THOMAS, 1922, Ann. Mag. Nat. Hist., (9) X, p. 401.

Squirrels of this species are marked by a bright chestnut patch in the anal region and by having the backs of the ears ochraceous, contrasting with the dark olivaceous, black and buff mixture of the back. The present subspecies has a rich dark tone with a faintly marked black line in the middle area of the back. Two specimens from Taipingpu, Shweli River, Yunnan, are referred to it. The type locality is Machangkai, twenty-five miles southwest of Tengyueh, Yunnan.

Dremomys pernyi flavior G. M. Allen

Dremomys pernyi flavior G. M. ALLEN, 1912, Proc. Biol. Soc. Washington, XXV, p. 178.

This is a smaller race, slightly paler in color. The type is from Mengtsz, southeastern Yunnan. Two skins from the Litien and Wie-shu Pass, 11,000 feet, and a third from Chungtu, Mekong River, 6000 feet, seem to be this race.

Dremomys pernyi lichiensis Thomas

Dremomys pernyi lichiensis THOMAS, 1922, Ann. Mag. Nat. Hist., (9) X, p. 403.

This race of the Lichiang Range is barely distinguishable. Compared with a series from western Szechwan, representing *D. p. griselda*, it is a very little less gray, the skull possibly smaller. Specimens were obtained by Messrs. Andrews and Heller between 8200 and 10,000 feet near Lichiang.

Dremomys pernyi calidior Thomas

Dremomys pernyi calidior THOMAS, 1916, Ann. Mag. Nat. Hist., (8) XVII, p. 394.

A darker, ruddier form from the mountains of Fukien, whence a single skin is in the collection.

Callosciurus erythræus gordoni (Anderson)

Sciurus gordoni ANDERSON, 1871, Proc. Zoöl. Soc. London, p. 140.

As a species, *Callosciurus erythræus* has a wide range, extending from Burma eastward to the coast of central China. Over this great

territory it is represented by a number of local races. The general coloring is grizzled black and buffy above, with the ventral surface of body and limbs sharply contrasted chestnut. In the subspecies *gordoni*, a narrow, sharply defined grizzled line similar in color to the back passes medially from the throat down the chest. The long hairs of the tip of the tail are black, tipped with chestnut, forming contrasting areas. The type locality is Bahmó, eastern Burma. Specimens from southwestern Yunnan (Homushu Pass, Taipingpu, Huiyao, Watien) are quite like Anderson's plate and doubtless represent typical *gordoni*. A series from the Salween drainage, however, is exactly intermediate between these and the paler *michianus* of the Lichiang range. Above, they are quite as dark as *gordoni*; but, below, they show great variation. Thus, in two the grizzled median stripe is absent, while in the others it is mixed with ochraceous in varying degree; but on the whole the series is perhaps nearer *gordoni*.

Callosciurus erythræus pranis Kloss

Sciurus erythræus pranis Kloss, 1916, Journ. Bombay Nat. Hist. Soc., XXIV, p. 178.

The under side is pale ochraceous, the median grizzled line indistinct, the tail fringed with pale ochraceous or whitish. Specimens secured by the Asiatic Expeditions from the Burma border on the Namting River agree exactly with the description of this form, the type locality of which is Pran, southwestern Siam. Its range must meet that of *gordoni* somewhere in southwestern Yunnan. Two embryos were found in a specimen killed March 1, a number correlated with the reduced number of mammæ (four) in this group of squirrels.

Callosciurus erythræus michianus (Robinson and Wroughton)

Sciurus castaneiventris michianus Robinson and Wroughton, 1911, Journ. Fed. Malay States Mus., IV, p. 234.

This is a paler race of the Lichiang highlands. Compared with *gordoni*, with which it intergrades, it is much paler, especially along the sides, and the tail is yellow-tipped instead of rusty. The mid-ventral grizzled stripe is typically lacking, or it may be represented by a contrasted line of ochraceous extending from the throat for a varying distance posteriorly. Specimens from Yunnanfu, to the east of Lichiang though referred here, are intermediate between this and the smaller-footed *hæmobaphes*.

Callosciurus erythræus castaneoventris (Gray)

Sciurus castaneoventris Gray, 1842, Ann. Mag. Nat. Hist., (1) X, p. 263.

The type of this race is a skin in the British Museum collected by Reeves, but with no other locality than "China." Bonhote, in his review of these squirrels, says that specimens from Fukien are typical. I have therefore referred to it a series from Futsing and Yenping in that Province, obtained by the Asiatic Expeditions. In this race the belly lacks the median gray line, and the tips of the long fringing hairs of the tail are pale ochraceous. The throat is usually gray but in two specimens the chestnut of the belly is continued nearly to the lips. A female containing two embryos was killed at Futsing on August 2, 1916.

Callosciurus erythræus ningpoensis (Bonhote)

Sciurus castaneoventris ningpoensis Bonhote, 1901, Ann. Mag. Nat. Hist., (7) VII, p. 163.

This is a poorly marked and perhaps untenable subspecies. A series of eleven topotypes brought back by Mr. Andrews from Ningpo, Chekiang Province, is barely distinguishable from the Fukien series, but averages a little grayer along the sides and slightly paler below. One or two of the series are practically identical with *castaneoventris* from Fukien.

Callosciurus erythræus styani (Thomas)

Sciurus styani Thomas, 1894, Ann. Mag. Nat. Hist., (6) XIII, p. 363.

A buffy-bellied race of the lower Yangtze valley. Two skins from Tunglu, Chekiang Province, taken in March, are probably best regarded as intermediates between *ningpoensis* and *styani*, with the latter of which they seem to agree in general coloring. One has a gray midventral line, as normally in the more southern representatives of the species, a character usually lacking, however, in the more northern races.

Callosciurus erythræus insularis (J. A. Allen)

Sciurus erythræus insularis J. A. Allen, 1906, Bull. Amer. Mus. Nat. Hist., XXII, p. 473.

This Hainan race is at once distinguished by its white-fringed tail. In the large series obtained at Nodoa and Nam Fong on the island of Hainan, there is every gradation from a clear chestnut belly to the condition in which a sharply defined narrow line of grizzled gray divides this area medially. The usual coloring, however, is with gray throat and chestnut belly, the latter shade sometimes extending forward nearly to the lips.

Sciurus vulgaris chiliensis Sowerby

Sciurus vulgaris chiliensis SOWERBY, 1921, Ann. Mag. Nat. Hist., (9) VII, p. 253.

This is the representative in eastern China of the tufted-eared squirrel of Europe. The type locality is the Tungling area, seventy-five miles northeast of Peking. In a series of eleven skins from near there, there is much variation in the amount of rufous mixed with the predominating black of the sides and upper surface. The cheeks are usually blue-gray, the blackish tail with a tinge of brown in the central portion. In three specimens the lower side of the forearms and hind leg is clear rufous as well as a narrow flank stripe, while in two of these the rufous extends to the backs of the hind feet. There is no white eye-ring.

Sciurus vulgaris (near **mantchuricus** Thomas)

Sciurus vulgaris mantchuricus THOMAS, Ann. Mag. Nat. Hist., (8) IV, p. 501.

A series of ten skins from localities fifteen miles north and forty-five and sixty miles northeast of Urga, Mongolia, seems to approach *mantchuricus* in having the dorsal surface much more mixed with gray than in *chiliensis* which is of a more intense black. The skulls are, as in the latter, 54–55 mm. long, hence slightly smaller than in *mantchuricus*. As usual in these melanistic forms of the species, occasional individuals show more or less rufous, one for example, having chin, throat and belly white bordered by a rufous line, and with rufous feet and inner surfaces of legs. The range in Mongolia is doubtless conterminous with that of the coniferous forest.

Ratufa gigantea (MacClelland)

Sciurus giganteus MACCLELLAND, 1839, Proc. Zoöl. Soc. London, p. 150.

A giant squirrel, shining black above, light ochraceous below including inner side of legs. This large species reaches the borders of western Yunnan. One was secured in 1917 on the Namting River, 1700 feet altitude, on the Burma border, and two other skins were bought at Watien, Yunnan.

Ratufa gigantea hainana J. A. Allen

Ratufa gigantea hainana J. A. ALLEN, 1906, Bull. Amer. Mus. Nat. Hist., XXII, p. 472.

Similar to *gigantea*, but the belly darker. This is apparently a rare species on Hainan. In addition to the type secured nearly twenty years ago, a female was obtained by Mr. Clifford Pope at Nam Fong. According to the native hunters, it lives only in heavy forest and is extremely agile, hence difficult to kill.

Ratufa indica maxima (Schreber)

Sciurus maximus SCHREBER, 1784, 'Säugethiere,' Pl. CCXVII B.

Ratufa indica centralis Ryley

Ratufa indica centralis RYLEY, 1913, Journ. Bombay Nat. Hist. Soc., XXII, p. 437.

Skins representing these two races were obtained by the Faunthorpe-Vernay Expedition in India, 1923.

PETAURISTIDÆ

Petaurista yunnanensis (Anderson)

Pteromys yunnanensis ANDERSON, 1875, Ann. Mag. Nat. Hist., (4) XVI, p. 282.

General color above maroon evenly ticked with white; membrane maroon; feet and adjacent borders of membrane, and terminal three-fourths of tail black; under surface of body white, extending out on the membrane. Two skins were purchased at Wei-shie, and two specimens collected at Taipingpu, 7000 feet, both localities in southwestern Yunnan.

Petaurista alborufus castaneus Thomas

Petaurista alborufus castaneus THOMAS, 1923, Ann. Mag. Nat. Hist., (9) XII, p. 172.

A specimen from the Szechwan-Hupeh border is practically a topotype (type locality, Ichang). This large flying squirrel is very handsome: back, except the dull buffy lower half, deep chestnut; the tail chestnut; feet black; lower sides of body and membrane rufous; head and throat, including a patch on upper surface of shoulder, white. As a species it ranges westward to the borders of Tibet and southward into the Yunnan highlands.

Petaurista alborufus ochraspis Thomas

Petaurista alborufus ochraspis THOMAS, 1923, Ann. Mag. Nat. Hist., (9) XII, p. 172.

An imperfect skin was purchased at Lichiang, Yunnan, and evidently represents this race. The buffy area of the back is a little paler than in *P. a. castaneus* and is narrowly continuous with the buffy area of the base of the tail; otherwise the two are much alike.

Petaurista petaurista rufipes, new subspecies

TYPE.—Adult male, skin only, No. 58224, American Museum of Natural History, from Yungan, Fukien Province, China. September 26, 1921. H. R. Caldwell.

DESCRIPTION.—Entire dorsal surface of the body, including the backs of the feet, the fingers and entire tail, rich "tawny" or ferruginous, glossy, the tips of some of the hairs of the nape and mid-dorsal area minutely tipped with black which causes a slight darkening. Vibrissæ, and a narrow eye-ring black; a minute dull brown spot

at the chin. Entire lower surface of the body pinkish rufous, nearly "ochraceous-salmon," deepening to "tawny" at the border of the membrane.

MEASUREMENTS.—The skin measures approximately: head and body, 375 mm.; tail, 330. The hind foot is 74 mm.

The typical form of this squirrel occurs in Java. Thomas, in reviewing the species in 1908 (under the specific name *nitidus*), recognized the animal of the Malay peninsula as a distinct subspecies for which Gray's name *melanotus* was revived. The discovery of the species in the wooded mountains of Fukien is apparently an extension northward of its previously known range. The two adults secured by Rev. H. R. Caldwell agree in lacking all trace of black on the feet, ears, and tip of tail, and in these respects are apparently different from the darker forms to the southward. A single young, about two-thirds grown, from Kweihwa, Fukien, is similar but, as usual, is less bright than the adults, with a darkening of black hairs at the sides of the toes and along the outer margin of the hind foot; below, the tail shows a narrow median line of black.

Petaurista hainana, new species

TYPE.—Adult female, skin and skull, No. 58200, American Museum of Natural History, from Nam Fong, island of Hainan, China. February 19, 1923. Third Asiatic Expedition; Clifford Pope, collector.

DESCRIPTION.—Occiput, nape, and entire dorsal surface of body, including the arm to the elbow and leg to the knee, as well as the base of the tail and the interfemoral membrane, a grizzled rusty and black, the individual hairs black-tipped with a subterminal ring of ochraceous buff to tawny, and long blackish bases. Forehead, sides of head and a broad area behind each ear along the side of the neck, shining black. Ears black narrowly bordered with whitish. Lips white, but the chin black. Hair of the throat brownish black, white-tipped, this coloring extending in a triangular point on the side of each cheek between the eye and the ear, and in a broader area at the side of the neck to the upper side of the humerus. Forearm, lower leg, and most of the parachute blackish brown, tipped with ferruginous above; the feet, anterior and posterior edges of the membrane, forearm below, and the tail all around (except upper side of base) deep shining black. Ventral surface of body, humerus, and that part of the parachute between elbow and middle of tibia white, the hairs in the median region of the body with gray bases. A narrow border at the lateral edge of the parachute consists of black-tipped hairs with broad cinnamon-rufous bases showing through. These become wholly black on that portion of the membrane outside the forearm, but white-tipped for about 40 mm. at the extreme outer edge just back of the long rod that spreads it from the wrist. The interfemoral portion of the membrane and the lower surface of the tibia are covered with white-tipped hairs, whose bases are gray, becoming tawny in the central portion of each patagium.

MEASUREMENTS.—The collector's measurements of the type are: head and body, 445 mm.; tail, 595; hind foot, 84; ear, 45.

The skull measures: greatest length, 75 mm.; condylo-basal length, 68; palatal length, 37.5; diastema, 14.5; zygomatic width, 49; interorbital width, 17; mastoid width, 36; upper cheek teeth, 17; mandible, 44; lower cheek teeth, 18.

This is a large and richly colored flying squirrel, seemingly one of the *oral* group, with the tips of the dorsal hairs rusty. In a considerable series obtained on Hainan by Mr. Clifford Pope, there is but little variation, though one specimen is much more rufous than usual, with a tuft of this color behind the ear and with the upper surface of the parachute and the tibiæ completely rufous. The tail also is much mixed with this color. In only one specimen in the series of twenty is the lower side of the parachute buffy.

This genus has not previously been reported from Hainan. Mr. Pope writes that it was found only in the "big woods more than fifteen miles to the south of Nodoa. There it must be abundant, for the Miao hunters shot as many as four in one day. The patches of jungle about Nodoa are entirely devoid of them and they do not seem to be found even in the wooded mountains eight miles to the west. There is no market for them at Nam Fong and their continued existence seems to be due to that condition. They have a very strong odor and perhaps the flesh is too strong to be eaten."

Petaurista clarkei Thomas

Petaurista clarkei Thomas, 1922, Ann. Mag. Nat. Hist., (9) X, p. 396.

A large, grizzled gray-and-buff species with ochraceous feet and lower surfaces, as well as a spot of the same behind each ear. Two imperfect skins were bought at Lichiang and Talifu, Yunnan, extending the known range southward from northern Yunnan, Mekong valley

Petaurista philippensis (Elliot)

Pteromys philippensis Elliot, 1839, Madras Journ. Lit. and Sci., X, p. 217.

A skin was brought back from India by the Faunthorpe-Vernay Expedition.

Petaurista melanopterus (Milne-Edwards)

Pteromys melanopterus Milne-Edwards, 1867, Ann. des Sci. Nat., Zool., (5) VIII, p. 375.

A long-haired gray species, with black-edged hind feet and a border of ochraceous along both surfaces of the parachute. This flying squirrel was obtained in Chili Province at Tungling and the Eastern Tombs.

Pteromys (Hylopetes) alboniger (Hodgson)

Sciuropterus alboniger Hodgson, 1836, Journ. Asiatic Soc. Bengal, V, p. 231.

A medium-sized, gray-and-buff flying squirrel, with dark feet, white hind toes, and whitish belly with the bases of the hairs everywhere pale gray. A single skin from Lichiang, Yunnan, is apparently this species; and Thomas has recorded it from the same range at 11,000 feet.

Pteromys (Petinomys) electilis, new species

TYPE.—Adult female, skin and skull, No. 58177, American Museum of Natural History, from Nam Fong, island of Hainan, China. April, 1923. Third Asiatic Expedition; Clifford Pope, collector.

DESCRIPTION.—A medium-sized species with pale russet back grading into fuscous on the upper part of the membrane. Tail tapering in width from the basal third to the dark tip.

Dorsal surface from the nose to the base of the tail uniform pale cinnamon, the basal four-fifths of the hairs fuscous. On the limbs and flanks the tips of the hairs are pale (grayish or whitish), becoming obsolete on the membrane which is blackish brown distally with a narrow white edging, most prominent along the posterior half and passing more to the ventral side in the anterior half. Backs of the feet covered with short hairs, whitish and fuscous, the latter predominating on the hind feet; terminal half or more of hind toes white. Side of the head from eye to ear dusky, below which the white of the lips is continued backward and upward, forming a white streak behind the ear on the side of the upper neck. A narrow dusky ring surrounds the eye. Below, the chin, throat and upper arm are pure white to the bases of the hairs; elsewhere the hairs have slaty bases, those of the membrane paler. Along the flanks a wash of cinnamon extends from axilla to knee. The tail is distichous, broadest at about its basal third, whence it tapers regularly to the tip. It is slightly darker than the back, pale cinnamon washed with dusky, the latter tint deepening distally to produce a distinctly dark tip. Ears naked.

Individuals vary in the relative amount of dusky and cinnamon. Some have the parachute membrane rusty instead of fuscous, and the tail may be less cinnamon. In some the pure white areas of throat and axilla may be continuous and even extend as a narrow line down the middle of the chest, or there may be a pure white area at the groin. Immature examples are grayer above than adults through the prevalence of white-tipped hair.

SKULL.—The skull shows the short rostrum and low uninflated bullæ typical of the subgenus. The cheek teeth are roughened on their crowns and show a small lateral cusp between the two main cusps of the molars.

MEASUREMENTS.—The dimensions of the type as noted by the collector are: head and body, 172 mm.; tail, 159; hind foot, 35; ear, 26. The skull measures: greatest length, 41.5; basal length, 35; palatal length, 21.7; diastema, 8.7; nasals, 11; zygomatic width, 25; mastoid width, 18.7; upper cheek teeth, 8; mandible, 24; lower cheek teeth, 7.6.

The discovery of this small flying squirrel on Hainan is an interesting extension of the range of the subgenus into southeastern China, but it seems specifically distinct from any of the other forms described from India and southeastern Asia, although agreeing well subgenerically with *Petinomys*. Mr. Pope, who secured nearly forty specimens, writes that many were obtained by the native Miao hunters while searching for the large *Petaurista* in the "big woods," but they appear not to inhabit the jungle areas north of the central mountains.

AMERICAN MUSEUM NOVITATES

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59,7,55H(51.2)

A NEW HOMALOPTERIN LOACH FROM FUKIEN[1]

By J. T. Nichols

Regan, 1911, proposed the genus *Hemimyzon* for *Homaloptera formosana* Boulenger, 1894, Formosa, a species more or less intermediate in form between *Homaloptera* and *Gastromyzon*. We have a similar undescribed species from the province of Fukien, China, which is here placed in *Hemimyzon*. Certain differences which it shows from *H. formosana*, namely ventral rays 9 to 11 (versus 15) and caudal obliquely truncate (versus forked), seem to require that it be subgenerically distinguished as *Pseudogastromyzon*, new subgenus.

Hemimyzon zebroidus, new species

Body depressed, disc-shaped anteriorly, flattened beneath, compressed behind; 1.5 times as broad as high. Rostral membrane crenulate; edge of the lower jaw narrow and firm; two pairs of minute inferior barbels on the snout, at the corners of and towards the center of the rostral membrane, each of the latter pair in a notch in its border; a pair of slightly larger barbels at the corners of the mouth. Width of head equal to its length; head in length of pectoral, 1.6. Origin of the ventral slightly in advance of that of the dorsal; pectorals subhorizontal and ventrals in a horizontal plane, second to fourth outer rays of ventral and second to eighth of pectoral bifid; anal well developed reaching lower caudal base; ventrals appreciably shorter than pectorals, pointed, their tips passing the vent; dorsal origin equidistant from snout and anal axil; caudal obliquely truncate. Pectoral with about 20 rays, ventral with 9 to 11.

Description of Type.—No. 8392, American Museum of Natural History, collected near Yenping, Fukien, by H. R. Caldwell, co-operating with the Third Asiatic Expedition of The American Museum of Natural History.

Length to base of caudal 63 mm. Depth in length 6; head 4.4; pectoral in length 2.7; ventral 3.5; width between pectoral axils 5. Eye in head 5; snout 1.7; interorbital 2; width of gill-cleft 3.5; depth of peduncle 2; its length 2.5; longest dorsal ray 1.3; height of anal 1.4; caudal 1.1. Width of mouth in snout 2.5; mouth to snout 3.

Dorsal 9½; anal 8; pectoral 21; ventral 10. Scales about 90.

Head below, breast, and belly flat; pectorals and ventrals expanded to resemble the condition in *Gastromyzon*, free ends of pectorals overlapping ventrals and appressed to sides in the same manner, but ventrals well separated, pointed behind; head

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 44.

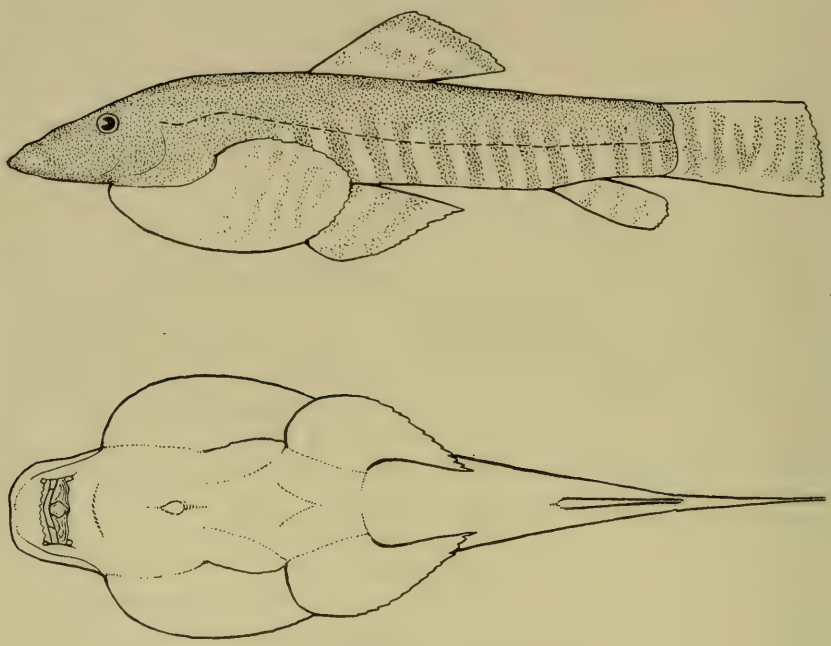

Fig. 1. *Hemimyzon zebroidus*, type.

depressed, the profile sloping; tail compressed; snout from above broad subtruncate, slightly rounded; vent appreciably nearer origin of anal than axil of ventral. Interorbital flat; eye with a free rim; pectoral origin under center of eye; thence a narrow membranous ridge borders the flattened lower surface of the head forward to the sides of the snout; free edge of opercle well curved; mouth inferior, semicircular, transverse; lips full, membranous, smooth, the upper overhanging the mouth, and in turn overhung by a snout membrane with crenulate edge; a small barbel at the end of the maxillary; small, scattered horny tubercles on the sides and tip of the snout. Dorsal origin equidistant from tip of snout and anal axil; slightly behind ventral origin; anal reaches to caudal base; more than the posterior half of the pectoral free; caudal obliquely truncate. Head, breast and belly to axils of ventrals scaleless; a large membranous ventral axillary flap with a rounded end; lateral line complete, in the middle of side, straight except for a slight double flexure behind the head.

Dark grayish brown; belly pinkish; dorsal with a black tip and imperfect crossbars; caudal with about four blackish bars; faint bars on pectoral and ventral; narrow, pale, somewhat oblique bars on the flanks. Smaller specimens are somewhat more sharply marked.

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59,7.55M(51)

AN ANALYSIS OF CHINESE LOACHES OF THE GENUS *MISGURNUS*[1]

By J. T. Nichols

Chinese loaches of the genus *Misgurnus* are exceedingly variable. A number of species have been described in the past, but recent authors are inclined to look upon their differences as individual variation, and to assign all or almost all to *Misgurnus anguillicaudatus* (Cantor), type locality Chusan, a coastal island south of the Yang-tze River. Berg, 1916, makes this a race of European *Misgurnus fossilis*. The variations are so great, however, that it is difficult to believe that more than one species is not involved. Thus, Jordan and Snyder, 1906, have revived *M. decemcirrosus* Basilewski, 1855, which name is also used by Fowler, 1924, for a fish which the present writer refers to *M. mizolepis* Günther, 1888.

In considerable *Misgurnus* material on hand from different parts of China, several distinct forms are apparently recognizable, complicated by individual variation so as to appear to be races rather than species. However, both in Anhwei and Fukien two such forms occur together, and in Tungting Lake of the Yang-tze River, Hunan, three forms. Nomenclature may best be adapted to the situation by recognizing three species, and two or three races of each. Unfortunately, most of the species of early authors are not described with sufficient accuracy for their names to be available. For the present at least, *decemcirrosus* Basilewski is uncertain from available data; *anguillicaudatus* Cantor is pretty definitely determinable by reason of its definite type locality; *mizolepis* Günther is clear enough.

Referring one of the three species here recognized to *anguillicaudatus* and a second to *mizolepis*, the third is represented in our collections by a plain-colored form from Yunnan and a heavily-spotted form from Tungting, to which, among our material, Berg's, 1916, figure of *Misgurnus fossilis anguillicaudatus* from the north Corean boundary, which may be taken as representative of *Misgurnus mohoity* (Dybowski), 1869, from

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 45.

the Onon and Ingoda rivers, east of Lake Baikal, seems to be closest. Without having seen material of this, its typical subspecies, our third Chinese species is provisionally referred to *mohoity*.

Consistency with recognition of three species of *Misgurnus* in China would seem to dictate consideration of European *M. fossilis* as a distinct species rather than as a race of one of these.

The following analysis of *Misgurnus* in China is published with some uncertainty at this time, although our material is probably more extensive than that of earlier writers. It may be considered as a preliminary treatment of the subject, a basis for discussion and for further collecting now in progress, in the light of which it will perhaps be advantageously revised at a later date.

Species and Races of *Misgurnus*

Misgurnus fossilis (Linnæus)

Cobitis fossilis Linnæus, 1758, 'Syst. Nat.,' 10th Ed., I, p. 303. Europe.
Misgurnus fossilis Berg, 1916, 'Poiss. Eaux Douces Russ.,' p. 353, Fig.

Differs from Asiatic forms in being marked with bold, lengthwise, dark stripes. Europe.

Misgurnus anguillicaudatus (Cantor)

Cobitis anguillicaudata Cantor, 1842, Ann. Mag. Nat. Hist., IX, p. 485. Chusan.

Striæ on scales little radiating; the scales more or less embedded or fully exposed. Head large, less than 6 in the length to base of caudal. Slender (depth between 7 and 8). Caudal long, equal to or slightly greater than head. Markings not very bold and sharp. East central China.

Misgurnus anguillicaudatus anguillicaudatus (Cantor)

This race occurs to the eastward, south of the mouth of the Yang-tze, Anhwei south into Fukien. Its limits to the north are uncertain.

Description of a specimen from Ningkwo, Anhwei, September 15 to October 15, 1921, C. H. Pope.—Length to base of caudal 130 mm. Depth in length 7.5; head 5.8. Snout in head 2.7; width of body 1.8; depth of peduncle 1.6; its length 1.3; pectoral 1.4; ventral 1.8; longest dorsal ray 1.5; longest anal ray 2; caudal 0.9. Eye in snout 2; interorbital 1.7; maxillary 1.5; anterior barbel (the longest) 1.

Dorsal 9; anal 7½. Scales about 155.

Elongate and a little compressed; vent at ¼ the distance from anal origin to ventral axil. Snout narrow and blunt; interorbital slightly convex; mouth inferior, horizontal, horse-shoe-shaped, with thick lips; 3 subequal barbels above mouth, of which the anterior is slightly the longest on one side and middle one on the other;

lower lip cleft, with one moderate (posterior) and one short barbel. Dorsal origin equidistant from base of caudal and gill-cleft; ventral origin slightly behind that of dorsal; pectoral reaching $\frac{2}{7}$ to ventral; ventral $\frac{4}{7}$ to anal; caudal narrow, rounded at the end. Scales rather irregular, more or less embedded in thick skin; with numerous slightly radiating striæ.

Dark above, paler below, with scattered faint dark marks of irregular size and placement, some along back as large as eye; caudal lightly barred; dorsal faintly marked; lower fins pale.

Misgurnus anguillicaudatus tungting, new subspecies

A race from the central Yang-tze, dark above, pale below, without large or pronounced markings on the body.

Description of the Type.—Number 8393, American Museum of Natural History. Huping, Tungting Lake, Hunan, C. H. Pope. Length to base of caudal 89 mm. Depth in length 7.7; head 5.6. Snout in head 2.6; width of body 2; pectoral 1.4; ventral 1.6; longest dorsal ray 1.5; longest anal ray 1.7; caudal 1; depth of peduncle 2; its length 1.2. Eye in snout 2; maxillary 1.6; interorbital 2.4; posterior upper barbel 1.4.

Dorsal 9; anal 8. Scales 143.

A little compressed; vent at $\frac{1}{4}$ the distance from anal origin to ventral axil; snout pointed; interorbital a little convex; eye somewhat superolateral; mouth inferior horizontal semi-circular; 3 barbels above it, the posterior the longest and central one the shortest, posterior 2 closest together; 2 small barbels below, the posterior the longest. Dorsal origin equidistant from base of caudal and center of opercle; ventral origin just appreciably behind that of dorsal; pectoral pointed, reaching $\frac{1}{3}$ the distance to ventral; ventral $\frac{1}{2}$ to anal, approximately in a horizontal plane; caudal narrow, somewhat rounded behind. Scales small, regular, exposed, with close-spaced only slightly radiating striæ.

Dark above and on upper sides; pale, unmarked below; the dark color in fine obscure freckling on sides, with slight tendency to concentrate into a broad dark lateral band anteriorly; a short dark bar at upper caudal base; caudal with fine blackish irregular bars; dorsal a little spotted, and lower fins slightly marked with dusky.

Misgurnus anguillicaudatus erikssoni Rendahl

Misgurnus erikssoni Rendahl, 1922, Ark. Zool., XV, No. 4, p. 3. Mongolia.

This race has a very long peduncle, depth of same 2.9 to 2.5 in its length.

Misgurnus mizolepis Günther

Misgurnus mizolepis Günther, 1888, Ann. Mag. Nat. Hist., I, p. 434. Kiu-kiang on the Yang-tze River.

Striæ on scales little radiating, scales embedded, peduncular keels always well developed, sometimes excessively so. Markings sharply contrasted, usually small. Yang-tze River valley and southward along the coast.

Misgurnus mizolepis mizolepis Günther

Deep-bodied (depth 5 to 6), the peduncular keels excessively developed; markings few, small; caudal short. Reaches a large size. Yang-tze Valley.

Description of a specimen from Tungting Lake, Hunan, January 3, 1921, C. H. Pope.—Length to base of caudal 167 mm. Depth in length 5.5; head 5.5. Eye in head 7.5; snout 2.5; interorbital 4; maxillary 3.5; depth of peduncle 1.3; dorsal height 1.5; anal 1.9; pectoral 1.3; ventral 1.7. Ventral under last third of dorsal, not reaching anal. Rudimentary rays of caudal above and below precurrent as fleshy keels.

Dorsal 7; anal 7. Scales about 135.

Color dark, fins and belly paler, brownish, lightly speckled.

Misgurnus mizolepis fukien, new subspecies

More elongate, sides well covered with scattered small black marks. Fukien.

Description of Type.—Number 8394, American Museum of Natural History, Yenping, Fukien, H. R. Caldwell. Length to base of caudal 127 mm. Depth in length 7.1; head 6.6. Snout in head 2.6; width of body 1.5; least depth of peduncle (with keel) 1.4; its length 0.8; pectoral 1; ventral 1.6; longest dorsal ray 1.4; longest anal ray 1.4; caudal 1. Eye in snout 2.5; interorbital 1.6; maxillary 1.4; posterior barbel 0.9.

Dorsal 8; anal 7. Scales about 140.

Compressed ; vent at $\frac{1}{4}$ the distance to ventral axil from anal. Snout broad and blunt; interorbital broadly convex; eye slightly superolateral; mouth inferior, horizontal, horse-shoe-shaped, with thick lips, the lower cleft; 3 barbels above (only 2 on one side) the posterior decidedly the longest, 2 small ones below, the posterior the larger. Dorsal origin equidistant from base of caudal and gill-cleft or slightly nearer the latter; ventral origin slightly behind that of dorsal; pectoral pointed; extending slightly more than $\frac{1}{3}$ the distance to ventral; ventral slightly more than $\frac{1}{2}$ to anal; caudal rounded, the precurrent keels prominent and fleshy. Scales irregular, more or less embedded in thick skin with numerous close-set, sub-parallel, slightly radiating striæ.

Dark above to about mid-line of side, paler below. Sides with evenly scattered fine black spots. Caudal speckled; dorsal faintly barred; lower fins plain. Upper basal caudal black spot, squarish, distinct.

Misgurnus mizolepis hainan Nichols and Pope

Misgurnus mizolepis hainan Nichols and Pope, (in press), Bull. Amer. Mus. Nat. Hist.

An elongate form approaching typical *anguillicaudatus*, with bold black markings of irregular size. Hainan Island.

Misgurnus mizolepis grangeri, new subspecies

Description of Type.—Number 8395, American Museum of Natural History, Yen-ching-kao, Szechwan, November, 1921, W. Granger. Length to base of caudal 117 mm. Depth in length 6.8; head 5.9. Snout in head 3; interorbital 4.5; width of body 1.8; depth of peduncle 1.6; its length 1.2; pectoral 1.4; ventral 2; longest dorsal ray 1.7; longest anal ray 1.8; caudal 1. Eye in snout 2.6; longest barbel 2.

Dorsal 9; anal 7. Scales about 140.

Little compressed except behind the dorsal; peduncular keels strongly developed, thick, the lower extending forward almost to anal axil, the upper stopping short of dorsal axil by a considerable space. Mouth inferior, horse-shoe-shaped, surrounded by 10 barbels as usual; eye small, deep beneath the skin. Dorsal origin equidistant from base of caudal and edge of preopercle; ventral origin appreciably behind that of dorsal; pectoral reaching $^{3}/_{11}$ the distance to ventral; ventral ½ the distance to anal; caudal pointed. Scales imbedded in thick skin, with conspicuous close-spaced subparallel striæ, the striæ above radiating somewhat from those below.

Dark gray above, paler, pinkish on the belly; sides with small, irregular scattered black spots. Dorsal faintly marked; caudal with a few irregular blackish bars and spots, no especially distinct one on its upper base.

Misgurnus mohoity (Dybowski)

Cobitis fossilis var. *mohoity* Dybowski, 1869, Verh. Zool.-Bot. Gesell., Wien, XIX, p. 957. Onon and Ingoda rivers, east of Lake Baikal.

Cobitis fossilis anguillicaudatus Berg, 1916, 'Poiss. Eaux Douces Russ.,' p. 354, Fig. Lake tributary to Tumen-Ula River (north Corean boundary).

Eastern Asia north of the Gobi. The following two forms from western China east to the central Yang-tze are provisionally considered conspecific with *Misgurnus mohoity mohoity* (Dybowski), which differs from them in being more slender, dorsal origin nearer base of caudal than gill-cleft, rather small dark marks evenly scattered on sides.

Misgurnus mohoity yunnan, new subspecies

Description of Type.—Number 8396, American Museum of Natural History, Yunnanfu, Yunnan, October 20, 1920, John Graham. Length to base of caudal 123 mm. Depth in length 6.6; head 5.4. Eye in head 6; snout 2.7; interorbital 5; maxillary 4; width of mouth 4½; posterior maxillary barbel 2.5; width of body 2; depth of peduncle 1.7 ; its length 1; pectoral 1.5; ventral 2.3; longest dorsal ray 1.5; longest anal ray 2; caudal 1.

Dorsal 9; anal 7. Scales about 130.

Elongate; moderately compressed; the back and belly rounded; vent at ¼ the distance from anal origin to ventral axil. Interorbital convex; snout somewhat pointed and compressed; mouth inferior, horse-shoe-shaped; a barbel at the side of the tip of the snout, and 2 close together near the end of the maxillary, the posterior the longer; upper lip loose, lower expanded, free behind, divided in the center; with two small barbels, the outer the longer. Dorsal origin equidistant from base of caudal and gill-cleft; ventral placed slightly before the center of dorsal base; pectoral

extending ¼ the distance to ventral; ventral ½ to anal; caudal bluntly pointed, its rudimentary rays precurrent in low keels. Scales small, firm, with conspicuous close-spaced radiating striæ.

Olive, finely freckled with pale above; pale below. A small oblique black bar on caudal base near the top; caudal faintly and irregularly barred with dark; dorsal with a few fainter bars; other fins plain.

Misgurnus mohoity leopardus, new subspecies

Description of Type.—Number 8397, American Museum of Natural History, Tungting Lake, Hunan, C. H. Pope. Length to base of caudal 105 mm. Depth in length 6.5; head 5.6. Snout in head 2.7; width of body 1.6; depth of peduncle (including keels) 1.6; its length 1.2; pectoral 1.2; ventral 1.6; longest dorsal ray 1.6; longest anal ray 1.7; caudal 1.2. Eye in snout 2; interorbital 2.2; maxillary 1.9; posterior barbel 1.

Dorsal 8; anal 8. Scales about 135.

Scarcely compressed; vent almost immediately before anal origin, at not more than ⅙ the distance to ventral axil. Snout rather pointed, narrow; interorbital slightly convex; the eye slightly superolateral; mouth small, horizontal, inferior, semi-circular; 3 barbels above it of almost equal length and equally spaced, two small ones below, the posterior decidedly the longer; lower lip deeply cleft. Dorsal origin equidistant from base of caudal and margin of opercle; ventral origin slightly behind that of dorsal; pectoral reaching ⅓ distance to ventral; ventral ⅔ to anal; caudal rounded or slightly pointed, with conspicuous precurrent keels, not fleshy. Scales small, rather regular, exposed; with comparatively few radiating striæ.

Back and sides with contrasting dusky spots, rather regular, and increasing in size upward to diameter of eye, the largest along back; caudal finely and irregularly barred with blackish; a black triangular spot at its upper base; dorsal spotted; lower fins with slight, faint marking.

Key to the Eight Chinese Races of *Misgurnus*

1.—Skin not thickened, scales rather regular and fully exposed.....2.
Skin more or less thickened and scales more or less embedded.....4.

2.—Striæ on scales well radiating. Scales moderate (about 130); depth moderate (about 6.5); head large (about 5.5); peduncle moderate (about equal to head); dorsal origin equidistant from base of caudal and gill-cleft. *Misgurnus mohoity.* Yunnan, Tungting.....3.
Striæ on scales little radiating. Scales moderate (about 145); elongate (depth over 7.5); head large (about 5.5); peduncle moderate (slightly less than head); dorsal origin equidistant from base of caudal and middle of opercle. Sides finely marked with dark, tending to form a broad band anteriorly. *Misgurnus anguillicaudatus tungting.* Tungting.

3.—Color, freckled olive above, pale below, without dark marking on body. Compressed, width of body 2 in head..*Misgurnus mohoity yunnan.* Yunnan.
Color, back and sides with contrasting dark spots, rather regular and increasing in size upward to the diameter of eye along the back. Very little compressed (width 1.6).....*Misgurnus mohoity leopardus.* Tungting.

4.—Moderate or elongate, peduncular keels about precurrent caudal rays sometimes fleshy, not excessively developed.....5.

Deep (depth less than 6). Skin very thick, peduncular keels greatly developed, fleshy. Black spot at upper caudal base, faint or wanting.
Misgurnus mizolepis mizolepis. Yang-tze Valley.

5.—Head large (less than 6). Dusky spotting on sides vague and irregular, the arrangement and size of spots variable; peduncle short, less than head; compressed (width about 2); scales fine and irregular.
Misgurnus anguillicaudatus anguillicaudatus. Anhwei, Fukien, Chusan.

Head small (6 or more). Dark markings on side contrasted; peduncle long (slightly longer than head), or else little compressed (width of body less than 2), black spot at upper caudal base faint or wanting. *Misgurnus mizolepis.* Hainan, Fukien, Szechwan, Tungting.....6.

6.—Spots on sides irregular, varying in size, some as large as eye. Compressed (width 2).....*Misgurnus mizolepis hainan.* Hainan.

Spots on sides small, blackish. Very little compressed (width less than 2).....7.

7.—Spots on sides irregular, that on upper caudal base ill-defined or absent.
Misgurnus mizolepis grangeri. Szechwan.

Spots on sides fine, regular, blackish, that on upper caudal base sharply marked.
Misgurnus mizolepis fukien. Fukien.

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59,7.55C(51)

THE TWO CHINESE LOACHES OF THE GENUS *COBITIS*[1]

By J. T. Nichols

Berg, 1916, recognizes a Chinese *Cobitis*, *Cobitis sinensis* Sauvage and Dabry de Thiersant, 1874, as subspecifically distinct from *C. tænia* which he credits to northern Asia as well as to Europe. Fowler, 1924, synonymizes it with *tænia;* but Nichols and Pope (in press), recognize this and another race of *C. tænia* from China.

Kreyenberg and Pappenheim, 1908, identify all their Yangtze material with *Cobitis* [*Lepidocephalichthys*] *macrostigma* Dabry de Thiersant, 1872, from lakes of central China. However, Mr. Clifford H. Pope's collections from Tungting Lake, Hunan, adjacent to the Yangtze, contain two distinct loaches. One of these is apparently a race of *C. tænia* and is here identified as *sinensis;* the other is clearly referable to *macrostigma*. A drawing by Miss Olive Otis of a specimen of each from Tungting of approximately the same size (*sinensis* 110 mm., *macrostigma* 115 mm., to base of caudal) is here reproduced to show the differences. *C. macrostigma* has a longer peduncle; smaller scales, about 135 versus 100 to 110 before the dorsal; dorsal origin midway between end of snout and middle of peduncle, versus base of caudal. There seems to be a difference in the lips, the free lip between maxillary and mental barbels pointed versus broad, squarish.

Cobitis tænia sinensis Sauvage and Dabry de Thiersant

Cobitis sinensis Sauvage and Dabry de Thiersant, 1874, Ann. Sci. Nat., Zool., I, Art. 5, p. 16. 'Ruisseaux du Se-tchuan occidental (A. David).'

Description of a specimen from Tungting Lake, Hunan, Clifford H. Pope.—Length to base of caudal 110 mm. Depth in length 7.3; head 5.4. Eye in head 6; snout 2.3; maxillary 4.2; depth of peduncle 2.1; its length 1.3; pectoral 1.4; ventral 1.6; longest dorsal ray 1.3; longest anal ray 1.5; caudal 1.2. Interorbital in eye 2; posterior barbel 1.

Dorsal 9½; anal 8. Scales before dorsal about 110.

Conspicuous low adipose keels from the upper and lower caudal origins, not quite to dorsal and anal axils respectively. Mouth flanked by 3 barbels, the posterior the longest, adnate to a broad free lip which is adnate at its inner edge to the single

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 46.

(paired) mental barbel, the lip between the two squarish. Dorsal origin equidistant from tip of snout and base of caudal; pectoral extending a little more than ⅓ the distance to ventral; ventral ½ to anal; anal more than ½ to caudal base; caudal narrow, truncate.

About a dozen faint blotches along the mid-line of the back; nine more or less narrow, oval, dark blotches along the side; darkish freckles above this series tending to form two lengthwise stripes; pale below it; a narrow stripe from below eye to snout. Dorsal with faint cross-marks; lower fins pale; caudal with a narrow, oblique, oval black spot on the base of its upper rays, and 3 or 4 broad V-shaped dusky cross-bands.

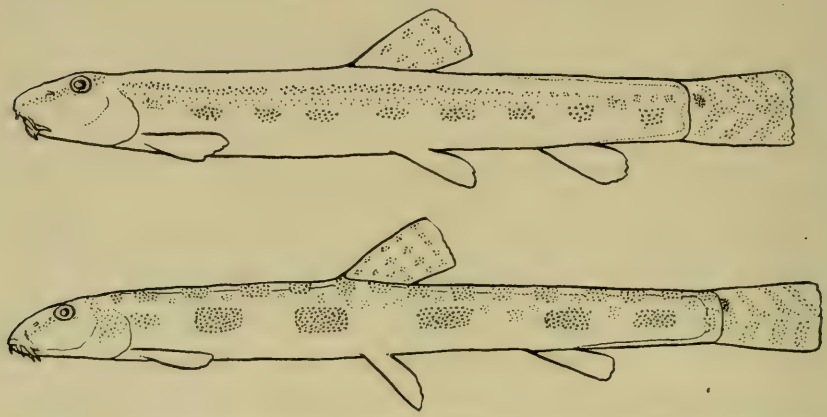

Fig. 1. *Cobitis tænia sinensis* (upper) and *Cobitis macrostigma* (lower) compared.

It is convenient for the present to consider this race of *Cobitis tænia* from the central Yangtze the same as Sauvage and Dabry de Thiersant had from its upper reaches, a point which cannot be settled without seeing material from nearer their locality. As to its range in eastern China, it occurs little changed farther down the river at Ningkwo, Anhwei. A specimen of 112 mm. from there has dorsal equidistant from end of snout and base of caudal; 9 cuboid blotches on side, those in front narrow; black mark on upper caudal base sharp and bold; lower lip squarish, but somewhat pointed at inner edge, which point extends well beyond mandibular barbel. Depth in length 7.5; depth of peduncle in head 1.8; its length 1.2. Scales before dorsal about 110. Another large specimen has about 12 blotches on the side. Eight small specimens, 55 to 74 mm. in length to base of caudal, from the same locality, are more variable than material to hand from any other one point. Depth in length 6.9 to 8.0. Snout in head 2.0 to 2.1; depth of peduncle 2.1 to 2.6; its length 1.3 to 1.5. Dorsal equidistant from base of caudal and end or front part of snout; peduncular keels variable, moderate or little developed. Colors

rather sharp, 10 to 15 blotches along side; mark on upper caudal base sharp and strong. This variability may be explained by supposing that *Cobitis tænia sinensis* is here mixed to some extent with *Cobitis* [*tænia*] *dolichorhynchus* Nichols, 1918, a smaller race described from Fukien. A specimen of 43 mm. would pass for the young of *dolichorhynchus*. Depth 5.8; snout 1.9; depth of peduncle 2.3; its length 2. Dorsal equidistant from base of caudal and middle of eye.

Small specimens from Kwei-hwa, Shansi, situate on a small river entering the Yellow River from the northeast, near where that master stream turns south, and others from Hsing-lung-shan, Chihli, are still referable to *C. t. sinensis*, though not typical. A number of specimens 50 to 63 mm. long to base of caudal from the first locality have depth in length 6.7 to 7.5; depth of peduncle in head 2.5 to 2.7; its length 1.0 to 1.4. Dorsal origin equidistant from base of caudal and front of eye, or a point before middle of snout; peduncular keels moderately developed. Blotches on sides narrow, with a tendency to join in a narrow lengthwise stripe; caudal sharply barred, spot on its upper base well defined. Four specimens 59 to 66 mm. long from the last mentioned (Chihli) locality resemble these others in color, one individual having a dark longitudinal streak without blotches on the side and lacking the spot on upper caudal base. They have depth in length 6.6 to 7; depth of peduncle in head 2.1 to 2.3; its length 1.2 to 1.3. Peduncular keels moderately developed; dorsal origin equidistant from base of caudal and fore part of snout. The above specimens are too small for conclusions based on them to be satisfactory. It will be noticed that they vary towards *dolichorhynchus* more or, properly speaking, away from *sinensis* in more posterior position of dorsal origin, but the development of peduncular keels characteristic of *sinensis* holds better than with small Anhwei material.

Three small specimens, 65 to 72 mm. in length, from Chin-ssu, Shansi, in the hills east of the southward-flowing limb of the Yellow River, have a uniform and rather striking color pattern. The locality is not very distant from Kwei-hwa in a south-southeasterly direction, but in what appears to be a rather distinct faunal area, very likely inhabited by a recognizable race of *C. tænia*, towards which *sinensis* from Kwei-hwa varies.

Cobitis tænia melanoleuca, new subspecies

Slender like *sinensis*, but more boldly marked, with posterior dorsal like *dolichorhynchus*. Peduncular keels little developed, especially above. Lip between maxillary and mental barbels broad, squarish, not pointed, the mental barbel little projecting. Depth in length to base of caudal 6.8 to 7. Depth of peduncle in head

2.4; its length 1.3 to 1.5. Dorsal origin equidistant from base of caudal and front of eye. Color sharply marked; 12 to 16 lengthwise blotches on side; spot on upper caudal base inconspicuous or absent; a more or less perfect, more extensive dark bar across caudal base.

The type is No. 8403, American Museum of Natural History; Chin-ssu, Shansi; Clifford H. Pope.

Cobitis macrostigma Dabry de Thiersant

Cobitis macrostigma Dabry de Thiersant, 1872, 'Pisciculture en Chine,' Pl. xlix, fig. 4. Lakes of central China.

Description of a specimen from Huping, Tungting Lake, Hunan, Clifford H. Pope.—Length to base of caudal 115 mm. Depth in length 8; head 5.5. Eye in head 5.5; snout 2.5; maxillary 4.7; depth of peduncle 2.3; its length 0.9; pectoral 1.4; ventral 1.5; longest dorsal ray 1.2; longest anal ray 1.4; caudal 1.2. Interorbital in eye 2; posterior barbel 1.

Dorsal 9½; anal 8. Scales before dorsal about 135.

Conspicuous low adipose keels from the upper and lower caudal origins not quite to dorsal and anal axils respectively. Mouth flanked by 3 barbels, the posterior the longest, adnate to a broad free lip which is adnate at its inner edge to the single (paired) mental barbel, and forms a pointed flap with an angle of slightly less than 90° between these two. Dorsal origin nearly equidistant from tip of snout and middle of peduncle; pectoral extending a little more than one-third distance to ventral; ventral less than ½ to anal; anal ½ to caudal base; caudal narrow, truncate.

About 15 rectagonal dark blotches along mid-line of back; about 6 large rectagonal blotches along side; a narrow stripe from below eye to snout; caudal with V-shaped cross-marks and dorsal speckled; lower fins plain. A short, oblique black mark on the upper caudal base.

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NEMACHEILUS AND RELATED LOACHES IN CHINA[1]

By J. T. Nichols

REVIEW OF THE GENERA AND SUBGENERA

There are a great number and variety of small loaches in Asia with no suborbital spine and three pairs of barbels, more or less generally referred to the genus *Nemacheilus*, and The American Museum of Natural History's recent Chinese collections contain several species of these, representing four distinct groups.

First, there is a very prettily marked species from Hainan Island, *Nemacheilus pulcher* Nichols and Pope (in press). This is a moderately short-bodied, symmetrical fish; finely scaled; lateral line complete; the caudal margin slightly forked; nostrils close together, well before the eye, the anterior in an even margined tube. It is evidently not distantly related to *Nemacheilus fasciatus* (Valenciennes), the type of *Nemacheilus*.

Secondly, there are specimens of Regan's *Nemacheilus nigromaculatus* and *Nemacheilus pleurotænia* from Yunnan. This latter fish is short-bodied, well compressed, the head slightly so; scales small, non-imbricate but distinct, lateral line imperfect; caudal margin slightly forked; nostrils separated by a distance greater than that of the posterior from eye, the anterior in a flap-like tube. The new subgenus **Yunnanilus** is proposed for *Nemacheilus pleurotænia* Regan, 1904, to include also *Nemacheilus nigromaculatus* Regan, 1904, and *Nemacheilus salmonides* Chaudhuri, 1911, doubtfully distinct from it, all from Yunnan.

Thirdly, there are three or four species from northern China which are more elongate, little compressed; without evident scales but the lateral line complete or essentially so, distinct; nostrils narrowly separated from eye, close together, the anterior with a flap behind, its rim little raised in front; caudal variously truncate or slightly indentate. One of these is *Nemacheilus toni* (Dybowski) Fowler, 1924. Berg, 1916, makes *Cobitis toni* Dybowski, 1869, a race of European *Nemacheilus barbatulus* (*Cobitis barbatula* Linnæus, 1758), which is the type of the genus *Barbatula*. *Barbatula* is, by the present writer, considered worthy of full generic rank for loaches of this third group.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 47.

The genus *Diplophysa* is an old one for barbatuloid loaches, mostly from high central Asia, having the posterior part of the air-bladder free and only the anterior part enclosed in a bony capsule. Herzenstein, 1888, in an analytical study of numerous forms of *Diplophysa* and *Barbatula* in Turkestan, Tibet, and elsewhere, concludes that this air-bladder character has here little systematic value and does not recognize *Diplophysa* as a genus or natural group. Berg, 1916, however, gives it full generic rank, and Hora, 1922, does so with emphasis. The present writer is inclined to agree with Herzenstein, but is not familiar with any member of the genus.

The classification of barbatuloid loaches with center of abundance and variety in high central Asia presents a problem of extreme intricacy and difficulty. Hora, 1922, bases his conclusions on a careful consideration of anatomical details, and a reasonable idea of the importance of such details, which, however, may or may not apply in the present case. In attacking the same problem, Herzenstein, 1888, had more material, or material from a wider area, and was more influenced in its arrangement by the apparent closeness of relationship of one form to another in view of his knowledge of the whole. It is not unreasonable to suppose, bearing in mind the inherent taxonomic difficulties these loaches present, that Herzenstein's findings may be emended to advantage, but the present writer agrees with his opinions where they differ from those of Hora as to the distinctness of the genus *Lefua*, as to the probable wide range, perhaps with geographic modification, of *Barbatula stoliczkai* and other species, and as to the comparative slight importance of certain structural characters here, and to the relatively great importance of other characters, usually trivial.

Fourthly, there is in the Museum's collections a singular small loach from Szechwan which is identified with *Nemacheilus potanini* Günther, 1896, from the River Ya. On the basis of this identification, *N. potanini* Günther is here made the type of **Homatula**, new (from *Homaloptera*, which it suggests, and *Barbatula;* for the present considered a subgenus of *Barbatula*), to include also *Barbatula berezowskii* (Günther, 1896) from Kansu and *Barbatula oxygnathus* (Regan, 1908) from Yunnan. Our specimens of *B.* (*Homatula*) *potanini* are moderately elongate, head well depressed, tail strongly compressed, approximately as deep as the greatest depth of body; caudal truncate; no evident scales, lateral line complete, well marked; nostrils close together at a moderate distance before eye, the anterior in a short tube with pointed flap behind. The jaws are peculiar, premaxillaries fused in a rounded point above, and each mandible firm, curved, prominent, the two separated by a notch.

NEW RACES OF *BARBATULA* IN NORTH CHINA

Barbatula toni fowleri, new subspecies

Nemacheilus toni Fowler, 1924, Bull. Amer. Mus. Nat. Hist., L, p. 396.

Barbatula toni (Dybowski), *Cobitis toni* Dybowski, 1869, was described from the Onon and Ingoda Rivers in Siberia, in the area north of eastern Mongolia and west of northern Manchuria. Berg, 1916, recognizes it as a widely distributed Asiatic subspecies of *Barbatula barbatula* of Europe and gives a very excellent figure of the form which he had to hand (*Nemacheilus barbatulus toni*, p. 341, Fig. 263, Lake Hanka, Ussuri drainage). Fowler, 1924, lists American Museum of Natural History material from Eastern Tombs, Chihli Province, as *Nemacheilus toni* (Dybowski), and considers *Nemacheilus pechiliensis* Fowler, 1899, the same. The present writer, however, cannot agree that the Eastern Tombs material is identical with that figured by Berg, or with *pechiliensis* as described by Fowler, 1899, from northeast of Dolon-nor close to the northern boundary of Chihli, and which resembles Berg's figure. He here proposes the name *Barbatula toni fowleri* for the Eastern Tombs fish.

Description of Type.—No. 8409, American Museum of Natural History, Eastern Tombs, Chihli, August 7, 1921, Clifford H. Pope.

Length to base of caudal 85 mm. Depth in length 6.2; head 4.6. Eye in head 5.7; snout 2.4; interorbital 4; maxillary 3; width of mouth 3.8; barbel 3.6; width of head and of body 1.8; depth of peduncle 2.3; its length 1.3; pectoral 1.3; ventral 1.7; longest dorsal ray, 1.4; longest anal ray 1.8; caudal 1.3.

Dorsal 9; anal 7½. Scales very fine, only evident on peduncle.

Elongate, sub-cuboid; very little compressed except behind; snout bluntly pointed, vent almost immediately before anal origin in a low, backwardly directed tube. Interorbital slightly concave; orbital rim free above and in front adnate below and behind; mouth inferior curved transverse, appreciably behind tip of snout; lips thick, smooth, free, the lower cleft in the center with keel-like flaps on either side of the cleft; nostrils close together, the anterior in a low tube with pointed flap behind; eye slightly superolateral; maxillary not nearly to under front of eye; with a terminal barbel equalling in length the outer and longer of 2 barbels on the snout; gill-cleft vertical, gill-membranes broadly joined to side of breast before the lower pectoral axil. Dorsal origin equidistant from tip of snout and base of caudal; ventral placed below the front part of dorsal; pectoral broad, extending ⅔ the distance to ventral; ventral ⅔ to anal; caudal oblong, subtruncate, its outer rays a little the longer; base of caudal slightly oblique forward and downward, with slight precurrent keels above and below. Lateral line complete, in the center, rising slightly to meet opercle.

Color dull yellowish, darker above; numerous vague broken dark bars on sides; faint ones on dorsal and caudal.

Prominent keel-like flaps on either side of the cleft of the lower lip, and appreciable precurrent caudal keels on the peduncle appear to be significant characters in Asiatic fishes of the genus and subgenus *Barba-*

tula, characteristic of the races of *B. toni*. Compared with *B. toni* as figured by Berg, 1916, *B. t. fowleri* has a longer pectoral, slightly concave versus truncate caudal, ventral origin slightly behind that of dorsal, and double versus single row of dark marks on the side.

Barbatula toni posteroventralis, new subspecies

Description of Type.—No. 8410, American Museum of Natural History, Chin Ssu, Taiyuanfu, Shansi, August 15, 1922, Clifford H. Pope.

Length to base of caudal 66 mm. Depth in length 7.3; head 4. Eye in head 5.3; snout 2.5; interorbital 3.3; width of mouth 2.5; maxillary barbel 3; width of head 1.5; depth of peduncle 3; length of peduncle 1.4; pectoral 1.3; ventral 1.6; longest dorsal ray 1.6; height of anal 1.7; caudal 1.4.

Dorsal with 9 developed rays; anal with 7½. No evident scales.

Slender, little compressed, deepest at shoulder; head large; belly flat. Mouth inferior, transverse, with thick soft lips loosely surrounding the smooth firm jaws; two membranous keels at the chin; two barbels on each side of the snout overhanging the front of the mouth; and one at the end of the maxillary; no spines about the eye; eye superolateral, with a free rim best developed above and in front; nostrils close together in front of the eye, the anterior with a shallow tube and flap behind; gill-membranes confluent with the breast, the clefts separated by about ⅔ snout. Paired fins in a horizontal plane; origin of dorsal about equidistant from tip of snout and base of caudal; ventral under hind part of dorsal, their axils apposed; pectoral not reaching ventral, ventral not quite reaching anal, anal not reaching caudal; caudal subtruncate, very slightly concave, its rudimentary rays precurrent above and below on the peduncle in rather conspicuous low keels. Lateral line ceasing on the peduncle shortly before caudal base, straight to its end.

Back and caudal freckled, the latter with a narrow pale tip; a series of small obscure dark blotches more or less confluent along the lateral line; dorsal speckled; lower parts and lower fins pale.

This race differs markedly from *B. t. toni* and *B. t. fowleri* by the more posterior position of the ventrals, placed under the hind part of the dorsal.

Barbatula yarkandensis sellæfer, new subspecies

Barbatula yarkandensis, *Nemacheilus yarkandensis* Day, 1876, was described from Turkestan. Herzenstein, 1888, credits it with a wide distribution in high Asia, where he divides it into several subspecies, but it has not been listed from even the western Chinese provinces. Nevertheless, we have a small loach from Shansi which agrees sufficiently with Herzenstein's diagnososis of *yarkandensis* to lead the writer to describe it as a race of that form. Its most noticeable difference is one of color, sharply marked, dark, cross-saddles on the back, whereas *yarkandensis* is said to have less tendency to dark cross markings than related forms. On

the other hand, it differs from the figure of *B. y. brevibarbus* (Herzenstein, 1888, p. 78, Pl. II, fig. 1), the subspecies to which it stands nearest, in having a decidedly longer peduncle, 1.4 versus 2 in the head.

Description of Type.—No. 8411, American Museum of Natural History, Chin Ssu, Taiyuanfu, Shansi, August 20, 1922, Clifford H. Pope.

Length to base of caudal 73 mm. Depth in length 6.8; head 3.9; peduncle 5.5; dorsal base 7.5; length of pectoral 4.7; ventral 6.4; anal base about 10. Eye in head 6.2; snout 2.3; interorbital 5; width of head 1.7; width of mouth 3; maxillary barbel 3.1; pectoral 1.2; ventral 1.7; longest dorsal ray 1.5; height of anal 1.8; caudal lobe 1.3; depth of peduncle 3.3; length of peduncle 1.4. Postdorsal depth in the greatest depth 1.3; depth of peduncle 1.9; depth of peduncle in its length 2. Eye in interorbital 1.4. Dorsal base in its longest ray 1.4; ventral in pectoral 1.4; anal base in its longest ray 2.

Dorsal with 9 developed rays; anal with 6. No evident scales.

Body elongate, little compressed; head large; belly flat; depth of peduncle considerably greater than its thickness. Mouth inferior, curved, with thick grooved lips; maxillary extending $\frac{2}{3}$ the distance to eye from snout; 2 pairs of barbels at snout overhanging front of mouth, one at end of maxillaries; nostrils close together in front of the eye, the anterior with a shallow tube and flap behind; eye superolateral, with a free rim best developed above and in front; gill-membranes broadly joined to isthmus. Pectorals and ventrals in a horizontal plane, the former broad; ventral base somewhat behind dorsal origin; dorsal origin equidistant from nostril and base of caudal; last simple ray of dorsal stiffened for somewhat less than half its length; pectoral bluntly pointed, not reaching ventral; ventral $\frac{3}{4}$ to vent; anal not reaching caudal; caudal shallowy lunate. Lateral line well developed, complete, ending in an abrupt drop and rise at base of caudal. Distance from the base of caudal to the vent equal to that from the vent to the tip of the pectoral; distance from the vent to the ventral axil greater than the snout by the diameter of the eye.

Broad dark saddles along the back, and irregular blotches on sides; pectoral and dorsal marked with dark; caudal with a broad dark V on its base opening backward, the limbs of the V brokenly produced as a streak on each lobe, also dark streaks between the limbs on center of fin.

Barbatula stoliczkai (Steindachner)

Cobitis stoličkai Steindachner, 1866, Verh. Zool.-Bot. Ges., Wien, XVI, p. 793, Pl. XIV, fig. 2.

This is an abundant and very widely distributed form in high central Asia, also listed from the western provinces of China by Günther, 1896. As Herzenstein, 1888, differentiates several subspecies to the westward, it is reasonable to suppose that our material from Shansi is differentiable. On the other hand, the writer finds no marked peculiarities therein and, such being the case, hesitates to recognize it as subspecifically distinct, lacking other material for comparison, more especially as Berg, 1916, synonymizes with *stoliczkai* forms recognized as full species by Herzen-

stein. For the benefit of those who would follow a different course, **Barbatula stoliczkai shansi,** new name, is available.

Description of a Specimen.—No. 8412, American Museum of Natural History, from Mai-tai-chao, Shansi (42 miles east of Paotow, Mongolia), May 27, 1922, Clifford H. Pope.

Length to base of caudal 78 mm. Head in length 4.5. Depth in head 2; head width 1.6; eye 6; snout 2.6; interorbital 3.6; width of mouth 3; maxillary barbel 3.6; depth of peduncle 2.9; length of peduncle 0.8; pectoral 1.3; ventral 1.5; longest dorsal ray 1.5; longest anal ray 1.9; caudal 1. Maxillary in snout 1.4.

Dorsal 10; anal 7. No evident scales.

Elongate, cylindrical, snout bluntly pointed; depressed before dorsal origin, compressed behind; belly flattened, the paired fins in a horizontal plane. Mouth inferior, curved, with thick grooved lips; two barbels on each side from snout overhanging the mouth in front, and one from near end of maxillary; eye superolateral with rim imperfectly free; nostrils close together in front of the eye, the anterior with a shallow tube, and flap behind; gill-membranes confluent with breast in front of pectoral base. Dorsal origin equidistant from front of nostrils and base of caudal; ventral origin slightly behind that of dorsal; pectoral falling far short of ventral, ventral almost to anal, passing vent; anal far short of caudal; caudal with margins converging, but notched shallowly behind, the lower "lobe" longest. A cutaneous roll or flap in ventral axil; lateral line well developed, straight, stopping just short of caudal base.

Freckles on the back; irregularly cross marked and spotted on the side; an incomplete dark bar across the base of caudal. None of the markings bold.

In addition to the above, the following species listed from China appear to belong to the genus and subgenus *Barbatula*. *Nemacheilus bleekeri* Sauvage and Dabry de Thiersant, 1874, western Shensi, *Nemacheilus grahami* Regan, 1906, Yunnan. *Nemacheilus robustus* Kessler, 1876, Kansu, a doubtful species. *Nemacheilus scleropterus* Herzenstein, 1888, extending eastward into Kansu. *Nemacheilus mongolicus* Bleeker?, listed from Yunnan by Regan, 1914. Incidentally, *Cobitis spiloptera* Cuvier and Valenciennes, 1846, from Cochin-china, looks like a race of *Barbatula toni*.

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HOMALOPTERA CALDWELLI, A NEW CHINESE LOACH[1]

By J. T. Nichols

Homaloptera caldwelli, new species

Description of Type.—Number 8413, American Museum of Natural History; from near Yenping, Fukien; H. R. Caldwell.

Length to base of caudal, 48 mm. Depth in length, 5; head, 4.6. Eye in head, 5; snout, 2; interorbital, 2.4; width of mouth, 3.5; posterior barbel, 5; greatest width of body (behind head), 1.5; depth of peduncle, 2; its length, 1.7; pectoral, 0 8; ventral, 1; longest dorsal ray, 1.1; longest anal ray, 1.3; caudal broken.

Dorsal, 10; anal, 7. Scales very fine, about 150.

Head depressed; body compressed; vent behind a thick papilla, a little nearer ventral axil than anal origin; lower surface of head and breast flattish. Interorbital very slightly convex; snout rounded above, moderately tapering to a rounded point; eye slightly superolateral; orbital rim free; mouth inferior, on the lower surface of snout, curved, transverse; overhung in front by a fleshy, slightly curved membrane, immediately before which on the snout are four small barbels, the outer the longer; a spongy lip on the lower surface of mandible, at each corner of which is a longer barbel with a little knob at its base on the inside; gill-membranes joined to breast below the front of the pectoral base. Dorsal origin equidistant from base of caudal and front of eye; ventral origin slightly behind it; pectoral reaching about ¾ the distance to ventral; ventral, ¾ to anal; caudal broken, was probably truncate or subtruncate. Lateral line complete, slightly curved upward, in the center of peduncle.

A black stripe from shoulder onto base of caudal; dorsal crossed by two or three broken streaks; back behind dorsal with four cross blotches.

We have only this one specimen. The species is related to *Homalosoma stenosoma* Boulenger, 1901, Ningpo. *Homalosoma* is probably best considered a subgenus of *Homaloptera*, which genus is typically East Indian. The former is very divergent from *Lepturichthys* Regan, 1911, of which *Homaloptera fimbriata* Günther, 1888, from the Yangtze, is the type. *Homaloptera abbreviata* Günther, 1892, mountain streams running into the Min (tributary to the western Yangtze in Szechwan), approaches *fimbriata*.

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[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 48.

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THE MICROSTRUCTURE OF THE DINOSAURIAN EGG-SHELLS FROM THE CRETACEOUS BEDS OF MONGOLIA[1]

By Victor Van Straelen[2]

Through the courtesy of President Henry Fairfield Osborn of The American Museum of Natural History, I have been given the opportunity of examining the structure of several of the dinosaurian egg-shells recently collected in Mongolia by the Third Asiatic Expedition under the leadership of Mr. Roy Chapman Andrews.

In view of an exhaustive study of this material, to be carried on together with the study of other fossil eggs of various origins, I am giving here a preliminary account of my observations.

I. PROBABLE EGGS OF *PROTOCERATOPS ANDREWSI*, FROM THE DJADOCHTA BEDS (CRETACEOUS) OF SHABARAKH USU, MONGOLIA

1. Samples of two eggs, out of a group of fifteen, Amer. Mus. No. 6508.

The parts of the shell which have been fossilized are the mamillar zone, i.e., the zone in contact with the chorion, and the prismatic zone. The shell, formed of calcite, mixed with phosphate of lime, is about 1 mm. thick. Its color is red brown, due to the infiltered iron oxide. High subparallel and meandriform hillocks, separated by very large and deep valleys, give a vermiculate aspect to the outer face. On the contrary, the inner face is nearly smooth, the mamillæ being very small and closely crowded together. The fibro-radious structure is therefore finely packed and the prisms of the prismatic zone are small. The pores are extremely reduced, both in number and size, and consequently the aëriferous canals have a very small diameter. Throughout their length, the canals maintain their diameter and are not ramified. The prisms of calcite are crossed by thin black layers of organic matter.

Secondary mineralization of the shell took place during the fossilization, so that the pores and canals are entirely choked with calcite.

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[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 49.

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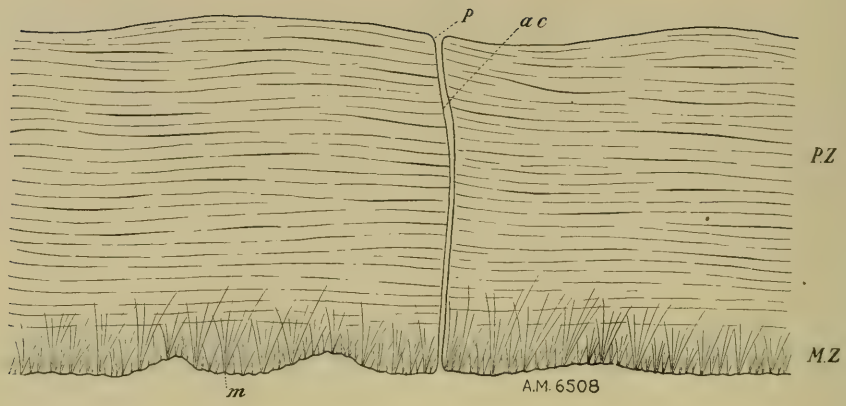

Fig. 1. Section through a portion of an egg-shell found at Shabarakh Usu, Mongolia. (Amer. Mus. No. 6508.)

M.Z.=mamillar zone; P.Z.=prismatic zone; m.=mamillæ; a.c.=aëriferous canals; p.=pores. ×48.

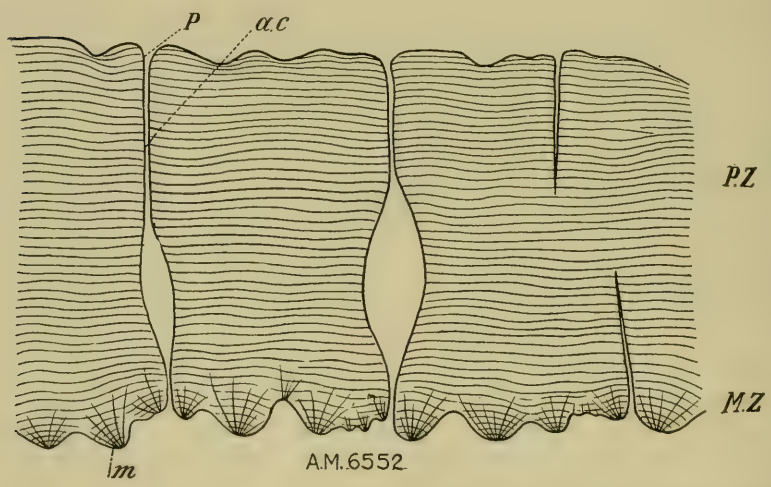

Fig. 2. Section through a portion of an egg-shell found at Iren Dabasu, Mongolia. (Amer. Mus. No. 6552.)

M.Z.=mamillar zone; P.Z.=prismatic zone; m.=mamillæ; a.c.=aëriferous canals; p.=pores. ×48.

2. Sample of one egg, out of a group of five, Amer. Mus. No. 6511.

The nature and state of preservation of this egg are just the same as in the samples of the group of fifteen described above.

3. Sample of one egg, out of a group of three, Amer. Mus. No. 6510.

The outer and inner faces of the shell are much corroded, only the layers showing the prismatic structure being left. The concentric layers, perpendicular to the crystalline fibres, are well shown and lined by thin black sheets of organic matter. The structure of the part left is identical with that of the eggs of the two other groups.

II. EGGS OF A DINOSAUR (? DUCKBILLED TYPE), FROM THE IREN DABASU BEDS (UPPER CRETACEOUS) AT IREN DABASU, MONGOLIA

Sample from a specimen, Amer. Mus. No. 6552.

The two faces, outer and inner, are worn; the shell formed by calcite, containing phosphate of lime, is reduced to the mamillar zone and a great part of the prismatic zone. Nevertheless, the thickness is still about 1.2 mm., which makes about 2 mm. for the complete shell.

The outer face is whitish and shagreened, due to small sinuous hillocks, separated by depressions. Numerous pores perforate that surface, many of these pores being visible with the naked eye and comparable in size with those existing in the eggs of certain crocodiles. These pores are the orifices of the aëriferous canals, which open indifferently on the ridges as well as in the depressions. The shape of the pores is apparently irregular.

The grayish brown inner face has a more irregular shape, the mamillæ being fairly isolated at their origin. The mamillæ are lining more or less circular alveolæ, at the bottom of which the aëriferous canals take their origin. The fibro-radious structure is particularly well developed in the most internal zones, where the crystalline fibers are very minute. In the more external parts, the fibers gradually thicken.

The aëriferous canals are largely expanded in their middle part.

Thus, there are striking differences between the eggs of Shabarakh Usu and those of Iren Dabasu. The first-named cannot be correlated with any of the actually known eggs, either living or fossil. The second-named have a structure similar to that of the supposed eggs of *Hypselosaurus priscus*,[1] the dinosaurian of Rognac, which themselves have a structure that partakes of the characters of both the palæognathic and the neognathic birds. But the Iren Dabasu eggs differ essentially from the Rognac eggs in the shape of the aëriferous canals.

[1]The only reptilian egg-shells of secondary times, whose microstructure is known, are those found in the lacustrine marls of Rognac (southern France), at the top of the Upper Cretaceous.

The eggs of *Protoceratops andrewsi* are of the utmost interest. From the rugosities of the outer surface together with the rare and extremely small pores, it is right to infer that the eggs had no outer cuticle. This is a character shown to-day by birds and turtles which lay their eggs in very dry regions. We may find herein a confirmation of the desert conditions prevailing in Mongolia during the formation of the Djadochta beds.

I wish to express to President Osborn my appreciation of the rare opportunity given me of examining these dinosaurian egg-shells. I am also indebted to Mr. Walter Granger, Palæontologist of the Third Asiatic Expedition, who has given me valuable information regarding them and who made the selection of the fragments submitted to me.

AMERICAN MUSEUM NOVITATES

Number 175 | Published by THE AMERICAN MUSEUM OF NATURAL HISTORY New York City | May 28, 1925

59.76(51)

NEW CHINESE AMPHIBIANS AND REPTILES[1]

BY KARL PATTERSON SCHMIDT[2]

The Chinese collections of The American Museum of Natural History contain four new forms of frogs and toads. In the course of the preparation of more extended reports on the Chinese amphibians and reptiles of the Third Asiatic Expedition (now ready for the press), seven additional new reptiles have been brought to light. Diagnosis of these new forms supplement the series described in American Museum Novitates No. 157, bringing the total number of new forms, in the collections reported upon, to twenty-six.

SALIENTIA

Bufo andrewsi,[3] new species

TYPE.—A. M. N. H. No. 5769; ♂; Likiang, 8500 feet altitude, Yunnan; October 4, 1916; R. C. Andrews and Edmund Heller.

DIAGNOSIS.—Closely allied to *Bufo bufo*, from which it is distinguished by the presence of a tarsal fold, its finer and more uniform tuberculation, the less divergent parotids, and the tuberculate top of the head.

Rana nigromaculata mongolia, new subspecies

TYPE.—A. M. N. H. No. 18149; ♂; Mai Tai Chao, northern Shansi; May 1922; Clifford H. Pope.

DIAGNOSIS.—Derived from *Rana nigromaculata nigromaculata*, with which it agrees in having a very elongate metatarsal tubercle. Distinguished by a much more rugose dorsal skin, with very short longitudinal folds, shorter legs, a broader head, and the absence of the light line on the dorsolateral fold.

Rana noblei,[4] new species

TYPE.—A. M. N. H. No. 5285; ♀; Yunnanfu, Yunnan; John Graham.

DIAGNOSIS.—Allied to *Rana nigromaculata*, from which it is distinguished by its more rounded snout, absence of dorsal folds between the dorsolateral folds, smaller metatarsal tubercle, and very different coloration, which is largely reddish brown.

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[1]Publications of the Asiatic Expeditions of the American Museum of Natural History. Contribution No. 50.

[2]Of the Field Museum of Natural History.

[3]Named for Mr. Roy Chapman Andrews, Leader of the Third Asiatic Expedition.

[4]Named for Dr. G. Kingsley Noble, Curator of Herpetology, American Museum of Natural History.

Rana caldwelli,[1] new species

TYPE.—A. M. N. H. No. 18485; ♂; Fukien Province (probably near Yenping); H. R. Caldwell.

DIAGNOSIS.—Allied to *Rana adenopleura*, of which it is the continental representative. Distinguished by having a more projecting snout, rougher skin, and the dorsolateral glandular folds broken up posteriorly.

SAURIA

Calotes alticristatus, new species

TYPE.—A. M. N. H. No. 17395; ♀; Yunnanfu, Yunnan; 1919; John Graham.

DIAGNOSIS.—Closely allied to *Calotes emma*, from which it is distinguished by a greater number of scales around the body, smaller postcanthal and nuchal spines, a longer nuchal crest, larger tympanum, and the absence of a dorsolateral light line. Differs from *Calotes yunnanensis* in having a better developed fold in front of the shoulder, and in the higher number of scales around the body.

Eremias barbouri,[2] new species

TYPE.—A. M. N. H. No. 24045; ♂; Mai Tai Chao, northern Shansi; May 1922; Clifford H. Pope.

DIAGNOSIS.—Directly allied to *Eremias argus*, from which it may be distinguished by its larger dorsal scales and a color pattern of light longitudinal lines or rows of spots, combined with transverse black bars.

SERPENTES

Natrix septemlineata, new species

TYPE.—A. M. N. H. No. 21051; ♂; Tengyueh, Yunnan; May 1917; R. C. Andrews and Edmund Heller.

DIAGNOSIS.—Dorsal scales, 19; weakly keeled, outer row smooth; ventrals, 159–171; anal divided; caudals, 82–89; upper labials, 8; preoculars, 1; postoculars, 3; temporals, 2–1–2; venter uniform light, without spots at the ends of the ventrals; back with seven dark longitudinal stripes.

Dinodon rufozonatum williamsi,[3] new subspecies

TYPE.—A. M. N. H. No. 17453; ♀; Changsha, Hunan; July 1920; J. W. Williams.

DIAGNOSIS.—Distinguished from the typical subspecies by a greater number of ventrals, 207–213; of caudals, 77–86; and of transverse light markings, 59+21 to 87+26.

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[1]Named for Mr. Harry R. Caldwell, Yenping, Fukien.
[2]Named for Dr. Thomas Barbour, of the Museum of Comparative Zoölogy.
[3]Named for Mr. J. W. Williams, of the College of Yale in China, Changsha, Hunan.

Elaphe bimaculata, new species

TYPE.—A. M. N. H. No. 24640; ♀; Ningkwo, Anhwei, September-October 1921; Clifford H. Pope.

DIAGNOSIS.—Closely allied to *Elaphe dione*, from which it is distinguished chiefly by color characters. Dorsal scales, 25; ventrals, 188–207; subcaudals, 67–74; transverse dorsal spots dumb-bell-shaped, often separated as a pair of spots; several of these spots unite on the neck and are confluent with the head marking; tail with a light median and dark dorso-lateral stripes.

Elaphe porphyracea pulchra, new subspecies

TYPE.—A. M. N. H. No. 17705; ♂; 20 miles north of Yunnanfu, Yunnan; July 6, 1920; John Graham.

DIAGNOSIS.—Closely allied to *Elaphe porphyracea porphyracea* in pattern; distinguished by having fewer ventrals, 177–185, and subcaudals, 51–56.

Trimeresurus orientalis, new species

TYPE.—A. M. N. H. No. 21028; ♀; Shaowu, Min River, Fukien; R. C. Andrews and Edmund Heller.

DIAGNOSIS.—Distinguished from its near relative, the Himalayan *T. monticola*, by having ten upper labials instead of eight or nine; a second near ally, *T. okinavensis*, has seven or eight labials; ventrals, 138; caudals, 37; dorsal scale rows, 27–25–21.

AMERICAN MUSEUM NOVITATES

Number 177 | Published by THE AMERICAN MUSEUM OF NATURAL HISTORY New York City | June 20, 1925

59.7(51)

SOME CHINESE FRESH-WATER FISHES[1]

BY J. T. NICHOLS

I.—LOACHES OF THE GENUS *BOTIA* IN THE YANGTZE BASIN

Botia rubrilabris (Dabry de Thiersant)

?Cobitis variegata DABRY DE THIERSANT, 1872, 'Pisciculture en Chine,' Pl. XLIX, fig. 5. Unidentifiable. Yetchuen.

Parabotia rubrilabris DABRY DE THIERSANT, 1872, 'Pisciculture en Chine,' Pl. XLIX, fig. 8. Yangtze (referred to Guichenot).

Botia variegata GÜNTHER, 1889, Ann. and Mag. Nat. Hist., IV, p. 228. Ichang, Yangtze.

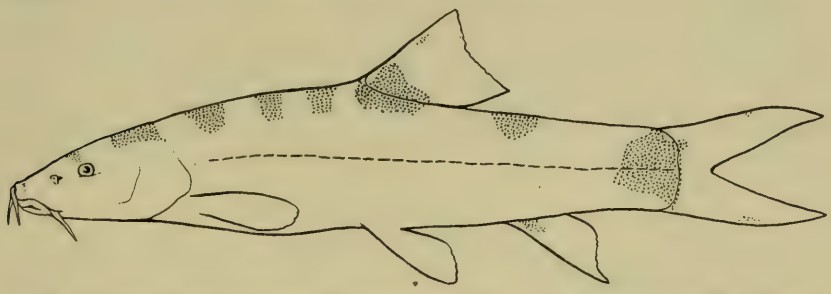

Fig. 1. *Botia rubrilabris* from Tungting Lake. Length, without caudal, 65 mm.

The synonymy of this, the best-known species of the genus in China, is somewhat uncertain and involved. Our two small specimens from Tungting Lake, Hunan, are clearly referable to Dabry's inaccurate but characteristic figure of *rubrilabris*, and also agree with Günther's type description of *variegata*. Günther aptly says in Ann. and Mag. Nat. Hist., 1888, I, p. 429: "I regret not to be able to make use of the notes on Chinese fishes in 'La Pisciculture et La Pêche en Chine par P. Dabry de Thiersant,' as the figures as well as the accompanying notes are the work of persons not conversant with the rudiments of descriptive ichthyology, and as likely to lead to misconceptions as to assist in the determination of the species." Nevertheless, some of the species in this work are perfectly identifiable.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 51.

A specimen from Huping, Tungting Lake, Hunan, collected by Clifford H. Pope, may be described as follows.

Length to base of caudal, 50 mm. Depth in length, 4.5; head, 3.3. Snout in head, 2.5; width of body, 2.4; depth of peduncle, 2.2; its length, 1.8; pectoral, 1.8; ventral, 1.8; longest dorsal ray, 1.4; longest anal ray, 1.6; caudal lobe, 1. Eye in snout, 4; interorbital, 2.1; maxillary, 2; maxillary barbel, 2.3.

Dorsal, 11; anal, 7. Scales very fine, evident only on peduncle.

Head long and pointed; peduncle moderately constricted; body compressed; peduncle strongly compressed; ventrals contiguous, in a horizontal plane; vent equidistant from ventral axil and anal origin. A row of four contiguous barbels across the tip of the snout, the inner slightly the longer and slightly shorter than a barbel on the end of the maxillary; mouth slightly oblique, inferior, horseshoe-shaped; the maxillary not reaching half the distance from tip of snout to under front of eye; lips thickish; the lower cleft in the middle; snout long and narrow; interorbital strongly convex; eye with a slight free rim, except behind; subtended by a simple, concealed, backwardly directed curved spine, a little longer than diameter of eye; gill-membranes broadly joined to side of breast beneath posterior third of opercle. Dorsal origin equidistant from base of caudal and middle of eye; ventral origin slightly behind that of dorsal; pectoral reaching $\frac{4}{7}$ the distance to ventral; ventral $\frac{2}{3}$ to anal; caudal deeply forked with pointed lobe (one broken). Lateral line complete, straight, in the center; short, bluntly pointed fleshy flaps in pectoral and ventral axils.

Pale; six dark saddles along mid-dorsal line; the first between the front of the eyes, the fifth on the dorsal base; a narrow stripe across the caudal base; a large blotch on the peduncle, two faint blotches anterior to this one on one side. A less perfect specimen of 63 mm. with seven dorsal blotches.

Botia pratti Günther

?Parabotia tæniops Sauvage, 1878, Bull. Soc. Philom. Paris, p. 90. Yangtze.
Botia pratti Günther, 1892, in Pratt, 'The Snows of Tibet,' p. 250, Pl. iv, fig. *A*.

This is a species with an elongate snout, but the very small eye rather nearer the end of the snout than the edge of the operculum. Depth rather more than $\frac{1}{5}$ the length to base of caudal; head in same, 3.5; interorbital narrow, convex, 3 or 4 times the diameter of eye. Dorsal origin midway between base of caudal and orbit; caudal deeply forked, its lobes as long as the head. Dorsal with 11 rays; anal with 8. Brownish olive, without distinct markings on the body; dorsal with two blackish bands parallel to the upper margin; caudal rays with numerous linear black markings or without spots; lower fins with indistinct blackish markings. The figure shows snout in head, 2.3; depth of peduncle, 2.4; its length, 1.6; longest anal ray, 1.5; eye in snout, 8.5.

Günther had three specimens 8 inches long, from Kia-tiang-fu (elevation 1070 ft.) at the foot of Omieshan. The locality is central Szechwan near long. 104° East, and where the Tung and Ya rivers join to enter the Min, a northern affluent of the Yangtze.

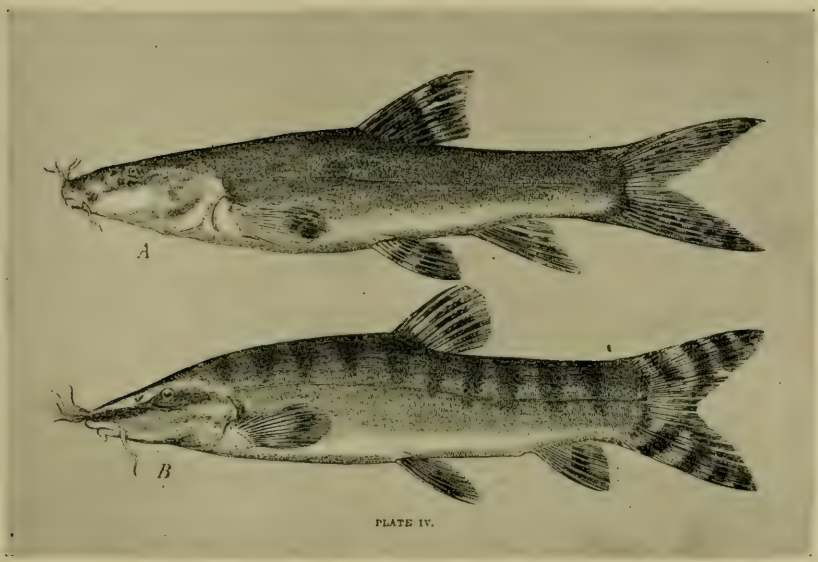

Fig. 2. *Botia pratti* (upper) and *Botia superciliaris* (lower) from Günther, by courtesy of the publishers, Longmans, Green and Co.

Botia superciliaris Günther

Botia superciliaris GÜNTHER, 1892, in Pratt, 'The Snows of Tibet,' p. 250, Pl. IV, fig. *B*.

This is a species allied to *B. rubrilabris* from the same locality as the above, with an elongate snout, eye behind the center of the head, and a short deep peduncle. Depth in length to base of caudal, 4.5; head, 3.5. Interorbital narrow, convex, 2½ times the diameter of eye. Dorsal origin midway between base of caudal and eye; caudal forked, its lobes shorter than the head. Dorsal with 11 rays; anal with 8; light olive, with broad, brownish bars across the back, five in front of and five behind the dorsal; a yellowish streak on the side of snout running back through superciliary region; three yellowish longitudinal lines on the crown of the head; dorsal and generally pectoral with a broad, dark cross-band well within the margin; each caudal lobe with three or four dark oblique bands. The figure shows snout in head, 1.9; depth of peduncle, 1.9; its length, 2.4; longest anal ray, 1.9. Eye in snout, 5.

Günther had five specimens, six inches long, from Kia-tiang-fu, Szechwan.

Botia purpurea, new species

Description of Type.—Number 8401, American Museum of Natural History, from Huping, Tungting Lake, Hunan; collected by Clifford H. Pope.

Length to base of caudal, 132 mm. Depth in length, 4.2; head, 4. Snout in head, 2.5; width of body, 2; depth of peduncle, 1.6; its length, 1.4; pectoral, 1.4;

Fig. 3. *Botia purpurea* of 63 mm. without caudal, from the side and from above.

ventral, 1.5; longest dorsal ray, 1.4; longest anal ray, 1.5; upper caudal lobe, 0.9. Eye in snout, 5.5; interorbital, 1.7; width of mouth, 2; maxillary, 1.6; maxillary barbel, 2.5; distance between gill clefts, 1.5.

Dorsal, 10; anal, 8. Scales about 150.

Compressed; peduncle broad and strongly compressed; snout pointed; vent equidistant from ventral axil and anal origin; ventrals contiguous, in a horizontal

plane. Mouth small, slightly oblique, inferior, transverse, horseshoe-shaped, with moderately thick lips, the upper free behind, the lower, which is split in the center, free in front; maxillary reaching half-way to under front of eye from tip of snout; three small barbels on each side, two at the side of the tip of the snout, and one at the end of the maxillary a little the longest; eye with a slight free rim, except behind; a strong, simple, backwardly directed spine beneath the eye, half as long again as same; gill-slit curving around pectoral base, gill-membranes broadly joined to side of breast before lower pectoral axil. Dorsal origin equidistant from tip of snout and base of caudal; ventral origin slightly behind that of dorsal; pectoral reaching $\frac{2}{3}$ the distance to ventral; ventral $\frac{2}{3}$ to anal; caudal deeply forked, with pointed lobes, the upper slightly the longer. Scales small, oval, imbricated, with concentric and parallel horizontal striæ; lateral line complete, straight, in the center; pectoral and ventral with fleshy axillary flaps joined by membrane to the fin, that of the ventral elongate, pointed.

Rather dark purplish, the sides vermiculated; midline of back from nape to dorsal with about five irregular dark saddle-marks, narrowly separated; fins with dark bases, each crossed by a blackish bar; mouth and barbels pale. In a sketch from life the ground color is dull purplish rose; broad dark cross-bars before the dorsal leave narrower interspaces of the ground color; behind the dorsal light and dark bars are more numerous and of about equal width; the sides are irregularly mottled.

A number of specimens of this form were collected at Tungting Lake.

Botia citrauratea, new species

Description of Type.—Number 8402, American Museum of Natural History, Tungting Lake, Hunan; December 29, 1921; collected by Clifford H. Pope.

Length to base of caudal, 50 mm. Depth in length, 5.4; head, 3.8. Snout in head, 2.6; depth of peduncle, 1.8; its length, 1.9; pectoral, 1.7; ventral, 1.8; longest dorsal ray, 1.5; longest anal ray, 1.8; caudal lobe, 0.9. Eye in snout, 3; interorbital, 2; maxillary, 1.4; maxillary barbel, 1.4.

Dorsal, 10; anal, 7. Scales minute, imbedded, scarcely evident.

Body strongly compressed, particularly the peduncle. Mouth inferior, strongly curved; two barbels on snout and one on maxillary on each side, which latter reaches back to opposite center of eye, none on chin. Small eye with a free rim; a strong, erectile, backwardly directed spine below eye; gill-membranes broadly joined to isthmus, gill cleft extending to opposite lowest ray of pectoral. Dorsal origin midway between base of caudal and middle of snout; ventral origin under first rays of dorsal. Lateral line complete.

Color purplish brown; yellowish below; a dark band across base of caudal; a few pale flecks on sides and dark flecks on dorsal; midline of back rather dark with a row of numerous small, close-spaced, rounded, pale blotches. Caudal faintly but distinctly mottled with dark. A sketch from life is orange in color, the center of the back dark gray; an orange stripe extends between the eyes and onto the back, behind which there are eight rounded orange spots in the midline of the back before the dorsal and nine behind it.

These five Chinese species of *Botia* may be conveniently differentiated as follows:

1.—Dorsal origin midway between base of caudal and eye.....2.
Dorsal origin midway between base of caudal and middle of snout. Center of back dark with a series of close-spaced, rounded, pale marks. Slender, depth about 5.5.....*B. citrauratea.*
Dorsal origin midway between base of caudal and end of snout. Dark saddles across the back, sides finely marked. Deeper, depth less than 4.5. *B. purpurea.*
2.—Eye very small, more than 3 times in the interorbital, and about 8 times in the snout. No dark cross-marks on back or sides. Eye in about the center of head. Depth about 5.....*B. pratti.*
Eye somewhat larger, less than 3 times in the interorbital, about 4 or 5 times in the snout. Dark cross-marks on back which may be continuous downward, represented by blotches or absent across the sides. Eye behind the center of head. Depth about 4.5.....3.
3.—About 10 cross-marks on the back. Peduncle short and deep..*B. superciliaris.*
About 5 to 7 cross-marks on the back. Peduncle moderate, its length 1.8 in head.....*B. rubrilabris.*

II.—A NEW MINNOW-LIKE CARP FROM SZECHWAN

Caraspius, new genus

A small, active cyprinid, with the chubby blunt-headed appearance of the goldfish (*Carassius*), but with a long, slender peduncle. Dorsal and anal short, without spinous rays. Mouth very oblique, lower jaw projecting. No barbels. A short keel on the belly before anal. Scales moderately large; the lateral line incomplete. Name from *Carassius* and *Aspius*. Type: *Caraspius agilis*, new species.

This genus resembles European *Leucaspius*, which has a longer anal, smaller scales, etc., and may be more or less closely related thereto.

Caraspius agilis, new species

Description of Type.—No. 8414, American Museum of Natural History, Yen-ching-kao, near Wanhsien, Szechwan, January 1923, collected by Walter Granger.

Length to base of caudal, 41 mm. Depth in length, 3.3; head, 3.6. Eye in head, 3.5; snout, 3.5; interorbital, 2.5; maxillary, 3; depth of peduncle, 1.9; length of peduncle, 1.4; width of body, 1.5; pectoral, 1.3; ventral, 1.6; longest dorsal ray, 1.4; longest anal ray, 1.5; caudal, 0.8.

Dorsal, 9; anal, 9. Scales, 31. Teeth, 4.2 (in one of the cotypes), their tips narrowed and curved.

Vent immediately before anal origin, with a short, naked keel before it almost to ventral axil. Lower jaw projecting; mouth very oblique; maxillary barely to front of eye; no barbels; gill-membranes narrowly joined to isthmus under edge of preopercle. Dorsal and anal without spinous rays; dorsal origin equidistant from base of caudal and edge of preopercle, between ventral axil and anal origin, which latter is very slightly behind dorsal axil; pectoral reaching to over ventral origin; ventral not quite to anal origin; caudal forked, the upper lobe pointed. Scales with radiating striæ; lateral line on about 3 anterior scales only.

Color dark above; paler, yellowish or reddish [rust from tins?], below and on fins; an indistinct blackish stripe from eye to caudal.

Two smaller specimens were taken with the type—"in a spring on the edge of a paddy field; cold water; very shy and active" (W. G.).

III.—THE CHINESE SUCKER, *MYXOCYPRINUS*

The peculiar Chinese sucker with big sail-like dorsal fin appears to be widely distributed in central China, but nowhere common. The type of its genus (*Myxocyprinus* Gill, 1878, Johnson's 'Cyclopædia,' p. 1574) is *Carpiodes asiaticus* Bleeker, 1865, (?probably northern) China. A second species, *Carpiodes chinensis* Dabry de Thiersant, 1872, Yangtze; *Sclerognathus chinensis* Günther, 1889, Ichang, Yangtze (named independently), has since been described. A specimen from Anhwei is identified with the former form, which very likely actually came from the vicinity of Shanghai, and two specimens from Tungting, with the latter. The two forms appear to be racially, though not specifically, distinct. A tangible difference is to be found in the number of dorsal fin rays. A fourth individual to hand from Fukien does not agree with either of the above, and is here made the type of a third race. Unfortunately, it is too small for very satisfactory comparison.

Myxocyprinus asiaticus asiaticus (Bleeker)

Carpiodes asiaticus Bleeker, 1865, Ned. Tijdschr. Dierk., II, p. 19.

Description of a specimen from Anhwei, bought 20 miles from Ningkwo, on a clear-water river on the way to Wuhu, by C. H. Pope, follows.

Length to base of caudal, 220 mm. Depth in length, 2.4; head, 4.6. Eye in head, 6; snout, 2.3; interorbital, 2.2; maxillary, 2.3; width of mouth, 3; greatest width (the back of head), 1.5; depth of peduncle, 2.6; its length, 3; pectoral, 0.9; ventral, 0.9; longest dorsal ray, 0.6; longest anal ray, 1; lower caudal lobe, 0.8.

Dorsal, 52; anal, 12. Scales, 53.

Deep, compressed; lower surfaces broad, very slightly convex; pectorals and ventrals in a horizontal plane; head short and blunt; back before dorsal steep and very narrow. Interorbital slightly convex, mouth inferior, transverse, surrounded with thick striate lips; maxillary not reaching to below front of eye; eye lateral, with a free rim; gill-membranes joined to side of breast behind the edge of the preopercle. Dorsal and anal without spinous rays, the former elongate, much elevated in front; dorsal origin equidistant from tip of snout and first third of depressed ventral; ventral origin well behind that of dorsal; pectoral about reaching ventral origin; ventral reaching three-fourths the distance to anal; caudal forked, with narrow, pointed lobes, the lower decidedly the longer. Scales with conspicuous, rather close-spaced radiating striæ; lateral line complete, straight, in the center; pectoral and ventral without modified free axillary flap or scale.

Body and fins blackish; mouth to breast, a vague band from origin of dorsal to between pectoral and ventral bases, upper caudal lobe, and narrow inner margin of pectoral, pale; snout and opercle grayish.

This race differs from *M. a. chinensis* (Günther) from the Yangtze in having fewer dorsal rays, slightly lower body and dorsal lobe, and more striate scales.

Myxocyprinus asiaticus chinensis (Dabry de Thiersant)

Carpiodes chinensis Dabry de Thiersant, 1872, 'Pisciculture en Chine,' p. 182, Pl. xl, fig. 1.

Sclerognathus chinensis Günther, 1889, Ann. and Mag. Nat. Hist., IV, p. 223.

Description of a specimen from Huping, Tungting Lake, Hunan, collected by C. H. Pope, follows.

Length to base of caudal, 200 mm. Depth in length, 2.3; head, 4.2. Eye in head, 5.5; snout, 2.5; interorbital, 2; maxillary, 2.6; width of mouth, 3.9; greatest width (the back of head), 1.6; depth of peduncle, 2.6; its length, 2.8; pectoral, 0.9; ventral, 0.9; longest dorsal ray, 0.6; longest anal ray, 1; lower caudal lobe, 0.8.

Dorsal, 57; anal, 14. Scales, 55.

Deep, compressed; lower surfaces broad, very slightly convex; pectorals and ventrals in a horizontal plane; head short and blunt; back before dorsal steep and very narrow. Interorbital convex; mouth inferior, transverse, surrounded with thick striate lips; maxillary not reaching to below front of eye; eye lateral, with a free rim; gill-membranes joined to side of breast behind edge of preopercle. Dorsal and anal without spinous rays; the former elongate, much elevated in front; dorsal origin equidistant from tip of snout and ventral origin; ventral origin well behind that of dorsal; pectoral passing ventral origin slightly; ventral extends $\frac{6}{7}$ the distance to anal origin; caudal moderately forked, the lower lobe slightly the longer and the less pointed. Scales with a few radiating striæ, less conspicuous than in typical *asiaticus;* lateral line complete, straight, in the center; pectoral and ventral without modified free axillary flap or scale.

Body and fins blackish; mouth to pectoral bases, upper caudal lobe, narrow inner margin of pectoral, and opercle, pale; snout, and origin of dorsal to belly in front of ventrals, grayish.

Myxocyprinus asiaticus fukiensis, new subspecies

Description of Type.—No. 8415, American Museum of Natural History, collected near Yenping, Fukien, by H. R. Caldwell.

Length to base of caudal, 36 mm. Depth in length, 2.6; head, 3.6. Eye in head, 3.6; snout, 2.7; interorbital, 2.1; maxillary, 3.5; depth of peduncle, 3; its length, 3.3; pectoral, 1.2; ventral, 1; longest dorsal ray, 0.7; longest anal ray, 1.4; lower caudal lobe, 0.9.

Dorsal, 55; anal, 14. Scales, 47.

Head rather broad and blunt; back steeply elevated to dorsal origin; body strongly compressed; breast flattish, so that the bases of pectorals (placed low) and

ventrals are in a horizontal plane; belly rounded. Top of head slightly convex; front of snout deep, vertical; mouth small, horizontal, transverse, curved, inferior, protractile downward; entirely surrounded with thick ridged-papillose lips; no barbels; maxillary not reaching under front of eye; orbit with a free rim, lateral placed high; gill-membranes adnate to breast near its center, about half of the diameter of eye apart. Dorsal high, not falcate (in this small specimen), occupying most of the back; its origin nearer tip of snout than to anal origin; pectorals reaching ventral origin; ventral passing anal origin; anal passing caudal base; caudal deeply forked, with narrow pointed lobes, the lower a little the longer. Lateral line complete, straight, in the center.

Color black; anterior and posterior ends of head, a broad band slanting down and back from origin of dorsal and involving the inner edge of pectoral, a narrow, less perfect parallel band from middle of dorsal base, and caudal, pale.

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HAMSTERS COLLECTED BY THE AMERICAN MUSEUM ASIATIC EXPEDITIONS[1]

By Glover M. Allen

The rodent family Cricetidæ is represented in eastern Asia by a number of small species collectively known as hamsters. All of these are burrowers, more or less modified for ground living, in contrast therefore to the long-tailed forest-living *Peromyscus* of North America (belonging to the same family), but recalling the American genus *Onychomys*, which again is an open-country or desert type. Hamsters are apparently absent in China south of about latitude 32° where, presumably, conditions have not in recent times been suitable for them.

The Asiatic Expeditions under the leadership of Mr. Roy Chapman Andrews have now assembled a fine series of these handsome little mammals from various points in North China and the Gobi Desert, making possible a comparison of specimens from various parts of a species' range and an estimate of the amount of geographic variation shown. As in the case of many other mammals, the dry interior of the country is inhabited by paler representatives, while nearer the coast in Chili, or along the damper borders of southern Shensi, darker coloration prevails. Some seem to be wholly confined to the Gobi.

Cricetulus andersoni Thomas

Cricetulus andersoni Thomas, 1908, Proc. Zoöl. Soc. London, p. 642.

A small gray hamster with prominent ears, a tail of medium length, and white belly with slaty bases to the hairs. This was considered by Anderson to be the commonest small mammal in Shensi and Shansi, and it was found in abundance by Andrews at Kwei-hwa-ting and He-shuin in the latter province. In Mongolia a large series was also secured by Andrews at Artsa Bogdo, but not elsewhere except for a single skin at Ussuk and another forty miles south of Tsetsenwan. I am unable to see tangible differences between the Shansi and the Mongolian series,

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 52.

though the latter are the least bit paler. A small series from Chili Province, northeast of Peking, is, however, much darker with a greater amount of black in the upper surfaces. It may be distinguished as follows.

Cricetulus andersoni nigrescens, new subspecies

TYPE.—Adult male, skin and skull, No. 56307, American Museum of Natural History, from Province of Chili, 100 miles northeast of Peking, China. March 1922. Third Asiatic Expedition.

DESCRIPTION.—Similar to *C. andersoni* but the dorsal surface of head and body much darkened by black hairs.

General color above, a buffy gray heavily lined with black particularly over the lower part of the back, with a tendency in some specimens to form an indistinct dark line medially. This general color is the result of a mixture of long, black-tipped hairs with the more numerous hairs that are slaty for their basal three-fourths, with a pale buff tip. At the sides of the body between fore and hind legs, the latter hairs predominate giving a nearly clear "light ochraceous buff." A small area behind each ear is similar. Upper side of tail dusky, with a few scattered white hairs. Ears blackish brown ("Natal brown"), their tips narrowly edged with white. Feet and under side of tail pure white to the roots of the hairs; upper lips and entire under surface of the body and limbs white with a distinct buffy wash on the chest, the bases of the hairs slaty.

The skull is not appreciably different from that of typical *andersoni.*

MEASUREMENTS.—None of the series of topotypes is accompanied by measurements, but the specimens do not seem to differ from typical *andersoni* in size except that the tail appears to be slightly shorter, about 30 instead of 38 mm.

The skull of the type measures: greatest length, 26 mm.; basal length, 22.5; palatal length, 12.5; diastema, 7.0; width of braincase, 11.7; interorbital width, 4.0; upper cheek teeth, 4.1; mandible, 14.3; lower cheek teeth, 4.0.

The series of twenty-three skins from 100 miles northeast of Peking is so very much darker than typical *andersoni* from near Taiyuenfu, central Shansi, as to be easily distinguishable on comparison. A series from northern Shansi, at Kwei-hwa-ting, is exactly intermediate between the pale typical animal and the Chili form, so that the subspecific standing of the latter is unquestionable. In addition to its darker back, the buffy wash on the chest seems distinctive.

Cricetulus griseus (A. Milne-Edwards)

Cricetus (*Cricetulus*) *griseus* A. MILNE-EDWARDS, 1868–1874, 'Recherches Hist. Nat. Mammifères,' p. 133; Pl. XII, fig. 1; Pl. XIII, fig. 1-1*h*.

A short-tailed buffy species, with a narrow black stripe in the middle of the back. This is common in parts of northeastern China. A series from Peking are topotypes and a large number were secured at Shan-hai-kwan in the same province (Chili). The collection also includes a

number from Chimo, on the north coast of the Shantung peninsula collected by Paul D. Bergen. These are all very uniform in color, and the young are but little darker.

Cricetulus griseus obscurus (A. Milne-Edwards)

Cricetus (*Cricetulus*) *obscurus* A. Milne-Edwards, 1868–1874, 'Recherches Hist. Nat. Mammifères,' p. 136; Pl. xii, fig. 2; Pl. xiii, fig. 2-2*c*.

This is similar to the preceding but paler. Milne-Edwards' type came from Saratsi, northern Shansi, so that Andrews' series from Kwei-hwa-ting in that province are practically topotypes. These already show a sandier, paler tint than those to the eastward, though occasional specimens are hardly distinguishable. Following Thomas's suggestion, however, the name may be retained in a subspecific sense for the pale western animal of Shansi and Mongolia. In the latter region this hamster was obtained at Turin, Loh, Ussuk, Gun Burta, Tsetsenwan, Tsagan Nor, and Sain Noin Khan. Compared with the Kwei-hwa-ting series these are a perceptible shade paler, with in some specimens pronounced white tufts at the exterior base of the ears, and the dark line on the back sometimes less sharply defined. Possibly this race will be found to merge with *kozlovi* from Sa-chou.

Cricetulus longicaudatus (A. Milne-Edwards)

Cricetus (*Cricetulus*) *longicaudatus* A. Milne-Edwards, 1868–1874, 'Recherches Hist. Nat. Mammifères,' p. 136; Pl. xii, fig. 3; Pl. xiii, fig. 3–3*a*.

Resembles *C. andersoni* but the hairs of much of the lower surfaces are white to their bases. This seems to be rare or local, and was not secured except at Artsa Bogdo, Mongolia, where a single male was taken that seems referable to the species. Its vibrissæ are noticeably longer and more abundant than in *C. andersoni*, which apparently greatly outnumbers it at the same locality; the feet also are larger, and the skull has a more elongate rostrum.

Cricetulus migratorius curtatus, new subspecies

Type.—Adult male, skin and skull, No. 57873, American Museum of Natural History, from Iren Dabasu, Mongolia. May 2, 1922. Third Asiatic Expedition.

Description.—A medium-sized hamster, uniform buffy gray above, feet and tail white, the latter very short, not exceeding the extended hind foot; belly white, the hairs with slaty bases except on skin, throat, forearms, and tail.

General color of the upper parts from the nose to root of tail, and laterally as far as the vibrissæ, cheeks, shoulder and lower thigh nearly "cinnamon buff" (Ridgway, 1912) faintly and evenly lined with fine black-tipped hairs. Half-way between

eye and ear an indistinct grayish-white bar extends upward from the white of the throat across the cheek on each side. A small tuft of white hairs is present at the anterior base of the ear, and an ill-defined pale buffy patch marks the posterior base. Outer surface of ears scarcely darker than the back, thinly covered with short whitish and dusky brown hairs. Lips (including the bases of the vibrissæ), the entire forearm and foot, and the hind leg from the lower part of the thigh, the tail, the sides and belly white, the hairs with slaty bases except on chin, upper throat, a narrow median area between the forelegs, the entire forearms, fore and hind feet, and the tail, which are white to the bases of the hairs. Vibrissæ and a narrow eye-ring black.

Immature specimens are "drab-gray" to "light drab" above with less of the pale cinnamon tint. The tail, though usually entirely white, may have a narrow line of scattered dark or blackish hairs mid-dorsally.

Measurements.—The type was measured by the collector as follows: head and body, 115 mm.; tail, 18; hind foot [s. u.], 17; ear, 16. The hind foot with claw measures on the dry skin, 19 mm. The largest specimen has a head-and-body length of 128 mm.

The skull of the type measures: greatest length, 32.6 mm.; basal length, 31; palatal length, 17; diastema, 9.5; zygomatic width, 18; mastoid width, 13.5; width outside anterior molars, 7; upper cheek teeth, 4.9; lower cheek teeth, 4.8; mandible to condyle, 20.

This appears to be one of the *C. migratorius* group, the center of whose range is western Asia to the borders of western Europe, and is apparently another of the species of that area to have made its way through the Altai region into the eastern Gobi Desert. In addition to being apparently the most eastern member of the *migratorius* group yet discovered, it is also the shortest-tailed. The tail is stumpy and conical, barely reaching the tip of the extended hind foot, the hairs at its base noticeably longer than those at its tip. The pale buffy or cinnamon color is indicative of the dry desert habitat. In addition to specimens from the type locality, others apparently indistinguishable were taken at the following places in the Gobi Desert, Mongolia: Gun Burte (6800 feet altitude), Pang Kiang, Tsagan Nor, Ussuk, Loh, Turin.

Cricetulus triton (de Winton)

Cricetus (*Cricetulus*) *triton* de Winton, 1899, Proc. Zoöl. Soc. London, p. 575.

Ten skins from Chimo, near the coast of the Shantung peninsula, are practically topotypes of the large hamster of northeastern China, and are very uniform in their general buffy-gray appearance, slightly darker in the middle of the back. The largest of the series, though unaccompanied by collector's measurements, are apparently of nearly the same size as *C. nestor* Thomas from northeast of Seoul, Korea, and the two are doubtless closely related. Thomas has lately described a third race, a pale gray subspecies, *C. t. incanus*, from the dry inland country

along the edge of the Ordos Desert. The collections obtained by the Third Asiatic Expedition include a small series from near Peking, which differ uniformly from the Shantung specimens in having the base of the tarsus dark instead of white like the rest of the foot, while still another lot from the hills of southern Shansi and Shensi are the opposite of *C. t. incanus* in their darkened coloration correlated with the moister climate of this area. The descriptions of these two races follow.

Cricetulus triton fuscipes, new subspecies

Type.—Adult male, skin and skull, No. 56792, American Museum of Natural History, from Peking, Chili Province, China. 1921. Third Asiatic Expedition.

Description.—Similar in general appearance to *C. triton*, but the ankles and basal part of the metatarsals dusky, instead of white like the distal part of the foot.

Entire dorsal surface of head and body a nearly uniform buffy, slightly darkened on the lower back by a greater admixture of long black hairs. Along the sides of the cheeks and flanks these black hairs are few or absent so that the color is here clearer, nearly "light ochraceous buff." The individual hairs of the back are of two sorts: some entirely black, others with a fine black tip, then a broad subterminal ring of "light ochraceous buff" and a slaty base. The ears are clothed with short brownish ("fuscous") hairs, with which are mingled a few grayish hairs, these latter more abundant at the extreme tip of the ear. The chin and a varying median area extending back from it, the hands and wrists are pure white to the roots of the hairs. The under side of the body and limbs is elsewhere white with the slaty-gray bases of the hairs showing through. The hind feet are white on the distal part of the metatarsals and on the toes, but the proximal third or half of the metatarsal area is contrastingly brownish ("fuscous"). The tail is thinly haired, dusky above and whitish below.

The skull is stoutly built, the orbits square-edged above, giving a less rounded appearance than in the smaller species of the genus.

Measurements.—The skins are unaccompanied by measurements, but the hind foot of the type measures 23 mm., or practically as in typical *C. triton*. As made up, the tails of the Peking series seem longer than those from the Shantung peninsula.

The following skull measurements are of the type and a topotype (No. 56335): greatest length, 35+, 38 mm.; basal length, 35, 34.5; palatal length, 18.5, 18.8; diastema, 10.5, 10.7; zygomatic width,—, 19.4; width of braincase, 15.5, 15.4; upper cheek teeth, 5.5, 5.5; lower cheek teeth, 5.4, 5.5; mandible, 22, 21.8.

Seven specimens from Peking agree in having the basal portion of the hind foot dusky brown, whereas in the other races at hand it is entirely white. In other respects this race is not obviously different from typical *C. triton* unless the longer tails of the skins as prepared are not a result of difference in preparing the specimens.

Cricetulus triton collinus, new subspecies

Type.—Adult female, skin and skull, No. 56389, American Museum of Natural History, from the base of Tai-pei-shan, Tsing-ling Mountains, Shensi Province, China. October 10, 1921. Third Asiatic Expedition.

Description.—A large hamster, similar to *C. triton* but much darker and with slightly longer tail.

General color of the upper parts from nose to tail between "drab" and "mouse-gray," the individual hairs either entirely black, or with minute black tip and a broad subterminal band of "warm buff," the latter predominating at the sides of the head and body, so that these portions are slightly brighter. Inner and outer sides of ears thinly covered with short blackish-brown hairs, except that the extreme edge is white. Feet and wrists, the chin, and a small median spot on the throat, clear white to the bases of the hairs; the lower surfaces elsewhere are clothed with whitish hairs whose slaty-gray bases everywhere show through and darken the general grayish tone. Tail thinly covered with short appressed hairs, blackish brown (near "sepia"), with many whitish hairs on the lower side. Vibrissæ blackish brown or whitish, short.

The skull hardly differs from that of *C. t. fuscipes*, except that the incisive foramina in adults tend to be longer, reaching about to the level of the cheek teeth. The interparietal in the latter also differs in that the anterior corners are produced forward so that the border is brace-shaped instead of V-shaped.

Measurements.—The collector's measurements of the type are: head and body, 155 mm.; tail, 72; ear, 22; the hind foot measures 24 mm.

The skull of a topotype (No. 56388) measures: greatest length, 37.5 mm.; basal length, 34.6; palatal length, 17.6; diastema, 10.2; zygomatic width, 19; width of braincase, 15.3; interorbital width, 4.7; upper cheek teeth, 5.2; mandible, 21.6; lower cheek teeth, 5.2.

The series of nine specimens from the base of Tai-pei-shan, Tsing-ling Mountains, comes from the northwestern border of the damp forested area of which Szechwan may be considered the center. The saturate or darkened appearance of this form of *C. triton* is therefore what might be expected in contrast to the very pale *C. triton incanus* from the edge of the Ordos Desert, or the pale-buffy *C. triton* from Shantung. A single specimen from the northern edge of the Tsing-ling range, about 45 miles south of Fengsiangfu, Shensi, is also referable to *C. t. collinus*, and probably represents nearly its northern limit. The altitude of this point is about 3600 feet. Two other similar specimens were taken at He-shuin, in southern Shansi. The discovery of a representative of *C. triton* in this southern part of Shensi is apparently a considerable extension of its known range, and it seems unlikely that it will be found to penetrate much farther southwestward.

Cricetiscus campbelli (Thomas)

Cricetulus campbelli Thomas, 1905, Ann. Mag. Nat. Hist., (7) XV, p. 322.

For these dwarf hamsters with shortened tail, black dorsal line, and with the white of the lower side extending up on the flanks to form a convex area on neck, body, and hip, Thomas has lately proposed the generic name *Cricetiscus*. The skull differs from that of *Cricetulus* in its

more spreading zygomata and in having the dorsal profile distinctly more bowed. The type of *campbelli* was from northern Chili near the southern edge of the Mongolian plateau. The Second and Third Asiatic Expeditions, under Mr. Roy Chapman Andrews, secured specimens at various places on the great plateau, namely, at Urga, and at localities along the caravan route 60, 80, 120, and 140 miles to the southeast, as well as at Ussuk, Turin, 30 miles to northeast of Tsetsenwan, and 40 miles southwest of there, as well as a single one on the Tola River 80 miles west of Urga. It seems to be a characteristic species of the tableland, but is represented by a similar and darker form in the Altai region, "*Phodopus*" (=*Cricetiscus*) *crepidatus* Hollister.

Phodopus bedfordiæ (Thomas)

Cricetulus bedfordiæ Thomas, 1908, December 22, Abstract Proc. Zoöl. Soc. London, p. 45.

A short-tailed dwarf hamster, pale buff above, pure white below. This was described from Yulinfu, Shensi, on the edge of the Ordos Desert. Three specimens were secured by the Third Asiatic Expedition at Tsagan Nor, and a fourth 160 miles southeast of Sain Usu, Mongolia, thus considerably extending its known range. These four do not differ appreciably from a topotype in the Museum of Comparative Zoölogy.

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SOME CHINESE FRESH-WATER FISHES[1]

By J. T. Nichols

IV.—GUDGEONS OF THE GENUS *CORIPAREIUS*

The genus *Coripareius* is based by Garman, 1912, on *Labeo cetopsis* Kner, 1867, from Shanghai. Some of Garman's material from the Yang-tze which he identified with *cetopsis* was probably referable to *Pseudogobio styani* Günther, 1889. We have no material referable to *cetopsis*, which apparently differs from *styani* in having the vent halfway between ventral and anal (from description), the dorsal origin equidistant from end of snout and front of anal (from figure).

This genus is characterized by a single pair of exceptionally long barbels, small eye a little before the center of the head, long compressed peduncle, rather small scales, and a single row of anvil-shaped teeth. Its distinguishing characters are perhaps less tangible than those of such specialized gudgeons as *Pseudogobio*, *Rhinogobio*, and *Saurogobio*; but the writer was of the impression, before finding that it had already been named by Garman, that it is actually less, rather than more, closely related to *Gobio* than are these. *Gobio uranoscopus caucasicus* as figured by Berg, 1916, is very suggestive of *Coripareius*. Recent collections of the Third Asiatic Expedition contain two species as follows.

Coripareius styani (Günther)

Pseudogobio styani Günther, 1889, Ann. and Mag. Nat. Hist., (6) IV, p. 224.

The following is a description of a specimen from Huping, Tungting Lake, Hunan, collected by C. H. Pope.

Length to base of caudal, 74 mm. Depth in length, 5; head, 4.1. Eye in head, 6; snout, 2.5; interorbital, 2.6; maxillary, 3.5; barbel, 2; width of body, 1.6; depth of peduncle, 2.2; its length, 1.2; pectoral, 1.1; ventral, 1.4; longest dorsal ray, 1; longest anal ray, 1.5; caudal lobe, 0.9; distance between gill-slits, 5.5.

Dorsal, 9; anal, 8. Scales, 56.

Little compressed before the dorsal, compressed behind it; lower surface of head flattish, the upper evenly convex; front of back narrow, breast broad and gently rounded; vent a short distance before anal origin. Snout bluntly pointed, extending

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 53.

a little beyond the small inferior horizontal curved mouth; lips rather thick and smooth; maxillary not nearly to eye; with a long cylindrical tapering roughened subterminal barbel; gill-membranes rather broadly joined to isthmus under edge of preopercle. Dorsal origin equidistant from tip of snout and middle of last anal ray; dorsal and anal without spinous rays; ventral under middle of dorsal; pectoral not quite reaching to ventral, ventral not nearly to anal; caudal well forked with pointed lobes; its rudimentary rays precurrent in a short low keel above and below. Scales with rather wide-spaced horizontal parallel striæ; lateral line complete, straight, in the center; an elongate pointed axillary ventral flap with 1 or 2 covert scales.

Color dull, uniform; the front and tip of the dorsal dusky.

Coripareius septentrionalis, new species

Description of Type.—Number 8416, American Museum of Natural History, from Paotow, Mongolia, on the Yellow River a little west of the Shansi boundary; collected by C. H. Pope.

Length to base of caudal 240 mm. Depth in length, 4.5; head, 4.8. Eye in head, 8.6; snout, 2.8; interorbital, 3; maxillary, 3; barbel, 1.8; distance between gill-clefts, 8.6; greatest width (at shoulder), 1.4; depth of peduncle, 2; its length, 1; pectoral, 1; ventral, 1.4; longest dorsal ray, 1.1; longest anal ray, 1.4; upper caudal lobe, 0.9.

Dorsal, 9; anal, 8. Scales, 55 (last three on caudal base).

Somewhat compressed; snout and anterior part of head depressed; the head narrowing forward; front of back elevated; breast broad; vent five times as far from ventral axil as from anal origin. Mouth inferior, transverse, horizontal, horseshoe-shaped; the bluntly pointed snout extending a little beyond it; lower jaw squarely truncate at the end; with free lip only at the side, the same confluent with maxillary and lip of upper jaw; lips and chin granular with non-prominent papillæ; maxillary not nearly to below eye; a subterminal, long, tapering, thick-based barbel which reaches to slightly beyond edge of preopercle; interorbital flattish across the top, dropping at the sides to the small eye which is appreciably below the profile and almost strictly lateral; gill-membranes joined to isthmus before edge of preopercle. Dorsal and anal without spinous rays; dorsal origin equidistant from tip of snout and middle of anal base; pectoral not reaching ventral; ventral about half-way to anal; free edges of dorsal and anal concave; caudal forked, the upper lobe a little the longer. Body fully scaled; scales with conspicuous close-set parallel horizontal striæ; lateral line straight, in the center, complete; a bluntly pointed ventral axillary flap scaled on its base.

Color rather dark; the border of dorsal, margin of caudal and center of pectoral more or less blackish.

This species is close to *C. styani*, than which it probably reaches a larger size, and, if it were not for the narrower head and more anterior dorsal origin, might be taken for an overgrown example of *styani*.

V.—GUDGEONS RELATED TO THE EUROPEAN *GOBIO GOBIO*

Certain of the numerous tribe of Chinese gudgeons are closely related to the typical species, *Gobio gobio* of Europe. In fact, Fowler, 1924,

synonymizes a form from Chihli with it. In the writer's opinion this fish is slightly different, though very likely identical with *Gobio gobio soldatovi* Berg, 1914 and 1916. A small fish from Shansi, again, would seem to be subspecifically separable from it, and another with exceptionally long barbel from the same province represents a well-marked species. Descriptions of these three forms follow.

Gobio soldatovi Berg

Gobio gobio var. *soldatovi* Berg, 1914, 'Faune Russ.,' Poiss. III, part 2, p. 461, Fig. 63.

The following is a description of a specimen from Hsing-lung-shan, Eastern Tombs, Chihli, August 7, 1921; collected by C. H. Pope.

Length to base of caudal, 76 mm. Depth in length, 4.6; head, 3.4. Eye in head, 4; snout, 3; interorbital, 3.8; maxillary, 3.3; width of mouth, 3.8; barbel, 3.8; greatest width of body (the back of head), 2.2; depth of peduncle, 2.7; its length, 1.4; pectoral, 1.5; ventral, 1.8; longest dorsal ray, 1.5; longest anal ray, 2; caudal lobe, 1.2.

Dorsal, 9; anal, 8. Scales, 40.

Little compressed; snout bluntly pointed; vent at one-quarter the distance from anal origin to ventral axil. Eye very slightly superolateral; interorbital slightly concave; a slight groove across snout; mouth slightly oblique, inferior, horseshoe-shaped; maxillary not quite to under front of eye; with a well-developed subterminal barbel; lips moderately thick, not free across chin; gill-membranes joined to side of breast under edge of preopercle. Dorsal and anal without spinous rays; dorsal origin slightly nearer tip of snout than base of caudal; ventral origin beneath about the center of dorsal base; pectoral rounded, reaching three-quarters the distance to ventral; ventral not quite to anal; caudal moderately forked, the upper lobe the more pointed and slightly the longer (another specimen with lower lobe the longer). Scales with conspicuous close-set radiating striæ; scales absent from breast before pectoral axil; lateral line complete, in the center, rising a little to meet opercle.

Top of head dark; lower surfaces pale; a blackish longitudinal stripe, faint and ill-defined in front; also ill-defined dark longitudinal streaks on back and sides; a black blotch over upper pectoral axil; a faint blackish blotch in the stripe near end of peduncle; dorsal and caudal lightly barred; pectoral with a couple of faint bars.

Gobio soldatovi minulus, new subspecies

Description of the Type.—Number 8417, American Museum of Natural History, from Kweihwa, Shansi; collected by C. H. Pope.

Length to base of caudal, 57 mm. Depth in length, 4.6; head, 3.5. Eye in head, 3.8; snout, 3; interorbital, 3.5; maxillary, 3.5; depth of peduncle, 3; length of peduncle, 1.4; pectoral, 1.3; ventral, 1.6; longest dorsal ray, 1.5; longest anal ray, 1.7; caudal lobe, 1. Barbel in eye, 1.3.

Dorsal, 9½; anal, 8. Scales, 41. Teeth (from a cotype), 5,2.

Slender, moderately compressed, broadest at the back of the head; eye placed high, almost strictly lateral, very little superolateral; the interorbital slightly concave due to orbital rim being slightly raised; profile rounding downward before the eye, with a shallow dent in front of nostril; breast and belly flattish but not so much so that either pectorals or ventrals lie in a horizontal plane; vent a little nearer anal origin than to ventral axil. Mouth horizontal, slightly inferior, semicircular; with thick, slightly and finely papillose lips, grooves behind sides of lower lip not quite meeting at the chin; maxillary not quite to front of eye, with a well-developed subterminal barbel; gill-membranes adnate to breast under edge of preopercle. Dorsal and anal without spinuous rays; center of dorsal base equidistant from front of eye and base of caudal; ventral base under center of that of dorsal; pectoral and ventral rounded; pectoral not quite reaching ventral, ventral not quite reaching anal; caudal shallowly forked; rudimentary caudal rays precurrent as short low keels above and below on peduncle. Lateral line complete, dipping slightly in front, straight and in center from behind dorsal axil; breast scaleless.

About seven blotches along side with a tendency to be confluent; somewhat dark above, a dark stripe from eye toward snout; lower surfaces and lower fins pale; dorsal and caudal faintly barred.

Gobio coriparoides, new species

Description of the Type.—Number 8418, American Museum of Natural History, from the vicinity of Ningwu, Kolan and Tsinglo, Shansi; collected by C. H. Pope.

Length to base of caudal, 77 mm. Depth in length, 4.6; head, 3.5. Eye in head, 4.5; snout, 3; interorbital, 3; maxillary, 3.3; barbel, 2.3; width of mouth, 3.4; greatest width (the back of head), 1.8; depth of peduncle, 2.5; its length, 1.2; pectoral, 1.2; ventral, 1.5; longest dorsal ray, 1.2; longest anal ray, 1.4; lower caudal lobe, 1.

Dorsal, 9½; anal, 8. Scales, 42. Teeth, 5, 2.

Moderately compressed; head below, breast and belly flattened; ventrals (and pectorals to a less extent) in a horizontal plane; vent at one-quater the distance from anal origin to ventral axil. Interorbital flattish; mouth inferior, horizontal, horseshoe-shaped; lower jaw included; maxillary not quite to under front of eye, with a long terminal barbel; eye almost strictly lateral; gill-membranes joined to side of breast below edge of preopercle. Dorsal and anal without spinous rays; dorsal origin equidistant from tip of snout and tip of depressed anal; ventral origin behind that of dorsal; pectoral passing ventral origin; ventral reaching to vent; anal falcate; caudal forked, the lower lobe the longer. Scales with conspicuous rather close-spaced radiating striæ; breast scaleless anterior to pectoral axil; lateral line complete, straight, in the center, rising a little to meet opercle at extreme front end.

Color rather dark, paler below; a faint dark longitudinal band on the peduncle.

From general appearance, the writer would be tempted to place this species in *Coripareius*, were its teeth not typical of *Gobio*.

There are two other somewhat aberrant, apparently undescribed species of the genus *Gobio*. One from Tungting suggests certain species of *Rhinogobio;* the other, from Shansi, has a form suggestive of *Sauro-*

gobio, color pattern of *Pseudogobio* but lips restricted, versus unusually developed as in these two specialized genera.

Gobio longipinnis, new species

?Rhinogobio ventralis Sauvage and Dabry de Thiersant, 1874, Ann. Sci. Nat., (6) I, Art. 5, p. 11.

Description of the Type.—Number 8419, American Museum of Natural History, from Huping, Tungting Lake, Hunan; collected by C. H. Pope.

Length to base of caudal, 95 mm. Depth in length, 4.7; head, 3.9. Eye in head, 7; snout, 2.1; interorbital, 3; maxillary, 2.4; width of mouth, 3.5; barbel, 7; greatest width of body (at back of head), 1.7; depth of peduncle, 2.2; its length, 1.4; pectoral, 1.1; ventral, 1.2; longest dorsal ray, 0.9; longest anal ray, 1.2; lower caudal lobe, 0.8; distance between gill-clefts, 3.

Dorsal, 10; anal, 9. Scales, 52. Teeth, 5, 2.

Moderately compressed; snout pointed; vent at three-eighths the distance from anal origin to ventral axil. Interorbital convex, striate with rows of small tough prominences; mouth at a distance behind tip of snout, one and one-half times eye, inferior, transverse, horizontal, forming a broad subtruncate curve; maxillary reaching a little short of front border of eye; with a terminal barbel; eye somewhat superolateral; gill-membranes broadly joined to side of breast behind edge of preopercle. Dorsal and anal without spinous rays; dorsal origin equidistant from tip of snout and tip of last anal ray; ventral origin slightly behind that of dorsal; pectoral passing ventral origin; ventral reaching to anal origin; anal three-fourths the distance to base of caudal; caudal well forked, lower lobe a little the longer. Scales with well-spaced horizontal striæ; small scales present on breast to line between gill-clefts; lateral line complete, straight, in the center, rising a very little to meet opercle at its extreme front end.

Color uniform.

Gobio rivuloides, new species

Description of the Type.—Number 8420, American Museum of Natural History, from Niang-tze-kwan, Shansi; collected by C. H. Pope.

Length to base of caudal, 133 mm. Depth in length, 5.5; head, 3.7. Eye in head, 6; snout, 2.3; interorbital, 3.8; maxillary, 2.6; width of mouth, 2.7; barbel, 2.6; width between gill-openings, 6; depth of peduncle, 2.8; its length, 1.4; pectoral, 1.3; ventral, 1.4; longest dorsal ray, 1.4; longest anal ray, 1.8; upper caudal lobe, 1.2.

Dorsal, 9½; anal, 9. Scales, 42. Teeth (from a cotype), 5, 3.

Head flat-topped; snout steep; body cylindrical; peduncle compressed; the back not elevated; belly flattish, ventrals in a horizontal plane; vent about equidistant from ventral axil and anal origin. Tip of snout soft, somewhat swollen, papillose; mouth inferior, semicircular, horizontal, with thick papillose lips produced backward at the corners and stopping at the sides of the lower jaw; maxillary not reaching eye; with a single well-developed subterminal barbel; eye superolateral; gill-membranes joined to the isthmus under edge of preopercle. Middle of dorsal base equidistant from nostril and base of caudal; the ventral origin slightly in advance thereof; pectoral reaching more than two-thirds the distance to ventral; ventral

more than three-quarters distance to anal; caudal forked, upper lobe the longer (in another specimen it is the shorter) and more pointed. Scales with rather close-spaced radiating striæ; breast naked, the scaleless area ending in a blunt point nearer isthmus than ventrals.

Color dark, paler along the belly, about ten vague squarish unequal blackish blotches along lateral line; two blackish stripes radiating from the lower border of the eye to the mouth; caudal crossed by rows of fine black spots; dorsal with a few such rows, and pectoral with two or three faint ones.

VI.—NEW GUDGEONS OF THE GENERA *GNATHOPOGON* AND *LEUCOGOBIO*

The recognition of *Gnathopogon* Bleeker, 1860, and *Leucogobio* Günther, 1896, genera of minnow-like and chublike gudgeons, as distinct from *Gobio*, is largely a matter of convenience. There seem to be several well-marked species of each in the Chinese fish-fauna. Recent authors sometimes synonymize these genera with *Gobio* (*Leucogobio chankaënsis* and *tæniatus*,—Berg, 1916; *Gobio* [*Gnathopogon*] *argentatus* and *wolterstorffi*,—Fowler, 1924) while recognizing *Paraleucogobio* Berg, 1907 (in the writers' opinion only subgenerically distinct from *Leucogobio*, in a single relative character of the last simple dorsal ray) as a full genus. Jordan, 1920, unites *Leucogobio* with *Gnathopogon*. They seem to be about equally different from one another and from *Gobio*, but the type of *Gnathopogon* (*Capoëta elongata*, Temminck and Schlegel, 1844) approaches *Leucogobio* more closely than do most of the species referable to *Gnathopogon*. *Squalidus chankaënsis* Dybowski, 1872, may be an aberrant species of *Leucogobio* as here understood, in which case *Leucogobio* becomes a synonym of *Squalidus* Dybowski.

Leucogobio polytænia, new species

Description of the Type.—Number 8421, American Museum of Natural History, from Niang-tze-kwan, Shansi; collected by C. H. Pope.

Length to base of caudal, 76 mm. Depth in length, 3.7; head, 3.7. Eye in head, 4; snout, 3.5; interorbital, 2.8; maxillary, 3.5; depth of peduncle, 1.9; its length, 1.3; pectoral, 1.3; ventral, 1.5; longest dorsal ray, 1.5; longest anal ray, 1.6; caudal lobe, 1.3. Barbel in eye, 2.

Dorsal, 9½; anal, 8. Scales, 39. Teeth (from a cotype), 5, 3.

Head and snout blunt; body little compressed; peduncle compressed; breast broad and rather flat. Jaws equal; mouth small, oblique, transverse; maxillary not reaching eye; with a small, slender subterminal barbel, the base of which is concealed behind the broad upper lip; tip of lower jaw squarish; gill-membranes narrowly joined in a fold across the isthmus. No spinous dorsal or anal rays; dorsal origin over that of ventral, slightly nearer tip of snout than base of caudal; pectoral rounded, not reaching ventral; ventral not quite to anal; caudal moderately forked,

the upper lobe the more pointed and the two equal. Scales rather rough, with close-set subparallel striæ; lateral line complete, straight, in the middle of side. Vent at tips of ventrals, three-quarters the distance from their axils to origin of anal.

Blackish above; the color most solid along mid-side; with indistinct pale streaks along back; side below lateral line with alternate dark and silvery streaks of about equal width, and belly paler; lower half of face silvery. Dorsal with a black spot on its front rays, continued backward as a faint shade across the fin; other fins plain.

Leucogobio tæniellus, new species

Description of the Type.—Number 8422, American Museum of Natural History, from streams in the Min River Basin, near Yenping, Fukien, 1920; collected by H. R. Caldwell.

Length to base of caudal, 55 mm. Depth in length, 3.7; head, 3.8. Eye in head, 3.5; snout, 3.5; interorbital, 3; maxillary, 3.3; depth of peduncle, 1.8; length of peduncle, 1.7; pectoral, 1.4; ventral, 1.6; longest dorsal ray, 1.6; longest anal ray, 1.6; caudal lobe, 1.3. Barbel in eye, 1.5.

Dorsal, 9; anal, 8. Scales, 36.

Moderately compressed; the head rather blunt; vent a little in advance of anal origin. Lower jaw slightly included; mouth moderately oblique; maxillary not reaching front of eye; with a moderate subterminal barbel; gill-membranes narrowly joined to isthmus under edge of preopercle. No spinous dorsal or anal rays; dorsal origin equidistant from tip of snout and base of caudal; ventral origin under that of dorsal; pectoral and ventral rounded; pectoral not quite reaching to ventral, ventral not quite to anal; caudal little forked. Scales with close-set slightly radiating striæ; lateral line complete, in the middle of the side except for a slight rise in front.

Irregularly dark along middle of side; along back; and in one or two lines between. Front of dorsal with a black mark, which is faintly indicated across the fin.

Gnathopogon punctatus, new species

Description of the Type.—Number 8423, American Museum of Natural History, from near Yenping, Fukien; collected by H. R. Caldwell. Close to *Gnathopogon wolterstorffi* (Regan).

Length to base of caudal, 46 mm. Depth in length, 4.5; head, 3.9. Eye in head, 3; snout 3.4; interorbital, 4; maxillary, 3.6; barbel, 4; greatest width of body (at back of head), 2; depth of peduncle, 2.7; its length, 1.6; pectoral, 1.4; ventral, 1.4; longest dorsal ray, 1.3; longest anal ray, 1.7; caudal lobe, 1.

Dorsal, 10; anal, 8. Scales, 35.

Symmetrical, fusiform, not much compressed; the vent at about one-third the distance from anal origin to ventral axil; breast and belly broadly rounded. Snout bluntly pointed; mouth very slightly oblique; maxillary to almost under front of eye; lower jaw very slightly included; a long slender terminal maxillary barbel; interorbital almost flat; eye large, oval; gill-membranes narrowly joined to isthmus under posterior margin of eye; suborbital crossed by fine subvertical lines of pores. Dorsal and anal without spinous rays; dorsal origin equidistant from the tip of snout and middle of peduncle; very slightly in advance of ventral origin; pectoral not reaching ventral, ventral not reaching anal; caudal narrow, well-forked, with pointed lobes.

Scales with conspicuous wide-spaced radiating striæ; lateral line complete, a little bent down, running in center of peduncle.

A series of small dark spots above the lateral line, and a faint plumbeous streak in the center of peduncle.

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SOME CHINESE FRESH-WATER FISHES[1]

By J. T. Nichols

VII.—NEW CARPS OF THE GENERA *VARICORHINUS* AND *XENOCYPRIS*

There are four species of *Varicorhinus* with very small barbels in the collections of the Third Asiatic Expedition. One of these from Fukien seems not to be differentiable from *Varicorhinus tamusuiensis* (Oshima, 1919) described from Formosa. The relationship of these forms is probably close to species figured by Berg, 1916, but it is improbable that any will prove to be identical with same.

Varicorhinus tamusuiensis (Oshima)

Scaphesthes tamusuiensis Oshima, 1919, Ann. Carn. Mus., XII, p. 209, Pl. L, fig. 1.

Description of a specimen from streams in the general Min River Basin, near Yenping, Fukien, August, 1920; collected by H. R. Caldwell.

Length to base of caudal, 95 mm. Depth in length, 4.3; head, 4. Eye in head, 3.4; snout, 3.4; interorbital, 2.9; maxillary, 2.7; width of mouth, 2.8; depth of peduncle, 2.8; its length, 1.4; pectoral, 1.2; ventral, 1.3; longest dorsal ray, 1.4; longest anal ray, 1.7; caudal lobe, 1.

Dorsal, 10; anal, 7½. Scales, 48. Teeth, 4 or 5, 3, 2.

Elongate, compressed; the head broad and blunt, rounded above and in front; the lower jaw flat, concave in profile. Mouth inferior, transverse, almost straight, the lower jaw very broad, with sharp, brown, horny edge, and no free lip; two pairs of minute barbels; maxillary horizontal, to under front of eye; front and sides of snout with large, horny warts; gill-membranes narrowly joined to isthmus under posterior margin of eye. Dorsal and anal without spinous rays; dorsal origin equidistant from tip of snout and base of caudal; ventral origin under first third of dorsal; pectoral not reaching ventral, ventral not reaching anal; caudal deeply forked, upper lobe a little the longer. Scales rough, with subparallel slightly radiating striæ; lateral line complete; dropping along the upper part of the opercular margin, little if any curved and near center of side from the tips of the pectorals back.

Color dark, paler beneath; margin of dorsal with black on the membrane.

Such differences as this species shows from *tamusuiensis* are mostly attributable to Oshima's Formosan specimen having been of larger size, 230 mm. The pectoral of our fish is longer, extending two-thirds versus three-fifths the distance to ventral, but this difference is insignificant.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 54.

Varicorhinus robustus, new species

Description of the Type.—No. 8424, American Museum of Natural History, from near Yenping, Fukien; collected by H. R. Caldwell.

Length to base of caudal, 103 mm. Depth in length, 3.7; head, 4. Eye in head, 3.5; snout, 3; interorbital, 2.6; maxillary, 2.5; width of mouth, 2; greatest width of body (at shoulder), 1.5; depth of peduncle, 2.4; its length, 1.4; pectoral, 1.2; ventral, 1.3; longest dorsal ray, 1; longest anal ray, 1.2; caudal lobe, 0.8. Posterior barbel in eye, 6.

Dorsal, 10; anal, 8. Scales, 47. Teeth (in a cotype), 4, 3, 2; hooked.

Not greatly compressed; the head rounded and blunt; breast broad, rounded; ventrals approximately in a horizontal plane. Mouth broad, almost straight across, a little behind tip of the rounded snout; upper lip over-hanging front of mouth and overhung in turn by transverse snout flap; lower jaw with a sharp, brown, horny edge; lower lip with slight line of demarkation behind; maxillary to under front of eye; with a small terminal barbel, a trifle longer than a similar barbel on each side of tip of snout flap; interorbital somewhat convex; gill-membranes narrowly adnate to isthmus below corner of preopercle. Dorsal and anal without spinous rays; dorsal origin equidistant from tip of snout and middle of peduncle; ventral base slightly behind middle of that of dorsal; pectoral not nearly reaching ventral; ventral not reaching anal; anal almost to origin of caudal; caudal forked with equal pointed lobes. Scales rough, with somewhat radiating striæ; lateral line complete, straight, in the center, rising a little to meet opercle.

Color dark, especially the tips and bases of the scales, paler below the eye and on belly.

This is a more robust fish than *Varicorhinus tamusuiensis* which occurs in the same locality.

Varicorhinus shansiensis, new species

Description of the Type.—No. 8425, American Museum of Natural History, from Niang-tze-kwan, Shansi; collected by C. H. Pope.

Length to base of caudal, 174 mm. Depth in length, 3.9; head, 4.5. Eye in head, 5; snout, 2.6; interorbital, 2.6; maxillary, 2.9; width of mouth, 2.9; greatest width (at front of dorsal), 1.5; depth of peduncle, 2.4; its length, 1.4; pectoral, 1.2; ventral, 1.2; longest dorsal ray, 1.3; longest anal ray, 1.3; caudal lobe, 0.8. Barbel in eye, 3; distance between gill clefts, 1.2.

Dorsal, 10; anal, 7. Scales, 51. Teeth (in a cotype), stout, slightly hooked, 5, 3, 2, first tooth of the main row small.

Little compressed; breast and belly broad. Mouth inferior transverse almost straight across, a little behind the blunt snout; lower jaw with a sharp, cartilaginous edge, pale in color, without free lip; maxillary almost to under front margin of eye; with a small subterminal barbel; a smaller second barbel at corner of snout flap on one side only; front and sides of snout with a few small horny points; gill-membranes joined to sides of isthmus under edge of preopercle. Dorsal and anal without spinous rays; dorsal origin equidistant from tip of snout and middle of peduncle; ventral under middle of dorsal base; pectoral reaching two-thirds the distance to ventral; ventral three-fourths the distance to anal; caudal well forked with equal pointed

lobes. Scales with rather close-spaced, slightly radiating striæ; scales small on the breast; lateral line complete, rising slightly to meet opercle, otherwise straight in the center.

Dark above, paler below, fins plain.

This species has smaller scales than the two preceding and differs from each of them in other details. We have three specimens from the base of Tai-pei-shan in the Tsingling Mountains, Shensi, which we also refer to it. The position of the dorsal origin is variable, sometimes nearer base of caudal than tip of snout.

Varicorhinus tungting, new species

Description of the Type.—No. 8426, American Museum of Natural History, from Huping, Tungting Lake, Hunan; collected by C. H. Pope.

Length to base of caudal, 126 mm. Depth in length, 4.5; head, 4.4. Eye in head, 5; snout, 2.4; interorbital, 2.2; maxillary, 2.5; width of mouth, 2.5; width of body, 1.5; depth of peduncle, 1.6; its length, 1.5; pectoral, 1.1; ventral, 1.3; longest dorsal ray, 1.1; height of anal, 1.4; caudal lobe, 0.7; across breast, gill slit to gill slit, 3.6. Barbel in eye, 2.5.

Dorsal, 12; anal, 7. Scales, 45. Teeth (in a cotype), 5, 3, 3, or 5, 4, 2; compressed, bluntly pointed, loosely attached, crowded.

Head somewhat depressed; body increasingly compressed backward. Interorbital gently convex; snout bluntly pointed; extending well beyond the broad inferior, slightly curved, transverse mouth; mouth overhung by a thick membrane with free notched-fluted edge; lower lip free in front, with a similarly notched edge; maxillary not to under front of eye; with a small terminal barbel; an exceedingly minute barbel on the side of snout in advance of corner of snout membrane; gill-membranes broadly joined to side of breast under edge of preopercle. Dorsal and anal without spinous rays; dorsal origin equidistant from tip of snout and base of caudal; ventrals under middle of dorsal; pectorals reaching two-thirds the distance to ventral; ventral to anal origin; caudal large, well forked. Scales rough, with close-spaced subparallel as well as the more marked concentric striæ; lateral line complete, straight in the center; body scaling extending onto caudal base.

Color dusky.

This species is well differentiated from the three preceding by the notched free membranes surrounding the mouth.

A number of species of *Xenocypris* have been described from China, and to draw up a satisfactory synonymy of this genus will be difficult and require more time than is now available. *X. microlepis*, *macrolepis* and *davidi* Bleeker, 1871, and *lamperti* Popta, 1908, are probably good species. *X. tapeinosoma* Bleeker, 1871, *argentea* Günther, 1868, *nitidus* Garman, 1912, *ænea* and *guntheri* Sauvage and Dabry de Thiersant, 1874, *argenteus* (Basilewski, 1855) and *simoni* (Bleeker, 1865) which may not belong in this genus, and *jesella* (Cuvier and Valenciennes,

1844) which is unidentifiable, are probably not good species. Mr. Caldwell has collected a species in Fukien which is quite distinct from all these, and is here described as new. It resembles *Distœchodon tumirostris* Peters, 1880, from Ningpo, Oshima, 1919, from Formosa, but is deeper, with a longer pectoral, etc. *Distœchodon* Peters, 1880, is said to be separated from *Xenocypris* by the character of the teeth, 2 rowed,—7,3.

Xenocypris compressus, new species

Description of the Type.—No. 8427, American Museum of Natural History, from near Yenping, Fukien; collected by H. R. Caldwell.

Length to base of caudal, 103 mm. Depth in length, 3.8; head, 3.9. Eye in head, 3.5; snout, 3.1; interorbital, 3.3; maxillary, 4.3; width of mouth, 3.6; greatest width of body (at back of head), 2; depth of peduncle, 2.6; its length, 2; pectoral, 1.3; ventral, 1.6; longest dorsal ray, 1.3; longest anal ray, 1.8. Mouth to tip of snout in eye, 2.7.

Dorsal, II, 7; anal, 12. Scales, 74. Teeth broken.

Compressed, pointed before and behind; top and bottom of head flat, slanting. Interorbital flattish; mouth inferior, transverse, almost straight across; gill-membranes narrowly joined to isthmus behind posterior margin of eye. Last simple dorsal ray a slender spine, its tip soft; dorsal origin equidistant from base of caudal and front of eye; ventral origin under that of dorsal; pectoral narrow and pointed, reaching two-thirds the distance to ventral; ventral two-thirds to anal; caudal forked. Scales with conspicuous concentric and wide-spaced slightly radiating striæ; lateral line complete, somewhat bent down behind head, running in center of peduncle.

Pale below and on sides, darker on back; sides with more or less distinct, fine dark streaks following the rows of scales, in one of which the lateral line is situated; fins plain.

VIII.—CARPS REFERRED TO THE GENUS *PSEUDORASBORA*

The type of *Pseudorasbora* Bleeker, 1859, is *Leuciscus parvus* Temminck and Schlegel, 1844, from Japan. A small fish, widely distributed on the mainland of eastern Asia, is generally considered identical therewith. We have also a closely related form which is distinct, collected by Mr. Granger in Szechwan.

Secondly there is to hand a fish from Anhwei, described and figured by Fowler, 1924, and referred by him to *Aphyocypris chinensis* Günther. An authentic specimen of *Aphyocypris*, courteously sent us more recently by Mr. J. R. Norman of the British Museum, shows this to be a quite different genus apparently related to the Abramidinæ. Fowler's species may be provisionally referred to *Pseudorasbora*, as may also a form resembling it from Shansi.

Thirdly, an undescribed fish from Fukien, is here included in *Pseudorasbora*.

Pseudorasbora parva (Temminck and Schlegel)

Leuciscus parvus Temminck and Schlegel, 1844, 'Fauna Japonica,' p. 215, Pl. cii, fig. 3. Japan.

Pseudorasbora parva Fowler, 1924, Bull. Amer. Mus. Nat. Hist., L, p. 382, Chihli.

Pseudorasbora altipinna, new species

Description of the Type.—No. 8428, American Museum of Natural History from Yen-ching-kao, Szechwan; collected by Walter Granger.

Length to base of caudal, 55 mm. Depth in length, 4; head, 3.8. Eye in head, 4; snout, 3; interorbital, 2.6; maxillary, 4.6; width of head and of body, 1.9; depth of peduncle, 2; its length, 1.1; pectoral, 1.3; ventral, 1.3; longest dorsal ray, 1; caudal lobe, 0.8; longest anal ray, 1.8.

Dorsal, 9; anal, 8. Scales, 38. Teeth (in a cotype), 5, small, hooked, in one row.

Compressed; nape slightly elevated; breast broad and belly rounded. Mouth small, transverse, vertical; lower jaw projecting; maxillary not reaching nearly to front of eye; no barbels; interorbital flattish; eye slightly infralateral; gill-membranes joined to side of isthmus well behind edge of preopercle. Dorsal and anal without spinous rays; dorsal origin equidistant from tip of snout and middle of peduncle; ventral origin under that of dorsal; pectoral not quite reaching ventral, and ventral not quite reaching anal; caudal forked, with equal lobes. Scales with faint, slightly radiating striæ; lateral line complete, in or slightly below the center, rising gently to meet opercle.

Color uniform. Several specimens were taken, of which this is one of the largest.

Pseudorasbora fowleri, new species

Aphyocypris chinensis Fowler, 1924, Bull. Amer. Mus. Nat. Hist., L, p. 383, Fig. 1. Anhwei. Not of Günther.

Pseudorasbora depressirostris, new species

Description of the Type.—No. 8429, American Museum of Natural History, from Chin-Ssu, Shansi; collected by C. H. Pope.

Length to base of caudal, 49 mm. Depth in length, 3.8; head, 3.6; eye, 4.2; snout, 3.3; interorbital, 2.5; maxillary, 4; depth of peduncle, 2; its length, 1.4; pectoral, 1.5; ventral, 1.5; longest dorsal ray, 1.3; longest anal ray, 1.6; caudal lobe, 1.2.

Dorsal, 9; anal, 8. Scales, 38. Teeth (in a cotype), 5, small, hooked, in one row.

Body compressed; interorbital broad, very slightly convex; nape elevated, snout depressed. Snout pointed; mouth small, transverse, almost vertical; lower jaw projecting; maxillary reaching about half the distance to eye; no barbels; opercle with a membranous edge; gill-membranes joined to breast behind edge of preopercle; 2 pairs of horny points on the chin, 2 such points in line back of angle of mouth, and one near maxillary higher up. Dorsal and anal without spinous rays; dorsal origin equidistant from tip of snout and base of caudal; very slightly in advance of ventral origin; pectoral short, reaching two-thirds the distance to ventral, ventral not reaching anal; caudal moderately forked. Scales with close-spaced, conspicuous, radiating

striæ; lateral line complete, dropping slightly behind opercle, thence straight to caudal base in center of side.

Dark above, pale below; scales of back and sides bordered with dark; fins plain, ventrals somewhat yellowish; an obscure dark band from eye to base of caudal, scarcely indicated in the type, but better marked in some individuals, of which we have several of about the same size.

Pseudorasbora monstrosa, new species

Description of Type.—No. 8430, American Museum of Natural History, from near Yenping, Fukien; collected by H. R. Caldwell.

Length to base of caudal, 62 mm. Depth in length, 4; head, 4. Eye in head, 4; snout, 3.2; interorbital, 2.7; maxillary, 4; depth of peduncle, 2.2; its length, 1.2; pectoral, 1.5; ventral, 1.5; longest dorsal ray, 1.4; longest anal ray, 1.8; caudal lobe, 1.1.

Dorsal, 9; anal, 8. Scales, 33. Teeth, 5, raised, hooked, in one row.

Moderately compressed; head blunt, its top broad and flattish, the nape slightly elevated; breast and belly rounded. Maxillary vertical; mouth small, almost strictly transverse; lower jaw very little projecting; no barbels; tip of snout before nostrils slightly swollen and set off by a groove; 2 large horny warts on side of snout, 2 or 3 smaller ones below eye; also a large two-pronged wart on one side of mandible; gill-membranes adnate to breast behind edge of preopercle. Dorsal without spinous rays, the 2nd (last) simple ray stiffened at base; dorsal origin equidistant from tip of snout and center of peduncle, directly over ventral origin; pectoral not reaching ventral, ventral not reaching anal; caudal forked with equal pointed lobes. Scales with conspicuous radiating striæ; lateral line straight to over anal origin, absent on peduncle.

Scales with dusky borders; the fins bordered with blackish.

This may be an abnormal, large individual of a variable species. Smaller ones which we refer to it, with some hesitation, are less elongate, especially the peduncle, have the lateral line complete, and the ventral origin before that of the dorsal. Mr. Pope, who is now in the field, is likely to obtain additional material bearing on this point.

IX.—THREE NEW ABRAMIDIN CARPS

Rasborinus fukiensis, new species

Description of the Type.—No. 8431, American Museum of Natural History, from near Yenping, Fukien; collected by H. R. Caldwell.

Length to base of caudal, 69 mm. Depth in length, 3.4; head, 4. Eye in head, 3.5; snout, 4; interorbital, 3.4; maxillary, 3.6; depth of peduncle, 2.5; its length, 2; pectoral, 1.2; ventral, 1.5; longest dorsal ray, 1.4; longest anal ray, 1.5; caudal lobe, 1.

Dorsal, 10; anal, 17. Scales, 39. Teeth (in a cotype), 5, 4, 1, slightly hooked.

Compressed, the head rather blunt; breast broadly rounded; a low, sharp, naked keel between ventrals and anal. Mouth oblique; lower jaw broad, slightly projecting, with a raised inner edge; maxillary to under front margin of eye; no barbels; inter-

orbital somewhat convex; gill-membranes narrowly united and free from isthmus at base. Dorsal and anal without spinous rays; dorsal origin equidistant from base of caudal and hind margin of eye, nearer anal origin than ventral axil; pectoral reaching ventral origin; ventral not reaching anal; caudal shallowly forked with equal lobes; upper ray of pectoral thickened, with fine tooth-like papillæ above on the inside. Scales with a few widely radiating striæ; lateral line complete, bent down, rising on peduncle to terminate in its center; anal with a broad sheath of scales.

Color uniform.

This species is closely related to one found in the island of Hainan, but is less deep, lower jaw slightly projecting, versus included, etc. Both species are close to *Rasborinus takakii* Oshima, 1920, from Formosa, with scales, 36, interorbital broader, 2.5, etc.

Hemiculterella engraulis, new species

Description of the Type.—No. 8432, American Museum of Natural History, from Huping, Tungting Lake, Hunan; collected by C. H. Pope.

Length to base of caudal, 148 mm. Depth in length, 5; head, 3.7. Eye in head, 4.4; snout, 3.4; interorbital, 3.6; maxillary, 2.5; depth of peduncle, 3.5; its length, 2.5; width of body (the back of head), 2; pectoral, 1.4; ventral, 2.1; longest dorsal ray, 2.3; longest anal ray, 2.8; lower caudal lobe, 1.2.

Dorsal, 9; anal, 22. Scales, about 50. Teeth, 4, 4, 2, hooked, pharyngeal bone heavy.

Broad, moderately compressed only; snout blunt, profile low; a low naked keel between ventrals and anal, traces of which (crossed by scales) continue forward to the pectoral axil. Interorbital convex; snout blunt; jaws equal; the pointed tip of mandible fitting into a notch in the middle of snout; front of jaws with an appreciable S-shaped curve; upper jaw protractile; mouth strongly oblique; maxillary to under front of eye; no barbels; angle of preopercle bluntly projecting; gill-membranes confluent with one another and center of isthmus behind edge of preopercle. Dorsal and anal without spinous rays; dorsal origin equidistant from base of caudal and posterior margin of eye; well behind ventral base; anal origin slightly behind dorsal axil; pectoral not reaching ventral, ventral not nearly to anal; caudal well forked, the lower lobe decidedly the longer. Scales deciduous; with radiating striæ; lateral line complete, slanting down to over tip of pectoral, thence turning back horizontally, rising in a steep slant over anal axil to run in the center of peduncle.

Dark on the back; pale below; fins plain.

This well-marked species, of which but a single example is to hand, is provisionally referred to *Hemiculterella* Warpachowski, 1888.

Hemicultur clupeoides, new species

Description of the Type.—No. 8433, American Museum of Natural History, from Tungting Lake, Hunan, December 24, 1921; collected by C. H. Pope.

Length to base of caudal, 127 mm. Depth in length, 4.3; head, 4.6. Eye in head, 3.7; snout, 3.9; interorbital, 3.2; maxillary, 3.9; depth of peduncle, 2; pectoral, 1; ventral, 1.6; height of dorsal, 1.4; height of anal, 2.5; caudal lobe, 0.7.

Dorsal, II, 7; anal, 14. Scales, about 55, the last well on caudal base. Teeth, 4, 4, 2, slightly hooked.

Body moderately compressed; jaws equal; maxillary concealed under preorbital, not quite reaching to below front of eye; gill-membranes joined, forming a narrow fold across isthmus. Last dorsal spine slender; ventral origin slightly in advance of that of dorsal; pectoral not reaching ventral, ventral falling far short of anal. A sharp, naked keel from ventrals to anal; scales deciduous; lateral line complete, running low, rising abruptly to center of peduncle over anal axil. Scales on breast pointed, with an appreciable slight keel running forward from ventrals two-thirds the distance to isthmus.

This species differs from others of the genus *Hemiculter* in being less compressed, with more deciduous scales, the anterior flexure in the lateral line less marked. *Hemiculter kneri* Kreyenberg and Pappenheim, 1908, is probably referable to it at least in part, but this is preoccupied by *Hemiculter kneri* Warpachowski, 1888.

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SOME CHINESE FRESH-WATER FISHES[1]

By J. T. Nichols

X. SUBGENERA OF BAGRIN CATFISHES

There are a number of related catfishes in China variously assigned to the genera *Pseudobagrus* Bleeker (type, *Bagrus aurantiacus* Temminck and Schlegel, Japan) and *Leiocassis* Bleeker (type, *L. micropogon* Bleeker, Sumatra, Borneo, etc.). Those referred to *Leiocassis* have the adipose rather long, and are supposed to have the orbital rim adnate. As a matter of fact they fall readily into two quite different series, neither of which is referable with any certainty to the type represented by East Indian *micropogon*, and it is best for the present to separate them from the same as subgenera, as follows.

Nasocassis, new subgenus. Snout with a tendency to be elongate or swollen. Orbital rim much as in *Pseudobagrus*, usually partially free, but eye much smaller, so that its rim appears adnate. Caudal well forked. Type: *Leiocassis longirostris* Günther, China.[2]

Dermocassis, new subgenus. Orbital rim completely or almost completely adnate. Caudal emarginate, truncate, or rounded. Type: *Leiocassis ussuriensis* Berg (*Bagrus ussuriensis* Dybowski), Manchuria, China, etc.

On the other hand, *Fluvidraco* Jordan and Fowler (type *Pseudobagrus ransonneti* Steindachner, Japan) for those species of *Pseudobagrus* wherein bones on the top of the head are exposed, rugose, is certainly not entitled to more than subgeneric rank.

A related but quite distinct form of catfish common in China, with elongate body, flat head and very long adipose, was described as *Hemibagrus macropterus* Bleeker, and is thus far recognized as a single species. The writer doubts the close relationship of this fish to *Bagrus nemurus* Cuvier and Valenciennes, Java, Malacca, Siam, etc., in fresh and brackish water, which is the type of *Hemibagrus* Bleeker. He here proposes for *Hemibagrus macropterus* Bleeker the subgenus **Macropterobagrus**, distinguished by elongate body, very long adipose, depressed head and

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 55.

[2]Günther, 1888, Ann. Mag. Nat. Hist., (6) I, p. 430, says: "This is not a Japanese species, as I was incorrectly informed when I described it."

weekly forked caudal; to stand as a full genus if *Hemibagrus* be subordinated to *Macrones* Dumeril (equals *Aoria* Jordan) or to *Pseudobagrus* Bleeker.

XI.—CERTAIN APPARENTLY UNDESCRIBED CARPS FROM FUKIEN

Barbus caldwelli, new species

Description of the Type.—No. 8434, American Museum of Natural History, from near Yenping, Fukien; collected by H. R. Caldwell.

Length to base of caudal, 100 mm. Depth in length, 3.6; head, 3.5. Eye in head, 4; snout, 3; interorbital, 2.7; maxillary, 3.1; width of mouth, 3.6; width of snout, 3; posterior barbel, 3.2; width of head and of body, 1.8; depth of peduncle, 2.8; its length, 2.5; pectoral, 1.5; ventral, 1.6; longest dorsal ray, 1.9; longest anal ray, 1.7; lower caudal lobe, 1.1.

Dorsal, 11; anal, 7½. Scales, 24.

Moderately compressed, the head broad, snout pointed. Mouth very slightly oblique; lower jaw included; two well-developed slender barbels, the posterior at the end of the maxillary decidedly the longer; maxillary to under front margin of eye; left side of snout only with a band of small, crowded, warty points above the maxillary; eye lateral; interorbital very slightly concave; gill-membranes rather narrowly joined to side of isthmus just before the edge of the preopercle. Dorsal and anal without spinous rays; dorsal origin equidistant from tip of snout and base of caudal; ventral placed slightly behind center of dorsal base; pectoral reaches two-thirds the distance to ventral; ventral three-fourths to anal; caudal moderately forked with pointed lobes, the lower slightly the longer. Scales rough, with close-spaced radiating striæ; lateral line complete, slightly bent down, in the center of peduncle.

Dorsal with a black free margin; scales faintly outlined in dark; a dark streak in the outer basal margin of each caudal lobe.

Three larger specimens also were collected of this handsome barb, which is closely related to a similarly colored form we have from the island of Hainan. Its differences from the latter seem to lie in a less chubby body, narrower, more pointed snout, and slightly higher scale count.

Barbus (Lissochilichthys) hemispinus, new species

Description of the Type.—No. 8435, American Museum of Natural History, from near Yenping, Fukien; collected by H. R. Caldwell.

Length to base of caudal, 64 mm. Depth in length, 3.1; head, 3. Eye in head, 3.5; snout, 2.6; interorbital, 4; maxillary, 3.8; posterior barbel, 4.5; depth of peduncle, 2.4; its length, 2; pectoral, 1.4; ventral, 1.5; longest dorsal ray, 1.5; longest anal ray, 1.6; caudal lobe, 1.1.

Dorsal II, 8½; anal, 8. Scales, 39.

Compressed, back somewhat elevated. Snout long and narrow; lower jaw included; lower lip deeply grooved in the middle, the jaw projecting forward beyond it; two rather long maxillary barbels, the posterior the longer; mouth horizontal; maxillary not reaching to below front border of eye; interorbital little convex; gill-

membranes broadly joined to side of breast below edge of preopercle. Last simple ray of dorsal stiffened and serrate behind, but soft distally; dorsal origin equidistant from base of caudal and middle of snout, over that of ventral; pectoral not reaching ventral, ventral not reaching anal; caudal forked, with pointed lobes. Scales rough, with well-marked, somewhat radiating striæ; scales somewhat smaller posteriorly; lateral line complete, almost straight in the center, very slightly bent down in front.

A vague dark mark on peduncle.

The presence and character of a dorsal spine does not appear to be of much significance in barboid carps, hence this species, on the basis of the structure of its mouth, is placed close to *Lissochilichthys matsudai* Oshima, 1920,[1] Formosa, which would apparently stand as a synonym of *Gymnostomus labiatus* Regan, 1908,[2] were *labiatus* not preoccupied by *Barbus* (*Labeobarbus*) *labiatus* Boulenger, 1902,[3] if *Lissochilichthys* be considered a subgenus of *Barbus*. *Barbus* (*Lissochilichthys*) *matsudai*, by the way, is common in Fukien, apparently not separable from the Formosan fish. Also there is a fish closely related to *B. hemispinus* in the island of Hainan, apparently more slender, with shorter barbels, and reaching a larger size.

Sarcocheilichthys sinensis fukiensis, new subspecies

Description of the Type.—No. 8436, American Museum of Natural History, from near Yenping, Fukien; collected by H. R. Caldwell.

Length to base of caudal, 90 mm. Depth in length, 3.6; head, 4.4. Eye in head, 3.5; snout, 3; interorbital, 2.5; maxillary, 3; width of mouth, 3.4; width of body, 1.5; depth of peduncle, 1.7; its length, 1.2; pectoral, 1; ventral, 1.2; longest dorsal ray, 0.9; longest anal ray, 1.2; caudal lobe, 0.9. Barbel in eye, 6.

Dorsal, 9½; anal, 8½. Scales, 41. 4 rows between lateral line and ventral; 16 around caudal peduncle; 11 between the lateral lines across nape.

Moderately compressed, snout somewhat pointed, nape little if at all elevated; vent at one-third the distance from anal origin to ventral axil, with a long ovipositor. Mouth slightly behind the tip of snout, horizontal, inferior, heart-shaped; with moderate lips, confined to the sides of lower jaw, which is, with an exposed shaft between them, somewhat expanded to a curved sharp horny tip; length of mouth 0.8 in its width; maxillary to under front of eye; a small barbel above its end; interorbital very slightly convex; gill-membranes broadly joined to side of isthmus behind edge of preopercle. Dorsal origin equidistant from tip of snout and anal axil; ventrals under center of dorsal base; pectoral reaching five-sixths the distance to ventral; ventral five-sixths to anal; caudal moderately forked. Scales rough, with subparallel horizontal or very slightly radiating striæ; lateral line complete straight in the center.

Four rather well-defined broad blackish cross-bands, one from shoulder to pectoral axil, one from dorsal to ventral narrowly crossing belly behind ventral axil, one opposite the anal, and one on peduncle; anterior and central portion of dorsal,

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[1]Proc. Acad. Nat. Sci. Phila., LXXII, p. 124, Pl. III, fig. 2.
[2]Ann. and Mag. Nat. Hist., (8) II, p. 358.
[3]Proc. Zoöl. Soc., part 2, p. 223, Pl. XVII, fig. 1.

anterior (upper) portion of pectoral, central portions of ventral anal and caudal, blackish, the margins of the fins pale.

Compared with a specimen of the same size (*S. s. sinensis*) from Tungting Lake on the central Yangtze which has depth, 3.7; nape more gibbous, snout blunter; length of mouth 1.4 in its width; barbel 8 in eye; 5 rows of scales between lateral line and ventral, 18 around caudal peduncle; cross-bands less defined and an ill-defined lateral band; more dusky on the bases of the fins, dorsal with less of a pale tip.

Berg, 1916,[1] considers *Barbodon lacustris*, type of the subgenus *Barbodon* Dybowski, to be a race of *Sarcocheilichthys sinensis* Bleeker, 1871,[2] doubtfully credited to the Yangtze by Bleeker. Our *Barbodon* from Tungting is certainly very close to *lacustris* as figured by Berg, and we follow him in identifying it with *sinensis* Bleeker; although a species of the subgenus *Chilogobio* inhabiting the same waters might perhaps as well have been so identified.

Sarcocheilichthys (*Barbodon*) *sinensis* from Ningkwo, Anhwei, may be taken as representing this species in the lower Yangtze Basin. The differences which it shows from the Tungting fish are too slight to receive taxonomic notice.

Garra orientalis, new species

Description of the Type.—No. 8437, American Museum of Natural History, from near Yenping, Fukien; collected by H. R. Caldwell.

Length to base of caudal, 75 mm. Depth in length, 4.4; head, 3.9. Eye in head, 5.5; snout, 2.2; interorbital, 2.7; maxillary, 2.3; width of mouth (and of disk), 2; mouth to posterior edge of disk, 2.7; distance between gill clefts, 3; greatest width of body (at back of head), 1.5; depth of peduncle, 2; its length, 1.7; pectoral, 1; ventral, 1.2; longest dorsal ray, 1; longest anal ray, 1.4; caudal lobe, 0.8. Barbels in eye, 1.5.

Dorsal, 10½; anal, 7½. Scales, 33.

Moderately compressed; the head broad and blunt, somewhat cuboid; lower surface of head and breast flattened so that bases of pectorals and ventrals are in a horizontal plane; vent at slightly more than one-third the distance from anal origin to ventral axil. Eye placed high; slightly superolateral; top of head slightly convex; marked off before the nostrils from the lower front part of snout by a groove; the tip of snout again slightly raised; mouth inferior, transverse, very little curved; overhung in front by the broad snout membrane which is finely pimply near its margin and with comblike serrations on its edge; a rounded disk on chin, smooth in the center and finely pimply near front and hind borders; a small barbel at the tip of the maxillary and another on the side of the front of the snout; forehead and top of snout with warty points; top of head and to some extent side of snout with fine, little prominent pimples; gill-membranes broadly joined to side of breast. Dorsal and anal without spinous rays; dorsal origin equidistant from tip of snout and anal axil; ventral placed under center of dorsal; pectoral not reaching ventral, ventral not reaching anal;

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[1] 'Poiss. Eaux Douces Russ.,' p. 234, Fig. 175.
[2] Verh. Akad. Wet. Amst., Nat., XII, p. 31, Pl. IV, fig. 2.

caudal forked, with equal lobes. Scales rough, with fine irregular parallel striæ; lateral line complete, straight, in the center, rising slightly to meet opercle.

Color uniform, rather dark, paler on belly; a vague dark blotch in center of peduncle near base of caudal.

This species, with a groove before the nostrils, approaches one found in the island of Hainan, wherein the forehead projects as in *Schismatorhynchos*.

XII.—A SMALL GOBY FROM THE CENTRAL YANGTZE

Gobius cliffordpopei, new species

Description of the Type.—No. 8438, American Museum of Natural History, from Tungting Lake, Hunan, December 16, 1921; collected by C. H. Pope.

Length to base of caudal, 34 mm. Depth in length, 4.7; head, 3.4. Eye in head, 5; snout, 3.5; maxillary, 2; depth of peduncle, 3; its length, 1.3; pectoral, 1.3; ventral, 2; longest dorsal spine, 1.7; longest dorsal ray, 1.8; longest anal ray, 2; caudal, 1.5. Interorbital, 4 in eye.

Dorsal VI or VII—9; anal, 8. Head naked before dorsal; scales, 28. No canine teeth.

Eyes close together, superolateral; mouth somewhat oblique, with thick lips, the maxillary extending to under front of eye; jaws equal or lower slightly projecting; gill-membranes joined to sides of breast under or behind edge of preopercle; pectorals reaching beyond ventrals, but not to front of anal; caudal bluntly pointed.

Broad black cross-bands posteriorly, somewhat variable in width.

Small gobies of the subgenus *Rhinogobius*, perhaps referable to *G. hadropterus* (Jordan and Snyder) of Japan, appear to be common in the coastal rivers of China. It is not unlikely that careful study of an adequate series will make it possible to recognize two or three species coastwise. At least the present species from Tungting Lake in the middle Yangtze is distinct from *hadropterus*, differentiated by the, if anything, slightly projecting lower jaw, and broad, conspicuous vertical bands on the sides. Absence of scales on the nape may be due to the small size of the type, but the species would seem to be a small one.

Named for Mr. C. H. Pope, the thoroughness of whose field work in China has brought to light many species of fishes previously overlooked.

XIII.—A NEW MINNOW REFERRED TO *LEUCOGOBIO*

There is to hand a single specimen of a small carp from Anhwei, the exact position of which was at first something of a puzzle. Careful study leaves no question that it is close to *Leucogobio*, in which genus it is provisionally placed. It bears a strong superficial resemblance to *Pseudorasbora fowleri* Nichols, 1925, Amer. Mus. Novitates, No. 182, p. 5.

Leucogobio imberbis, new species

? *Aphyocypris chinensis* Fowler, 1924, Bull. Amer. Mus. Nat. Hist., L, p. 383, in part, not of Günther.

Description of the Type.—No. 8439, American Museum of Natural History, from Ningkwo, Anhwei, September 15 to October 15, 1921; collected by C. H. Pope.

Length to base of caudal, 68 mm. Depth in length, 3.7; head, 3.4. Eye in head, 4.4; snout, 3.7; interorbital, 3.1; maxillary, 3.4; depth of peduncle, 2.8; its length, 1.5; pectoral, 1.4; ventral, 1.6; longest dorsal ray, 1.6; longest anal ray, 1.8; caudal, 1.3.

Dorsal, 9; anal, 8 (counting 2 simple rays). Scales, about 42. Teeth, 5, 2 or 3, rather stout, slightly hooked.

Moderately compressed; back elevated; nape slightly gibbous; top of head flat. Jaws equal; mouth oblique; maxillary not quite reaching to under front of eye, with a minute thick barbel concealed near its tip, on one side only; gill-membranes joined, free from isthmus, at extreme base; opercle with a membranous edge reaching pectoral base. Dorsal without spinous ray; its origin equidistant from end of snout and base of caudal; ventral origin directly under that of dorsal; pectoral not quite reaching to ventral, ventral not quite to anal, caudal moderately forked. Lateral line apparently complete (scales lost on peduncle), running almost straight and about in the middle of the side; scales rather rough, with slightly radiating striæ; an elongate folded membranous scale in ventral axil, with a second, pointed scale as covert.

A blackish band from shoulder to base of caudal, and dark mark from back of eye towards shoulder; a pale area above the lateral band, divided by a darkish stripe; back mostly dark; fins plain.

XIV.—TWO APPARENTLY UNDESCRIBED FISHES FROM YUNNAN

A considerable amount of scattered systematic work has recently been done on the fishes of Yunnan, which province appears to possess a large fish fauna. With only a small series of forms from there for comparison, the writer has some hesitation in proposing the following two new species, which, nevertheless, he is unable to find anywhere described in the literature.

Xenocypris yunnanensis, new species

Description of the Type.—No. 8440, American Museum of Natural History, from Yunnan-fu Lake, Yunnan, February 20, 1919; collected by John Graham.

Length to base of caudal, 123 mm. Depth in length, 4.2; head, 3.9. Eye in head, 3.5; snout, 4; interorbital, 3; maxillary, 4.5; width of mouth, 4.6; width of body, 2.6; depth of peduncle, 2.6; its length, 1.7; longest dorsal ray, 1.3; longest anal ray, 2.6; pectoral, 1.5; ventral, 1.6; caudal lobe (broken), about 1.

Dorsal. II, 7½; anal, 13½. Scales, 72. Teeth, 6, 4, 2.

Moderately compressed; a very slight keel on belly reaching perhaps halfway forward to ventrals. Top of head very slightly convex; snout blunt; lower jaw slightly included, the almost terminal mouth curved, transverse, with narrow-edged jaws, and little or no free lip; gill-membranes joined to isthmus under preopercle; maxillary only slightly oblique, not reaching front of eye; lower jaw oblique, its lower margin

straight; no barbels; opercle with a conspicuous membranous edge. Last simple dorsal ray a slender spine, articulate towards the end and with a short soft tip; dorsal origin equidistant from base of caudal and middle of snout; ventral origin under that of dorsal; pectoral extending about two-thirds the distance to ventral, ventral about two-thirds to anal; caudal well forked, with narrow pointed lobes. Scales with conspicuous radiating striæ, lateral line complete, almost straight, running rather low, ending in the center of peduncle; irregularly broken and doubled in two or three places in this specimen.

Silvery white, a little darker along the back.

Ischikauia transmontana, new species

Description of the Type.—No. 8441, American Museum of Natural History, from Yunnan-fu, Yunnan, October 20, 1920; collected by John Graham.

Length to base of caudal, 100 mm. Depth in length, 4.4; head, 3.7. Eye in head, 4; snout, 3.6; interorbital, 3.5; maxillary, 3; width of body (at shoulder), 2; depth of peduncle, 2.8; its length, 1.6; pectoral, 1.4; ventral, 1.7; longest dorsal ray, 1.3; longest anal ray, 1.9; lower caudal lobe, 1.

Dorsal, 9½; anal, 11. Scales, 66. Teeth (in a cotype), 4, 4, 2, hooked.

Compressed; a low keel between ventrals and anal, scaled to the edge and crossed by scales except its posterior part. Snout pointed; lower jaw projecting; interorbital flattish; mouth oblique; maxillary barely or not reaching to below front margin of eye; no barbels; gill-membranes narrowly joined to center of isthmus behind posterior margin of eye. Dorsal and anal without spinous rays; dorsal origin equidistant from base of caudal and middle of snout; pectoral narrow and pointed, reaching two-thirds the distance to ventral; ventral two-thirds to anal; caudal well forked with narrow pointed lobes, the lower the longer. Scales with conspicuous radiating striæ; lateral line complete, slanting down over pectoral, then running rather low to anal axil, rising on front part of peduncle to its center, but without sharp changes in direction as in *Hemiculter*.

Pale, silvery, a little darker along back.

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FAUNA AND CORRELATION OF THE GASHATO FORMATION OF MONGOLIA[1]

By W. D. Matthew and Walter Granger

In the Gurbun Saikhan piedmont basin, just north of the eastern end of the Altai Mountains, there are two distinct formations. The lower of these is the Djadochta formation of Cretaceous age and contains abundant remains of the primitive horned dinosaur *Protoceratops* and its eggs. Resting unconformably upon these Cretaceous beds is a series of not less than two hundred feet of reddish and drab sediments to which the name Gashato has been assigned and which yielded the interesting primitive mammalian fauna herein described.

The exposures of the Gashato beds are of rather limited extent in the type locality, which is near Shabarakh Usu on the Kweihwating—Uliassutai trail, and are only very sparingly fossiliferous. Mr. F. K. Morris, while studying the stratigraphy of the beds, discovered the first mammalian remains, and later Mr. George Olsen, with an assistant, spent several days there. The fragmentary and weathered remains of the largest form, *Phenacolophus*, were all found within a small area, and the rest of the collection, all diminutive forms, came from two small knolls not far distant. A most careful examination of the entire exposure resulted in no further discoveries.

The fauna is later than Lower Cretaceous, and there can be scarcely any question that it is older than the Irdin Manha, Upper Eocene. The faunal list follows.

Palæostylops iturus	Order Notoungulata
Prionessus lucifer	" Multituberculata
Baënomys ambiguus	" Glires
Eurymylus laticeps	" ? Menotyphla
Phenacolophus fallax	" ? Condylarthra
Hyracolestes ermineus	" Creodonta
Sarcodon pygmæus	" uncertain (?creodont or carnivorous marsupial)

The presence of a multituberculate suggests Paleocene or late Cretaceous age; the ancestral relationship of *Palæostylops* to the Wasatch

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 56.

genus *Arctostylops* is indicative of Paleocene, Torrejon or possibly older age. The remaining genera throw no light upon the correlation, as they are but distantly related to any known types and three are of very doubtful ordinal position; but they are not incongruous with a Paleocene fauna, although not representing the ancestral relations to the Eocene faunæ of Europe and America that had been anticipated. A more extended faunal list might modify this conclusion, but the absence of primitive perissodactyls, artiodactyls, etc., and the rather aberrantly specialized character of the several genera are unexpected, and fail thus far to confirm the hypothesis that the Eocene invaders of Europe and North America came from Central Asia.

On the other hand, the minute and primitive notoungulate *Palæostylops* confirms the view that the South American Tertiary hoofed mammals were originally derived from the north, although undergoing a great secondary evolution in the Neotropical region.

NOTOUNGULATA

Arctostylopidæ Schlosser[1]

Palæostylops[2] iturus, new genus and species

TYPE.—No. 20414, a lower jaw.

PARATYPE.—No. 20415, an upper jaw. Both from the Gashato formation. A considerable series of more or less fragmentary upper and lower jaws is also referred.

CHARACTERS.—Dentition $\frac{?\cdot\overset{1}{1}\cdot 4\cdot 3}{3\cdot 1\cdot 4\cdot 3}$. Canines not differentiated, all anterior teeth of lower jaw short-pointed, sharp-crested, much compressed, and of nearly uniform size and character, changing gradually into the simple compressed premolars of somewhat larger size, with prominent anterior and posterior accessory cusps. $P_{2\text{-}4}$ two-rooted. No diastemata. No molariform premolars. Molar construction as in *Arctostylops*, the pattern much like those of the Entelonychia and toxodonts, but the trigonid relatively shorter than in any of the South American genera. The crest, extending from middle of outer wall of talonid inward into center of basin, is well displayed, as in *Arctostylops*. Premolars all simple and trenchant, none molariform, but p_4 shows an incipient molariform structure.

Upper molars with a high, straight, ectoloph crest, and prominent anteroexternal pillar, much as in rhinoceroses, toxodonts, etc.; protoloph extending obliquely back from anteroexternal angle, and metaloph extending transversely inward from near middle of ectoloph; both protoloph and metaloph are short, and apparently tend to send out a wing from the inner end posteroexternad; but the heavy wear of the surface between ectoloph and inner end of protoloph and metaloph precludes an exact

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[1]In Zittel's Gründzuge der Palæontologie, 4*e* Aufl., 1923, p. 614.

[2]The name is intended to be suggestive of the relationship of the genus to the Wasatch *Arctostylops* and to the numerous South American genera (*Notostylops*, *Pleurostylops*, *Trigonostylops*, etc.) of primitive notoungulates. The species name alludes to the subsequent migration to North and thence to South America, of the Notoungulata.

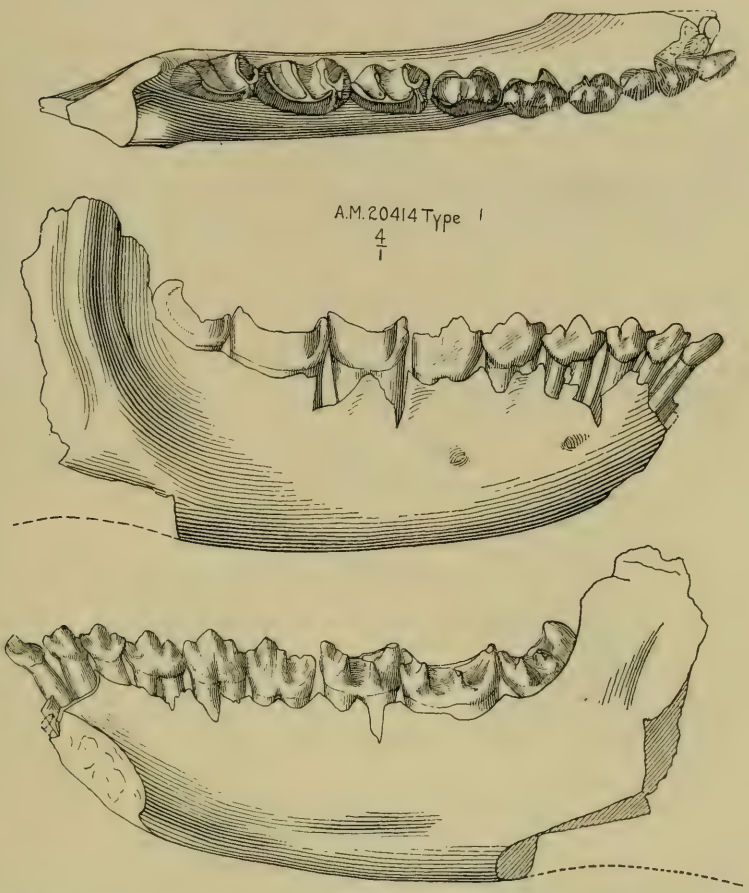


Fig. 1. *Palæostylops iturus*, new genus and species. Lower jaw with complete dentition, except crowns of first two incisors; superior, external and internal views. Type specimen, No. 20414. Four times natural size.

description from any of our specimens. On the inner side of the tooth is a sharp internal cingulum, extending around the bases of the two inner lophs. Metaloph absent on m^3, which is of trigonal outline and smaller than m^2; m^1 smaller than m^2, of similar pattern but less extended anteroposteriorly. The upper premolars are much smaller than the molars, of simple construction, sharp, high external crest on all and a basal internal pillar on p^{2-4}, none on p^1. The canine is larger than p^1 but only its alveolus is preserved. The infraorbital foramen is above the anterior end of m^1; the zygomatic process is stout and springs from a point between m^2 and m^3.

The affinities of this genus to the notoungulates can hardly be questioned; but it is more primitive than any described form in the

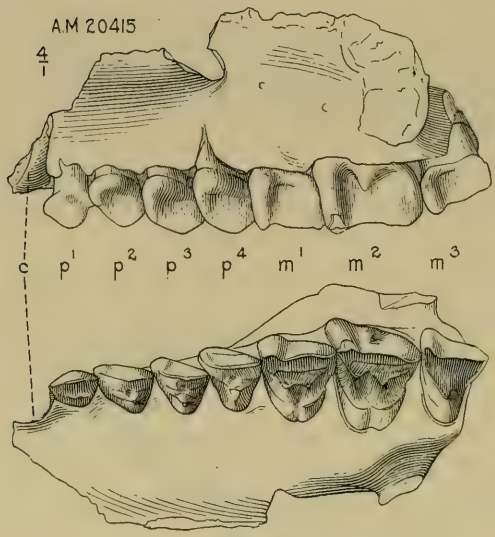
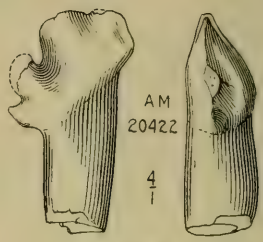


Fig. 2



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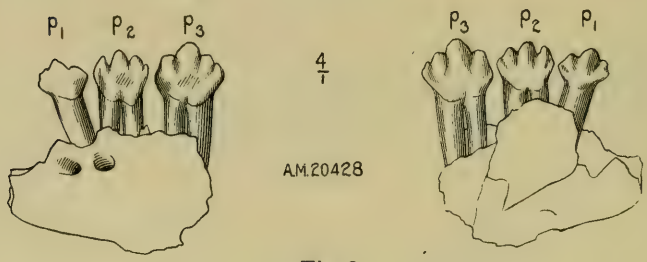

Fig. 3

Fig. 2. *Palæostylops iturus*, new genus and species. Upper jaw with premolar-molar series, external and palatal views.

No. 20415, topotype. Four times natural size.

Fig. 3. *Palæostylops iturus*, new genus and species. Fragment of lower jaw with three premolar teeth, unworn. External view (left) and internal view (right).

No. 20428, topotype. Four times natural size.

Fig. 4. *Palæostylops* sp. Anterior tooth, perhaps from upper dentition; or p_1 of a larger species.

No. 20426 (20422 by error in figure), topotype. Four times natural size.

perfectly simple premolars, although quite hypsodont in comparison with many of the South American genera. It may be regarded as ancestral to *Arctostylops* and through that genus to some of the South American Eocene Notoungulata (e.g., *Leontinia*, *Notostylops*, etc), but to the latter only in a broad way, as no one of the genera of the Deseado fauna

can be cited as clearly following out the line indicated by *Palæostylops-Arctostylops.*

An isolated tooth, No. 20422, appears to agree more nearly with the anterior teeth of *Palæostylops* than with any other known type, but is of much larger size, about twice the lineal dimensions of p_1 in *P. iturus.* The upper front teeth of *P. iturus* are not known, but it is to be expected that they would conform more or less to the lower teeth, which decrease forward regularly in size. The single, backward-pitched root shows that the present tooth is well forward, and it is provisionally identified as a first premolar, on account of the relative complexity of the crown.

We therefore distinguish *Palæostylops* from any of the South American families of Notoungulata by the extreme reduction of the trigonid and simple premolars, associating *Arctostylops* with it in the family Arctostylopidæ.

GLIRES

(Fam. indet.)

Baënomys[1] ambiguus, new genus and species

TYPE.—No. 20424, a lower jaw fragment with two teeth preserved, alveoli of the remaining teeth, from the Gashato formation.

CHARACTERS.—Dentition $\frac{1.0.2.3}{}$. Incisor rootless, stout, diastema short, p_3 much reduced, p_4 of size of molars, m_{1-2} rather high-crowned, quadrate, pattern of crown two transverse crests or pillars united at the base, of equal width, but the anterior one a little higher; m_3 probably similar but small.

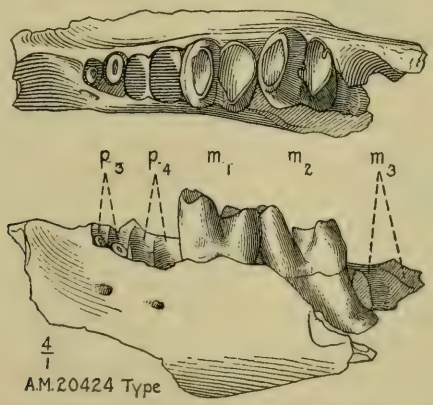

Fig. 5. *Baënomys ambiguus,* new genus and species. Lower jaw fragment, superior and external views.

Type specimen, No. 20424. Four times natural size.

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[1]βά, intensive; ἔνος, old; μυς, mouse.

The pattern of the molars suggests the more hypsodont genera of pocket-mice, but has more definite suggestion of the Lagomorpha. The retention of p_3 distinguishes the genus from all simplicidentate rodents, but does not exclude it from their ancestry; however, the hypsodont molars of heteromyid pattern are by no means what one would expect in a prosimplicidentate rodent. Their pattern is suggestive of an ancestral relationship to the Lagomorpha, but the reduction in number has gone further than in the rabbits, and the subequal crests, although shorter than in *Desmatolagus* of the Oligocene, do not explain the marked reduction of posterior moiety of tooth in the most primitive known Lagomorpha; nor has the jaw the slender proportions of the lagomorph jaw. It seems probable that the genus represents some archaic specialization of the rodent order, but whether lagomorph or simplicidentate is doubtful until better specimens are found.

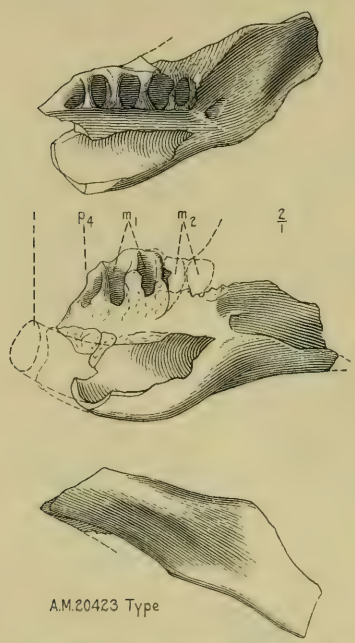

Fig. 6. *Prionessus lucifer*, new genus and species. Lower jaw with alveoli of teeth; superior, internal and inferior views.

Type specimen, No. 20423. Twice natural size.

MULTITUBERCULATA

Plagiaulacidæ

Catopsalinæ

Prionessus[1] **lucifer**, new genus and species

TYPE.—No. 20423, a lower jaw without teeth, from the Gashato formation.

DIAGNOSIS. — Dentition $\frac{}{1.0.1.2}$. Incisor enlarged, scalpriform, long-rooted, stout; diastema short, 'premolar' much reduced, with two connate roots, followed by two rather small subequal two-rooted molars, each apparently about as wide as long. Lower jaw short and deep, flattened beneath as in other multituberculates, with prominent external crest beneath the masseteric fossa, and sharp internal crest beginning abruptly at a point directly behind the root of the incisor and extending backward to the inflected angular process of the jaw.

The genus agrees with *Catopsalis*, *Meniscoëssus* and *Tæniolabis* (*Polymastodon*) in the greatly reduced premolar,

[1]πρίων, saw; ἧσσων, inferior or weaker. The name is intended also to be suggestive of *Dipriodon*, *Tripriodon* and *Meniscoëssus*, three names which have been applied to a related genus from the Lance formation. The species name alludes to the light cast upon the probable age of this fauna by the recognition in it of a multituberculate.

stout incisor and short, deep jaw, but differs in the smaller size and relatively smaller, shorter and probably simpler, molars. In *Ptilodus* and its allies the premolar is much enlarged, the incisor compressed and slender, the jaw much more elongate and narrow, the first molar probably more elongate. The present genus is possibly an ancestral type of the catopsaline subfamily ("Polymastodontinæ") but is too imperfectly known for any precise determination of its affinities.

MENOTYPHLA

?Plesiadapidæ

Eurymylus laticeps,[1] new genus and species

TYPE.—No. 20422, an upper jaw with the five cheek teeth preserved, from the Gashato formation.

CHARACTERS.—Two premolars and three molars in the cheek-tooth series, anterior teeth unknown. Teeth low, bunodont, wide transversely, paracone and metacone round conical, external, no outer cingulum, protocone crescentic, internal, no additional cusps observed. Premolars smaller than molars, submolariform, with strong selenoid inner cusp, two conical outer cusps, the posterior one much smaller and imperfectly separate, no other cusps observed.

First molar the largest, second one-fifth smaller, third two-fifths smaller lineally. Fourth premolar equalling m^2 in size, third smaller than m^3.

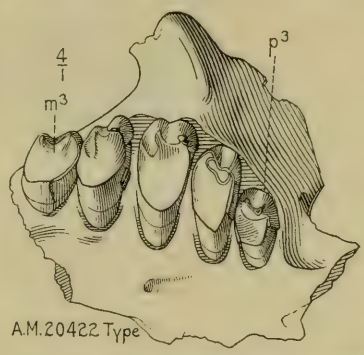

Fig. 7. *Eurymylus laticeps*, new genus and species. Upper jaw, premolar-molar series, p^3-m^3, palatal view.

Type specimen, No. 20422. Four times natural size.

The wide molars and simplicity of the dentition, with conical external para- and metacone, are unlike any Insectivora except Leptictidæ, and suggestive of Mioclænidæ, the smaller Periptychidæ, *Onychodectes*, etc., types distributed at present among several orders. But they suggest more than any other group the Eocene tarsioids and plesiadapids, to which group they might be referred except for the complexity of the premolars. The genus is provisionally placed in the Menotyphla, but its affinities to any known mammal, living or extinct, are not close enough to be decisive as to the ordinal position.

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[1] ἐυρύς, broad; μύλη, mill (i.e., molar tooth). The species name alludes to the wide, short skull indicated by the proportions of the palate.

?CONDYLARTHRA

Phenacolophus[1] fallax, new genus and species

TYPE.—No. 20411, a lower jaw with p_3-m_3, r., m_{1-3}, 1, associated with upper jaw with m^{1-3} damaged by corrosion of surface, from the Gashato formation.

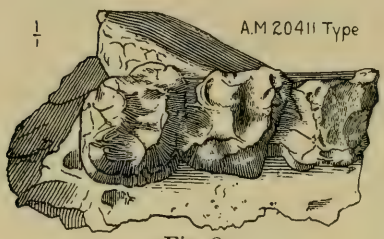

Fig. 8

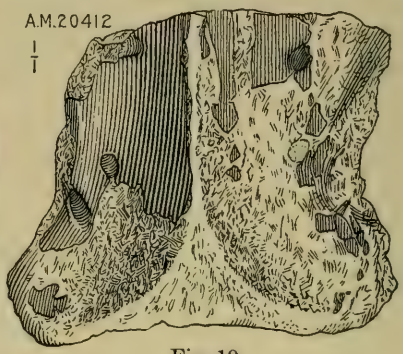

Fig. 10

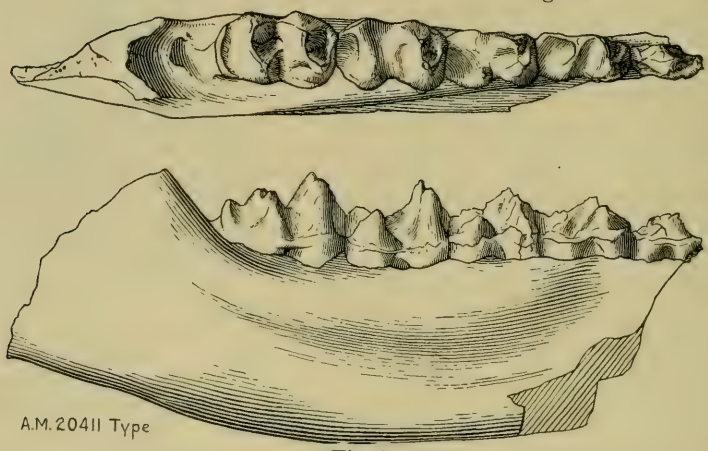

Fig. 9

Fig. 8. *Phenacolophus fallax*, new genus and species. Upper jaw fragment with molar teeth.

Type specimen, No. 20411. Natural size.

Fig. 9. *Phenacolophus fallax*, new genus and species. Lower jaw with molar teeth and two posterior premolars; superior and external views.

Type specimen, No. 20411. Natural size.

Fig. 10. *Phenacolophus fallax*, new genus and species. Occiput, superior view. No. 20412, topotype, perhaps a part of the type specimen. Natural size.

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[1]From φεναξ, a deceiver; λοφος, crest, in allusion to the pseudolophiodont character of the molar and premolar teeth.

PARATYPES.—No. 20430, symphyseal parts of three lower jaws. A number of skeleton fragments are also referred here.

CHARACTERS.—Molars lophodont, rather low-crowned. Upper molars with six cusps, three in the anterior crest, three in the posterior, and a prominent mesostyle continuous with the posterior crest. Basal cingulum continuous around the tooth. (This structure is best shown in m^3, which is slightly larger than the others.) Lower molars composed of two slightly oblique cross-crests and a small, low heel; the crests consisting of an external and an internal cusp, the former having an oblique wing running inward and forward, much as in *Eohippus*. Premolars narrower and smaller than molars, the size and relative width of the teeth increasing uniformly from p_3 to m_3. Anterior premolars not known, except for the roots in the paratypes, which indicate a continuous unreduced series without diastema. Canines considerably enlarged, incisors not preserved, presumably small and very likely reduced in number or wholly absent.

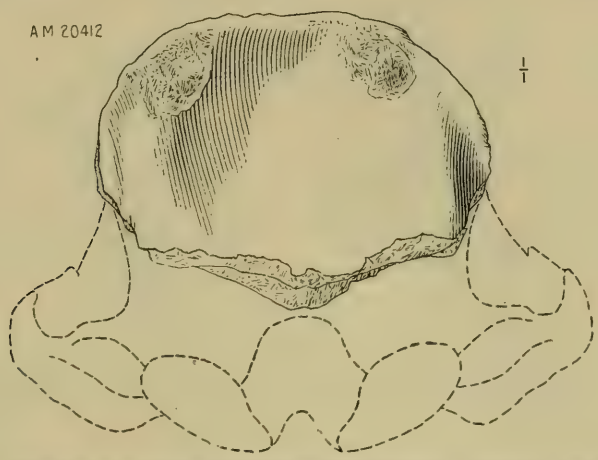

Fig. 11. *Phenacolophus fallax*, new genus and species. Occiput, posterior view. No. 20412. Natural size.

Among the skeleton fragments doubtfully referred to *Phenacolophus* is a calcaneum of very singular type, comparable to some degree with Periptychinæ and *Ectoconus*, more closely with Isotemnidæ of the South American Eocene. It is short and massive, with broad fibular facet at a very low angle with the astragalar facet, which is nearly flat and in the same plane with the sustentacular facet; and the cuboid facet is very strongly oblique, facing more internad than distad, and is moderately convex dorsoventrally and not concave laterally.

The femur of a young individual is short and stocky with a fairly well developed third trochanter; the distal end is wide and the trochlea broad, short and shallow. The head of the ulna is short, notably deep

and compressed, and almost in line with the shaft. Some fragments of humerus and scapula, condylarthran or taligrade in general appearance, may belong to a larger species of this genus.

As the name implies, the lower teeth have a deceptive resemblance to the lophiodont perissodactyls, but the construction of the upper molars can hardly be reconciled with that order, nor is there anything perissodactylic about the anterior part of the lower jaw, or the very characteristic calcaneum.

The genus may be related to some of the South American Eocene ungulates, but probably rather to those that are provisionally referred to Condylarthra than to the Entelonychia or other notoungulate groups.

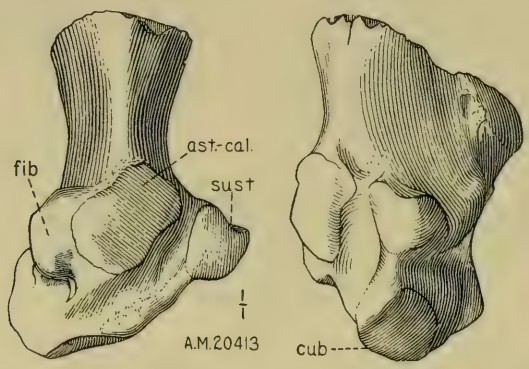

Fig. 12. *Phenacolophus fallax*, new genus and species. Calcaneum doubtfully referred to this genus and species. Superior view (left) and internal view (right). No. 20413, topotype, perhaps part of type specimen. Natural size.

There is a certain degree of suggestion of litoptern affinities, but not much. Comparisons with the hyracoids, arsinoitheres, barytheres, primitive proboscideans and various other groups are equally unsatisfactory. The genus differs so much from any known mammal, living or extinct, that its ordinal position is provisional, and it is impossible to assign it to any described family.

?Creodonta

?Oxyclænidæ

Hyracolestes[1] **ermineus**, new genus and species

Type.—No. 20425, a lower jaw with p_4-m_2 and roots of other teeth, from the Gashato formation.

[1] ὑραξ, shrew; λῃστης, robber,—i.e., a carnivore of shrew-like size.

CHARACTERS.—Molars with high three-cusped trigonid and small low-crested heel. Protoconid highest, paraconid lowest of the trigonid cusps, metaconid distinct on m_1, more prominent on m_2. M_3 appears to have been as large as m_2. P_4 small, high, sharp, moderately compressed, with small posterior basal cusp, rudimentary anterior basal cusp, no accessory cusps. Anterior premolars appear to have been rather small, crowded, perhaps reduced, and canine of moderate size for a creodont. Posterior mental foramen beneath p_4. Jaw of moderate depth and rather convex inferior outline.

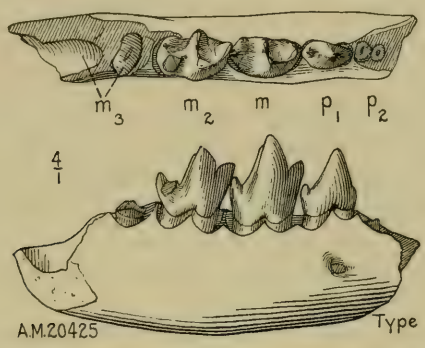

Fig. 13. *Hyracolestes ermineus*, new genus and species. Lower jaw, superior and external views.

Type specimen, No. 20425. Four times natural size.

This is a primitive type of creodont in many respects, but apparently somewhat specialized in a direction unfamiliar to us, not closely paralleled in the Cernaysian or American Paleocene faunas. It is still less like any Eocene types. The minute size is suggestive of Insectivora, but the dentition is not like any known insectivores.

Order Uncertain (?Creodont or Carnivorous Marsupial)

Sarcodon pygmæus, new genus and species

TYPE.—No. 20427, an upper molar.

CHARACTERS.—Molar construction as in certain creodonts and carnivorous marsupials (cf. *Limnocyon*, *Sinopa* and related oxyænid hyænodont genera, also *Cladosictis* and *Amphiproviverra* or the modern *Thylacinus* and *Sarcophilus*), but with a heavy posterointernal flange like that of mustelid carnassials. Size small, comparable with *Putorius*. Protocone large, strongly compressed and extended anterointernally, paracone and metacone strongly connate, parastyle rudimentary, metastyle considerably extended as a shearing crest, no external cingulum. Hypocone a large, prominent, anterointernal flange.

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[1]From σαρξ, flesh; ὀδόντ, tooth.

This tooth evidently represents a specialization paralleling the Mustelidæ but superposed upon a predaceous adaptation with carnassiform molars instead of eucreodine type with carnassial fourth premolar. Three known groups might give rise to such a specialization, the pseudocreodont Carnivora Oxyænidæ and Hyænodontidæ of the Eocene and later Tertiary; the Leptictidæ, Paleocene to Oligocene; or the carnivorous marsupials, especially the Borhyænidæ of the South American Tertiary and Cimolestidæ of the northern Cretaceous. It is impossible to assign it to any one of these groups without some light on the number of upper molars and position occupied by this tooth in the series. The creodonts offer the closest analogies, but the faunal association with a notoungulate is very suggestive of carnivorous marsupials which take the place of true carnivores in the South American Tertiary faunas, as they probably did in the Upper Cretaceous faunas of North America.

Fig. 14. *Sarcodon pygmæus*, new genus and species. Upper molar, crown view. Type specimen, No. 20427. Four times natural size.

A certain degree of correspondence may be noted to *Didymoconus* (fam. Oxyænidæ) of the Hsanda Gol fauna, as also to the Leptictidæ, but it is less suggestive of relationship.

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NEW CREODONTS AND RODENTS FROM THE ARDYN OBO FORMATION OF MONGOLIA[1]

By W. D. Matthew and Walter Granger

The Third Asiatic Expedition secured in 1923 a considerable collection of fossil mammals from the Ardyn Obo formation. It adds materially to the small faunal list published by us in 1923,[2] and affords a somewhat more exact correlation with other Mongolian Tertiaries and with the Tertiary succession in North America and western Europe. The *Cadurcotherium* skulls have been described by Osborn[3]; the smaller Perissodactyla and Artiodactyla and the *Brontops* skull will be described in forthcoming numbers of *Novitates*.

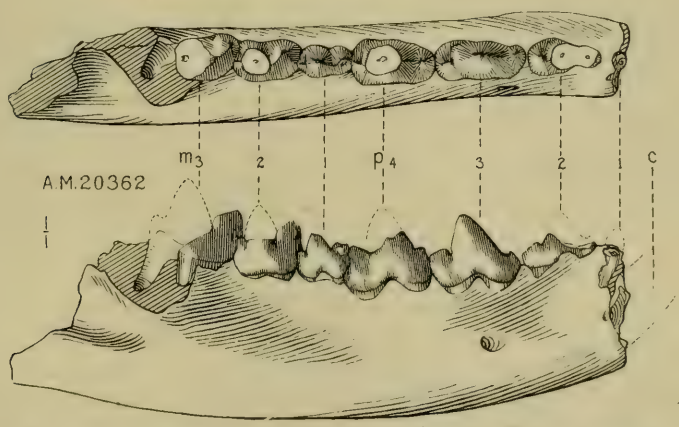

Fig. 1. *Hyænodon eminus.* Lower jaw, external and crown views. Type specimen No. 20362. Natural size.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 57.

[2]1923, The Fauna of the Ardyn Obo Formation, Amer. Mus. Novitates, No. 98, December 18.

[3]Osborn, Henry Fairfield, 1923, Amer. Mus. Novitates, No. 95, October 19; 1924, idem., No. 147, November 11.

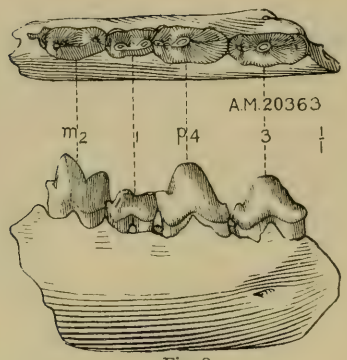

Fig. 2

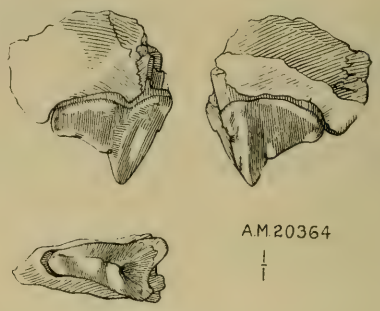

Fig. 3

Fig. 2. *Hyænodon eminus.* Part of lower jaw, external and crown views. No. 20363. Natural size.

Fig. 3. *Hyænodon eminus.* Last upper molar, external, internal, and crown views. No. 20364. Natural size.

CARNIVORA

Hyænodontidæ

Hyænodon eminus,[1] new species

TYPE.—No. 20362, a lower jaw with p_2-m_3 and roots of c-p_1.

PARATYPES.—No. 20363, lower jaw, p_3-m_2; No. 20364, upper jaw fragment, m^3.

CHARACTERS.—Size of *H. minor* Gervais, but teeth and lower jaw more slender and compressed than in specimens of that species figured by Depéret. Anterior premolars not spaced, p_1 small, one-rooted; p_3 moderately pitched backwardly, with minute anterior basal cusp as well as the large posterior one.

This species agrees in teeth and jaw proportions rather nearly with referred specimens of *H. minor* from Euzet-les-Bains, identified by Professor Depéret. It belongs clearly to the brachyrhynchine group of the genus, not known in America.[2]

Oxyænidæ

Ardynictis furunculus, new genus and species

TYPE.—No. 20366, front of skull and lower jaw.

PARATYPE.—No. 20365, upper and lower jaw. (Both found interlocked.)

CHARACTERS.—Dentition $\frac{3 \cdot 1 \cdot 3 \cdot 2}{3 \cdot 1 \cdot 3 \cdot 2}$; size of *Didymoconus colgatei*, but teeth less aberrant throughout, the protocones of upper molars higher and more compressed, without hypocone crest, the paracone and metacone somewhat more connate, parastyles of molars and metastyle of p^4 more prominent, p^4 smaller than m^1 with metacone

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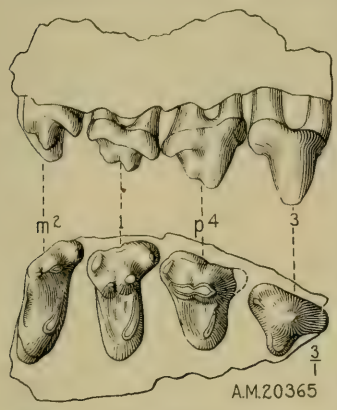
[1] *Fminus* = at a distance or from afar.

[2] *H. paucidens* has been referred to this group, but has none of the distinctive group characters, and is probably a mere individual variant of *H. crucians*, with which it agrees in proportions of skull and jaws and detail construction of all the teeth, differing only in absence of p^1 and partially transverse setting of p^3 and p_3 characters often seen as individual variants among Carnivora and not specific where not associated with confirmatory evidence of their constancy.

rudimentary and closely connate, no parastyle, and small low protocone (lingual cusp). Heel of p^3 rudimentary. Lower molars with high, well separated, rounded, paired main cusps (protoconid and metaconid), low small paraconid and heel. M_2 somewhat larger than m_1; p_4 with high main cusp slightly twinned, vestigial heel; p_3 similar but without heel; p_2 small, one-rooted, spaced. Canines large, stout; incisors small, not preserved.



Ffg. 4. *Ardynictis furunculus.* Upper jaw of type specimen. No. 20365, external and crown views. Three times natural size.

This genus is nearly related to *Didymoconus* and structurally ancestral throughout, connecting that very aberrant and peculiar genus with the more typical Oxyænidæ of the Eocene. It differs from any Oxyænidæ except *Didymoconus* in the well separated, rounded protoconid and metaconid and vestigial paraconid, as also in the corresponding but less obvious specializations in the upper teeth. It is a specialization more or less parallel to *Dissacus* among the Mesonychidæ, *Apterodon* among the Hyænodontidæ, and the Leptictidæ among Insectivora, but unmistakably a derivative of the oxyænid stock. *Didymoconus* is a further development of the same specialization, more closely parallel to the Leptictidæ.

The adaptive significance of such a specialization would seem to be the piercing of somewhat hard tough shells of small prey, soft within

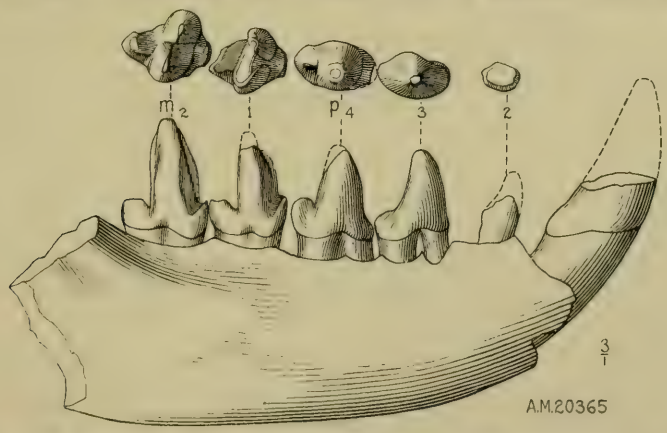


Fig. 5. *Ardynictis furunculus.* Lower jaw of type specimen. No. 20365, external and crown views. Three times natural size.

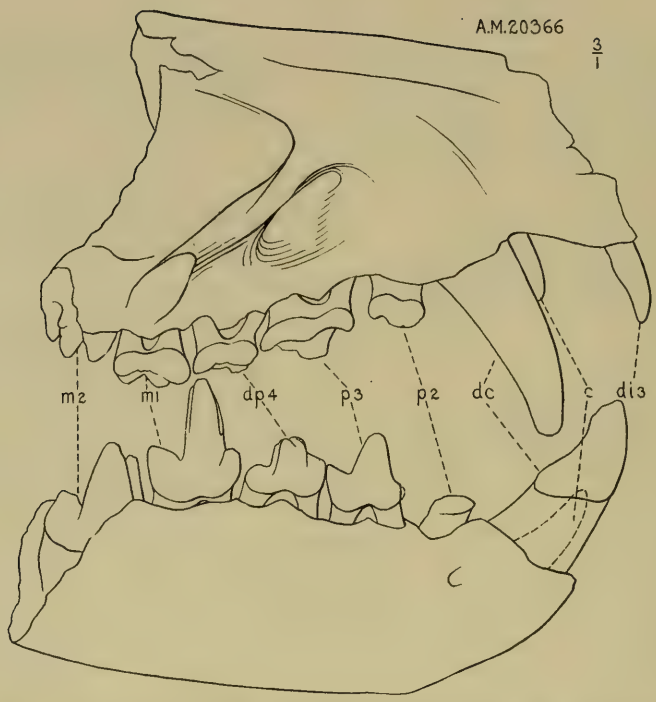


Fig. 6. *Ardynictis furunculus.* Front of skull and lower jaws, young individual. No. 20366. Three times natural size.

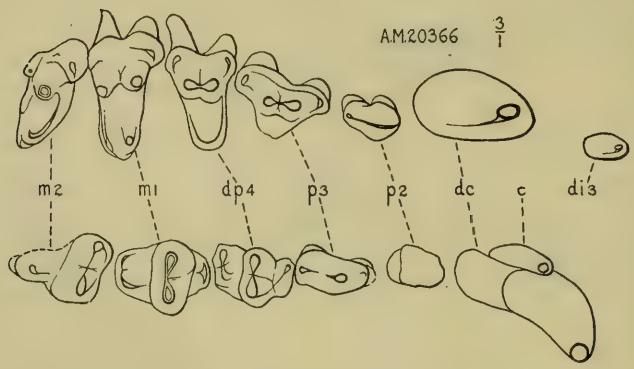


Fig. 7. *Ardynictis furunculus.* Crown views of upper and lower teeth of young individual. No. 20366. Three times natural size.

the shell, requiring only a moderate amount of cutting and little crushing. It is not adapted to vertebrate prey, save possibly small mailed fishes; nor is it adapted to very small insect prey, such as ants and termites, which are handled by crushing apparatus. It is too delicate for the heavy-shelled mollusks but might be adapted to the smaller and rather thin-shelled types, and to the larger mailed insects, crickets, beetles and such. No very close modern parallel can be cited; some of the smaller Mustelidæ are as near as anything.

Ischyromyidæ

Ardynomys olseni, new genus and species

TYPE.—No. 20368, a lower jaw with p_4-m_3, from the Ardyn Obo formation of Mongolia, found by George Olsen in 1923.

CHARACTERS.—Angle of jaw, so far as indicated, a deep vertical plate with the lower border inflected; the masseteric fossa posterior in position, its anterior border beneath the posterior part of m_2. Jaw rather short and deep anteriorly, incisor stout with anterior face flattened and slightly concave. Molars short-crowned, subequal in width, p_4 slightly shorter anteroposteriorly, and m_3 a little longer anteroposteriorly than the intermediate molars. Protomere of molars, a shallow inner basin with low protocone external to it, low anterior and internal marginal crests, and a commissure behind the protocone connecting with the metamere. Metamere, a stout hypocone crest considerably more external than the protocone, extending internally into two closely parallel transverse crests with a narrow valley between, the anterior crest of less height and width but extending further internally, and separated at its internal end by a notch from the internal crest of the protomere.

The premolar has a metamere similar in proportions to that of the molars but with only a single transverse crest, and the protomere consists of two stout cusps, the inner one extending into a crest curving around the anterointernal angle of the tooth, separated posterointernally by a notch from the metamere; the commissure behind the protoconid is weak.

In terms current for more hypsodont rodent teeth, the pattern consists essentially of a main external inflection, a principal central internal inflection, a narrow compressed posterior internal inflection, while the anterior internal inflection is quite rudimentary; the premolar is well developed but only its posterior half is molariform and that not fully so.

The teeth retain the partly subcircular outlines of *Tillomys* and have not taken on the rectangular proportions of *Ischyromys*, but the relationships of the genus are probably with this family, as Troxell has also urged for *Tillomys*. The posterior position of the masseteric scar probably indicates that the masseter was not extended forward on the

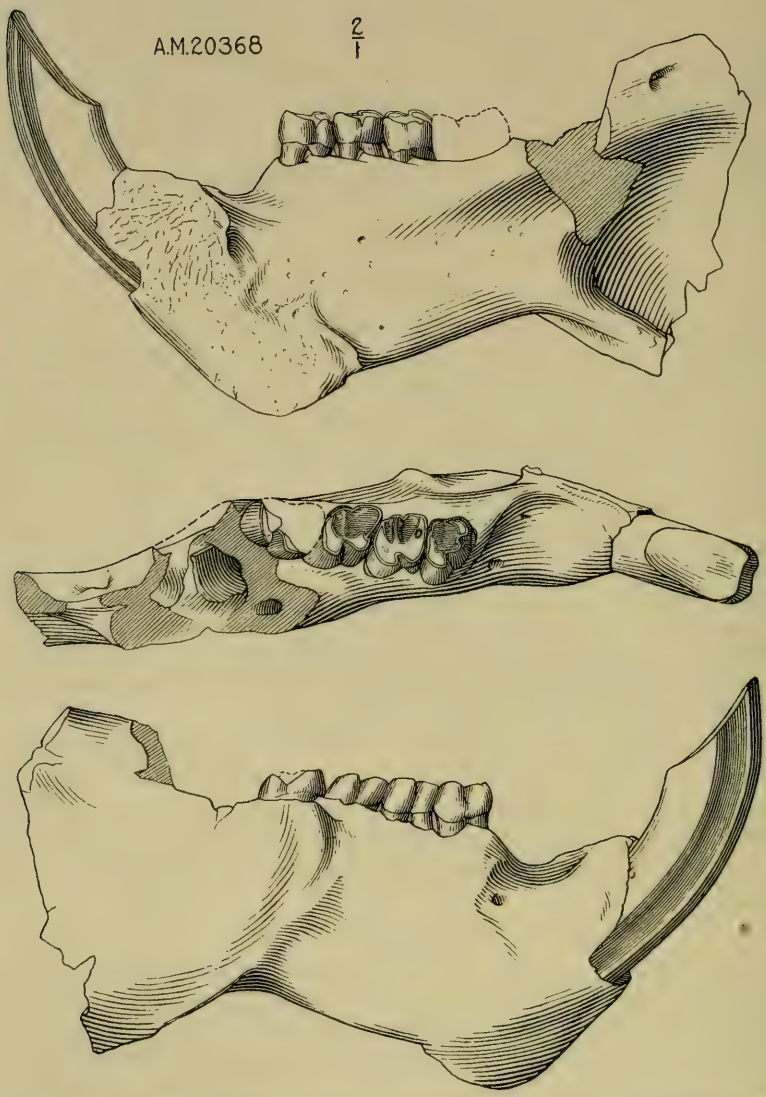


Fig. 8. *Ardynomys olseni.* Lower jaw, internal, superior, and external views. Type specimen. No. 20368. Twice natural size.

muzzle, but limited as in the more primitive rodents to the zygomatic arch. The flat vertical angle is as in the Paramyidæ, Ischyromyidæ, Theridomyidæ, Eomyidæ, retained also in many myomorphs, pedetids, etc.

The genus is provisionally referred to the Ischyromyidæ, but without more complete material its true relationships can hardly be determined. It might represent a group ancestral to *Palæocastor* of the Upper Oligocene, but lacks the specialized construction of teeth and jaws of the beaver group.

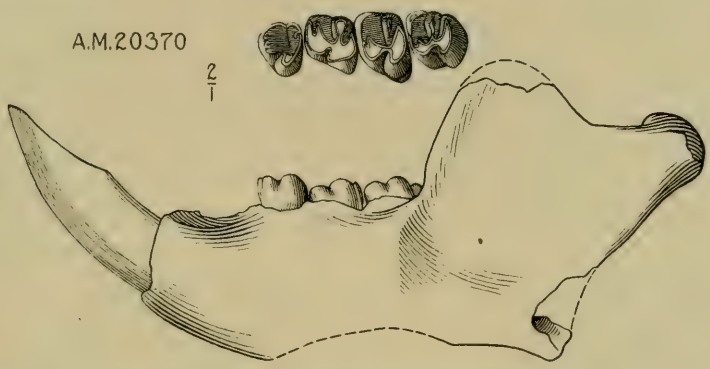


Fig. 9. *Ardynomys chihi.* Lower jaw, external view, and crown view of lower cheek teeth. From the type specimen. No. 20370. Twice natural size.

Ardynomys chihi, new species

TYPE.—No. 20370, lower jaws, i-m_3 r., p_4-m_3 l.

PARATYPES.—No. 20371, lower jaw, dp_4-m_3 r., p_4 preformed in the jaw; and No. 20372, lower jaw with heavily worn teeth, p_4-m_3.

SIZE one-tenth less than the preceding, molars less robust, central inner valley of m_3 closed by a marginal inner crest, posterior inner valley more widely open.

Ochotonidæ

Desmatolagus robustus Matthew and Granger

Two lower jaws, Nos. 20373-4, referable to this species, are in the Ardyn Obo collection. The better one shows a minute vestigial stump of a tooth which may be the last remnant of the lost p_2. Until this is shown to be a constant character of the Ardyn Obo species, it is inadequate to distinguish it from the Hsanda Gol *D. robustus,* with which the rest of the teeth agree in structural details.

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NEW UNGULATES FROM THE ARDYN OBO FORMATION OF MONGOLIA[1]

WITH FAUNAL LIST AND REMARKS ON CORRELATION

By W. D. Matthew and Walter Granger

In a preceding article[2] we described two creodonts and three rodents from the Ardyn Obo formation, collected in 1923 by the Third Asiatic Expedition. The ungulate remains from this horizon include skulls of an amynodont rhinoceros already described by Professor Osborn and a complete titanothere which he will describe in a forthcoming number of *Novitates*. The smaller and more fragmentary ungulate material, including four perissodactyls and three traguloid ruminants, is described in the following pages.

Perissodactyla

Schizotherium avitum

Matthew and Granger, 1923

This species is based on a last lower molar. No. 20384, a poorly preserved piece of the lower jaw with p_2 and dp_3-m_1, probably represents the same species. The second premolar is unworn and only partly emerged. It has a compressed protocone with sharp and prominent anterior and posterior ridges, the anterior curving around to the antero-internal corner of the tooth, the posterior extending back to become continuous with the sharp-crested, nearly median heel. There is a small, low-set, but quite sharply defined little cusp on the inner face of the tooth, a little above the base and posterior to the point of the protocone. It occupies about the position one would expect for a rudimentary metastylid, corresponding substantially in its relations to the base of the metastylid of the molars. We have not found this

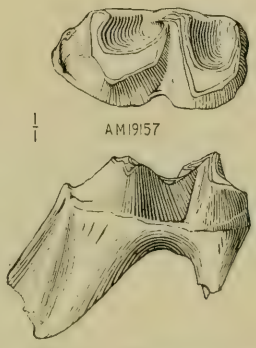

Fig. 1. *Schizotherium avitum*, last lower molar, superior and external views, natural size.

Type specimen, No. 19157, Ardyn Obo formation, Mongolia.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 58.

[2]Amer. Museum Novitates, No. 193.

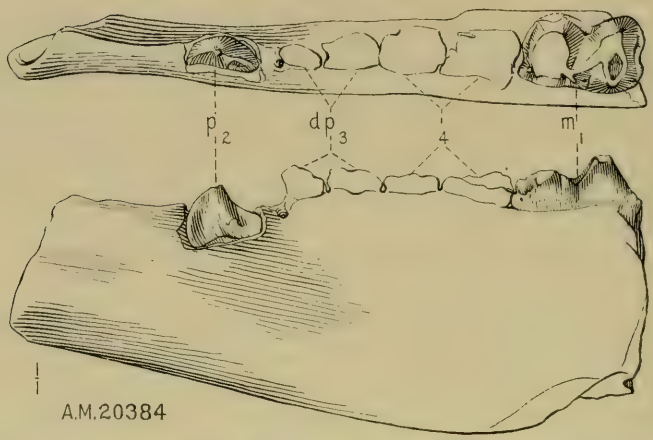

Fig. 2. *Schizotherium avitum*, part of lower jaw, immature, superior and internal views, natural size.
No. 20384, Ardyn Obo formation.

cusp in p_2 of any other chalicothere, but it might be expected to occur in the family in view of the characteristic development of the metastylid in the molars. It is not present in p_2 of *Moropus*. The supposed milk teeth behind p_2 are so worn and shattered that nothing except the size and proportions of the teeth can be learned from them. The first molar is characteristically chalicothere in construction, although considerably worn. It compares rather closely with the type m_3 save that it is a little broader and lacks any trace of heel. It is a little larger in both dimensions than m_1 of *S. modicum*.

? **Schizotherium** species

No. 20385, a small jaw fragment, has an unworn molariform tooth, the alveolus of a larger two-rooted tooth behind it, and behind the alveolus a part of a pocket for a preformed tooth. This tooth may perhaps be dp_3, although no exact comparison can be made with the shattered dp_3 of No. 20384, and the length and verticality of the roots suggest a permanent molar. The tooth has the construction of the *Schizotherium* molar, with a small transverse hypoconulid heel, not unlike the m_3 of *S. modicum;* but it is considerably smaller than the molars of *S. modicum* and *S. avitum*, and the alveoli behind it indicate a considerably larger tooth. If a permanent tooth, it would necessarily be m_1, and the proportions of m_1 to m_2 would differ considerably from those of the known species.

A.M.20385

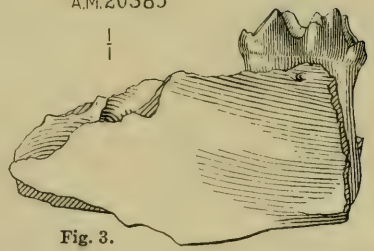

Fig. 3.

A.M.20357

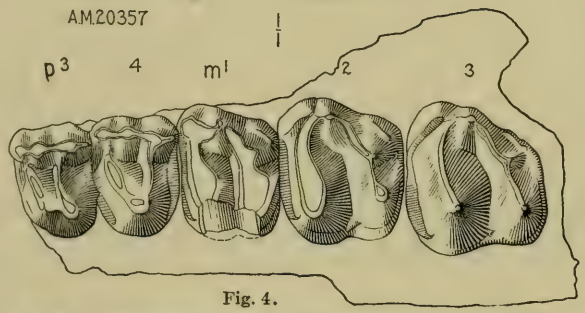

Fig. 4.

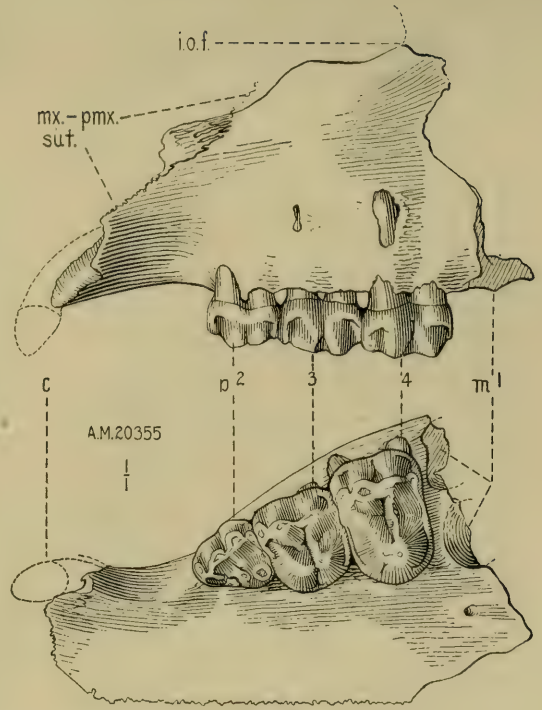

Fig. 5.

Fig. 3. *Schizotherium* species, fragment of lower jaw, superior and internal views, natural size. No. 20385, Ardyn Obo formation.

Fig. 4. *Colodon inceptus*, new species, upper jaw, type specimen, No. 20357, crown view of teeth, natural size. Ardyn Obo formation.

Fig. 5. *Paracolodon curtus*, new genus and species, part of upper jaw with premolar teeth, outer and crown views, natural size. Type specimen, No. 20355.

Colodon inceptus, new species

TYPE.—No. 20357, upper jaw with p^3-m^3 of the left side.

CHARACTERS.—Size of *C. occidentalis* (Leidy) (as represented by the palate figured by Osborn and Wortman), molars similar in construction, except that the posterior crest of m^3 runs nearly straight from paracone to hypocone, while in *C. occidentalis* it curves outward just behind the paracone. M^2 shows a similar difference but less marked. Inner cusp of p^4 single, on p^3 partly divided but still closely connate, as in p^3 and p^4 of *C. occidentalis*.

This species is a little more primitive than the *C. occidentalis* of the *Oreodon* beds. The type of Leidy's species is recorded as from the *Titanotherium* beds but is known only from the last lower molar. It might be equivalent to *C. inceptus*, although probably not cospecific.

Among the fragmentary lower jaws and teeth, there are two or three specimens that may belong to this or the following genus, but we cannot identify them with certainty.

Paracolodon curtus, new genus and species

TYPE.—No. 20355, upper jaw with p^{2-4} and parts of alveoli of canine and first molar.

GENERIC CHARACTERS.—Premolar construction as in *Colodon* but the premolars progressively reduced forward, p^1 absent, postcanine diastema short and molars relatively large. P^2 is proportioned like p^1 of *Colodon*, but the construction is more as in p^2, with two outer cusps, two inner cusps, the anterior one vestigial, the posterior connecting crest incomplete. P^3 constructed much as in *Colodon* but nearly quadrate, the anteroposterior and transverse diameters subequal. P^4 like that of *Colodon*. Narial notch extending far back, at least to a point above p^4. Premaxilla extending backward to a point above p^2, probably farther.

SPECIFIC CHARACTERS.—About the size of *C. inceptus* and p^4 of nearly identical size and proportions. A slight groove obscurely separates the inner cusps; the postero-external cusp less flattened than in *C. inceptus*, in which it has begun to resemble the corresponding part of the molars. Inner cusps of p^3 well separated, of subequal size and prominence, whereas in *C. inceptus* the posterior cusp is larger. Postcanine diastema less than the length of p^{2-3}. Transverse diameter of molar roots fifteen per cent. greater than that of p^4; in *Colodon* they are nearly equal.

AFFINITIES OF *Colodon* AND *Paracolodon*

The relationship of the Mongolian and of Borissiak's species to the American genus appears to be beyond reasonable doubt. *Colodon* in turn appears to be rather nearly related to "*Desmatotherium*" *mongoliense*, which is certainly near to *D. guyotii* of the ? Washakie,[1]

[1]Recorded as Bridger, but it may have come from the Washakie. It has not been recognized in any of the subsequent collections from the Bridger and appears to be decidedly later in type than the Bridger lophiodonts.

although congeneric only in a broadly inclusive sense. We are unable to agree with Peterson that *Desmatotherium* should be removed from the Helaletidæ to the Hyracodontidæ, but a general discussion of the affinities of this group of lophiodonts may better be postponed until the Irdin Manha material is more fully described. Among the European genera, *Chasmotherium* comes nearest in molar structure, but the premolars and anterior teeth differ widely. *Lophiodon* differs in the molar construction, as pointed out by Stehlin and Depéret, and is decidedly

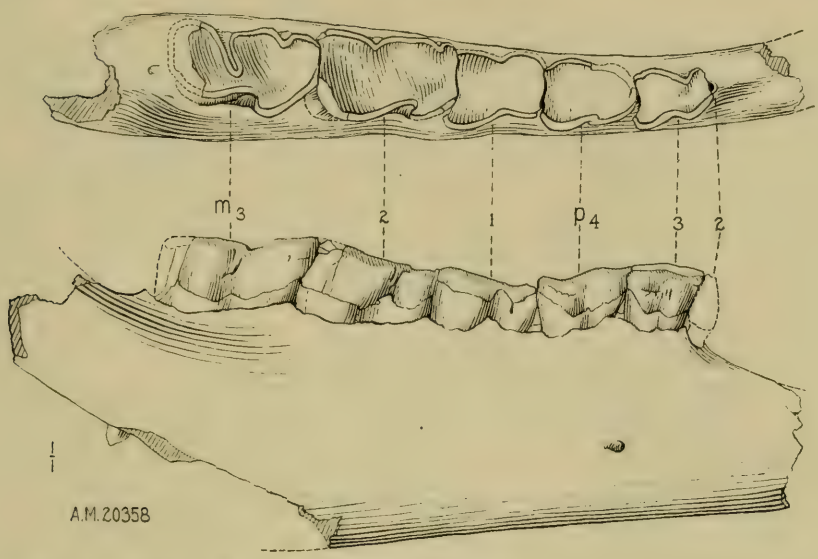

Fig. 6. *Ardynia præcox* Matthew and Granger, lower jaw with premolar and molar dentition, crown and outer views, natural size.
No. 20358, Ardyn Obo formation.

more primitive in its premolars. Both *Desmatotherium mongolicum* and *Paracolodon curtus* had apparently the same peculiar recession of the narial notch that is seen in skulls of *Helaletes* collected by one of us in 1904, and has been observed by Peterson, 1919, and Troxell, 1922, in the type of this genus. The character is not known in the remaining species of this group, but may well have been distinctive of all of them, and would separate them from *Lophiodon*, *Chasmotherium* and *Hyrachyus*, as well as from *Systemodon* and *Isectolophus*. The beginnings of this recession are doubtfully seen in *Heptodon*.

Ardynia præcox, Matthew and Granger, 1923

This small rhinocerotoid is represented by a number of fragmentary jaws and teeth. No. 20358, a lower jaw with p_3-m_3 and alveolus of p_2, shows the marked reduction in the lower premolars corresponding to that in the upper premolars of the type. The combined length of the three premolars was about half that of the three molars. A small round alveolus indicates that p_2 was reduced to a vestigial tooth. P_3 is reduced

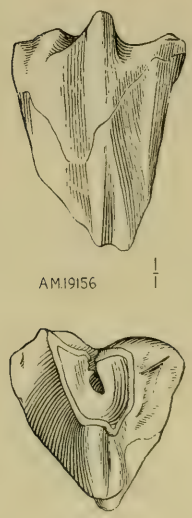

Fig. 6.

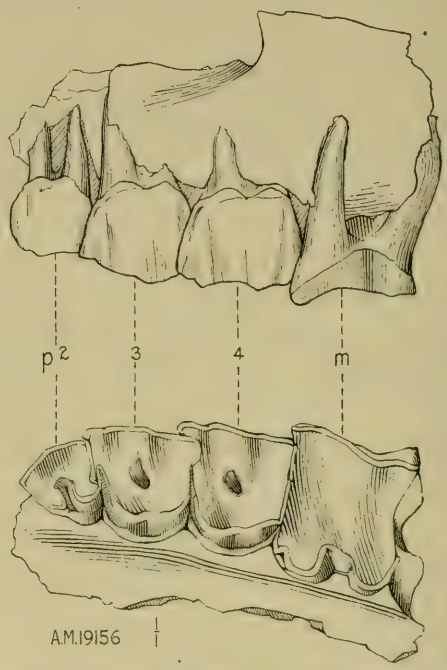

Fig. 7. *Ardynia præcox* Matthew and Granger, last upper molar, external and crown views, natural size.

Paratype, No. 19156.

Fig. 8. *Ardynia præcox* Matthew and Granger, part of upper jaw, outer and crown views of premolars and first true molar, natural size.

Type specimen, No. 19156.

anteriorly somewhat as in p_2 of *Hyracodon*. The second and third molars are subequal, the first considerably smaller and about equal in size to p_4. No. 20386, lower jaw fragment with p_{3-4}, has alveoli of p_2, c_1, and part of an incisor alveolus. The front teeth correspond in size and arrangement to *Hyracodon*.

"*Prothyracodon*" *uintense* Peterson resembles *Ardynia* to some extent, but appears to be more brachydont, and the premolars, so far as one may judge from the milk teeth, are not reduced. Peterson's species can hardly be congeneric with *P. obliquidens* (Scott and Osborn), in which m^3 retains the free posterior flange of the ectoloph, but may be comparable with *Prohyracodon* Koch of the Eocene of Hungary.

ARTIODACTYLA

LOPHIOMERYX Pomel

TYPE.—*L. chalaniati* from the Oligocene of France.

CHARACTERS.—Distal end of fibula separate from tibia. Navicular and cuboid united, median pair of metacarpals and metatarsals separate, not closely appressed, lateral metacarpals (and probably metatarsals) complete with slender shafts, distal

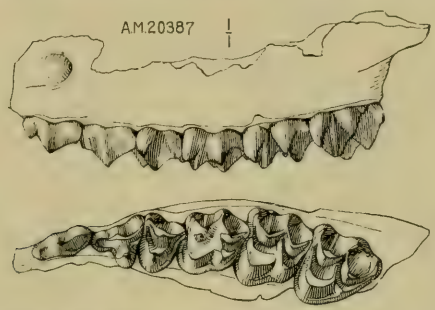

Fig. 9. *Lophiomeryx angaræ*, new species, upper jaw, outer and crown views, natural size.

No. 20387. Last molar reversed from opposite side of jaw. Ardyn Obo formation.

keels very sharp posteriorly but not extended in any degree over anterior face of metapodials. Molars brachydont, with mostly crescentic cusps, hypocone of m^3 reduced or vestigial. Upper molar crescents in obliquely set pairs, outer styles prominent, anterior rib sharp and prominent, no trace of posterior rib. Fourth upper molar of two crescents, third non-crescentic, composed of three outer cusps in a row and a median internal cusp, the outer cusps partly united into a crest but more or less clearly distinguishable, middle cusp the highest. Third upper molar similar but no inner crests and anterior and posterior outer crests weaker.

Lower molars with imperfect inner crescents, the anterior flange of metaconid and posterior flange of entoconid in varying degree imperfect or absent. Heel of m_3 with two subparallel crests running forward from apex, the inner one imperfect, no inner cusp on heel.

Premolar composition of anterior, median, and posterior inner transverse crests, the last cingular (distinction from *Prodremotherium*) in position and imperfect, so that no closed pocket is formed between it and the median crest (distinction from *Eumeryx*); the anterior crest also little developed.

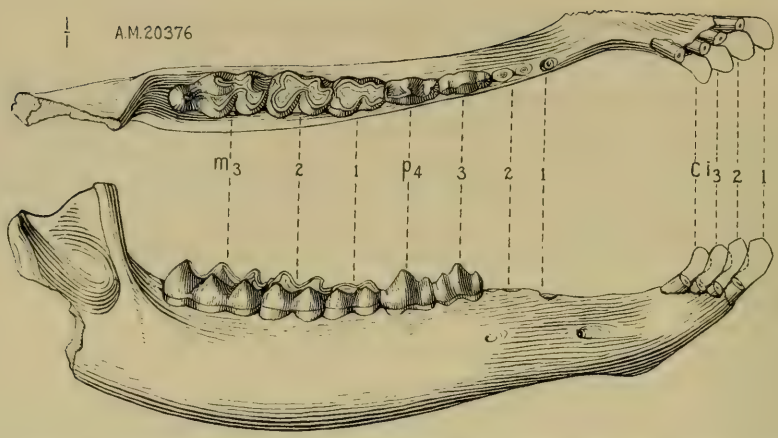

Fig. 10. *Lophiomeryx angaræ*, new species, lower jaw, outer and crown views, natural size.

Type specimen, No. 20376; the front teeth supplied from No. 20387.

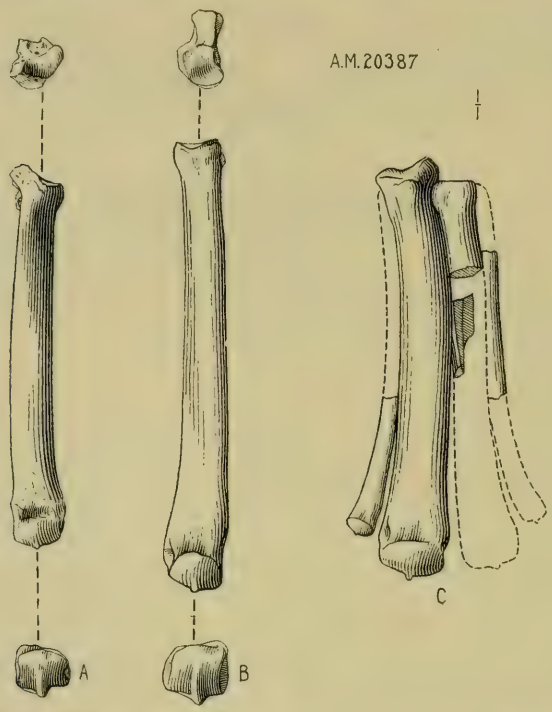

Fig. 11. *Lophiomeryx angaræ*, new species, foot bones associated with upper and lower jaws.

A, metacarpal iii, proximal, dorsal, and distal views. B, corresponding views of metatarsal iv. C, metacarpals articulated, incomplete, showing completeness and relative size of lateral digits. All natural size. No. 20387.

The characters specified above show, first, that we are dealing with a member of the pecoran-traguline division of the Selenodontia; second, that it is a traguloid, not one of the higher groups; third, that its affinities lie with *Prodremotherium*, *Gelocus*, *Leptomeryx*, and other early Oligocene genera of that group, but that it is more primitive than any of them in the complete separation of both metacarpals and metatarsals, as well as in the imperfection of the inner crescents of the molars, and various other details of composition of the teeth.

Gelocus retains a more primitive construction in the simple heel of m_3 and the simple trenchant premolars of traguloid type, but is much more progressive in reduction of lateral digits, union of metatarsals into a cannon bone, and compression of metacarpals, and in the transverse set of the upper molar crescent pairs. *Prodremotherium* has the molars of more distinctly cervid construction, premolars more progressive, metatarsals united and metacarpals compressed.

The above diagnosis is based upon the Ardyn Obo species, chiefly upon *L. angaræ*, of which we have numerous parts of jaws and skeleton bones, some of the foot bones partly articulated, found at two or three localities along the Chinese Post-road near Ardyn Obo. As there is no admixture of other artiodactyl remains, the association is reasonably certain. These specimens agree closely in dentition with *Lophiomeryx* from the Phosphorites received from the Munich Museum in 1896 and identified by Doctor Schlosser. As to the foot-construction, Schlosser remarks in the last edition of Zittel's Grundzüge that the "metapodials are separate," and places the genus in the traguline group, but we have failed to find any more detailed description or figures of the foot bones which might verify the generic reference of these Asiatic species. The close correspondence in teeth, however, renders it a highly probable one.

Lophiomeryx is typical from the Cournon (Stampian) but our comparisons are with the Phosphorites species referred to it. We have not personally verified the accuracy of this reference, but it rests upon the high authority of Schlosser and Stehlin.

Lophiomeryx angaræ, new species

Type.—No. 20376, lower jaw, associated with No. 20387, a series of jaws and skeleton bones found together.

Species Distinction.—P_1-m_3 = 60; m_{1-3} = 32. M^3 with vestigial hypocone; p^2-m^3 = 49; m^{1-3} = 29. P_1 single-rooted, a short diastema behind it, a long one in front of it.

Lophiomeryx gobiæ, new species

TYPE.—No. 20381, lower jaw, associated with various fragmentary lower and upper jaws found together; Nos. 20379-80, upper jaws.

SPECIES DISTINCTIONS.—$M^{1-3} = 24$ mm. Hypocone of m^3 well developed, although smaller than protocone. Three lower premolars. Metaconids of lower molars crescentic, the anterior crest complete. Premolar and molar construction otherwise resembling that of the larger species.

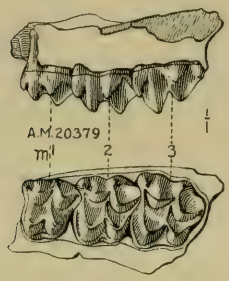

Fig. 12.

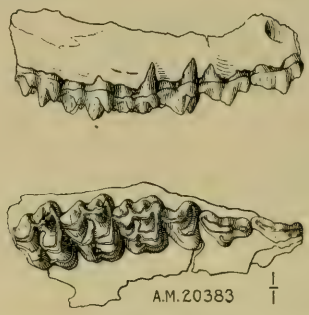

Fig. 13.

Fig. 12. *Lophiomeryx gobiæ*, new species, upper jaw, outer and crown views, natural size. No. 20379.

Fig. 13. *Miomeryx altaicus*, new genus and species, upper jaw, outer and crown views, natural size.

Type specimen, No. 20383.

There is some doubt about the reference of this species to *Lophiomeryx*, as it lacks p_1 and also one characteristic feature of the genus, the imperfect antero-internal crescent of the molars.

Miomeryx altaicus, new genus and species

TYPE.—An upper jaw, No. 20383, with p^2-m^3.

Nearly related to *Lophiomeryx*, but distinguished by more brachydont molars, less development of inner cusps of premolars, stronger external ribs on anterior halves of molars, an external rib on p^4, more rugose enamel. Size smaller than *L. gobiæ;* the length of p^2-$m^3 = 34$ mm.

P^2 has neither internal root nor cusp. Dimensions of p^3 are tr., $4.0 \times$a-p., 7.5; of p^4, tr., $6.4 \times$a-p., 5.2, with medial anteroposterior width of 3.5. Corresponding dimensions of p^3 in *L. angaræ* are 6.0×8.5; of p^4, 7.6×6.1, with medial width of 4.9.

RATIOS	*M. altaicus*	*L. angaræ*
P^3 a-p	100	100
P^3 tr.	53%	71%
P^4 a-p	100	100
P^4 tr.	123%	124%
P^4 med. width	67%	80%

The molars of this genus compare nearly with specimens from the Phosphorites identified by Doctor Schlosser as *Bachitherium*. We have no premolars for comparison, and Filhol's figures of the upper dentition of the type species *B. insigne* do not agree well in the molars and have obviously a distinct type of premolars, the inner crescents well developed on both p^3 and p^4. Filhol's figures are obviously not very accurate and represent referred specimens which may well belong to another genus; but we have not found any published redescription of the genus or any accurate figures. Pending an adequate revision of the Phosphorite artiodactyls, it appears better to record the Gobi genus as new. It is, however, nearly related to certain material from the Phosphorites, whatever name properly applies to that material.

Leptomeryx, the nearest American genus, differs in the better development of inner cusps on the premolars, in higher crowned molars with weaker anteroexternal rib and less rugose enamel.

List of Ardyn Obo Fauna as Identified March 1,1925

Carnivora
- Oxyænidæ
  - *Ardynictis furunculus*, n. g., n. sp. ..... front of skull and lower jaws
- Hyænodontidæ
  - *Hyænodon eminus*, n. sp. ..... lower jaws, upper molar
- ? Canidæ
  - *? Cynodictis* ..... front of lower jaw

Rodentia
- ? Ischyromyidæ
  - *Ardynomys olseni*, n. g., n. sp. ..... lower jaws
  - *Ardynomys chihi*, n. sp. ..... lower jaws
- Ochotonidæ
  - *Desmatolagus robustus* M. and G. ..... lower jaws

Perissodactyla
- Titanotheriidæ
  - *Brontops gobii* Osborn ..... skull and jaws, etc.
- Chalicotheriidæ
  - *Schizotherium avitum* M. and G. ..... m_3; part of lower jaw
- Helaletidæ
  - *Colodon inceptus*, n. sp. ..... upper jaw
  - *Paracolodon curtus*, n. g., n. sp. ..... part of upper jaw
- ? Hyracodontidæ
  - *Ardynia præcox* M. and G. ..... parts of upper and lower jaws
- Amynodontidæ
  - *Cadurcotherium mongoliense* Osborn ..... skulls, jaws, part of skeleton

? Amblypoda
- Gen. indet. ..... fragment of skull with horn

ARTIODACTYLA
? Anthracotheriidæ
Gen. indet. . . . . lower molar
Hypertragulidæ
Lophiomeryx angaræ, n. sp. . . . . numerous jaws, parts of feet
Lophiomeryx gobiæ, n. sp. . . . . upper and lower jaws
Miomeryx altaicus, n. g., n. sp. . . . . upper jaw
CHELONIA
Testudo insolitus M. and G. . . . . parts of carapace and plastron; lower jaw.

CORRELATION OF THE ARDYN OBO

Present evidence indicates that this fauna is older than the Hsanda Gol, approximately equivalent to the *Titanotherium* zone in the American succession and probably to the Sannoisian or Ludian faunas of Europe. There is, however, little or nothing on which to base any exact correlation with the European succession. The absence of any higher types of Artiodactyla, of true rhinoceroses, of higher Carnivora, with one doubtful exception, and of any Oligocene rodents, gives the fauna a broadly Eocene aspect, while the specialized stages reached in the various Eocene phyla point to its being at least at the end of the Eocene. It appears distinctly older than the Hsanda Gol in the survival of titanotheres and perhaps of amblypods, absence of the Rhinocerotidæ, of the higher Carnivora and more specialized rodents of that fauna, and especially in the tragulid ruminants in contrast to the cervid *Eumeryx* of the Hsanda Gol. The creodonts are more primitive stages in the same phyla. It is decidedly more advanced than the Irdin Manha and Shara Murun faunas as shown by the more progressive titanotheres, tragulids, lophiodonts and hyænodonts.

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56.9(1181:51.7)

NEW MAMMALS FROM THE SHARA MURUN EOCENE OF MONGOLIA[1]

By W. D. Matthew and Walter Granger

The Shara Murun formation is typically exposed about 100 miles south of the Irdin Manha Eocene and carries a fauna of corresponding type, including the very characteristic titanotheres which enabled the expedition to refer it in the field to the end of the Eocene. It was at first regarded as a probable equivalent of the Irdin Manha, but, as first observed by Professor Osborn in his studies upon the titanotheriids of the two faunas, and fully confirmed by the present review of the smaller mammals, it is quite distinct and represents a later phase of the Upper Eocene.

Carnivora (Creodonta)

Hyænodontidæ

Pterodon hyænoides, new species

Type.—No. 20307, complete skull from Shara Murun formation at Ula Usu, Mongolia. Third Asiatic Expedition, 1923.

Characters.—Dentition 2.1.4.3. Premolars enlarged and robust as in *Hyænodon*. Last molar transverse, as in *P. dasyuroides*, but smaller and more vestigial in cusp construction. Protocones of molars $\underline{1}$-$\underline{2}$ probably present, but less prominent than in *P. dasyuroides*, and worn off in the type and only known specimen. P^1 one-rooted as in *Pterodon* and the Eocene hyænodons. Molar series extended on maxillary portion of zygomatic arch behind the back of the palate, but not so much so as in *Hyænodon*. Skull broad and robust, comparable in proportions with *Pterodon;* basicranial construction as in *Hyænodon* except for greater width, this portion of the *Pterodon* skull being undescribed so far as we can find.

This species is in all observed particulars an intermediate between *Pterodon* and *Hyænodon*. It is very well distinguished from the European species of either genus; its precise relations to the several more or less intermediate species from the Fayûm 'fluviomarine' fauna are not certain. These species as distinguished by Osborn[2] are based upon the lower jaws. Schlosser[3] comments upon their intermediate position

[1]Publications of the Asiatic Expeditions of the American Museum of Natural History. Contribution No. 59.

[2]Osborn, H. F., 1909. Bull. Amer. Mus. Nat. Hist., XXVI, pp. 415–424.

[3]Schlosser, M., 1911. Beitr. z. Pal. u. Geol. Österreich-Ungarns u. d. Orients., XXIV, pp. 87–88.

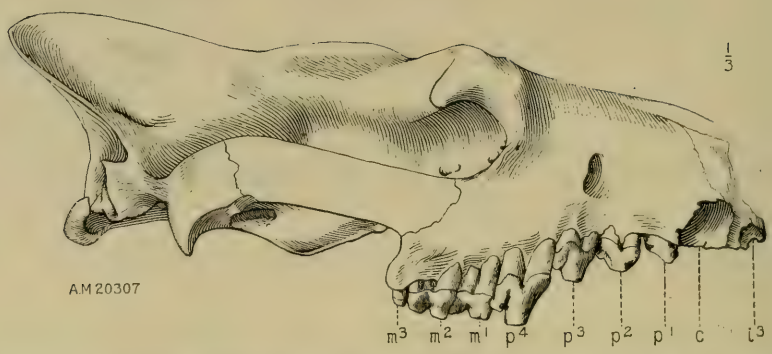

Fig. 1. *Pterodon hyænoides.* Skull, side view, one-third natural size. Type specimen No. 20307.

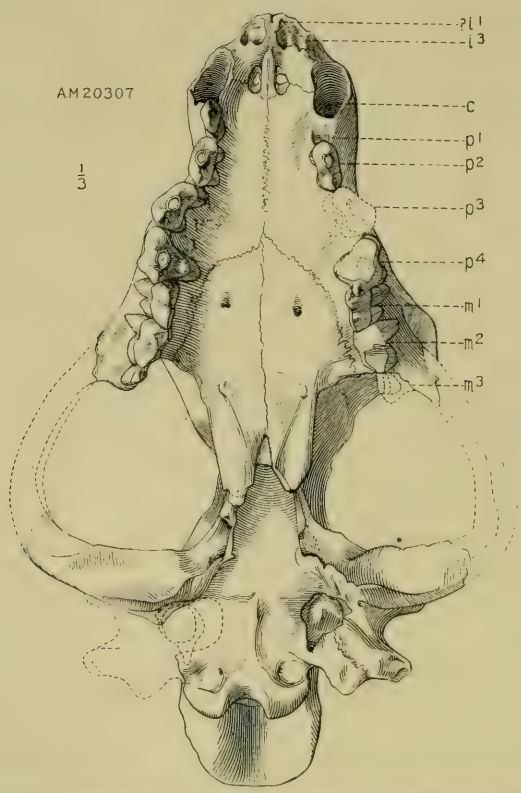

Fig. 2. *Pterodon hyænoides.* Type skull, palatal view, one-third natural size.

between the two genera. None of the species, however, appears to be very near to *P. hyænoides.*

? **Mesonychidæ**

Olsenia mira, new genus and species

TYPE.—No. 20303, left astragalus.

CHARACTERS.—Size comparable to the tapir. Trochlea broad and rather shallow, both keels prominent, a prominent external flange on outer face of outer keel. Neck short, distinct, head about as deep as wide, intermediate in type between perissodactyls and mesonychid creodonts, with a considerable cuboid facet, separated by a marked keel from the narrow but deep navicular facet, the keel running parallel with the facet for distal end of calcaneum. Astragalo-calcanear facet long, narrow, deeply concave, with parallel margins, sustentacular facet set far back on the body of the astragalus, so that its posterior border is strongly rolled down under the back of the

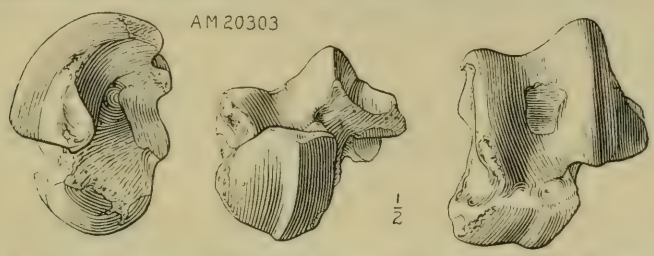

Fig. 3. *Olsenia mira.* Astragalus, internal, distal and dorsal views, one-half natural size. Type specimen, No. 20303.

trochlea. The body of the astragalus is singularly shallow on its external side, the space between trochlear and astragalo-calcanear facets very small; on the inner side the depth of the body is more nearly normal.

We are unable to refer this astragalus to any known genus, and are uncertain as to its family relationships. It is not a perissodactyl or artiodactyl, although it has some points of resemblance to both orders. It is unlike any normal creodont or carnivore, but it conforms to the constructive features of Mesonychidæ in most respects. It is distinguished from most mammals by the peculiar type of cuboid facet, which is characteristic of Mesonychidæ and of Artiodactyla. The distal ginglymus of artiodactyls is lacking, and the bone is in other ways much nearer the mesonychid type, although the astragalar foramen is absent and various other differences appear. The proportions are not unlike those of the Ursidæ, but the bear astragalus never shows the sharply keeled separation between navicular and cuboid facets.

To this genus is possibly referable No. 20319, an upper premolar of mesonychid type, recalling in its size and proportions the fourth premolar

of *Dissacus* or of *Pachyæna*. It appears small in proportion to the astragalus; it may, however, be a milk tooth. These two specimens sufficiently indicate the survival of aberrant Mesonychidæ in the Shara Murun.

GLIRES (Rodentia)

The only rodent specimens in the collection are a jaw fragment with one molar, and two isolated incisors.

Lagomorph, indet.

A fragment of lower jaw with one molar, No. 20326, from the Shara Murun beds, is comparable with *Desmatolagus*, but is too incomplete for definite identification. It differs from that genus in a much less hypsodont crown and more divergent roots, and probably represents a primitive undescribed genus of Lagomorpha.

PERISSODACTYLA

Helaletidæ (Colodontidæ)

Deperetella, new genus

We name this genus in honor of Professor Charles Depéret, whose discoveries and researches have added so greatly to our knowledge and understanding of the Tertiary faunas of Europe.

TYPE.—*D. cristata* infra.

CHARACTERS.—Molar pattern related to that of *Desmatotherium* and *Colodon* but more specialized in the direction of sharp transverse crests; the premolars more molariform. Limbs and feet long and slender, manus and pes tridactyl. The upper molars have high, sharply compressed, nearly transverse crests curving around to join externally. Parastyle and free portion of ectoloph much reduced, joined by a continuous basal cingulum which passes around the anterior, inner and posterior margins of the tooth. Upper premolars with sharp, well separated, transverse crests, external crest higher, somewhat convex externally, distinct parastyle and encircling basal cingulum. P^1 small, ? one-rooted. Lower molars with wide, sharp transverse crests, no connecting ridge, a low, transverse, crested cingulum behind the posterior crests of all three, but no heel on m_3. External and anterior basal cingula, inner cingulum imperfect to absent. Fourth lower premolar fully molariform, third partly so, with strong connecting crest between the transverse crests and well-developed paraconid. First and second premolars compressed, two-rooted, the second submolariform and longer than the posterior premolars. Diastema short, canine of moderate size, incisors smaller.

Humerus of moderate proportions, radius much elongate, one-third longer than humerus, manus tridactyl, the fifth digit reduced to a small, short, strongly divergent, vestigial nodule. Pes long and slender, all the tarsals relatively long as well as the metatarsals. Lateral digits reduced much as in *Colodon*. Phalanges short.

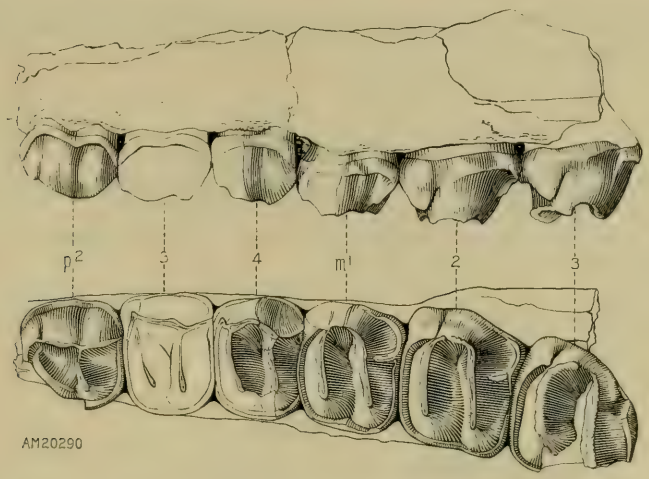

Fig. 4. *Deperetella cristata.* Upper jaw, external and crown views, two-thirds natural size. Type specimen, No. 20290.

The outlined portions of teeth restored from No. 20293.

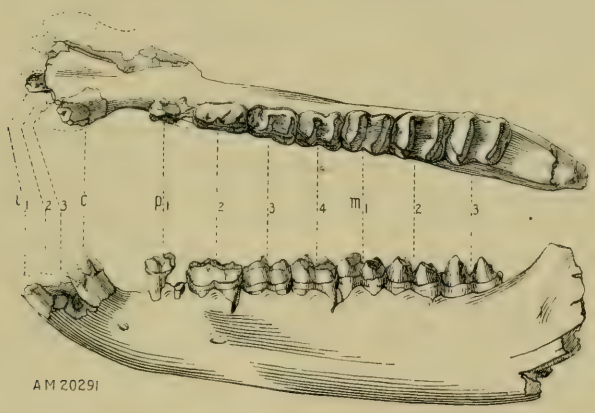

Fig. 5. *Deperetella cristata.* Lower jaw, external and crown views, one-third natural size. No. 20291.

This remarkable genus is clearly related to *Colodon*, with which it agrees in teeth and feet more nearly than with any other described perissodactyl. It is, however, very well distinguished by the sharply crested, peculiar pattern of the molars, entire absence of heel on m_3, etc. It is the largest and most specialized of the colodont group. The character of the entocuneiform is tapiroid and not rhinocerotoid or equid; it

would probably be more nearly approached by *Colodon* if the bone were known in that genus.

Deperetella cristata, new species

TYPE.—No. 20290, parts of upper jaws and fragments of skull, young individual, with unworn molars and premolars.

PARATYPES.—Nos. 20291, lower jaw; 20292, lower jaws; 20295 and 20305, hind feet; 20294, humerus, radius, part of forefoot.

HORIZON AND LOCALITY.—Ula Usu beds of the Shara Murun formation.

Size comparable to modern Brazilian tapir, but limbs much longer. Length of p_1-m_3 = 141 mm.

Hyracodontidæ

Cænolophus, new genus

Upper teeth rhinocerotoid in structure. Upper molars with very oblique protoloph and metaloph, the metaloph relatively reduced. Posterior flange of ectoloph of m^3 reduced to varying degree. P^4 with two strongly oblique transverse crests, the protoloph higher and directed toward the parastyle, the metaloph directed toward the paracone or anterior external rib; no distinct postero-external rib. P^3 with the transverse crests united internally to protocone but similar relations externad.

Lower molars with crests somewhat more oblique than in *Prothyracodon*, no heel on m_3.

This genus appears to be rather nearly related to *Prothyracodon* of the Uinta, but the construction of the premolars does not agree entirely with that shown in Osborn's figures ("*Triplopus*"), and the proportions of m^3 are considerably different. The lower teeth are characteristically like those figured by Osborn. Skull and feet are unknown, but if, as seems probable, they are like those figured by Peterson as *Prothyracodon obliquidens*, the nares are not extended backward and the manus is tridactyl.

Cænolophus promissus, new species

TYPE.—No. 20297, left upper jaw with p^3-m^3 moderately worn.

HORIZON AND LOCALITY.—Shara Murun formation, Ula Usu, Expedition 1923.

SPECIES CHARACTERS.—Size medium, p^3-m^3 = 61, m^{1-3} = 43 mm. M^3 trapezoidal, with moderate posterior flange or ectoloph. Metaloph of p^4 shorter, metaloph of p^3 imperfectly separated. No. 20304, m_{1-2} in a fragment of jaw from the Shara Murun beds, is probably of this species. There is no trace of paraconid cusp on the lower molars, the anterior crest sweeping down uniformly to the base of the tooth at the antero-internal angle.

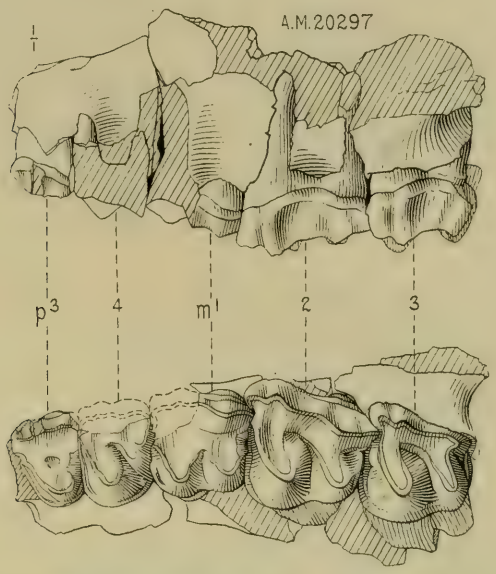

Fig. 6. *Cænolophus promissus.* Upper jaw, external and crown views, natural size. Type specimen, No. 20297.

Cænolophus obliquus, new species

Type.—No. 20296, upper jaw with dp^3-m^1, part of m^2, p^{3-4} preformed and chamber of m^3. Shara Murun formation, Ula Usu, Mongolia.

Characters.—Larger than the two preceding species; p^{3-4} with strongly oblique transverse crests united at protocone on p^3. P^3-m^2 approximately 66 mm.; estimated length of p^3-m^3 = 83 mm.

Cænolophus progressus, new species

Type.—No. 20298, left upper jaw with m^{1-3} moderately worn. Same horizon and locality as *C. promissus.*

Species Characters.—Size smaller, m^{1-3} = 35 mm. M^3 subtrigonal, the posterior flange of ectoloph vestigial.

No. 20309, lower jaw fragment with m_{1-2} (possibly dp_4-m_1), may belong to this species, although smaller than the type if the teeth are both permanent molars. It has the same characters as the jaw fragment referred to *C. promissus.*

Cænolophus ? minimus, new species

No. 20310, a jaw fragment with m_{1-2}, represents a species provisionally referable to this genus, but decidedly smaller than any of the preceding. The molars have the same characters as those referred to the preceding species, but the length of m_{1-2} is 15.5 mm., of m_{1-3}, estimated at 24 mm.

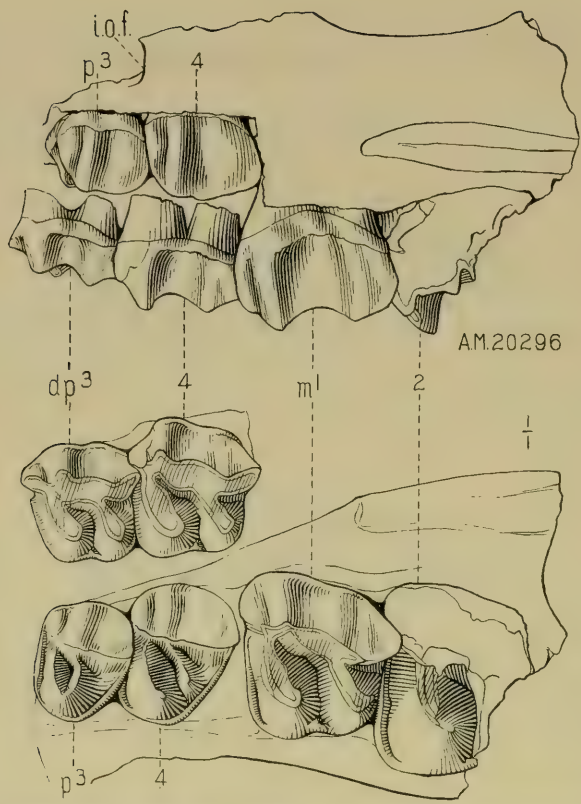

Fig. 7. *Cænolophus obliquus.* Upper jaw, external and crown views. Natural size. Type specimen, No. 20296.

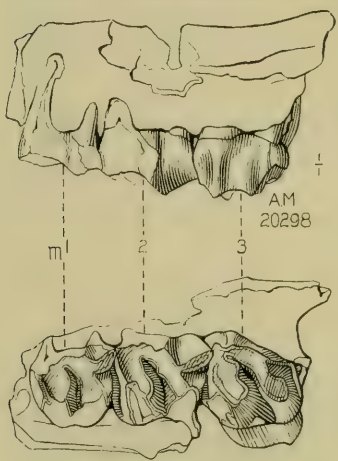

Fig. 8. *Cænolophus progressus.* Upper molars, external and crown views, natural size. Type specimen, No. 20298.

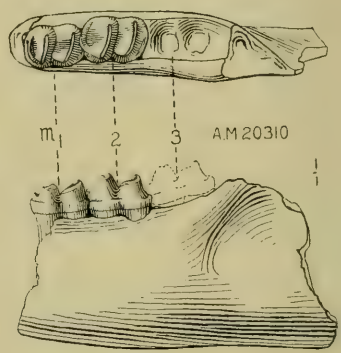

Fig. 9. *Cænolophus minimus.* Lower jaw fragment, m_{1-2}, crown and external views, natural size. Type specimen, No. 20310.

ARTIODACTYLA

Hypertragulidæ

Archæomeryx optatus, new genus and species

TYPE—No. 20311, skull and jaws; paratypes, Nos. 20320-20322, articulated skeleton, skulls and jaws, all found associated in one pocket in the Ula Usu locality, Shara Murun formation, later Eocene.

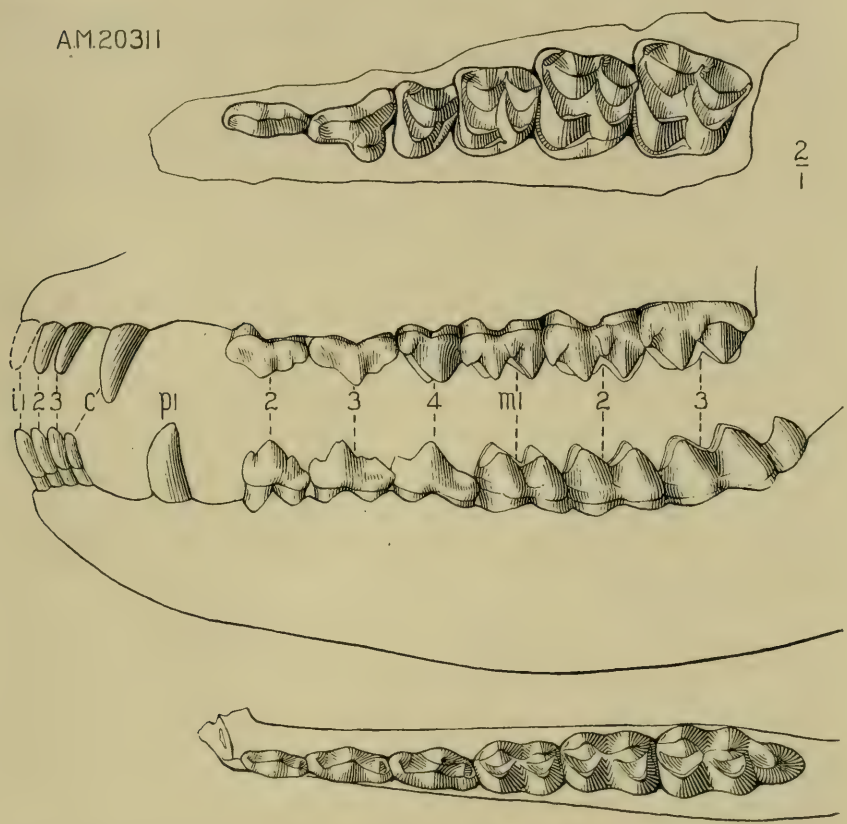

Fig. 10. *Archæomeryx optatus.* Upper and lower dentition, external and crown views, twice natural size. Type specimen, No. 20311.

Front teeth supplied from No. 20322.

CHARACTERS.—Dentition $\frac{3.1.3.3}{3.1.4.3}$. Upper molars tetracuspid, brachyselenodont, the pairs of cusps somewhat obliquely set, the posterior wings of the inner crescents low and incomplete. Parastyles prominent, continuous with anterior wing of antero-internal crescent; mesostyles well developed; metastyles very weak or absent on

m^{1-2}, moderately developed on m^3. Anterior external rib prominent, posterior rib absent. Postero-internal crescent of molars smaller than antero-internal; inner cingula well developed; molars increasing somewhat in size from first to third.

Upper premolars three, p^4 with complete inner and outer crescent, p^3 with inner cusp and three-cusped outer crest, p^2 with outer crest imperfectly three-cusped, no inner cusp. Postcanine diastema rather short, canine small, pointed, recurved, one-rooted, three very small, pointed, simple incisors in front of it, a little spaced, but no considerable diastemata.

Lower incisors three, very small and like the upper incisors; lower canine close behind them and but little larger. P_1 with short diastemata before and in some individuals slightly spaced behind, small, simple caniniform, but with more flattened crown. P_2 two-rooted, with three strongly compressed cusps in line, the central one highest. P_3 similar, but with anterior crested cusp inturned to a transverse ridge, and a suggestion of posterior transverse ridge behind the posterior cusp. P_4 with anterior crest partly inflected, a distinct cusp internal to the central and the transverse crest at posterior border further developed and sweeping around to become connected with the median inner cusp; a small oblique crest also extending posterointernad from the posterior of the three original cusps.

Lower molars tetracuspid, brachyselenodont, with the pairs of cusps set somewhat obliquely, third lobe of last molar looped, no internal cusp. The crests of the loop correspond to the wings of the external crescents of the molars, the posterior wing sweeping around to an internal basal crescent.

Skull about as large as that of *Tragulus javanicus*, but much more primitive and generalized. The braincase is much smaller and the orbits are smaller; the orbits appear to be enclosed behind; from the postorbital process the postorbital crests run obliquely inward and backward to meet at the anterior ends of the parietals and form a low continuous sagittal crest. The occipital crest appears also to be prominent, as usually in Eocene mammals. The skulls are so crushed and incomplete that little more has been determined from them than the above. The lower jaws are rather heavier than in *Tragulus* and shorter anteriorly, the muzzle in front of p_2 being little more than half as long.

Skeleton somewhat larger than that of *Tragulus*, the femur an eighth longer and heavier in the shaft, the tibia of the same length but considerably heavier shaft. Radius and ulna separate, the ulnar shaft with less breadth but greater thickness in its distal portion than *Tragulus* or *Hyæmoschus*, the shaft of the radius more slender than in *Tragulus* but the proximal and distal ends about the same size. Fibula reduced to proximal and distal vestigia, the latter with long, slender splint, but shaft apparently not complete. Navicular and cuboid coössified, carpals all separate. Metacarpals and metatarsals separate, the lateral digits complete and moderately reduced, less relatively than in *Hyæmoschus*, much less than in *Tragulus*. Distal keels of metapodials not extended over dorsal face. Phalanges proportioned much as in *Tragulus*, but both fore and hind feet are of considerably larger size.

Ischia constructed as in *Hyæmoschus* and the pecora, in contradistinction to *Tragulus*. Tail long (cf. anoplotheres).

This genus is of exceptional interest, as it appears to be an approximate ancestral type for the pecora. It has assumed the characteristic pecoran-traguline character of the united naviculo-cuboid, but it still

retains the separate median pair and complete lateral pair of digits, the ulnar and fibular shafts are more primitive than in any pecora, the upper incisors are still retained, the premolars are of primitive pattern, the molars brachyselenodont. It lacks any of the various aberrant specializations which exclude all of the Eocene genera hitherto described from direct ancestry to the pecora and, as fortunately the principal osteological and dental characters are determinable from the exceptionally complete material, the affinities of the genus can be very satisfactorily appraised. So far as the higher ruminants are concerned, it affords tangible and very convincing proof of the theory of an Asiatic dispersal center.

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NEW MAMMALS FROM THE IRDIN MANHA EOCENE OF MONGOLIA[1]

By W. D. Matthew and Walter Granger

The following descriptions are based upon collections secured by the Third Asiatic Expedition during 1923. The stratigraphy of the Irdin Manha formation has been briefly described and notices of some of the fossil mammals secured in 1922 and 1923 have been published in preceding articles in *Novitates*.[2] The most important finds of the expedition in this formation, skulls of a series of titanotheriids, and skeleton, skulls, etc., of a large amynodont rhinoceros, are described by Professor Osborn in articles now in press or forthcoming. The smaller perissodactyls are described by us in a following number of *Novitates*.

Carnivora (Creodonta)

Mesonychidæ

In addition to the giant *Andrewsarchus*[3] skull, this family is represented by scattered teeth and jaw fragments of at least four smaller animals.

Mesonychid, gen. indet.

One species, No. 20132, is of about the size of *Harpagolestes uintensis* of the Uinta, but we are unable to determine the molar formula, and it cannot be even provisionally assigned to any genus.

Mesonychid, gen. indet.

A second, smaller species, about the size of *Synoplotherium lanius*, is likewise represented by isolated teeth, No 20133, and cannot be placed in any one of the mesonychid genera.

Hapalodectes serus, new species

Type.—No. 20172. Lower tooth, molar or posterior premolar.

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[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 60.

[2]Amer. Mus. Novitates, Nos. 42, 77, 91, 104, 145, 146.

[3]Osborn, Henry Fairfield, 1924, Amer. Mus. Novitates, No. 146, November 11.

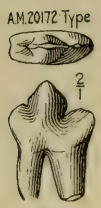

Fig. 1

Fig. 1. *Hapalodectes serus.* Lower molar, type specimen, No. 20172, twice natural size, crown and side views.

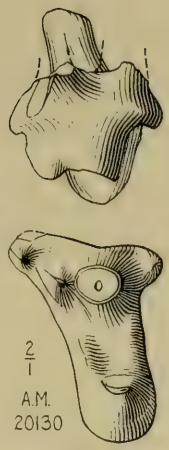

Fig. 2

Fig. 2. *? Hapalodectes auctus.* Upper molar, type specimen, No. 20130, twice natural size, crown and side views.

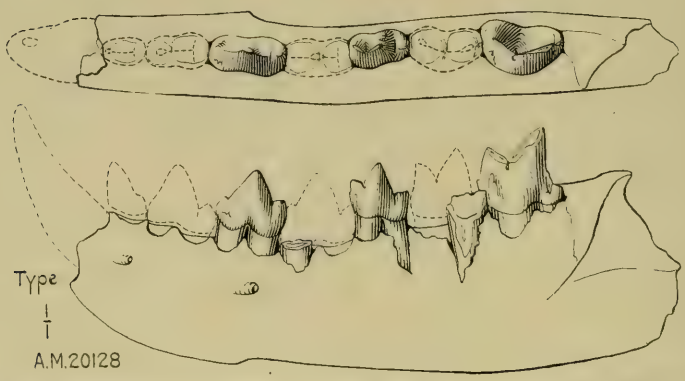

Fig. 3. *Propterodon irdinensis.* Lower jaw, type specimen, No. 20128, natural size, external and crown views.

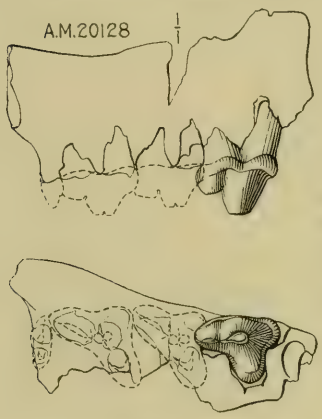

Fig. 4

Fig. 4. *Propterodon irdinensis.* Upper jaw with p^4 and roots of molars, somewhat doubtfully associated with the type lower jaw. Natural size, crown view.

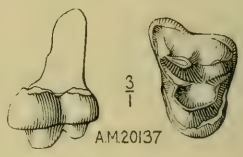

Fig. 5. *Miacis invictus.* Upper molar, type specimen, No. 20137, three times natural size, external and crown views.

CHARACTERS.—Cusps high and sharply compressed, the principal cusp (protoconid) showing no trace of metaconid; the heel large, sharply crested in the characteristic mesonychid style, a minute anterior basal cusp (paraconid). Length of tooth 5.6 millimetres, smaller than either of the described American species. Much smaller than *?H. auctus.*

?Hapalodectes auctus, new species

TYPE.—No. 20130. An upper molar (possibly a premolar).

CHARACTERS.—Tooth much wider than long, protocone high, round, metacone and paracone moderately connate into a high, rounded cusp, with basal heels representing parastyle and metastyle. Valley between inner and outer portions of tooth deep and wide, this portion of the tooth rather strongly constricted. No crests from protocone. Size of the smaller *Dissacus* species, but very different in proportions of the tooth.

In its general character this peculiar tooth somewhat suggests the Leptictidæ. It is unlike any known mesonychid upper molars, and it may not in fact belong to the Mesonychidæ. The upper teeth of *Hapalodectes* (Wasatch and Wind River) are not known, but they should be much of this type, and the peculiar roundness of the cusps and the absence of connecting crests are suggestive of mesonychid and not leptictid relationships. The tooth, therefore, is referred provisionally to *Hapalodectes.*

Hyænodontidæ

This family is represented in the Irdin Manha fauna by a lower jaw described in 1923 as *Paracynohyænodon morrisi*, and by a number of jaw fragments of a species referable to *Propterodon.*

Propterodon Martin, 1906

GENOTYPE.—A lower jaw from the Egerkingen beds, probably identical with *Hyænodon schlosseri* Rutimeyer.

Martin bases this genus[1] upon a lower jaw, figured by Rutimeyer[2] under the name of *Pterodon*, but not given any specific name. On a later page of the same memoir (*op. cit* , p. 461), Martin discusses two lower molars which Rutimeyer figured (*op. cit.*, figs. 13, 14) and described as *Hyænodon schlosseri.* Rutimeyer regarded these teeth as m_2; Martin identifies them as m_3 and observes that they must represent a genus distinct from *Hyænodon* and retaining the third upper molar; but he does not say whether he refers them to *Propterodon* or make any comparison

[1]Martin, Rudolf, 1906, Revision der obercocänen und unteroligocänen Creodonten Europas. Rev. Suisse de Zool., XIV, p. 454.

[2]Rutimeyer, Ludwig, 1891, Eocäne Säugethierwelt von Egerkingen. Abh. schw. pal. Ges., p. 99, Pl. VII, fig. 15.

with m_3 of the genotype jaw. So far as one can judge from Rutimeyer's figures, they might well belong to the same species, and we have provisionally so referred them.

Depéret[1] questions Martin's identification of the type teeth of *H. schlosseri* as m_3, but without considering the evidence afforded by the lower jaw above mentioned, or the peculiar proportions of the teeth, which are not like the m_2 of *Hyænodon*.

The above record is cited to show the status of *Propterodon* in nomenclature of the hyænodonts. It does not affect the validity of the genus or the reference to it of the species here described.

Propterodon irdinensis, new species

TYPE.—No. 20128, a number of jaw fragments, probably in part associated (field No. 156), from the Irdin Manha Eocene of Mongolia.

CHARACTERS.—M_3 with minute talonid, no metaconid, protoconid broad, with flat posterior face (in place of the narrowed ridge of *Hyænodon*); m_1 with rather large, high-crested heel nearly as broad as the body of the tooth, a minute metaconid, paraconid considerably smaller and lower than metaconid. Four rather large, close-set premolars, not pitched backward, p_3 lacking anterobasal cusp, p_1 one-rooted, crowded. Three upper molars, the third about as in *Pterodon*, transverse, two-rooted, crown unknown. First and second with well-separated antero-internal roots, crowns unknown. P^4 lacks antero-external cusp, the inner root is well developed, antero-internal in position (not median as in *Hyænodon* and *Pterodon*), and carries a shelf and cingulum but no distinct cusp. Principal cusp and postero-external cusp much as in *Hyænodon crucians*. In size the species about equals *Hyænodon mustelinus*.

The heel of m_3 is decidedly more reduced than in *Pterodon*, but in other particulars the teeth are more like the primitive hyænodonts *Sinopa*, *Tritemnodon* and *Cynohyænodon*, especially the constitution of p_3, p^4 and m_1, and the genus—or at least this species— might be regarded as a connecting link and structurally ancestral to *Hyænodon*.

Whether its stratigraphic position would admit of this is another question. *Hyænodon* proper makes its first appearance in Europe in the lower Ludian[2] (Euzet-les-Bains), in America in the Chadron, *Titanotherium* beds, commonly regarded as Sannoisian. The Irdin Manha is correlated with the lower Uinta of America, but its European equivalent is by no means certain; it may be Ludian, but is possibly older. There is little or nothing on which to base a direct comparison.

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[1]Depéret, Charles, 1917, Mammifères fossiles d'Euzet-les-Bains, Ann. Univ. Lyon, N. S., fasc. 40, p. 187.

[2]"*Hyænodon*" *nouleti*, Bartonian of Castrais, is excluded as generically indeterminate; "*H.*" *schlosseri*, Lutetian of Egerkingen, as probably not *Hyænodon* (vide supra).

Miacidæ

Miacis invictus, new species

TYPE.—No. 20137. An isolated upper molar, m^1.

CHARACTERS.—Size nearly as in *M. medius* of the Washakie, but construction of molar more as in *M. parvivorus* of the Bridger. Anteroposterior width considerably greater than in m^1 of *Procynodictis vulpiceps*. Paracone larger than metacone, protocone with both wings complete, conules distinct, parastyle well developed as a simple crest, no meta- or mesostyle, a moderately broad shelf external to the paracone and metacone. Cingulum encircling outer half of tooth, joining conules at its inner ends, a separate basal cingulum encircling inner half of tooth broadened into a "bourrelet" at the postero-internal part of the protocone.

The reference of a single tooth is necessarily doubtful, but this specimen agrees very closely with the genotype of *Miacis, M. parvivorus*. It is readily distinguished from *Cynodictis* and other genera by the inequality of para- and metacone, from *Procynodictis* by the less compressed proportions of the tooth, from *Viverravus* and *Uintacyon* by the equal development of the wings of the protocone. The proportions of the tooth indicate that it belongs in the typical section of the genus, represented in the Uinta by *Miacis* ("*Mimocyon*") *longipes* Peterson, rather than to the subgenera *Lycarion*, *Harpalodon* and *Prodaphænus*, in which the tubercular dentition is relatively reduced. A species of *Miacis* (*M. exilis* Filhol) is recorded from the Phosphorites, but it is much smaller than this one; *Viverravus angustidens* is distinguishable by absence of metaconule and of "bourrelet" on m^1.

AMBLYPODA

Eudinoceras mongoliense Osborn

This genus was based upon two upper premolars identified by Osborn as p^3 or p^4. A third isolated upper premolar, No. 20134, is probably p^2 of the same genus. It is considerably smaller and less expanded transversely, the outer crescent is not so deeply inflected, the inner cusp more rudimentary (?vestigial), and a strong encircling cingulum expanded into a considerable shelf on the antero-internal face.

Osborn regards these teeth as representing a higher stage of specialization than "*Dinoceras*," and specifies that he applies the prefix "eu" in this sense [i.e. = meta]. It might equally well be regarded as more primitive, the small internal cusp being intermediate between the uintatheres, in which it is absent, and *Coryphodon* and *Pantolambda*, in which it is well developed. The new tooth is suggestively like the *Bathyopsis* premolars, although the type teeth are very unlike p^4 of that genus.

Fig. 6. *Eudinoceras*. Upper premolar, No. 20134, natural size, external and crown views.

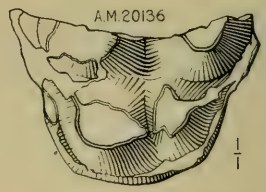

Fig. 7. Achænodont. Supposed upper milk molar, No. 20136, natural size, crown view.

ARTIODACTYLA

Achænodontidæ

No. 20136, an incomplete upper tooth, is doubtfully identified as dp^4 of an achænodont. It is too incomplete for positive reference. The outer border of the tooth is missing, but it appears to have been of rounded subtrigonal outline with two major outer cusps (paracone, metacone) rounded and well separated, a smaller internal cusp (protocone) and a much smaller postero-internal cusp (hypocone) which stands a little apart but not far from intermediate between protocone and metacone.

The tooth has some resemblance to dp^4 of the entelodonts, differing in absence of the conules, which are well developed in the deciduous as also in the permanent molars of entelodonts. In the achænodonts they are absent in the permanent molars; dp^4 is not known, but presumably would conform to the permanent molar construction. The Mesonychidæ have a similarly simple construction of the molars, but lack the hypocone; dp^4 appears to be unknown in Mesonychidæ but presumably would also conform to the permanent molar pattern and lack a hypocone.

The above reasons warrant a provisional reference of No. 20136 to the Achænodontidæ. We agree with Peterson that this group is not ancestral to the entelodonts, and probably only distantly related.[1]

[1]This view was indicated by Matthew in 1899, *Achænodon* and *Protelotherium* being referred to a separate family from *Entelodon*.

The relationship to *Helohyus* may be much closer, and, if brought into the same family, the name Helohyidæ Marsh, 1877, would have precedence.

Helohyidæ

Gobiohyus, new genus

Type.—*Gobiohyus orientalis* infra.

Diagnosis.—Teeth bunodont, low-crowned, upper molars five-cusped, without hypocone or mesostyle, with small parastyles and encircling cingula. Third and fourth upper premolars trigonal, with deuterocone and inner root, large on p^4, rather small on p^3; p^2 simple-crowned, compressed, two-rooted. Lower molars with very small internal paraconids, minute hypoconulids on m_{1-2} and large conical third lobe on m_3. P_4 with distinct deuteroconid. Anterior premolars spaced, p_1 one-rooted, c_1 large, procumbent, incisors small.

A few specimens in the Irdin Manha collection represent a bunodont artiodactyl resembling the Bridger genus *Helohyus*, but distinguished by the double cusp of p_4 (upper premolars unknown in *Helohyus*). It is well distinguished from any of the genera of the European Eocene, nor do any of the known bunodont artiodactyls of the Uinta approach it closely. The absence of hypocone distinguishes the new genus from Dichobunidæ and Entelodontidæ, the proportions of teeth and jaw, size of third lobe of m_3, etc., from *Cebochœrus* and *Chœromorus*, and from the earlier genera of Suidæ and Tagassuidæ. The conical cusps and lack of external stylar cusps on the upper molars sufficiently distinguish it from the Anthracotheriidæ, to which, however, it may be rather nearly related. From *Chœropotamus* it is distinguished by absence of either mesostyle or central cuspule on the upper molars, simple third lobe of m_3 and other details that suggest the closer affinity of the Parisian genus to the pigs.

Chœropotamus and *Cebochœrus* are generally regarded as primitive suillines, and grouped by Depéret under the family Hyotheriidæ. On the other hand, Schlosser makes *Chœropotamus* the starting-point of the Anthracotheriidæ. Whether *Hyotherium*, which is much more clearly of Suidæ affinities, should be included in a separate Eocene family may be open to question; in any event the family name Chœropotamidæ Owen, 1840, long antedates Hyotheriidæ Cope, 1888.[1] This family might be regarded as the common ancestral stock of suillines and anthracotheres, and it may well prove that *Helohyus* and its allies, separated as a distinct family by Marsh in 1877, united with the Dichobunidæ in Sinclair's revision, are in reality a more primitive group of the same stock, and

[1]Hyotheriinæ, Amer. Nat., XXII, p. 1087. *Hyotherida* Hæckel, 1895.

should be referred to Chœropotamidæ.[1] The American genera are very imperfectly known at present, and no distinctively suilline or anthracothere characters appear in the parts described, so that it seems better to retain the family for the present, pending determination of its real affinities. Near relationship between *Gobiohyus* and *Helohyus* is indicated by the close resemblance throughout of the molars and premolars, apart from the more progressive character of the latter (indicated in p_4, inferred in upper premolars), a difference to be expected in an Upper Eocene genus compared with its Middle Eocene relatives. It should also be observed that Stehlin's interpretation of the anterior teeth in *Chœropotamus* would exclude it from any typical position in the common ancestral stock of Suidæ and Anthracotheriidæ. The Helohyidæ may likewise prove to belong rather with the dichobunids than with the chœropotamids, in spite of the absence of hypocone.

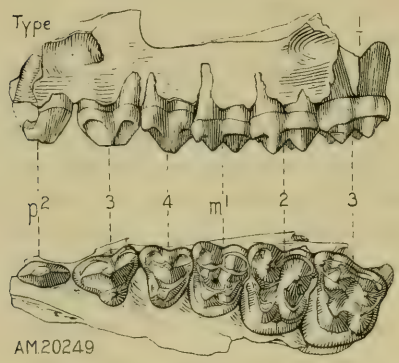

Fig. 8

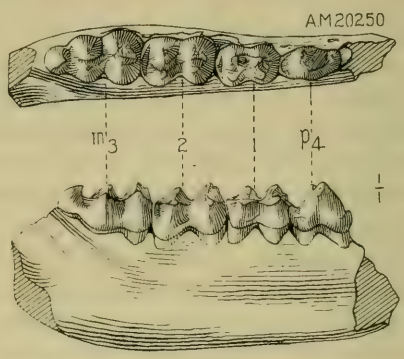

Fig. 9

Fig. 8. *Gobiohyus orientalis.* Upper jaw, type specimen, No. 20249, natural size, external and crown views.

Fig. 9. *Gobiohyus orientalis.* Lower jaw, No. 20250, natural size, crown and external views.

Gobiohyus orientalis, new species

Type.—No. 20249, upper jaw with p^2-m^3. Paratypes: No. 20248, lower jaw, m_{1-3}, and two upper molars probably accidentally associated; No. 20250, lower jaw, p_4-m_3. All from Irdin Manha formation.

Species Characters.—P^2-$m^3 = 50$; $m^{1-3} = 26.5$; $m_{1-3} = 30$; $m_{2-3} = 22$. Lower molar teeth more robust, trigonid of m_3 wider and heel smaller; m_3 $\frac{\text{length}}{\text{width}} = \frac{12.8}{8.2} = 1.56$

[1]Stehlin, H.-G., 1906, however, regards *Helohyus* as more probably of dichobunid affinities. See his discussion in Säugethiere des schweizerischen Eocäns, part iv, 1906, p. 672.

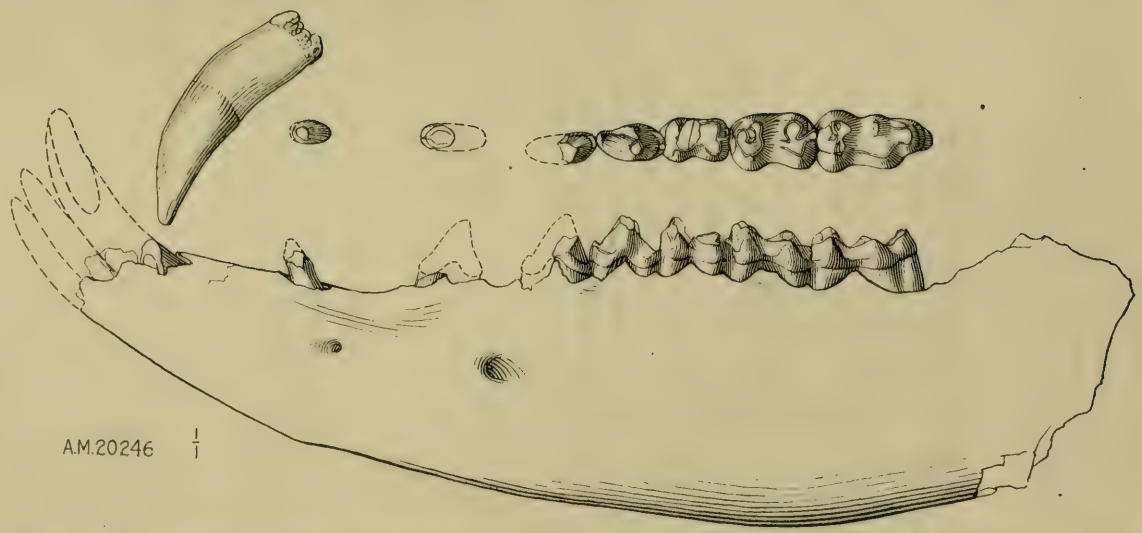

Fig. 10. *Gobiohyus robustus*. Lower jaw, external and crown views, with external view of upper canine. Type specimen, No. 20246. Natural size.

Gobiohyus pressidens, new species

TYPE.—No. 20247, lower jaw fragment with m_{2-3}. Irdin Manha formation.

SPECIES CHARACTERS.—Size smaller than *G. orientalis*, teeth narrower, m_3 with narrower trigonid and larger heel. $M_{2-3} = 18.5$; m_3 $\frac{\text{length} = 11}{\text{width} \quad 5.2} = 2.11$.

Gobiohyus robustus, new species

TYPE.—No. 20246, lower jaw, p_4-m_3, broken canine and premolars, and alveoli of incisor teeth.

CHARACTERS.—Teeth eighteen per cent. larger than in *G. orientalis*, relatively more robust, the trigonids of lower molars equaling talonids in breadth, whereas in *G. orientalis* they are narrower.

The relations of the anterior lower teeth as shown in the type specimen are presumably typical of the Helohyidæ. The canine is enlarged, procumbent, the incisors small, three in number, as indicated by their alveoli. The first premolar is rather small, one-rooted, with rather long diastemata before and behind it. There was apparently a considerable diastema behind the two-rooted, compressed second premolar. The third premolar was compressed, apparently simple, as long as p_4 or slightly longer. P_4 has the same construction as in the genotype, but is more robust, as are also the three molars.

This construction of the anterior teeth suggests the primitive Anthracotheriidæ[1] and Suidæ—not *Chœropotamus* if Stehlin's interpretation of the front teeth in that genus be correct.

TRAGULINA

cf. **Archæomeryx,** gen. indet.

No. 20173. A fragment of lower jaw, with p_{3-4} badly damaged, belongs to the ruminant group, but can hardly be definitely placed or compared. It is about the size of *Archæomeryx*, and the construction of the premolars, so far as preserved, appears to be similar.

The principal interest of this specimen is that it shows the presence of pro-Pecora in the Irdin Manha fauna as well as in the Shara Murun.

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[1]The arrangement of the lower premolars is exactly as in the type of *Lophiohyus* Sinclair of the Bridger Eocene; a complete skull and jaws of a small anthracothere from the Eocene of Burma (shortly to be described by Barnum Brown) also agrees in the relations of the anterior teeth.

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56.9,72(1181:51.7)

THE SMALLER PERISSODACTYLS OF THE IRDIN MANHA FORMATION, EOCENE OF MONGOLIA[1]

By W. D. Matthew and Walter Granger

A series of skulls of titanotheres, complete skeleton of an amynodont rhinoceros, and various more fragmentary specimens of these two families of Perissodactyla, were secured from the Irdin Manha formation by the Third Asiatic Expedition in 1923. They are described by Professor Osborn in forthcoming numbers of *American Museum Novitates*. Besides these larger animals, there were numerous fragmentary remains of small perissodactyls assigned to the present writers for study and description. They appear to be referable to the Helaletidæ, Lophiodontidæ, and Hyracodontidæ, the entire absence of horses and palæotheres being a feature of this and other early Tertiary faunas of Mongolia.

Helaletidæ (?Colodontidæ)

Desmatotherium mongoliense Osborn

Type.—No. 19161, a right maxilla with p^2-m^2.

This species was based upon "parts of ten individuals of a small lophiodont," among which the specimen selected as type belongs to a different genus and family from the rest. The species is here restricted to the type maxilla among the 1922 collections, the other specimens being referred to the lophiodont genus *Lophialetes*. The description and measurements of *D. mongoliense* are based only in part upon the type, and are rather misleading. It is about the same size as *D. guyotianum*, not smaller; the metacone is not flat but deeply concave, with its free flange quite short; referred specimens show that in m^3 it is further reduced. The lower molars are sharply cross-crested, and m_3 has no heel. The premolars are of the helaletid type, very different throughout from the hyracodont premolars, but resembling those of *D. guyotii* and of *Colodon;* more primitive than in the latter, and more progressive than in *Helaletes*.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 61.

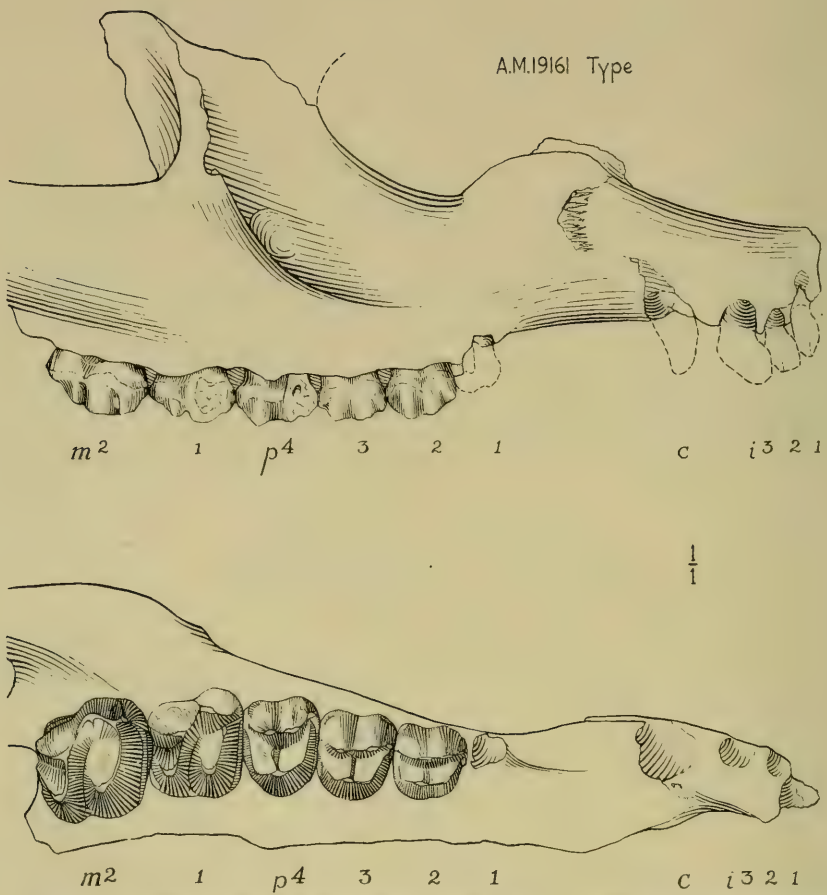

Fig. 1. *Desmatotherium mongoliense* Osborn, 1922. Upper jaw, type specimen, No. 19161.

Natural size, external and occlusal views.

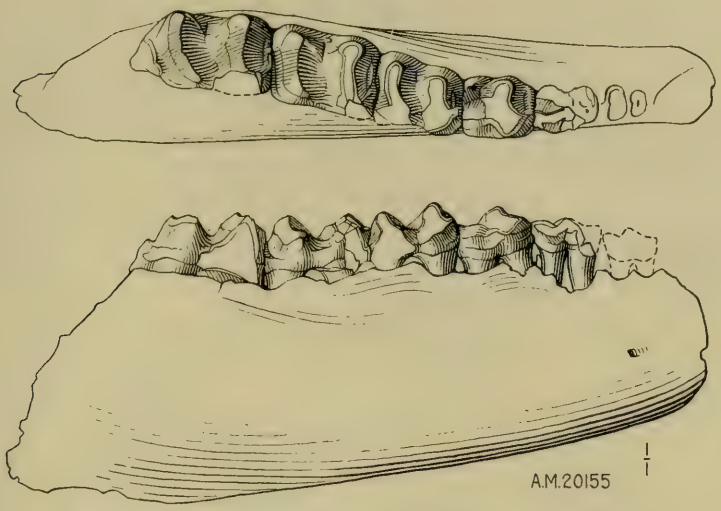

Fig. 2. *Desmatotherium mongoliense.* Lower jaw, No. 20155.
Natural size, external and superior views.

Desmatotherium fissum, new species

TYPE.—No. 20161, upper jaw fragment, p^{2-4}.

CHARACTERS.—Somewhat smaller than *D. mongoliense,* the internal cusps of p^2 and p^3 wide apart, that of p^4 indicated by a sharp groove on the inner face and a broadening of the apex. Paracone and metacone on p^{2-4} well separated, convex externally, parastyles lower and somewhat smaller cusps, no distinct metastyles.

Fig. 3. *Desmatotherium fissum.* Upper premolars, type specimen, No. 20161.
Natural size, crown view.

Teleolophus[1] **medius,** new genus and species

TYPE.—No. 20166, lower jaw with p_1-m_3.

PARATYPES.—No. 20163, lower jaw, p_4-m_3; No. 21064, upper jaw, dp^4-m^1; No. 20165, miscellaneous upper and lower teeth and jaw fragments.

All from the Irdin Manha formation, Telegraph Line Camp.

CHARACTERS.—Lower molars sharply cross-crested, increasing in size from first to third, no heel on m_3, premolars all two-rooted, non-molariform, a transverse crest in front and an anteroposteriorly-crested hypoconid behind, entoconid rudimentary. On p_2 the transverse crest is imperfect and on p_1 barely suggested. Upper molars with high, crested protoloph and metaloph curving around externally to join the flattened paracone at its anterior and posterior ends; the metacone has practically disappeared, the only vestiges of it being small crests (=free posterior flange of

[1]Greek τέλειος, complete, perfect; λόφος, crest.

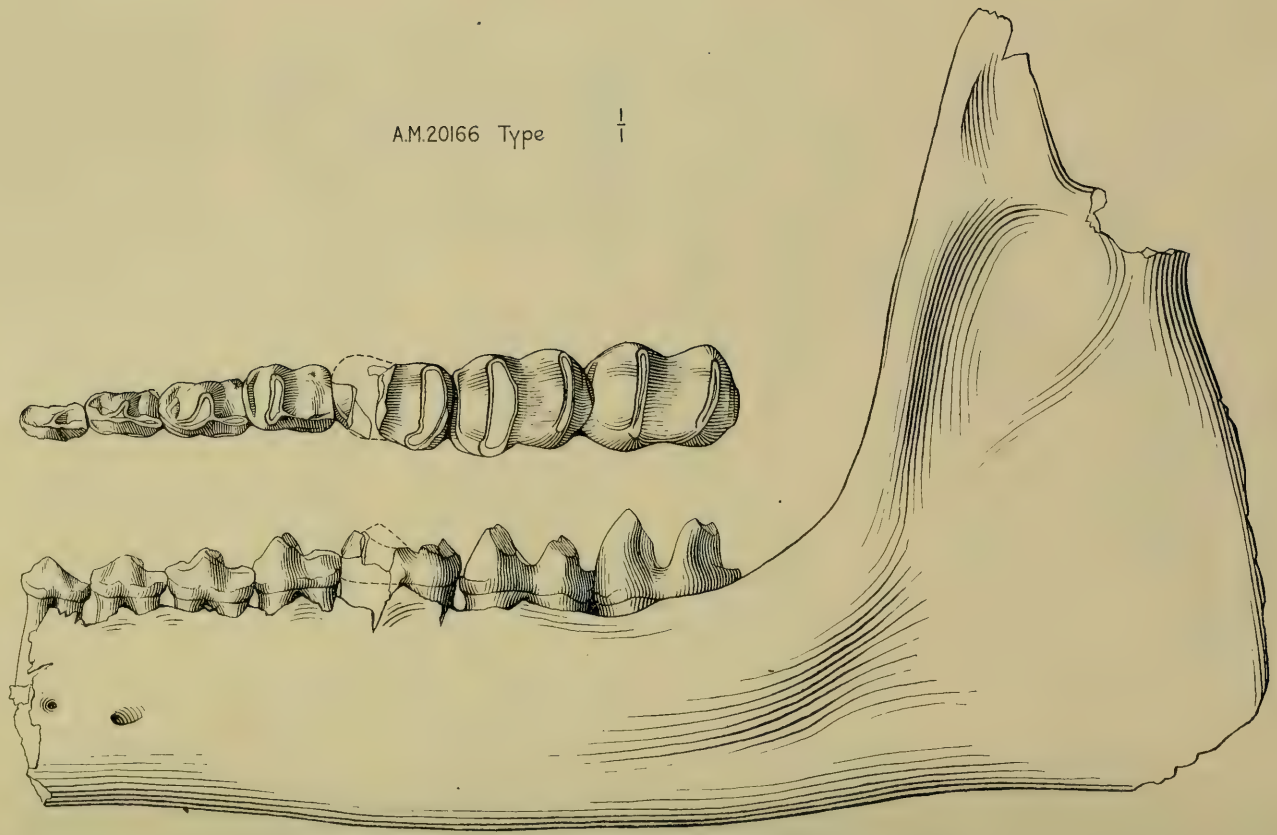

Fig. 4. *Teleolophus medius.* Lower jaw, type specimen, No. 20166.
Natural size, external view and crown view of premolar-molar series.

ectoloph) at the postero-external angles of m^{1-2} which rise only half-way up to the vertex of the metaloph and are entirely absent on m^3.

Length of p_1-m_3 = 52 mm. Dimensions of m^3, a.-p. × tr. = 21 × 26 mm.

This genus differs from "*Desmatotherium*" *mongoliense* and *fissum* as well as from the type of *Desmatotherium* in the decidedly higher and more sharply-crested crowns, reduction of the metacone on the upper molars, absence of heel on m_3, of entoconid on p_4, etc. The molars are very like those of *Deperetella* but the premolars are simpler, resembling those of *Desmatotherium*. It may well be ancestral to *Deperetella*.

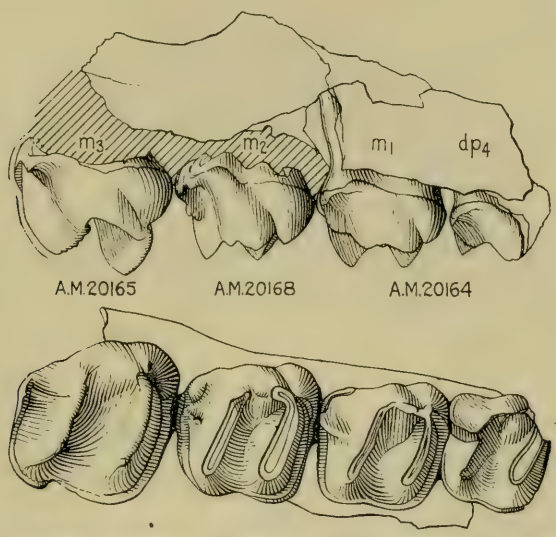

Fig. 5. *Teleolophus medius*. Upper teeth. Composite of three specimens, Nos. 20164, 20165, 20168, as indicated in the drawing.

Natural size, external and crown views.

Lophiodontidæ

Lophialetes[1] expeditus, new genus and species

TYPE.—No. 19163, upper jaw, with p^4-m^3 r.

PARATYPES.—Nos. 19162, 20144-20160.

HORIZON AND LOCALITY.—Irdin Manha, type locality.

CHARACTERS.—Metacones of upper molars flat externally, with long, free flange. Lower molars sharply lophodont, with connecting crests moderately developed; a reduced third lobe on m_3, with looped crest as in *Lophiodon*. Upper premolars with crested metacone, nearly flat externally, inner crescents undivided, but both wings

[1]*Lophiodon* + *Helaletes*—as combining characters of the two genera.

Fig. 6

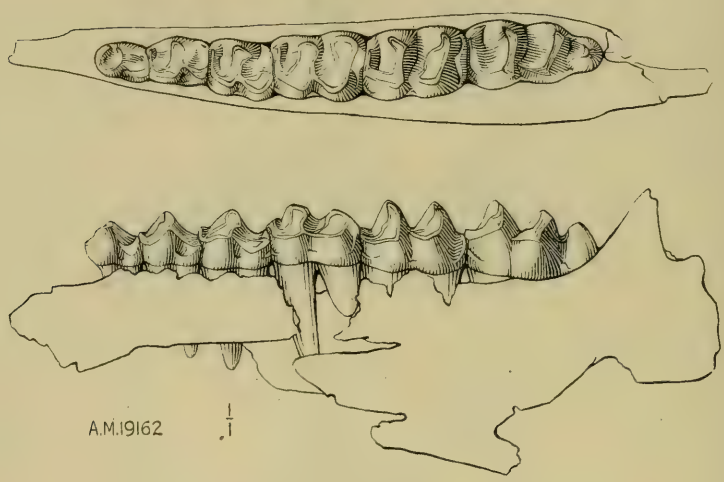

Fig. 7

Fig. 6. *Lophialetes expeditus.* Upper jaw, type specimen, No. 19163.
Natural size, external view and crown view of teeth; anterior premolars from No. 20160.

Fig. 7. *Lophialetes expeditus.* Lower jaw, No. 19162.
Natural size, superior and external views.

complete on p^{3-4}. Size one-sixth smaller than *Desmatotherium guyotii*, $m^{1-3} = 37$ mm.; p_2-$m_3 = 67$ mm. (Osborn, 1923, "*D. mongolicum*").

The upper molars have the primitive rhinocerotoid structure much as in *Triplopus*, but the last lower molar has a distinctly *Lophiodon-*

like heel. The construction of the premolars distinguishes it from the type of *Prothyracodon* as well as from that of *Triplopus*.

A great number of fragmentary specimens, teeth and parts of jaws from the type locality of the Irdin Manha formation belong to this genus, and represent probably one rather widely varying species. The skull is sufficiently known (No. 20144) to show that it has somewhat the helaletid type of recession of the nares. The feet are not known.

The present genus resembles the Hyracodontidæ in the rhinocerotoid type of the upper molars, sharply crested, with the metaloph joining the ectoloph far foward, and the external face of the ectoloph flat behind the anterior pillar. The premolars are rather helaletid than hyracodont in

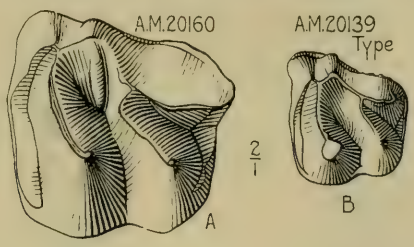

Fig. 8. *Lophialetes expeditus* and *L. minutus*. Upper molars, Nos. 20160, and 20139 (type).

Twice natural size, crown view.

type, and the heel of m_3 is of the looped type of *Lophiodon*, differing from the small transverse heel of *Helaletes* or the absence of heel in *Triplopus* or in *Hyracodon*. It appears to occupy a somewhat intermediate position, not closely related to any of these groups, and probably will have to be placed in a separate subfamily, **Lophialetinæ**, distinguished by the above combination of characters.

Lophialetes minutus, new species

Type.—No. 20139, upper molar, Irdin Manha beds, Telegraph Line Camp, Mongolia.

Characters.—Size little more than half the preceding; diameters of molar a.-p. $\times$tr. $=8\times9$ mm. No crista at head of median valley.

Hyracodontidæ

Cænolophus proficiens, new species

Type.—No. 20141, lower jaw, p_1-m_3, from Irdin Manha formation, Mongolia.

Species Characters.—Size larger than *C. promissus* of the Shara Murun (type of the genus), p_1-$m_3=89$, $m_{1-3}=54$ mm. Lower molars moderately increasing from

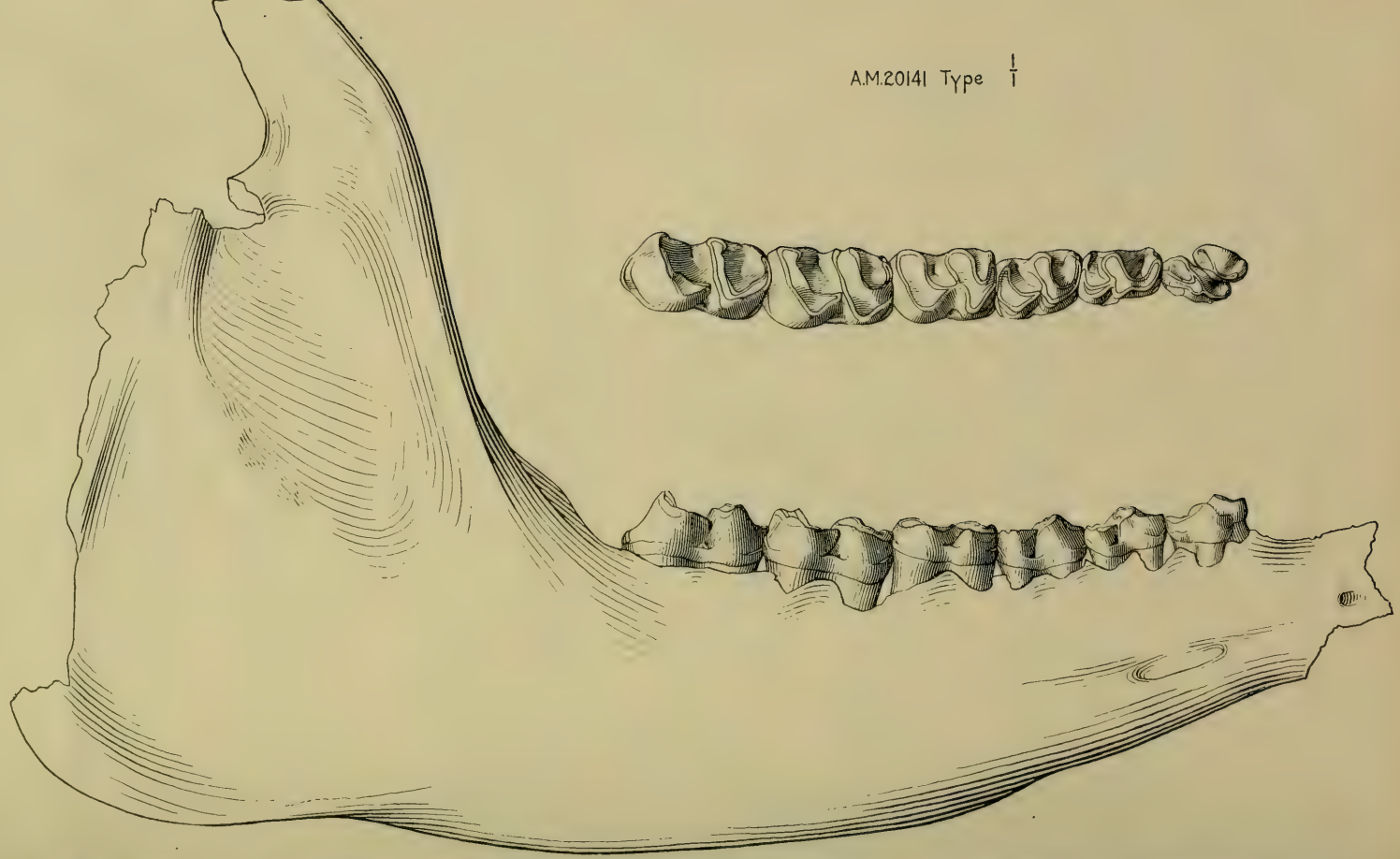

Fig. 9. *Cænolophus proficiens.* Lower jaw, external view, and crown view of teeth. Type specimen, No. 20141. Natural size.

first to third, posterior crest of m_3 pitched forward and inward, with a narrow cingular ledge behind it, coming to a blunt point posteromedially. Third and fourth premolars submolariform, first and second nearly simple, with a double posterior crest; p_1 in type two-rooted and crowded so as to be mainly internal to p_2 instead of anterior to it (probably abnormal—in No. 20140 it is one-rooted and not displaced).

Two isolated upper teeth, probably dp^3 and m^2, from the Irdin Manha beds are referred to this species. They are hardly distinguishable from *C. obliquus* of the Shara Murun. Other specimens referred to *C. proficiens* show the characters of the front teeth. They retain the primitive characters from which typical amynodonts have departed by enlargement of the canines to powerful tusks, and typical hyracodonts by reduction of the canines to completely incisiform status. In one specimen of *C. proficiens*, however, the second incisor appears to be moderately enlarged, thus suggesting a beginning of the true rhinoceros specialization in which i_2 becomes a powerful tusk. Unfortunately the tooth is broken off, and of the adjacent teeth only the roots remain.

The genus is placed provisionally in the Hyracodontidæ. It is not nearly related to *Lophialetes*, or to *Desmatotherium*.

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56.9(116:51.7)

A MESOZOIC MAMMAL SKULL FROM MONGOLIA[1]

By George Gaylord Simpson

Among the many remarkable discoveries of the Third Asiatic Expedition of The American Museum of Natural History is a large part of the skull with associated lower jaws of a Mesozoic mammal. This unique specimen was found by A. F. Johnson in the Djadochtá formation at Shabarakh Usu in Mongolia. Mesozoic mammals are among the rarest of the fossils, and, while it might well have been inferred that there were multituberculates in Mongolia in Cretaceous times, this splendid confirmation is no less startling than it is welcome. Only one other partial Mesozoic mammal skull has been found, that of *Tritylodon* Owen (1884) from the Lower Jurassic of South Africa, and the lower jaw of the latter form is quite unknown. No Mesozoic mammal has hitherto been found in Asia, and, although mammals occur at earlier and later horizons, none has yet been found in a formation of age equivalent to the Djadochta. Consequently, this specimen is noteworthy, not only in being the second known skull, and the first with associated lower jaws, and as adding new morphological knowledge, but it also adds a new horizon to the stratigraphic range and a new continent to the geographic distribution. The writer is deeply indebted to Professor Osborn and Doctor Matthew for the great privilege of naming and describing this important form.

The preparation, a task calling for the greatest delicacy and address, owing to the softness of the bone and the nature of the sandstone matrix, has been undertaken with great skill by Mr. Albert Thomson. This preparation is not yet complete, but enough has been done to reveal all the essential features and to make possible this preliminary description.

Djadochtatherium matthewi, new genus and species

Type.—Amer. Mus. No. 20440. Anterior part of skull with associated lower jaw.

Horizon.—Djadochta formation, early Upper Cretaceous, Mongolia.

Generic Characters.—A multituberculate of moderate size; the third upper incisors widely separated from the second ones and antero-internal to the first pre-

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 62.

molars; the lower premolars reduced to one; the lower molars with six cusps. (The specific characters are included in the following description.)

The anterior half of the skull is present and is well preserved save for the extreme tip and for a little distortion due to crushing. The palate anterior to P^3 is present and exposed. The nasals and pre-

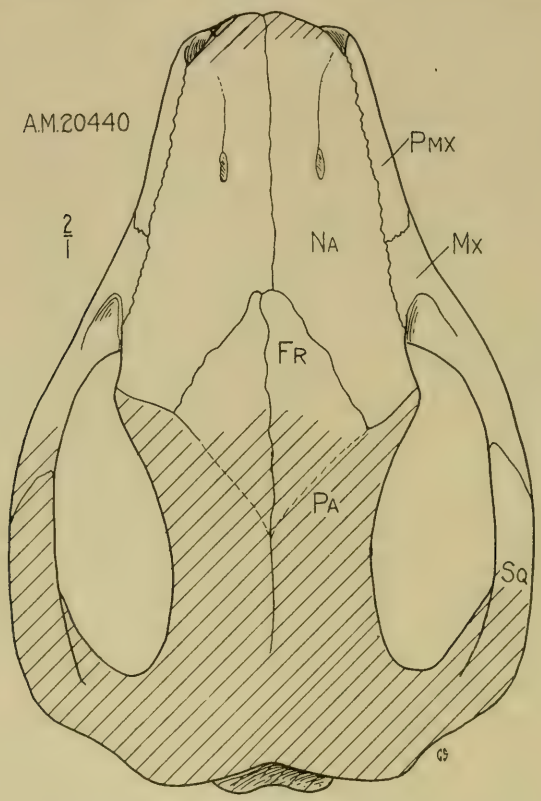

Fig. 1. *Djadochtatherium matthewi*, superior view of the type skull. ×2.
The distortion has been corrected and the parts cross-lined restored.

maxillæ are present and complete, as are also the maxillæ save for the posterior parts of their alveolar and palatal portions. The sutures are well defined, and the only possibility of misinterpretation lies in the posterior upper part, where crushing has been most severe.

As seen from above, the facial region is triangular, resembling *Ptilodus* closely in this respect. Most of the upper surface is formed by the very large nasals, which are broad at all points but slightly more so

posteriorly. They reach back almost to the posterior border of the orbit and form a part of the superior border of the latter. The anterior parts of the frontals seem to be present; they come forward to a median point as in *Polymastodon* or *Ornithorhynchus,* and each was probably much reduced and triangular as in those genera. No part of the parietals is preserved, but from the shape of the nasals and frontals it seems fairly certain that they had a well-developed nasal contact at about the point where the nasals are broken off. The parietals did not reach the maxillæ.

The premaxilla is well developed with long maxillary and nasal sutural contacts, and is unusually elongated. It forms a larger part of the lateral aspect of the face than does the maxilla. The latter element

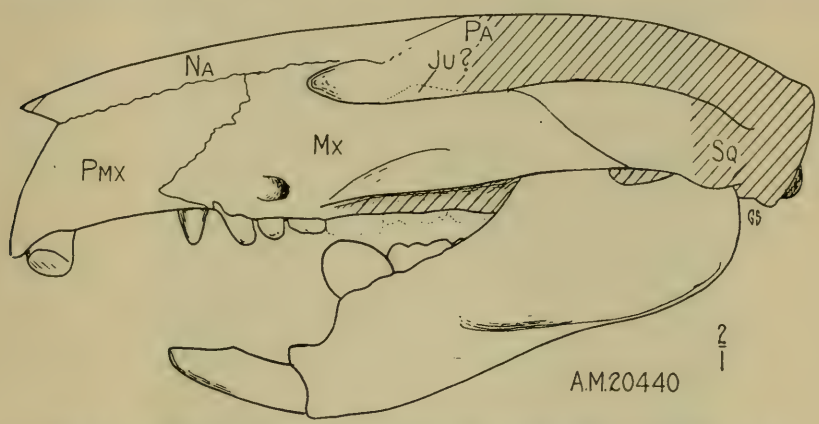

Fig. 2. *Djadochtatherium matthewi,* side view of type skull and jaws. × 2.
Only the parts not present on either side are cross-lined.

is also large, but with its strictly facial portion much reduced. It probably formed at least half of the zygomatic arch, which is uncommonly stout and arises opposite the third premolar. The infra-orbital canal is short, and the single foramen is situated not far from the alveolar border just anterior to the root of the zygoma.

There is no trace of a lacrymal bone, and this element is probably absent. Neither is there any trace of a jugal, and this bone, too, may have been totally absent. If present, it was very small and was confined to the upper part of the zygomatic arch.

A somewhat questionable but interesting feature is the apparent presence near the middle of each of the large nasals of a small elliptical foramen. These were present before burial, and their presence in both

nasals in symmetrical positions seems to indicate that they are original features of the animal. If so, the only condition which might be compared is that seen in *Ornithorhynchus:* the supra-orbital foramina of the latter are nearly but not quite inclosed within the nasals—if they became fully so they would agree in position with the present doubtful foramina. Anterior to these openings are two longitudinal cracks which are as well marked as sutures but which are probably due to pressure on the buried skull.

The palatal aspect, although incomplete posteriorly, is very instructive. The palatine processes of the premaxillæ are well developed and somewhat longer and broader than is usual. They meet in a slight

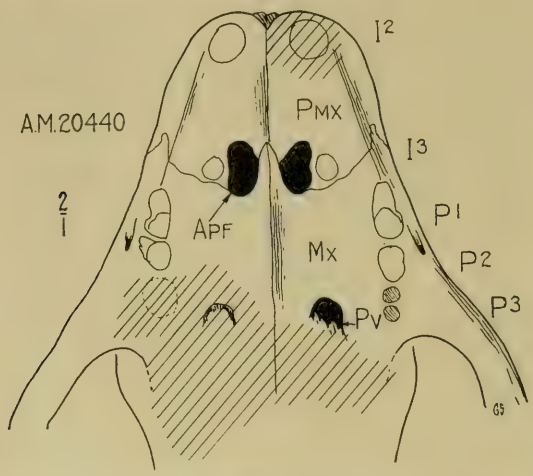

Fig. 3. *Djadochtatherium matthewi*, palatal view of type skull. × 2.
Cross-lined parts restored.

groove along the midline. Consonant with the elongation of the premaxillæ, the anterior palatine foramina appear to have been shifted posteriorly, but they retain their relationships with the third incisors, being immediately internal to them as in other multituberculates.

The palatine portions of the maxillæ are also large, and meet in a low longitudinal ridge at the midline. Opposite the third premolar may be seen the anterior end of a small palatal vacuity.

The mandible is of the familiar multituberculate type, differing only in detail (and in some features of the dentition) from that, for instance, of *Ctenacodon*, and the resemblance to *Ptilodus* is even closer. Above the symphysis, where the two rami were loosely united by carti-

lage, is a small median bony protuberance such as is seen, for example, in the rat. The coronoid process arises with its anterior border outside the last molar. The process is small and is separated from the condyle by a large semicircular notch. The masseteric and pterygoid fossæ are not well defined anteriorly or superiorly, but the masseteric crest, although now broken off, was strong, while the pterygoid crest opposite it, on the inner side of the posterior portion of the mandible, was very promi-

Fig. 4. *Djadochtatherium matthewi*, photograph of type skull from above. × 2.

nent. As seen from above or below, its edge is a gentle, unbroken curve departing from near the condyle, and there is not the slightest reason to speak of an angle, inflected or otherwise.

The condyle is sessile, not marked off by a neck or constriction. The articular facet is roughly oval with its longest diameter in the same plane as the longitudinal axis of the jaw. It is convex in all directions, but more so along the longer diameter.

Dentition.—The teeth, unfortunately, are on the whole very poorly preserved, and they leave a number of very important points to

be cleared up by hoped-for further finds. The dental formula, so far as indicated, is $\frac{2(3?)\cdot 0\cdot 3+?}{1\ \cdot\ 0\cdot 1\cdot 2}$ and it seems most probable that it was $\frac{2\cdot 0\cdot 4\cdot 2}{1\cdot 0\cdot 1\cdot 2}$. One cannot be sure that small first upper incisors did not occur as in *Tritylodon* and *Ctenacodon* (*Allodon*), but there is no indication of them. The second incisors are the largest and are implanted nearly vertically near the anterior end of the premaxillæ. Their tips did not meet in the midline. The apparent mode of wear is peculiar, for the worn facet, instead of facing backward, faces obliquely outward and forward. The third incisors, instead of closely following the second ones, are some distance directly back of the latter. Since the width of the palate ex-

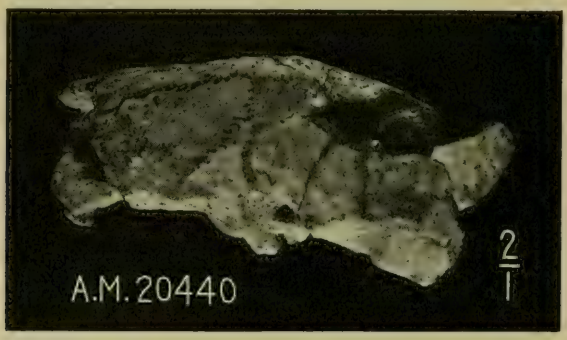

Fig. 5. *Djadochtatherium matthewi*, photograph of type skull from the side. × 2.

pands considerably in this distance, while these teeth are but little farther apart than the preceding ones, they are internal to the border of the palate and give the impression of actually standing on the latter itself. This very unusual character, together with the reduction of the lower premolars and simplicity of the lower molars, may be considered diagnostic of the genus. These incisors were conical and pointed.

The upper premolars are so worn that their crowns are nearly shapeless. Two are preserved on the right side and two and the roots of a third on the left. On the left side, where they are a little less worn, it is seen that the crown of P^1 is nearly equilaterally triangular, with an angle external. On P^2 of this side two external cusps can be seen, one a little more external than the other, but the inner part of the crown seems to have been broken or worn off. The third premolar had two roots closely approximated, as had also the first and second, and was not larger than the second. There appears to be a diastema back of this

tooth, but in view of the condition of the specimen this remarkable impression may well be erroneous. Nothing remains of a possible fourth premolar or of the molars. Judging by analogy with other multituberculates, the large lower premolar would require a mate, the fourth premolar, in the upper series, and the two lower molars would each occlude with an upper molar, making the formula that indicated as probable at the beginning of this section. It is very improbable, in view of the small

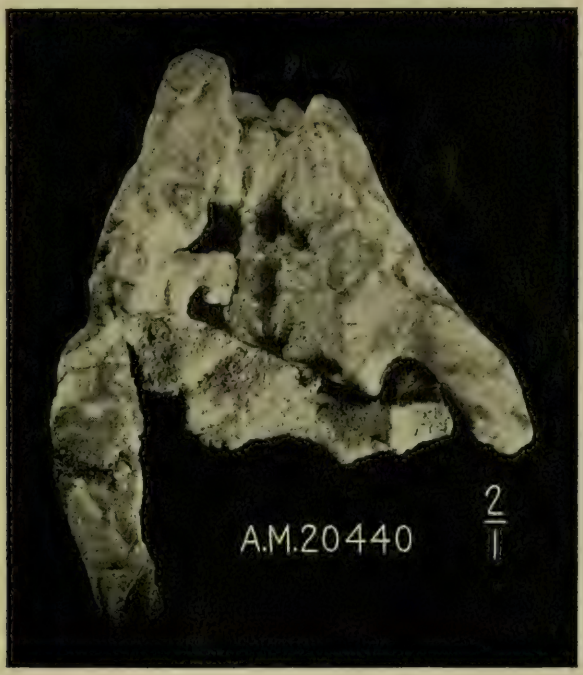

Fig. 6. *Djadochtatherium matthewi*, photograph of palate of type skull. × 2.

amount of space between the lower molars and the incisors and in view of the reduction of the lower premolars, that there were five upper premolars as in *Ctenacodon* and *Plagiaulax*.

The lower dentition is much better known, although still hardly satisfactory. The incisors are remarkably stout, and their long curved fangs extended back at least to beneath P_4 or M_1 and undoubtedly were derived from a persistent pulp. The chief wear is on the superior (posterior) face, and here is developed a facet which faces backward and

inward. The premolar series has been reduced to a single tooth, P_4. As preserved, this tooth is large, blunt, rather formless, and somewhat compressed laterally. It seems probable that it was a sharp-edged shearing tooth, but this is not absolutely demonstrated. The first

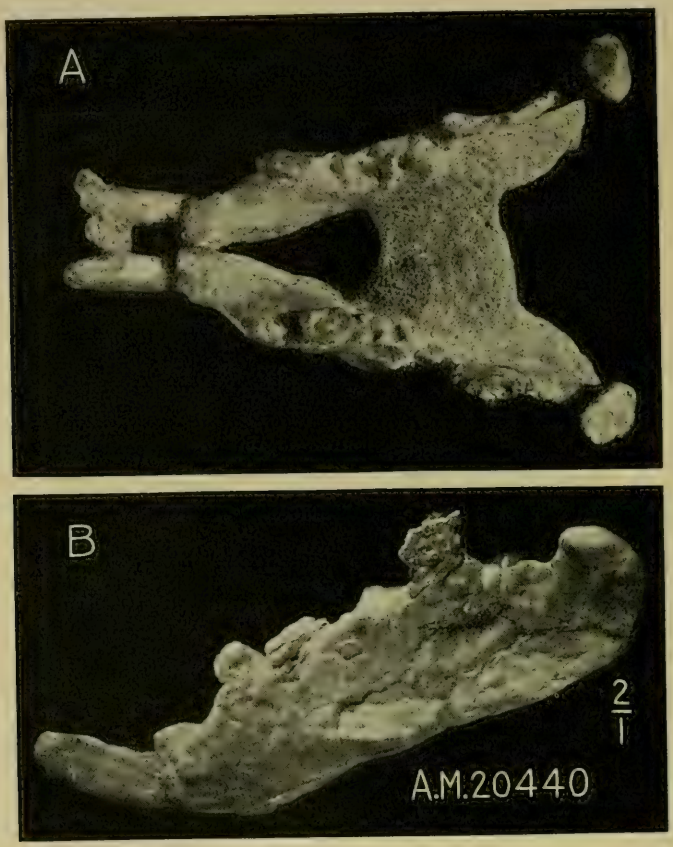

Fig. 7. *Diadochtatherium matthewi*, photographs of mandible of type. × 2.
A, from above; B, from the side.

molar again is poorly preserved, not only badly worn but also broken. The crown had two longitudinal rows of cusps with a small number of cusps, quite surely three, in each. The posterior molar is unknown.

When the jaws were closed, the lower incisors had their tips inserted between the small posterior upper incisors. It seems certain,

however, that sufficient anteroposterior motion was possible for the lower incisors to work against the anterior upper ones—the facets on the two are complementary.

AFFINITIES

That *Djadochtatherium* is a multituberculate is, of course, obvious. That part of the dentition preserved is absolutely diagnostic, as are also the mandibular and cranial characters. The order Multituberculata may be divided into two great groups, one including *Tritylodon* and its allies and the other including all the upper Jurassic, Cretaceous, and Paleocene forms, with probably some earlier ones also. The *Tritylodon* group is characterized by almost undifferentiated upper cheek-teeth with three rows of two to four cusps each, and by the retention of a large lacrymal and jugal and of unreduced frontals. *Djadochtatherium* is plainly very distantly related to this group, if at all.

The other group, or suborder, which may be called the Plagiaulacoidea in contrast to the Tritylodontoidea, is much in need of revision and of careful redefinition of the several families which compose it, but it is quite outside the scope and aim of *Novitates* to present this taxonomic revision here, and it will suffice to point out merely the course of evolution as it is now known. The uppermost Jurassic multituberculates have simple molars with six cusps each in two rows both above and below. There are four or three trenchant lower premolars, and five upper premolars, the last two of which are trenchant. In the Upper Cretaceous and Paleocene, the multituberculates have more complicated molars with two rows of cusps below and three above, and the first molar is larger and more complex than the second, instead of being nearly equal as in the Jurassic. In the more usual of these later types there is a trenchant lower premolar and sometimes another functionless one in front of this, and there are four upper premolars, only one of which, the last, is trenchant. In another type (*Polymastodon*), the premolars are reduced to a single conical one above and below. The cranial osteology is known only in two forms, *Ptilodus* and *Polymastodon*, but the Jurassic forms seem already to agree in the most striking specializations, i.e., the reduction or loss of the lacrymal and jugal.

On comparing the subject of this paper with these plagiaulacoids, the first impression is the remarkable agreement. If it were found in beds of age equivalent to the Djadochta formation, but in England or America, the Mongolian form would, indeed, be a new and marked type,

but not a surprising or anomalous one, and certainly a hypothesis of Asiatic or other exotic origin would be entirely unnecessary.

Djadochtatherium is in a very definitely Upper Cretaceous or, indeed, even Paleocene state of evolution. The reduction of the lower premolars is complete, for but one remains. The upper premolars, it must be inferred, were reduced to four, and of these only the last one can have been shearing. The size also is larger than that of any Jurassic forms but well within the range of the more common later genera. The simple character of the lower molars, if correctly interpreted, is a remarkably persistent feature in view of the specialization elsewhere. The equal size of the two lower molars, as also the small number of cusps, shows little or no advance beyond *Plagiaulax* or *Ctenacodon* of the Purbeck and Morrison. It is interesting that no known feature of *Djadochtatherium* precludes direct descent from these English and American Upper Jurassic forms.

The Mongolian mammal is, of course, very distinctive. The action of the lower incisors, the peculiar specialization of the upper ones, the early reduction of the lower premolar series, the prolongation of the premaxillæ, and the retention, in the face of these advances, of primitive molars, all place this form in a unique position. It could not possibly have been ancestral to any later known North American or European multituberculate, but is a member, perhaps the terminal member, of a hitherto unknown sideline of descent. Whether that line was close to that of the *Ptilodus*-like forms, the numerous Cretaceous and Paleocene ptilodontids, or whether its departure was in an entirely different direction, cannot be definitely asserted until the crucial upper molars are known. If these are simple, with only two rows of cusps and no indications of a third, *Djadochtatherium* would undoubtedly have to be placed in a different family, as will also be the case if, as is very possible, the unknown parts exhibit unpredictable peculiarities in keeping with those now known. If the upper molars are three-rowed, with twelve cusps or more, only a minor branch of the ptilodont stock would be indicated. The latter view may be adopted provisionally in view of the fact that the contour and size of the skull, shape of the lower jaw, premolar reduction and (so far as can be deduced) form, all agree remarkably with the later ptilodonts.

The cranial osteology is very similar to that of *Polymastodon*. The probable reduction of the frontals and the reduction or total loss of the lacrymal and jugal are significant, especially in view of the age of *Djadochtatherium*, which is much greater than that of *Polymastodon*, and

also in view of the great differences from the only other known Mesozoic mammal skull, *Tritylodon*.

So far as regards the bearing of this specimen on the affinities of the Multituberculata, a full discussion is not possible here. Many of the characters of *Polymastodon* and *Ptilodus* cited by Broom as indicating monotreme relationship are substantiated and carried back to a greater antiquity. In two features, the parietonasal contact without a parieto-maxillary one and the apparent presence of supraorbital foramina, *Djadochtatherium* resembles *Ornithorhynchus* even more than does *Polymastodon*, but these facts should not be overemphasized, not only because they are not very binding evidence of affinities but especially because their reality is not considered as established beyond all doubt.

CONCLUSIONS

The finding of a mammal in a later Mesozoic uplands formation of central Asia is an event which has been awaited by paleontologists with passionate interest, for it has long been felt by many that in such a formation the ancestors of the mammals which appear so suddenly in Europe and North America at the close of the Mesozoic might be found. *Djadochtatherium* goes far toward answering such anticipations with a firm negative. It is a Mesozoic mammal in every sense of the word, belonging to a previously known Mesozoic order, suborder, and probably family, and finding a possible structural ancestor in the Upper Jurassic either of England or of America. In conjunction with what we know of other faunas, it seems to indicate quite positively that the earlier Cretaceous mammals of Asia, Europe and North America were from a common source and not very different. Although the possibility is not to be flatly denied, it would be very surprising to find the ancestors of the Tertiary, or even of the Paleocene, placental mammals living with *Djadochtatherium*.

In any event, this fine specimen has permitted the description of a second Mesozoic mammal skull, the addition to the known multituberculates of a new and interesting adaptive type, the extension of the peculiar sort of cranial osteology seen in *Polymastodon* well down into the Cretaceous, and the addition of a new continent to the known range of the Mesozoic Mammalia.

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UPPER EOCENE AND LOWER OLIGOCENE TITANOTHERES OF MONGOLIA[1]

By Henry Fairfield Osborn

The Eocene and Oligocene titanotheres of Mongolia, discovered by members of the Third Asiatic Expedition in the years 1922 and 1923, will be described and figured in detail by the author in Monograph 55 of the U. S. Geological Survey, now going to press. Subsequent and still more complete description will appear in "The Natural History of Central Asia," the series of volumes dealing with the Central Asiatic explorations of the American Museum. The object of the present issue is to name the various titanotheres discovered and to briefly designate the genera and species to which they belong as well as the geologic life zones in which they occur. Fortunately for purposes of correlation and bearing on zoögeographic relations in Upper Eocene and Lower Oligocene time, seven of the genera closely correspond in the two countries, namely, Mongolia and the Rocky Mountain region of North America. The geologic distribution of these genera and species in *descending* order is as follows:

Lower Oligocene, Ardyn Obo Formation, Brontops gobiensis Life Zone.

Brontops gobiensis, the broad-skulled 'thunder-eyed' titanothere of the Gobi desert, in a similar stage of evolution to *Brontops brachycephalus* of the Chadron A formation, Lower Oligocene, South Dakota.

Menodus mongoliensis, the 'long-skulled' titanothere of the Gobi desert, in a similar stage of evolution to *Menodus giganteus* of the Chadron B formation, Lower Oligocene, South Dakota.

Uppermost Eocene, Shara Murun Formation, Protitanotherium mongoliense Life Zone.

Protitanotherium andrewsi, named in honor of Roy Chapman Andrews, leader of the Third Asiatic Expedition; in a somewhat more advanced stage of evolution than *Protitanotherium superbum* of the Uinta C formation, northern Utah.

Protitanotherium mongoliense, the titanothere first named from Mongolia, believed to be in a somewhat similar stage of evolution to the *Protitanotherium superbum* of the Uinta C formation, northern Utah.

Dolichorhinus kaiseni, named in honor of Peter Kaisen, a member of the Third Asiatic Expedition; believed to be in a more progressive stage of evolution

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 63.

than *Dolichorhinus* (*cornutus*) *hyognathus* of the Uinta B formation, northern Utah.

Genus?, species?, a long, slender-limbed titanothere, possibly ancestral to *Menodus mongoliensis*, represented by the fore limb bones (Amer. Mus. 20253).

UPPER EOCENE, IRDIN MANHA FORMATION, PROTITANOTHERIUM GRANGERI LIFE ZONE.

Protitanotherium grangeri, the first titanothere found in Mongolia, named in honor of Walter Granger, chief palæontologist of the expedition; believed to be in a stage of evolution similar to that of *Protitanotherium emarginatum*, lower levels of the Uinta C formation, northern Utah.

Dolichorhinus olseni, named in honor of George Olsen, a member of the Third Asiatic Expedition.

Telmatherium berkeyi, named in honor of Charles P. Berkey, chief geologist of the expedition, who collected the first titanothere jaw.

Manteoceras? irdinensis, of doubtful generic affinity to the *Manteoceras* of the Uinta B, Utah, named specifically in reference to its discovery in the Irdin Manha formation of Mongolia.

Metarhinus? mongoliensis, of doubtful generic reference to the fluviatile *Metarhinus* of the Uinta B of Utah, named specifically in reference to its discovery in Mongolia.

FIELD CATALOGUE AND NOTES BY WALTER GRANGER, 1922 and 1923

Of great importance is the precise geographic and geologic distribution of titanothere remains, skulls, jaws, and portions of the skeleton, collected from the three chief localities. Treated in geologic descending order, the records are as follows.

Ardyn Obo Formation, Lower Oligocene. Teeth, Jaws, and Skull collected on the Kalgan-Uliassutai Trail, southeastern Gobi, Mongolia

Amer. Mus. No.	Genus and Species	Material	
20354	*Brontops gobiensis*, new species.	Crushed skull.	July 2, 1923.
20353	" " referred.	Symphysis of jaw.	June 30, 1923.
20351	*Menodus mongoliensis*, new species.	Lower grinding tooth.	June 29, 1923.

Shara Murun Formation, uppermost Eocene. Remains of twenty-seven Titanotheres collected on the Kalgan-Uliassutai Trail, southeastern Gobi, Mongolia, chiefly during the season of 1923. Type of *Protitanotherium mongoliense* collected in 1922

Amer. Mus. No.	Genus and Species	Material
20252	*Dolichorhinus kaiseni*, new species.	Male skull and jaws, nearly complete dentition.

Amer. Mus. No.	Genus and Species	Material
20257	*Dolichorhinus kaiseni*, paratype.	Palate and basicranium, complete dentition.
20255	*Dolichorhinus kaiseni*, referred.	Female skull and jaws, nearly complete dentition.
20260	*Dolichorhinus kaiseni*, referred.	Male skull and jaws, complete dentition.
18653	*Protitanotherium mongoliense* Osborn, type.	Right ramus, fragment, with six grinders. First titanothere to reach Museum from Mongolia.
20263	*Protitanotherium mongoliense*, neotype.	Palate and dentition complete.
20256	*Protitanotherium mongoliense*, referred.	Palate, canine, superior grinders, lower jaws.
20261	*Protitanotherium mongoliense*, referred.	Female skull complete (crushed), incisors, canine, grinders.
20270	*Protitanotherium mongoliense*, referred.	Right maxilla and zygoma, superior grinders.
20273	*Protitanotherium mongoliense*, referred.	Fine pair jaws, lacking symphysis, inferior grinders.
20271	*Protitanotherium andrewsi*, new species.	Complete male skull, dentition, nasals wanting.
20251	*Protitanotherium andrewsi*, paratype.	Male? Left ramus, inferior grinders.
20254	*Protitanotherium andrewsi*, referred.	Male skull, superior dentition.
20262	*Protitanotherium andrewsi*, referred.	Jaws, symphysis, upper incisors, grinders.
20269	*Protitanotherium andrewsi*, referred.	Symphysis of jaws, with canines.
20280	*Protitanotherium andrewsi*, referred.	Juvenile palate, deciduous premolars, first, second molars.
20272	*Protitanotherium andrewsi*, referred.	Fine jaw, male, inferior dentition.
20253	Genus? and species? not determined.	Premaxilla, incisor; ulna, femur, vertebræ, foot bones, pro-*Menodus* phylum?
20265	Genus? and species? not determined.	Maxilla fragment.
20268	Genus? and species? not determined.	Left ramus of lower jaws.
20258	Genus? and species? not determined. *Protitanotherium?*	Fore foot, with distal end ulna and radius.
20259	*Protitanotherium andrewsi?*, referred.	Part of fore foot (metapodials).
20267	Genus? and species? not determined, *Protitanotherium*.	Associated foot bones.
20274	*Protitanotherium mongoliense*, referred.	Incomplete hind foot.
20275-20276	Genus? and species? not determined. *Protitanotherium?*	Fore and hind foot bones.
20277	*Protitanotherium mongoliense*, referred.	Complete hind limb and foot.
20327	*Protitanotherium andrewsi*, referred.	Right humerus, 2 right tibiæ, left tibia, foot bones.

Irdin Manha Formation, Upper Eocene. Remains of twenty-six Titanotheres collected north and south of the Kalgan-Urga Telegraph Line, southeastern Gobi, Mongolia. Chiefly collected during the season of 1923. First specimen found in 1922

Amer. Mus. No.	Genus and Species	Material
20111	*Manteoceras? irdinensis*, new species.	A right lower jaw.
20117	(Misplaced.)	Field label, "titanothere lower jaw."
20167	*Metarhinus? mongoliensis*, new species.	Small lower jaw, two grinders, milk superior grinders.
20103	*Protitanotherium grangeri* Osborn, type.	Female skull, jaws, incisors, canines, fragmentary molars.
19179	*Protitanotherium grangeri*, referred.	Left jaw and symphysis, with six grinders. First titanothere found in Mongolia.
20120	*Protitanotherium grangeri*, referred.	Perfect portion of right maxilla.
20122	*Protitanotherium grangeri*, referred.	Juvenile palate and grinding teeth.
20123	*Protitanotherium grangeri*, referred.	Fragment of left maxilla and grinding teeth.
20126	*Protitanotherium grangeri*, referred.	Fragment of left ramus with grinding teeth.
20105	*Protitanotherium grangeri*, referred.	Large adult male jaw with teeth.
20108	*Protitanotherium grangeri*, referred.	Small female right maxilla and grinding teeth.
20113	*Protitanotherium grangeri*, referred.	Facial portion of female cranium, anterior grinders.
20114	*Protitanotherium grangeri*, referred.	Anterior portion female cranium with dentition.
20119	*Protitanotherium grangeri*, referred.	Left jaw fragment with four grinding teeth.
20112	*Protitanotherium grangeri*, referred.	Young male right ramus of jaw with six grinders.
20104	*Protitanotherium grangeri*, referred.	Very large male jaw with nearly complete dentition.
20110	*Protitanotherium grangeri?*, referred.	Large male jaws with complete dentition.
20106	*Telmatherium berkeyi*, new species.	Adult female lower jaws, right maxilla, canines, grinders.
20107	*Telmatherium berkeyi*, paratype.	Anterior half of jaw, canine, inferior grinders.
20121	*Telmatherium berkeyi*, referred.	Perfect left maxilla and grinding teeth.
20127	*Telmatherium berkeyi*, referred.	Palate and superior grinders.
20115	*Telmatherium berkeyi*, referred.	Juvenile lower jaw with incisors and grinder.
20125	*Telmatherium berkeyi*, referred.	Left maxilla with premolar teeth.
20124	*Telmatherium berkeyi*, referred.	Right jaw with well-preserved grinders.
20109	*Dolichorhinus olseni*, new species.	Fine pair of jaws.
20171	*Protitanotherium grangeri*, referred.	Right humerus, 2 right ulnæ, left ulna and radius, axis, right tibia.

Brontotheriidæ

Brontopinæ

Brontops gobiensis, new species

In the Ardyn Obo formation were found remains of three titanotheres in a distinctly Oligocene stage of evolution. The type skull (Amer. Mus. 20354), named herewith *Brontops gobiensis*, contains three superior incisors with distinct tetartocones in the three molars, no hypocone in M^3. The massive symphysis (Amer. Mus. 20353) is referred to the same species.

The type of *Brontops gobiensis* (Amer. Mus. 20354) consists of the cranium reconstructed after comparison with that of *Brontops brachycephalus*. The horns partake of the short, broad character of the cranium; they are obtusely prominent. The nasals are elongated, broad, and shovel-shaped as in *Protitanotherium* and *Menodus* (=*Titanotherium*). The symphysis of a referred jaw (Amer. Mus. 20353) is extremely massive like that of *Brontops*. The dental formula $I\frac{3-3}{3-3}$ $C\frac{1-1}{1-1}$ $P\frac{4-4}{4-4}$ $M\frac{3-3}{3-3}$ agrees with that of *Teleodus* Marsh in the presence of three superior incisors, and differs from that of *Brontops brachycephalus* Osborn, in which the incisive formula is $I\frac{2-2}{2-2}$. The cranium is as brachycephalic as that of *B. brachycephalus*. The strong, well-developed tetartocones of the premolars or double internal premolar cones mark the chief progression beyond *Protitanotherium*.

Menodontinæ

Menodus mongoliensis, new species

The type of *Menodus mongoliensis* (Amer. Mus. 20351), from the Ardyn Obo formation, is a second right inferior molar tooth in which the second lobe is perfect, the first lobe is broken in front. The generic and specific characters, as compared with the *Brontops gobiensis* type, are:

An animal equal in size to the large male individuals of *Menodus giganteus* (=*ingens* Marsh) of South Dakota; length of two lobes of second inferior molar estimated at 93 mm., actual breadth of anterior lobe 40 mm., height of relatively unworn second lobe 53 mm.; prominent postero-external cingulum; prominent posterior crests on metaconid and hypoconid; internal valleys of trigonid and talonid widely open; inferior molar proportions similar to those of *Menodus*, wholly dissimilar to those of *Brontops*, indicating that *M. mongoliensis* was a long-headed rather than a broad-headed animal.

Manteoceratinæ (Brontopinæ)

Protitanotherium andrewsi, new species

The seven specimens, including the type of *Protitanotherium andrewsi* (Amer. Mus. 20271), the paratype (Amer. Mus. 20251), and the referred skulls and jaws of this species, as listed above, while recorded from the same formation as *Protitanotherium mongoliense*, exhibit decidedly progressive mutations and rectigradations warranting a specific separation. This advance is indicated not only by the greater measurements of the cranium and jaws throughout, but by several progressive characters more or less clearly observed in the grinding teeth, although the grinders do not greatly exceed in length those of *Protitanotherium grangeri*.

The specific distinctions are as follows: (1) Tetartocones prominent in P^{2-3}; (2) rudiments of a hypocone in M^3; (3) grinders otherwise similar to those of *P. mongoliense;* (4) male canines larger and more robust; (5) relative reduction of lateral superior incisors; (6) bluntly rounded summits of the second superior incisors.

The comparative measurements in three of the species of *Protitanotherium* are as follows:

Chief Comparative Measurements	Basilar length of skull	Superior grinding teeth, P^2-M^3	Inferior grinding teeth, P_2-M_3
Protitanotherium andrewsi Type (Amer. Mus. 20271), paratype (Amer. Mus. 20251)	757	283	308
Protitanotherium mongoliense Type (Amer. Mus. 18653), neotype (Amer. Mus. 20263), referred (Amer. Mus. 20261)	677	269	289
Protitanotherium grangeri Type (Amer. Mus. 20103)	695	242	174

Protitanotherium mongoliense Osborn, 1923

Original Reference.—Osborn, H. F., 1923, Titanotheres and Lophiodonts in Mongolia. Amer. Mus. Novitates, No. 91, October 17, p. 3.

Supplementing the type of *Protitanotherium mongoliense* (Amer. Mus. 18653), a right ramus with a well-preserved series of grinding teeth, discovered in 1922, is a very fine series of specimens, fully listed above, discovered in 1923. Although recorded from the same Shara Murun formation as the more progressive species *Protitanotherium andrewsi*, all the above specimens agree in their relatively less advanced stage of

evolution, as shown chiefly in the rectigradations of the grinding teeth and in the inferior dimensions throughout. As pointed out in the original description (Osborn, 1923, p. 3), *P. mongoliense* is intermediate in its actual measurements and dental indices between *Protitanotherium emarginatum* and *P. superbum* of the Uinta C formation, Utah.

Specific Characters.—The skull, the two palates, the right maxilla, and the two pairs of jaws agree sufficiently with the type jaw in size and in progressive evolution of the incisors, canines, and grinding teeth to clearly demarcate this species of the Shara Murun from the more primitive *Protitanotherium grangeri* of the Irdin Manha formation. At the same time they indicate a phase of *Protitanotherium* evolution somewhat more ancient geologically than *P. andrewsi*, the giant species of this genus. Unlike *P. grangeri*, the inferior premolars (type Amer. Mus. 18653, referred Amer. Mus. 20256, 20273) exhibit very distinct entoconids in P_{2-4}, with distinct entoconid shelf and deep talonid basin partly closed internally by the metastylid. Similarly the superior premolars (skull Amer. Mus. 20261 referred, palate Amer. Mus. 20256 referred, neotype palate Amer. Mus. 20263, right maxilla Amer. Mus. 20270 referred) all exhibit progressive tetartocones in the second and third premolars, P^{2-3}, and a more or less well-developed tetartocone rudiment in the fourth premolar, P^4. The several maxillæ and premolar grinding series show progressive steps in the development of this tetartocone of P^4; in fact, the palatal series (Amer. Mus. 20263) exhibits the tetartocones of P^{3-4} in their most rudimentary stage, whereas the tetartocones in the skull (Amer. Mus. 20261) are in their most progressive stage.

Protitanotherium grangeri, new species

Occurring in the more ancient geologic formation of the Irdin Manha, the type female skull and jaw of *Protitanotherium grangeri* (Amer. Mus. 20103) and the numerous referred specimens listed above, found north and south of the Kalgan-Urga telegraph line, exhibit very uniform cranial and dental characters supplemented by the remains of fore and hind limbs of both the right and left sides (Amer. Mus. 20171, belonging to several individuals).

Specific Characters.—The exceptional features of the type cranium (Amer. Mus. 20103), such as (a) the horseshoe-shaped concavity bordering the posterior nares and (b) the deep pits on either side of the presphenoid, characters observed also in specimens of (a) *Dolichorhinus* and of (b) *Sphenocœlus*, led us at first to regard this type as related to the above genera.

The real propinquity of the species *grangeri* to *Protitanotherium* is, however, firmly established by: (1) The elongate horns, the broad, shovel-shaped nasals, (2) the broad sweep of the zygomatic arches, and (3) the saddle-shaped cranial top; also (4), in the dentition, by (5) the sharply incurved canines, (6) the enlarged lateral superior and inferior third incisors, I $\frac{3}{3}$, (7) the diminishing second and first incisors, which in this species retain their pointed, postcingulate form.

Dentition.—The ancestral or primitive character of the grinding teeth of *Protitanotherium grangeri*, as compared with the more progressive grinders of *P. mongoliense* and of *P. andrewsi*, is seen in the absolutely simple internal deuterocones without even a rudiment of the tetartocones. The ancestral character is observed also in the absence of any trace of a hypocone in M^3 (compare type Amer. Mus. 20103, also referred Amer. Mus. 20114, 20108, and 20120). These non-progressive *superior* grinders indicate that *P. grangeri* is geologically far more ancient than the *P. mongoliense* and the *P. andrewsi* of the Shara Murun.

Telmatheriinæ

Telmatherium berkeyi, new species

Remains of this very large and deep-jawed titanothere were discovered in the Irdin Manha formation in two localities intermingled with those of *Protitanotherium grangeri* and in one locality intermingled with those of *P. grangeri* and of *Dolichorhinus olseni*.

The specific characters are derived solely from the gigantic type jaw and maxilla (Amer. Mus. 20106) and from six other specimens of superior and inferior maxillæ, none of which yields a knowledge of the cranium, yet we may be confident that the skull was relatively high and deep as well as elongate, that the bony horns were somewhat rudimentary, while the canine tusks were sharp and powerful. The jaws contrast widely with those of the Mongolian *Dolichorhinus* and *Protitanotherium*, not only in their prodigious size but in the great depth of the mandibular rami, of the chin processes, and of the lower borders. The incisors are the largest known among the titanotheres, the second pair being greatly enlarged. The canines are very large, pointed, sublanceolate. The premolars have prominent crowns and highly sculptured internal cingula. The posterior molars are exceptionally long and relatively narrow, the breadth-length index being 82 as compared with 98 in *Dolichorhinus* and 115 in *Brontops brachycephalus*. The elongate jaw of *Telmatherium berkeyi*, measuring 30 inches from condyle to symphysis, nearly 9 inches

in its deepest portion below M_2, M_3, and 7½ inches at the symphysis, is quite unique; it betokens a long deep cranium of prodigious size. Unlike its contemporaries, the coronoid is very broad, the condyle is only moderately elevated above the line of the molar teeth, the angle is small, not prominent; the lower border is deeply depressed below the grinding series, then rises slightly below the premolars and sinks into the deep, powerful symphysis which rises like the inclined straight prow of a ship to the elevated border of the cutting teeth.

The cutting teeth are all extremely prominent. The prominent superior canines resemble those of *Telmatherium* and of *Menodus* (=*Titanotherium*). The lateral incisors are smaller than the second incisors, although I^{1-3} are very prominent, flattened anteroposteriorly, not deeply cupped behind. High, laterally compressed inferior premolars with sculptured crowns; superior premolars with prominent sculptured ectolophs. Molars elongate, compressed, with prominent ectolophs, fairly prominent protocones and hypocones. In M^3 a very prominent hypocone; this tooth is extremely long and narrow.

Dolichorhininæ

Dolichorhinus kaiseni, new species

This species is based upon the type male skull and jaws (Amer. Mus. 20252) and the paratype palate and basicranium (Amer. Mus. 20257) from the Shara Murun formation, of uppermost Eocene age, which also yields *Protitanotherium mongoliense* and *P. andrewsi*. Strikingly uniform in character and measurements are the type, paratype, and referred specimens, as fully listed above.

Specific Characters.—As shown in a comparative series of measurements, *Dolichorhinus kaiseni* is superior in length of jaw and in all its dental measurements to *Dolichorhinus olseni;* the breadth-length indices of the fourth inferior premolar, P_4, and of the third inferior molar, M_3, are approximately the same in the two species. These relatively long, narrow indices are harmonic with the extremely dolichocephalic, elongate cranium and jaws. As in several of the Wyoming and Utah species of this genus, the small canines, even in the males, are in compensation for the precociously developed horn swellings; these bony horns are relatively much more prominent than in *Dolichorhinus hyognathus* (=*cornutus*) of the Washakie and Uinta formations. Although the canines are relatively small as compared with the robust canines of *Protitanotherium*, we judge that the four crania (Amer. Mus.

20252, 20257, 20260, 20255) belong to male individuals because of the uniform size of the canines and of the uniform development of the protuberant bony horns. These horns project outward rather than upward; the fore-and-aft diameter of the horn-base is short as compared with the elongate horns of *Protitanotherium*. Below them are the flaring sides of the premaxillo-nasal junction, which are extended forward into the hooded nasals that resemble the inverted, rounded prow of a boat; this exaggerated evolution of the long and narrow nasals suggested the name *Dolichorhinus cornutus* for the 'horned-long-nosed' titanothere of Wyoming and Utah. Back of this extension is the long tubular cranium, which in section is quite hollow, including the large tubular air chambers which completely conceal the small brain-case below.

The cranial proportions are correspondingly elongate, laterally compressed, arched superiorly, with slender, flattened zygomatic arches correlated with relatively feeble powers of mastication; the breadth-length index, length 695 mm., breadth 330 mm., index 47, contrasts with an index of 69 in a skull of *Protitanotherium grangeri* of the same basilar length, namely, 695 mm. The horns do not partake of this elongated character but are rounded, short, obtuse, and much more prominent than in any known American species.

The jaws are of elongate, slender, angulate character, with slender coronoid processes. The dentition harmonizes with the relatively feeble masticating and offensive powers, the canines being relatively small, incisors of medium size with posterior cingula, second lower incisors slightly enlarged. As in the American species, the premolars are simple with large median internal deuterocones and rudimentary tetartocones.

It is this intermingling of the characters observed in the American specimens with those discovered in this Mongolian species of *Dolichorhinus* that gives these animals such exceptional interest.

Dolichorhinus olseni, new species

The type of *Dolichorhinus olseni* is a fine pair of jaws (Amer. Mus. 20109) found one-half mile north of the Kalgan-Urga telegraph line. This is the only specimen referable to *Dolichorhinus* discovered in the Irdin Manha formation, whereas the more progressive species *Dolichorhinus kaiseni* is very abundant in the overlying Shara Murun formation.

The type jaw of *Dolichorhinus olseni* is inferior in size throughout to the referred jaw of *D. kaiseni* (Amer. Mus. 20260). Besides its smaller size we observe the following less progressive characters: (1) Canines narrow and sharply pointed; (2) lateral first and second incisors more

pointed, less broadly cupped or cingulate posteriorly; (3) first premolars small, single-fanged, pointed; second and third premolars, P_{2-3}, lacking cup-shaped concavity of talonid which is present only in P_4; that is, all rudiments of entoconid and all evidence of broadening of talonid are lacking in *D. olseni* in P_{2-3}; these teeth are far more primitive than the corresponding teeth of *D. kaiseni;* (4) the fourth inferior premolar still very primitive, exhibiting a shallow concavity of the trigonid, a relatively broad, slightly concave talon.

Manteoceratinæ (Brontopinæ)

Manteoceras? irdinensis, new species

The type of *Manteoceras? irdinensis* (Amer. Mus. 20111) is a right mandibular ramus with symphysis, containing M_{1-3} and alveoli of the premolar and cutting teeth. The locality is the Irdin Manha formation, Upper Eocene, two miles north of the Kalgan-Urga telegraph line. The generic reference to *Manteoceras* is doubtful and provisional, because the dentition does not agree with that of any known American species of this genus.

The distinctive characters are: (1) Lower canines enlarged, approximated, and strongly procumbent; (2) incisive border of alveoli correspondingly narrow and laterally compressed; (3) apparently three premolars, anterior alveolus of P_2? seemingly double; entire premolar alveolar border short (80 mm.); molar border relatively elongate (190 mm.); molars typically titanotheroid; anteroposterior measurement of $M_1=42$ mm., of $M_2=60$ mm., of $M_3=83$ mm., transverse measurement of $M_3=33$ mm.; (4) symphysis broad, extremely shallow, flattened on inferior surface.

On further knowledge, this may represent a new genus of titanotheres.

Dolichorhininæ?

Metarhinus? mongoliensis, new species

The type of *Metarhinus? mongoliensis,* consisting of the anterior portion of a right mandible (Amer. Mus. 20167), is also from the Upper Eocene Irdin Manha formation, the exact locality being unrecorded. This jaw fragment, containing P_4, M_1, is inferior in size both to *Manteoceras? irdinensis* and to the smallest individuals of *Protitanotherium grangeri.*

The distinctive characters of this species are: (1) Linear measurement of P_4, $M_1 = 43$ mm., anteroposterior measurement of $M_1 = 24$ mm., transverse measurement 14 mm.; anteroposterior measurement of $P_4 =$ 19 mm., transverse measurement 11 mm.; (2) in *Protitanotherium grangeri* the linear measurement of P_4, $M_1 = 45$ mm., anteroposterior measurement of $M_1 = 24$ mm., transverse measurement 17 mm.; (3) valleys of metalophid cupped or deeply concave; (4) valleys of protolophid open with prominent paraconids.

While the resemblances of the type teeth to those of both *Metarhinus* and *Mesatirhinus* of Utah are fairly close, the generic reference of this species is decidedly doubtful.