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## EXPLORATIONS, RESEARCHES AND PUBLICATIONS OF PIERRE TEILHARD DE CHARDIN, 1911-1931

WITH MAP AND LEGEND SHOWING CHIEF FOSSIL COLLECTING AREAS  
OF CHINA, 1885-1931

BY HENRY FAIRFIELD OSBORN

In recent years the Department of Vertebrate Palæontology of the American Museum has enjoyed the cooperation of Pierre Teilhard de Chardin, especially in the Eocene fauna of France from the Paleocene stage up to the close of the Phosphorites or Lower Oligocene time, also through explorations and researches first reported to the Musée National d'Histoire Naturelle of Paris in the year 1920. The American Museum Central Asiatic Expedition of the summer of 1930 was fortunate in obtaining the cooperation of Teilhard in the field. On February 10, 1931, he addressed the Osborn Research Club and summarized the results of his explorations in China, accompanying his address by the map which is reproduced herewith. The present article is prepared as a brief outline of the principal observations made by Teilhard in the Eocene of France and Belgium and as a summary of the observations made in China, concluding with an abstract of the address of February 10 above mentioned, a bibliography of his writings now contained in the Osborn Library of the American Museum, and a map showing twenty-three of the chief fossil collecting areas of China prepared by Teilhard for the present publication.

### OLIGOCENE TO MIDDLE EOCENE

Under the direction of Marcellin Boule, now the ranking vertebrate palæontologist of France, Teilhard began his studies in 1911 with a synthetic review of the creodonts and true carnivores, of the PHOSPHORITES DU QUERCY, the famous fissure horizon of Eocene to Oligocene age, tracing their phylogeny (1915, p. 64) in polyphyletic lines through the families of adaptive creodonts, of viverrines, of mustellines. Here occur the genera *Miacis*, ancestral to the dogs, *Viverravus*, *Cynodon* and *Cynodictis*. Teilhard concludes that the PHOSPHORITES fauna represents (1) the close of Eocene time, embracing *Miacis*, *Viverravus* and

*Cynodictis*; (2) also Lower Oligocene time in which are added primitive cynodonts and stenoplesictids; (3) finally, Upper Oligocene of AQUITANIAN, in which are added *Amphicyon*, *Cephalogale*, *Plesictis*, etc., almost exact equivalents of the JOHN DAY American fauna of canids and mustelids. In brief, the carnivores of QUERCY (op. cit., p. 87), taken altogether, completely fill the gap between the Middle Eocene LUTETIEN, and the Upper Oligocene AQUITANIAN.

Teilhard in 1911 was disposed theoretically to trace the wolf, *Canis vulpes*, back to some of the cynodictids of QUERCY; the bear, back to *Cephalogale*; the raccoon (possibly) back to *Phlaocyon* and *Pachycynodon*; the marten back to *Plesictis*.

#### EXPLORATIONS IN THE LOWER EOCENE AND PALEOCENE

Between 1916 and 1921, Teilhard devoted himself partly to the lemuroids of QUERCY and partly to Paleocene mammals. Of the former he remarked that the smaller lemuroids, *Microchaerus*, *Necrolemur* and *Pronycticebus*, were rare and revealed themselves slowly, while the larger *Adapis* was abundant. Stehlin (1915), just previously, had coordinated the work of Filhol and Rüttimeyer by comparing the fossil primates of QUERCY with those of other fissure deposits—EGERKINGEN and LISSIEU—describing three new genera (*Anchomomys*, *Nannopithec*, *Pseudoloris*). It remained for Teilhard to establish a systematic relation of the *Pseudoloris* of Stehlin with the American Eocene *Anaptomorphus* of Cope, as transitional to the modern tarsiids (1916.1, pp. 9–13).

Most fortunate for vertebrate palæontology was the entry of Teilhard into the Paleocene fauna of France as revealed in the basin of Paris at Rheims, a fauna scarce at the time and little understood. In this (1916.2) as in previous memoirs, Osborn's nomenclature of the teeth was adopted in full. This memoir is a masterpiece, revealing (p. 100) new and previously undemonstrated relationships with America of multituberculates, arctocyonids, oxyclænids, meniscotheres, previously regarded as confined to the WASATCH or SUESSONIAN of America; added as a new element is the close relationship of *Nothodectes* of CERNAY near Rheims with the corresponding form of the TIFFANY beds of New Mexico preceding the WASATCH. From the morphological, zoögeographical and phylogenetic standpoints, this memoir marks a great step forward. Agreeing with Osborn, Teilhard regards most of the true Paleocene mammals as not ancestral to more modern *Ceneotherip*, with the exception of the "*Pleuraspidotherides*," which Teilhard regards as possibly related to the modern *Hyrax* of Africa.

In 1920 (pp. 1161-1162) appeared the geologic classification of the Lower Eocene animals into (1) CERNAYSIAN, with *Nothodectes* and lower fauna described by Lemoine; (2) SPARNACIAN, with *Coryphodon-Hyracotherium* fauna equivalent to our lower WASATCH; (3) CUISIAN, somewhat more recent than the above; (4) the faunistic separation period between western Europe and America, extending to the summit of the Eocene (See Osborn: "Age of Mammals," 1910, p. 138).

In 1921, Teilhard announced the discovery of a condylarth in the Paleocene of Belgium, seemingly related to the problematic *Hyopsodus* of the Bridger, which W. D. Matthew in 1899 indefinitely placed with the Primates.

### EXPLORATIONS IN CHINA

(See map and legends)

From the Licent expedition of 1920, the Paris Museum received a collection of fossil mammals from northeast Kansu of the *terres rouges Hipparion* zone—giraffes, hyenas, mustelids—which Teilhard examined and reported as of PONTIAN age, with analogies to Persia and Europe (but not to India) and with, at the same time, characters peculiar to the province of China; this is the fauna of King Yang Fou (1922.1, pp. 979-982).

The next step in Teilhard's career occurred in the summer of 1923, when the French Ministry of Education and the Musée National d'Histoire Naturelle sent him, with Father E. Licent, for a geological expedition in the region of the Ordos, along the Great Wall of China. Here he did his first geologic and stratigraphic work in China, including the recognition in northwestern Ordos of a series of Oligocene beds containing *Baluchitherium* (HSANDA GOL formation of the Central Asiatic Expedition). This Ordos region presents at least three great recent stages: (1) typical Pliocene clays, (2) Lower Pleistocene high gravel terraces, and (3) a comparatively Recent phase (true Loess) falling distinctly in the Age of Man. Dramatic and important was the discovery of a true palæolithic deposit in the southeast corner of the Ordos, with most welcome knowledge of palæolithic (Mousterian) stratigraphic and palæontologic conditions, giving us at the hands of Teilhard and Licent (1924.5) one of the most important discoveries of modern times. Geologic observations followed in rapid succession (1924.6) in northern Chihli and eastern Mongolia, and Teilhard ably qualified himself as a member of the National Geological Survey of China.

In 1925 appeared the first contribution of an expedition (1924) in the eastern Gobi volcanic area, followed by return to observations in the Paleocene of Belgium (1925.2, p. 48) which yielded, from Orsmael and Erquelinnes, the Lower Eocene, a rich series of mammals referred to *Omomys*, *Plesiadapis*, *Heterohyus*, *Ectocion* (near *Phenacodus*) and *Palæonictis*, thus enriching the previous knowledge of the Orsmael and Erquelinnes.

Teilhard now launched into the Neolithic of China (1925.3), following the steps of J. G. Andersson, and began to take up the problem of the invasion of America from northern Asia, returning the same year (1925.4, pp. 201-234) to the more serious exploration of the Palæolithic of China based on discoveries of flints akin to those subsequently found by N. C. Nelson of the Central Asiatic Expedition in the Gobi. In this Palæolithic work, Teilhard enjoyed the cooperation of the Abbé Breuil. The fauna is that of the glacial period of all of northern Europe, chiefly of the steppe type but embracing also the '*Elephas* [*Palæoloxodon*] *namadicus*' (Idem, p. 223) [possibly *Parelephas*? sp. Osborn] as well as the giant ostrich *Struthiolithus* of Eastman, mingled with names of more modern types resembling modern gazelles and the steppe ass (*Equus hemionus*), rightly correlating the fauna of the upper "yellow earths" of Asia with the loess of Europe, especially with the *ergeron* of France of the time of Mousterian or early Aurignacian flint culture.

In 1926 appeared a geologic study (1926.4) of the region of DALAI NOR, as a result of the 1924 journey of Licent and Teilhard, enriching the fauna and extension of the RED PONTAIN clays (p. 52) and establishing above this Lower Pliocene series a new Lower or Middle formation (possibly of the same age as the TUNG GUR formation subsequently discovered in 1928 by the Central Asiatic Expedition). The work of 1926 also included a treatise on the older rocks and eruptions of eastern Mongolia.

During 1926 announcement was made by Licent, Teilhard and Davidson Black of a human upper incisor, strongly fossilized, found with *Struthiolithus*; this was described and figured (1927.3) as the "Ordos tooth," truly fossil, and compared by Hrdlicka with the tooth of La Quina age in France. Cooperation with Licent yields the late Pliocene fauna of SANGKAN HO (1927.2), rather modern, with the exception of some more ancient forms such as *Machairodus*, *Hipparion*, *Chalicotherium* and large extinct deer. The PONTIAN, SANMERIAN (Basal Pleistocene) and LOESS prove more and more to constitute the three important geological stages of north China, in Upper Tertiary and Quaternary times.

In 1927 Teilhard and Licent analyzed, for the National Geological Survey of China, the superior Quaternary and Tertiary of Honan and southern Shansi, the first distinct step in the recognition of a thick series intermediate between the lower Pliocene PONTIAN and the late Pleistocene of northern China. During this year also, Teilhard contributed to *Palæobiologica* (1928.1) a philosophical generalization on the extreme slowness of the evolution of mammals over a long period of time on the continent of Asia, derived from comparison of certain genera like the Musk Deer (*Moschus*), the gazelles, the hyenas, and the rodents *Siphneus* and *Lagomys*. The repeated alternation of sands, red earths and loess points to climatic rhythms in central and eastern Asia of stocks of mammals peculiarly Asiatic.

In April, 1928, appeared a second report (1928.3, pp. 960-961) on post-Palæozoic eruptions of western China, emphasizing the distinction of two fundamental phases in the Mesozoic intrusives of eastern China (a basic followed by an acid phase). This was followed by an elaborate memoir, "Le Paléolithique de la Chine" (1928.4), in collaboration with Boule, Breuil and Licent, in the *Archives de l'Institut de Paléontologie Humaine* which will constitute the foundation of all future human palæontology in China and Mongolia, based upon close analysis of all the Pleistocene of China known up to 1928, with flint implements closely analyzed by Breuil and with the geology and mammalian fauna treated in a masterly way by Teilhard, the mammals closely approaching those of the Middle or Upper Pleistocene of Europe.

The year 1929 brought forth a detailed report (1929.1) on the geology of the now famous CHOU KOU TIEN (16A) fissure deposit which yielded the Peking man, *Sinanthropus*, regarded by the authors, Teilhard and Young, as Lower Pleistocene (1929.1, pp. 173-202)—a determination dependent upon the precise subspecific stage of the '*Elephas namadicus* ref.' Of great interest is the geologic age of *Sinanthropus pekinensis* from the cave of CHOU KOU TIEN (16A), thirty-five miles southwest of Peking. Teilhard gives us (1931.1) the first clear critical light on this important subject, dating the Peking man as undoubtedly early Pleistocene, quite as ancient as the Gibraltar man and much more ancient than the Neanderthal man. CHOU KOU TIEN (16A) was a true cave, although filled by a succession of deposits and consequently displaying different stratigraphic levels; it is certainly older than the widespread Upper Pleistocene 'yellow loess' of China characterized by the woolly rhinoceros (*R. tichorhinus*), the urus (*Bos primigenius*), the stag (*C. elaphus*), the spotted hyena (*H. crocuta*), etc., with occasional

Palæolithic quartzite implements of Mousterian and Aurignacian type.

The CHOU KOU TIEN (16A) fossil deposits positively belong to the early Pleistocene containing the giant rhinoceros (*Rhinoceros* cf. *sinensis*), the primitive hyena (*H. sinensis*), the saber-toothed hyena (*H. machairodus*), the fossil dog (*Canis sinensis*), and the fossil horse (*E. sanmeniensis*), species which closely correspond with similar forms in the Nihowan deposits, but CHOU KOU TIEN (16A) lacks certain of the distinctly Upper Pliocene fossils found in Nihowan, such as *Hipparion sinense*, chalicotherid (*Circotherium*), etc. In geologic character the period is clearly distinguished from Upper Pleistocene 'yellow loess,' namely, a series of sands, clays, and 'reddish loess,' a formation which begins at the end of the Pliocene and extends into the Lower Pleistocene.

Teilhard's latest contributions are two analyses of the thick intermediate 'reddish clays' or older loess, relatively unfossiliferous, which lie between the well-known Lower Pliocene PONTIAN or *Hipparion* stage and the late Pleistocene *terres jaunes* or yellow loess (the stage of the woolly mammoth and rhinoceros).

First subdividing the Pliocene by the evolution of burrowing rodents chiefly of the genus *Siphneus* (1930.1), he described (1930.2, pp. 3-134) a very rich and important fauna collected in 1924-6 by Licent and himself in the basin of Nihowan in the Sangkan Ho valley northwest of Peking. This newly known fauna is of an uppermost Pliocene age, and its discovery is the culmination of fifteen years of exploration, affording a solid base for the oldest prehistory in China. In this last memoir (1930.2) were summed up not only the previous geologic analyses of the three great east Asiatic levels, PONTIAN, REDDISH CLAYS, LOESS, but also an important new fauna, including '*Elephas* [*Palæoloxodon*] *namadicus*,' chalicotheres, both *Hipparion* and *Equus*, a giant camel (*Paramamelus gigas*), four types of cervids, a variety of bovids including a primitive *Bison*, a mingling of modern and ancient carnivores, including *Machairodus*. This fluvio-lacustrine, Plio-Pleistocene fauna of Nihowan, considered parallel with that of Sênèze, France, described by Depéret, is not absolutely determinable but appears to belong to the very top of the Pliocene age. It appears that the lake-border and molluscan fauna descended over the Plio-Pleistocene lakes of the Gobi to the lower lakes of the Sangkan Ho, and some of the Mollusca can be traced even in degenerate forms to the actual border of the Pechili Gulf.

A new area was also described (1930.1) for the Palæolithic in China (western Shansi and northern Shensi), strictly connected with the distribution of quartzite material.

## SUMMARY OF THE PALÆONTOLOGIC AND CLIMATIC SUCCESSION IN CHINA

In the report of his informal address before the Osborn Research Club on February 10 (*Natural History*, XXXI, No. 3, May-June, 1931, pp. 338-339), Teilhard's more recent observations were summarized as follows:

A good deal of work had been done in a locality in the northwestern part of Shansi Province near the Yellow River where there is a limited area of Upper Pliocene and Lower Pleistocene exposures. Teilhard described a hard floor of Palæozoic sediments, covered by a thick series (reaching 300 meters in depth) of Quaternary deposits; these lowest beds are much more complex than those of simple loess origin. Directly overlying the Palæozoic beds occurs a red clay of Upper Pliocene age which, for convenience, is called Member 3 of the later series. A few fossils are found in it, including *Hipparion* and *Aceratherium*.

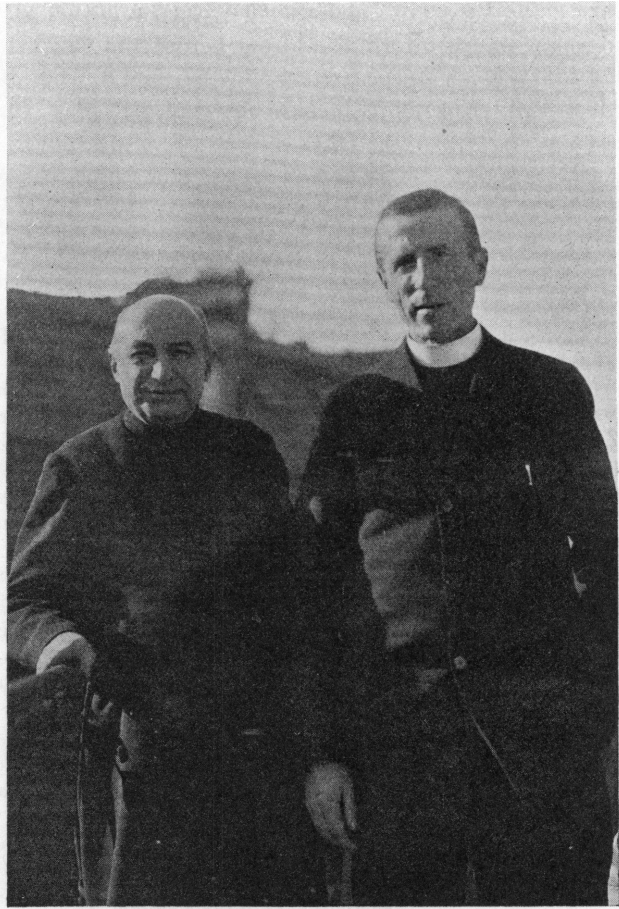
The next higher series, Member 2, consists of reddish clays, rich in limestone nodules. These concretions are found in pocket layers, sometimes in gravels, covered by loess or reddish clay; fossils are not very common in these reddish clays except in the concretions which are full of rodent skulls and skeletons. These are mostly of the mammal genus *Siphneus* represented by several good species, and very similar to a mole-like rodent now common in that region. A few specimens of horse, wild cattle, and deer were secured, but they were scarce in this locality. Teilhard considers this Member 2 series an older, sometimes banded, loess, of either Upper Pliocene or Lower Pleistocene age.

The uppermost layers of loess, Member 1, are of Lower Pleistocene age and contain more recent species of *Rhinoceros*, *Bos*, *Equus*, etc. The loess deposits of Member 1 and probably also of the older Member 2 were apparently formed because prevalent winds from the northwest drifted the dust from the Mongolian deserts over this section of China.

Another basin appearing to be the same as the Member 2 beds was discovered, where fossils of horse, bison, water buffalo, deer and sheep were abundant, and a study of the fauna seems to link it with Upper Pliocene times.

The Tung Gur beds near Iren Dabasu, where the Central Asiatic Expedition has collected, are also supposed to be the same age as these reddish clays of Member 2. They are extraordinarily similar, lithologically and in the vertebrate and invertebrate faunas, to the beds of an Upper Pliocene lake which Teilhard has described in his most recent paper "Les Mammifères Fossiles de Nihowan (Chine)." He supposes that in the Upper Pliocene there was a series of lakes in the eastern Gobi which retreated southward with advancing desiccation.

In southern China, Teilhard believes the Upper Pliocene is represented mostly by cave deposits, and in northern China by gravels. The Yellow River has cut through in various places so that the sections are clearly shown, and he thinks similar sections can be found both to the north and south along the river. He also made mention of a Palæolithic flint which was found, covered by loess, near the bottom of the Member 2 series of reddish clays, about fifty meters above the river level, where it had apparently been washed down from a higher level.



ABBÉ BREUIL AND PIERRE TEILHARD DE CHARDIN (right), January, 1931

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#### HISTORY OF FOSSIL COLLECTING IN CHINA, 1885-1931

All the early fossil collections in China came from Chinese apothecary shops or from wholesale dealers in medicines. The Szechwan deposits (16) probably yielded the original materials to Ernst Koken ("Ueber Fossile Säugethiere aus China," 1885), to Richard Owen ("On fossil remains of Mammals found in China," 1891), and to Hikoshichiro Matsumoto ("On Some Fossil Mammals from Sze-chuan, China," 1915). The Max Schlosser Collections, described in his great memoir, "Die fossilen Säugethiere Chinas," 1903, were assembled or purchased from the apothecary shops of many parts of China by Dr. K. A. Haberer.

Undoubtedly many of these specimens, probably the great majority of those from North China, came from the *Hipparion* fauna locality

(12), in northwestern Shansi on the Yellow River. Quarrying for "Dragon bones" for medicinal purposes has been carried on in this area for a long time. Otto Zdansky, under the direction of Dr. J. G. Andersson, visited this locality (12), made a survey and has published a report ("Fundorte der Hipparion-Fauna um Pao-Te-Hsien in N. W. Shansi," 1923) upon it. Previous to Zdansky's visit, Andersson had obtained large collections from this locality through the agency of his native Chinese assistant.

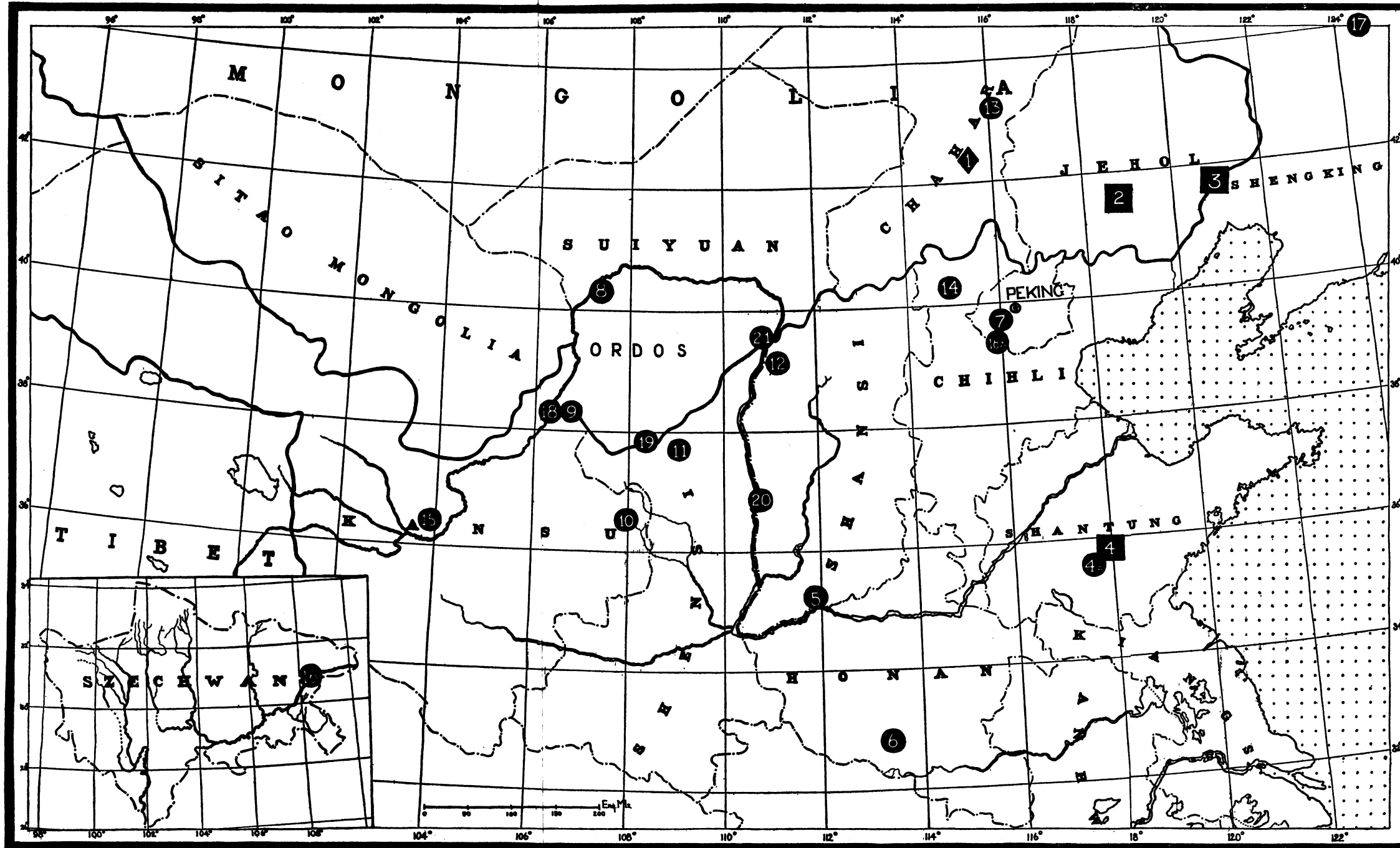
The chief Jesuit Mission localities are situated around the borders of the Ordos (8, 9, 18, 19, 21) and in the Nihowan Basin, northwest of Peking (14). Licent made a general survey of this country, and on discovering the richness of the fossil deposits sent for a trained geologist and palæontologist from France. Teilhard came out to join Licent in 1923, and most of the work which Teilhard carried on was done in cooperation with Licent, first around the Ordos region, later in eastern Mongolia (1 and 13) and in western Manchuria (17); their work also included locality 14, northwest of Peking, the important Nihowan fauna. Subsequently Teilhard became associated with the National Geological Survey of China and made an extended journey into northwestern China, visiting localities 10, 11, 15 and 20 for a general survey; he was accompanied by Chung-Chien Young, the Chinese vertebrate palæontologist of the Survey.

TWENTY-THREE OF THE CHIEF FOSSIL COLLECTING AREAS OF  
CHINA, 1885-1931, AS INDICATED BY TEILHARD,  
FEBRUARY, 1931

1. CARBONIFEROUS. Chahar. Fusuline limestone.
2. LOWER CRETACEOUS. Jehol. Insects, Lycoptera, etc.
3. LOWER CRETACEOUS. Shengking-Jehol border. Insects, Lycoptera, etc.
4. CRETACEOUS. Fossiliferous areas of Shantung. Mengyin Hsien and Lai Yang Hsien yielding sauropod dinosaurs: *Helopus zdanskyi* and *Tanius sinensis*.
- 4A. EOCENE. Shantung, Mengyin Hsien and Hsin T'ai Hsien. Mammal-bearing beds explored by Zdansky.
5. UPPER EOCENE. Southern Shansi, Yüan Chü Hsien on Yellow River; beds extend across Yellow River into northern Honan. Fossiliferous clays and gravels. Molluscan and small mammalian fauna including amynodont rhinoceroses and lemuroids. Explored by Zdansky.
6. UPPER EOCENE. Southern Honan, Mien Chih Hsien. Irдин Man-ha Fauna. Small mammalian fauna, described by Zdansky.
7. UPPER EOCENE. Chihli, Chang Sin Tien, southwest of Peking. Fossiliferous gravels.
8. OLIGOCENE. Northwest Ordos Basin. *Baluchitherium* zone. Contains Oligocene Hsanda Gol fauna. Described and explored by Licent and Teilhard.
9. OLIGOCENE. Kansu-Ordos border. *Baluchitherium* sands, equivalent to 8. Explored and described by Licent and Teilhard.
10. PLIOCENE-PONTIAN FAUNA. Eastern Kansu. Palæolithic cultures in the overlying loess. Excavated by Licent.
11. PLIOCENE-PONTIAN FAUNA. North Shensi, You Fang T'eon.
12. PLIOCENE-PONTIAN FAUNA. Northwest Shansi, Pao Te area. Fossiliferous reddish clays. The most important of the *Hipparion* fauna localities. First explored by Andersson and later by Zdansky; from this locality a great amount of material had come through the Chinese excavations for "Dragon bones"; probably also a source of much of Schlosser's apothecary shop material.

13. Pliocene-Pontian Fauna and later. Chahar, eastern Mongolia, Chitong Gol Basin. White Pliocene beds, which may be equivalent to Tung Gur beds of Mongolia, overlying fossiliferous Pontian.
14. Uppermost Pliocene and Early Pleistocene. Chihli, Nihowan Basin, northwest of Peking. Late Pliocene, Nihowan fauna. Area worked by Licent and Teilhard, yielding highly important Nihowan fauna.
15. Pliocene, Pontian and later. Central Kansu, Lanchow Basin.
16. Lower Pleistocene. Eastern Szechwan, Yen Ching Kou. It is probable but not certain that the type materials of Ernst Koken (1885), of Richard Owen (1891) and of Hikoshichiro Matsumoto (1915) came from these cave deposits of eastern Szechwan, also probably some of that described by Schlosser. Excavations by natives for "Dragon bones" have been carried on for at least two generations in this area. Cave deposits explored by Granger in winters of 1921-1922, 1922-1923, 1925-1926. A rich fauna containing *Stegodon*, *Megatapirus*, *Aeluropus*, etc.
- 16A. Lower Pleistocene. Chihli, Chou Kou Tien, thirty-five miles southwest of Peking. *Sinanthropus pekinensis* and large mammalian fauna. Discovered by J. G. Andersson, August, 1921; explored first by Andersson and Zdansky, and later by Bohlin and others under the auspices of the National Geological Survey of China.
17. Upper Pleistocene. Southeast of Chancow, Manchuria. Rich fossiliferous deposits, *Rhinoceros tichorhinus*, bison, *Elephas*.
18. Pleistocene. Southwestern Ordos, Choei Tang Keon, on Yellow River. Loessic Basin, Palæolithic site. One of the areas discovered and explored by Licent and Teilhard.
19. Pleistocene. Southern Ordos, Sjara Osso Gol Basin. Rich mammalian fauna; important Palæolithic site. Discovered and explored by Licent and Teilhard.
20. Pleistocene. Shensi-Shansi border, Yellow River. Gravels bearing Palæolithic cultural remains.
21. Pleistocene. Eastern Ordos. Loess and sub-loessic gravels. Palæolithic quartzite implements. Also one of the Licent and Teilhard localities.





Twenty-three of the Chief Fossil Collecting Areas of China, 1885-1931, as indicated by Pierre Teilhard de Chardin, February, 1931.

