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Science with Boundaries: Yang Zhongjian and Vertebrate Paleontology in Republican China, 1919–1950

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Introduction

One of the most exciting discoveries in the recent history of paleontology is that of the feathered dinosaur fossils: the *Sinosauropteryx*, or Chinese Dragon Bird. They were discovered in Liaoning, China by Chinese paleontologists in 1996. Their existence strongly suggests the evolutionary path from dinosaurs to birds. The rapid development of paleontology, especially vertebrate paleontology and dinosaurology, in China since then has made ‘Chinese Paleontology’ an important subfield of paleontology and China the powerhouse of paleontological research. Giving the fact that there was virtually no Chinese paleontologist at the turn of the 20th century, and that Chinese fossils at the time were discovered and studied solely by foreign scientists, the advancement and development of vertebrate paleontology as a scientific discipline in China over the last century is worth investigating.

YANG Zhongjian 楊鍾健, also known as C.C. Young (1897–1979), is often praised by students of paleontology as the father of Chinese vertebrate paleontology. According to a dictionary of important scientists, Yang was ‘[a]lmost single-handedly responsible for generating research in the field of vertebrate paleontology through the century’s central decades, [and] also named many of the most iconic dinosaurs from the Mesozoic formations of China’.¹ This chapter explores the formation of Chinese vertebrate paleontology through the lens of Yang’s early academic training in China

¹ David Norman, ‘Yang Zhongjian’ in *Complete Dictionary of Scientific Biography*, 25 (Detroit, 2008), 383.

and Germany during the 1920s, his field experience in China throughout the 1930s, his independent research during World War II, and his overseas networking. The making of a professional paleontologist in China in the first half of the 20th century provides a non-Western perspective on the entanglement between research training and disciplinary formation. Yang's experience shares a general picture of the establishment of higher education and disciplinary research based on the Euro-American model in non-Western societies, as described in the other chapters. But it also illuminates some specific local variations through factors that were intrinsic to the development of scientific disciplines in China during a time when the rise of Chinese nationalism intersected with scientific internationalism and imperialism. How did the academic practices of paleontology reflect geo-political realities? How were activities of fossil hunting and ownership of pre-historical objects tied to the modern concept of sovereignty and territoriality? How was paleontology seen as a 'local' scientific practice through which a trans-local system of the earth was built?

At Peking University, 1919–1923

Yang enrolled at Peking University in 1919 as a geology major. The geology department was first set up in 1909 when the university was still known as the Imperial University of Peking, China's modern national university founded by the Qing government. After the university was renamed National Peking University in 1912 with the fall of the Qing and the establishment of Republican China, the department, along with the entire college of sciences, was shut down the following year due to lack of funding. It was not until 1917 that the department was re-established.² By the time Yang entered the program, there were around 36 students at three different stages, with only two professors,³ limited resources that students had to compete for, and a curriculum centering on textbooks and lectures without much fieldwork.⁴

As a result of the efforts made by the president of the university, CAI Yuanpai 蔡元培, one of the most influential intellectuals and educators in

² For more details of the establishment and development of geology in higher education in China during the time, see WANG Genyuan, 'Zhongguo dizhi jiaoyu shilue' (A brief history of the geological education in China), *Diqiu kexue, Zhongguo dizhi daxue xuebao* (Earth science: journal of China University of Geosciences) 11/2 (1986), 207–15. Also cited in Grace Shen, *Unearthing the Nation: Modern Geology and Nationalism in Republican China* (Chicago, 2013), 222n83.

³ HE Jie, with a master degree in geology from Lehigh University, USA, and WANG Lie, a graduate from the Freiberg Mining Academy, Germany, taught mining and mineralogy in the department. See Shen, *Unearthing the Nation*, 219n61 and 222n82.

⁴ *Ibid.*, 64.

20th century China, two more professors were hired in 1920: LI Siguang 李四光 and Amadeus Grabau. Li was a geologist with a master's degree in geology from the University of Birmingham, and Grabau was an American geologist and paleontologist who was dismissed from teaching at Columbia University for his pro-German attitudes during World War I. While the previous curriculum of the geology program at Peking University focused on the studies of mineralogy and petrology, the new faculty brought in more vibrant dimensions. Besides introducing new courses, such as structural geology (taught by Li), historical geology and paleontology (both taught by Grabau), the newly expanded program was reoriented toward fieldwork as an essential part of geological training.⁵ It soon became the best geology department in Asia.⁶

Like many contemporary Chinese students, Yang studied science primarily for the pragmatic benefits at a time when the development of science and technology was deemed to be the key to national prosperity. Yang's choice for geology was not out of any enthusiasm for the discipline. He picked geology among the four available departments in the college of sciences – mathematics, physics, chemistry and geology – due to his lack of interest in math and laboratory work. Moreover, as he later commented, 'geology is an interesting discipline because it keeps one close to nature'.⁷ But his attitude toward geology, and later paleontology, would go through a more nationalistic turn when 'nature' became a representation of the 'nation'. Geology, as Grace Shen cogently describes, offered 'a coherent system that located their [the Chinese students] homeland and its material resources within a broader pattern of global history and causation'.⁸ And geological, as was the case with paleontological, activities and practices were tied to the legitimate ownership of the land.

With Grabau's new courses, paleontology was introduced to students at Peking University for the first time.⁹ He designed a curriculum that systematically familiarized students with paleontological knowledge and

⁵ A 1927 course schedule shows that for first- and second-year students, a full day of fieldwork was required each week, in addition to several hours of surveying practice and lab time. Extensive field time was needed during vacations for upper-class students. See *Ibid.*, 69.

⁶ *Ibid.*, 68.

⁷ YANG Zhongjian, *Yang Zhongjian huiyi lu* (Yang Zhongjian's memoir) (Beijing, 1983), 26.

⁸ Shen, *Unearthing the Nation*, 45.

⁹ To be sure, paleontology was often taught in the department of geology or biology and did not become an independent discipline in many Euro-American universities until the late 19th and early 20th centuries. See David Polly and Rebecca Spang, 'History of Paleontology', in Brian S. Baigrie (ed.), *History of Modern Science and Mathematics*, 4 (New York, 2002), 69–97.

local variations. Through the ‘Agassiz Method’,¹⁰ Grabau trained his Chinese students, who had relied too much on memorizing textbooks, to learn classification through close observation of fossils and specimens.¹¹ Besides teaching, Grabau also promoted the research of paleontology in China by launching the *Palentologia Sinica*, an English-language journal published by the National Geological Survey of China (*Zhongguo dizhi diaochasuo*).

In 1921, Grabau delivered a series of public lectures with the title ‘Earth and Evolution’ at Peking University. The 16 lectures that ran for an entire year were very popular and well-received.¹² Yang attended the lectures and participated in transcribing the contents for publication.¹³ Undoubtedly, Yang was influenced by Grabau and decided to choose paleontology as his focus in the third year of his study. A measure of Grabau’s impact is that three of the twenty-seven graduates of the class of 1923, Yang, TIAN Qiqiong 田奇瓊, and ZHAO Yazeng 趙亞曾, had later become important paleontologists.

Although paleontology was gradually taking root in China, research was limited to the study and collecting of invertebrate fossils. For Grabau, invertebrate fossils from the Paleozoic period were important to testify his theory that China, in the basin of the ancient Pacific, was the great center of marine life, and later during the time of dramatic geological, climatic, and evolutionary change, these marine faunas disseminated to Western America and Europe.¹⁴ Notwithstanding Grabau’s personal preference, the research on vertebrate paleontology in China then was however discouraged largely by technical obstacles. Vertebrate fossils, unlike invertebrate fossils, are fewer in quantity and much larger in size. The excavation and preservation of vertebrate fossils demand much more investment

¹⁰ Louis Agassiz (1807–1873) was a Swiss-American biologist and geologist. His legacy is often tainted by his objection to evolutionism. However, being one of the greatest naturalists of his time, Agassiz was also known for his method of teaching natural sciences. He promoted close observation of specimen and phenomena and aimed at making legitimate comparison and classification.

¹¹ SUN Chengcheng, “‘Taxiang taoli fa xinzhì’: Gelipu yu Beijing daxue dizhi xuexi’ (The father of China’s paleontology: Amadeus W. Grabau and the department of geology of Peking University), *Ziran kexueshi yanjiu* (Studies in the history of natural sciences), 35/3 (2016), 346.

¹² For more details of the lectures and their influence on the popularization of evolutionism in republican China, see Sun, “‘Taxiang taoli fa xinzhì’: Gelipu yu Beijing daxue dizhi xuexi’, 350–4.

¹³ The contents of the lectures first appeared in the university bulletin and local newspapers. Later, they were organized into a book: Amadeus Grabau, *Diqiu yuqi shengwu zhi yanhua* (Earth and Evolution), transcribed by Yang Zhongjian and ZHAO Guobing (Shanghai, 1924).

¹⁴ Amadeus Grabau, ‘Paleontology’, in Sophia H. Chen Zen (ed.), *Symposium on Chinese Culture* (Shanghai, 1931), 153–5.

of both money and manpower. It is no wonder that during the early period of the 20th century most vertebrate fossils in China were discovered by foreign explorers and shipped over to foreign museums and institutions for studying.¹⁵

In 1923, after the completion of his bachelor degree, Yang decided to pursue his graduate study in vertebrate paleontology, a virgin field for Chinese students to explore. And Germany would be the ideal place offering such an opportunity, since the deflation of the German currency after World War I made it relatively inexpensive to live in Germany, compared to other countries in Europe and North America.¹⁶ Carrying with him three recommendation letters written by Grabau, Yang arrived in Germany in 1923 after a long trip across the globe.

At the University of Munich, 1923–1927

Grabau's three letters were addressed to Ferdinand Broili of the University of Munich, Johannes Walther of the University of Halle, and Josef Felix Pompeckj of the University of Berlin. All three were famous earth scientists.¹⁷ Yang eventually decided to enter the Institute for Paleontology and Historical Geology at the University of Munich (Ludwig-Maximilians-Universität München), the leading research center for vertebrate paleontology in Germany, to study with Broili, who was also the director of the institute. Broili was the favorite student of the internationally renowned paleontologist Karl von Zittel, under whose guidance he received his doctorate in paleontology in 1898. After the death of Zittel, Broili became the director of the institute, specializing in Saurian fossils. The other incentive for Yang to choose the institute was Max Schlosser, an emeritus member who was a pioneer in the study of Tertiary vertebrate and mammal fossils of China.¹⁸

Yang majored in paleontology and minored in geography and zoology. The institute was located in the city center, very close to the Bavarian State Collection for Paleontology and Geology. Yang spent most of his daily life taking classes and identifying fossils in the lab. The lab was very well

¹⁵ For example, between 1923 and 1932, there were around 330 articles on vertebrate fossils discovered in China published in foreign journals. See YANG Tsui-hua, 'Lishidizhixue zai Zhongguo de fazhan (1912–1937)' (The development of historical geology in China, 1912–1937), *Zhongguo yanjiuyuan jindaishi yanjiusuo jikan*, 15 (1985), 327.

¹⁶ Yang Zhongjian, *Yang Zhongjian huiyi lu*, 31.

¹⁷ *Ibid.*, 32.

¹⁸ Max Schlosser (1854–1932) was one of the first Westerners to study the so-called 'dragon bones' (mammalian fossils) discovered in China. He examined more than 95 species of mammal fossils purchased from drugstores in China and published his results in *Die Fossilien Säugethiere Chinas nebst einer Odontographie der recenten Antilopen* (München, 1903).

equipped. All the teaching materials were arranged according to Zittel's textbook, *Textbook of Paleontology*, perhaps the most authoritative textbook of paleontology available at the time.¹⁹ Besides lab work, Yang also traveled throughout Bavaria for field work.

After 6 semesters of hard work, Yang took the qualifying examination in the subjects of paleontology, as well as zoology and geography on February 16, 1927. He received an overall grade of 3 (cum laude).²⁰ He also completed an 82-page manuscript in German for his dissertation, entitled *Fossile Nagetiere aus Nord-China* (Fossil Rodents from North China). Yang began to prepare for this work during his fourth semester upon Broili's approval. WENG Wenhao 翁文灏, who was the director of China's Geological Survey 地質調查所 at the time, suggested him to work on the vertebrate fossils collected in north China by the Survey's Swedish researcher Johann Gunnar Andersson. Lacking professional paleontologists to identify these fossils, Andersson, who was a geologist, had been sending the enormous number of fossils he had collected to paleontologist Carl Wiman at the University of Uppsala.²¹ Upon Weng's request, Wiman agreed to ship three boxes of unexamined rodent fossils to Munich for Yang to study under the supervision of Schlosser, who had helped Wiman identify some of the fossils from Andersson's collections.²² Yang had to repair the fragmented fossils and then classify and analyze them.²³ In *Fossile Nagetiere aus Nord-China*, Yang identified 31 species from the Cenozoic era, 13 of which were new discoveries. This work was immediately published in the *Palaeontologia Sinica*. Grabau later noted that this was not only a significant study of extinct rodents, but it was in fact the earliest monograph on vertebrate fossils by a Chinese paleontologist.²⁴ Yet, one cannot ignore the irony of the kind of 'international' collaboration functioning behind the completion of Yang's dissertation. A Chinese

¹⁹ Yang, *Yang Zhongjian huiyi lu*, 34. The book was originally published in German as *Grundzüge der Paläontologie* (München, 1895) and translated to English as *Textbook of Paleontology* (London, 1900).

²⁰ According to the German grading system, grade 3 (cum laude) is considered as good and above average. The examination was conducted by his advisor Broili, Professor Enrich Kaiser from the Institute of General and Applied Geology, Professor Karl Ritter von Frisch from the Zoological Institute, and Professor Erich von Drygalski from the Geographical Institute. Protokoll (Chung-Chien Young), Universitatarchiv, Ludwig Maximilians-Universitat Munchen (OC-Np WS1926/27).

²¹ The agreement was made between the Geological Survey and the University of Uppsala: all the materials were prepared and studied by Wiman and other European specialists while the research results had to be published in *Palentologia Sinica*. See Yang Zhongjian, *Yang Zhongjian huiyi lu*, 37.

²² See Ferdinand Broili, Votum Informativum for the dissertation by Chung-Chien Young (Yang Zhongjian), Universitatarchiv, Ludwig-Maximilians-Universitat Munchen (OC-Np WS1926/27).

²³ Yang, *Yang Zhongjian huiyi lu*, 38.

²⁴ Grabau, 'Paleontology', 160.

student had to travel all the way to Germany to study the material objects collected by the Swedes from his homeland. This exhibited the unequal power relations between countries in the practice of science.

After completing his dissertation, Yang accepted Weng's offer to work for the Geological Survey of China. He did so in hopes of fulfilling his nationalistic dream to save China through science, a dream held by many contemporary Chinese intellectuals and overseas students.²⁵ When one of his foreign friends asked him why he chose to return to his impoverished country rather than staying in Germany, he replied, 'I cannot abandon China, no matter how backward and poor she is; just like a son can never abandon his mother'.²⁶ Right before Yang returned to China in 1928, Broili invited him to his house for a farewell dinner. Broili congratulated his young Chinese student for his success in completing the degree and wished him a bright future, 'All the rich paleontological materials of China are waiting for you to discover'.²⁷ At that moment, Yang made the firm determination to devote himself to Chinese paleontology.

The Cenozoic Research Laboratory in the Interwar Period

Upon Yang's return to China, he immediately participated in the excavation project of the Peking Man fossils in the Zhoukoudian area near Beijing and served as a technician. During the years when he was studying in Germany, north China and Mongolia had attracted many foreign scientists who advocated the Asiatic hypothesis (the evolutionary theory that designates Asia, instead of Africa, as the cradle of humans and the center of outward human migration) to search for the remains of human ancestors.²⁸ Andersson's 1926 announcement of the discovery of

²⁵ 'Saving China through Science' (*kexue jiuguo*) was embraced at the turn of the 20th century by many of the Chinese overseas students to study Western science and technology in order to strengthen the wealth and power of China. The founding of *Zhongguo kexue she* (Science Society of China), China's first modern comprehensive scientific organization, together with the launch of the journal *Kexue* (Science) in 1915 by REN Hongjun, ZHU Kezhen and other Chinese students studying in the United States manifested such a determination. See Zuoyue WANG, 'Saving China Through Science: The Science Society of China, Scientific Nationalism, and Civil Society in Republican China', *Osiris*, 17 (2002), 291–322.

²⁶ WANG Guozhen, 'Yi wangshi: huannian qinren Yang Zhongjian' (In memory of my husband Yang Zhongjian) in QIN Huanzhong (ed.), *Zhongguo gujizhui dongwuxue de dianjiren: ji jiechu de dishi gushengwuxue jia Yang Zhongjian* (The founder of Chinese vertebrate paleontology: in memory of the geological paleontologist Yang Zhongjian) (Xi'an, 2008), 36.

²⁷ Yang, *Yang Zhongjian huiyi lu*, 43–4.

²⁸ For details of the Asiatic hypothesis and the activities of foreign scientists in China during the 1920s, see Hsiao-pei YEN, 'From Paleoanthropology in China to Chinese Paleoanthropology: Science, Imperialism and Nationalism in North China, 1920–1939',

two hominid teeth in Zhoukoudian further promoted Beijing as the hub of international human paleontological research. When the Cenozoic Research Laboratory 新生代研究室, an institute staffed by an international crew under the Geological Survey to carry out the Zhoukoudian project, was established in 1929 with funding from the Rockefeller Foundation, Yang was promoted to deputy director, under the guidance of director Davidson Black, a Canadian anatomist who had worked in the Peking Union Medical College since 1919.²⁹

Although the main project of the Cenozoic Research Lab was the excavation of the Peking Man fossils, it also promoted other paleontological and geological research related to China's Cenozoic deposits and formations. In 1929, Yang took his first long field trip with Pierre Teilhard de Chardin, a member of the crew: a three-month expedition to Shanxi and Shaanxi to examine the red and yellow soils of the late Tertiary and early Quaternary sediments.³⁰ Teilhard de Chardin was a French Jesuit priest who was a student of the famous French paleontologist Marcellin Boule. He arrived in China in the early 1920s to help Emile Licent, another French Jesuit, to collect specimens for the Musée Hoang Ho Pai Ho established by Licent in Tianjin. The two priests explored areas in Inner Mongolia on donkey-back and discovered the Paleolithic 'Ordos Man' in 1923.³¹

Teilhard was hired as a consultant for the Cenozoic Research Lab, and Yang took several field trips with him in the early 1930s.³² The French priest not only had rich field experience, but also had broad interest in archaeology, anthropology, physiography and petrology, in addition to paleontology and stratigraphy. During their collaborations, Yang benefited mostly from Teilhard's rich archaeological knowledge of the Paleolithic and Neolithic remains, which helped his own research and study of the fossils and relics discovered at the Zhoukoudian site.³³ With Teilhard's Christian connections, the two often received extensive support and help from the local churches along their research routes. However, Yang also noticed that when they worked together in the field, locals often mistook him for the servant of the French priest, because foreigners traveling in

History of Science, 53/1 (2015), 21–56, and 'Evolutionary Asiacentrism, Peking Man, and the Origin of Sinocentric Ethnonationalism', *Journal of the History of Biology*, 47/4 (2014), 585–625.

²⁹ Yang, *Yang Zhongjian huiyi lu*, 64.

³⁰ *Ibid.*, 67–8.

³¹ For the activities of the Jesuit in Inner Mongolia, see Yen, 'From Paleoanthropology in China to Chinese Paleoanthropology: Science, Imperialism and Nationalism in North China, 1920–1939', 28–32.

³² Yang Zhongjian, 'Huai dizhixuejia De Rijin xiansheng' (Thinking about geologist Mr. Teilhard de Chardin), *Zhenli zazhi*, 1/4 (1944), 463.

³³ Yang, *Yang Zhongjian huiyi lu*, 139.

China were often accompanied by Chinese servants or assistants. This made Yang self-conscious and uneasy.³⁴

The Central Asiatic Expedition

To test the Asiatic evolutionary theory, the American Museum of Natural History (AMNH) in New York City organized five major scientific expeditions to the Gobi Desert between 1922 and 1930. The AMNH Central Asiatic Expeditions team, led by the legendary Roy Chapman Andrews (said to be the prototype of the cinematic hero Indiana Jones), invested a huge budget in the equipment and personnel. In the case of the third expedition in 1925, the caravan was composed of 40 team members, 5 American-made cars, 2 trucks and 125 camels. Though the team failed in their effort to find remains of the earliest human ancestors, they collected numerous boxes of vertebrate fossils, including new species of dinosaurs and intact dinosaur eggs.³⁵ The scale and the accomplishment of the American team set new record in the history of scientific exploration.

When the Chinese Nationalist Party established the Nanjing government in 1927, anti-imperialist sentiment rose high and a strong anti-foreign nationalism reached its climax nationwide. The Central Asiatic Expeditions were seen in the eye of nationalistic Chinese as imperialistic aggression violating Chinese sovereignty. A group of professors and scholars formed the Chinese Association of Learned Societies 中國學術團體協會 to stop the activities of foreign explorers who 'infringe our sovereignty, plunder our research materials, and cause great loss to the future of Chinese academic development'.³⁶ Soon the non-official organization was integrated into the National Commission for the Preservation of Antiquities 中央古物保管委員會, which detained the collections of the American team's 1928 exploration.³⁷ After several negotiations, the Central Asiatic

³⁴ Ibid, 68.

³⁵ For the activities of the American Museum of Natural History in Mongolia, see Yen, 'From Paleoanthropology in China to Chinese Paleoanthropology: Science, Imperialism and Nationalism in North China, 1920–1939', 32–9. See also Lukas Rieppel, *Assembling the Dinosaur: Fossil Hunters, Tycoons, and the Making of a Spectacle* (Cambridge, 2019).

³⁶ 'Beijing xueshu tuanti fandui wairen caiqu guwu zhi xuanyan zuori yeyi fabiao' (The manifesto of the Association of Learned Societies in Beijing against foreigners collecting ancient relics was announced yesterday), *Chenbao* (Morning news), March 10, 1927, cited in WANG Chen (ed.), *Gaoshang zhe de muzhibing* (The epitaph of the nobles) (Beijing, 2005), 521–2.

³⁷ Guwu baoguan weiyuanhui (Commission for the Preservation of Antiquities), (ed.) *Guwu baoguan weiyuanhui gongzuo huibao* (The report of the Committee for the Preservation of Antiquities) (Beijing, 1935), 11–40.

Expeditions were allowed to proceed only if the Americans invited Chinese scientists to participate in their next venture into the Gobi.³⁸

Yang, Pierre Teilhard de Chardin, and ZHANG Xiti 張席禔 (a professor of geology) were the three 'Chinese members' in the joint Sino-American expedition to Mongolia in 1930. Instead of cooperation, Andrews and his American team members intentionally isolated the three 'Chinese representatives' in order to prevent them from interfering with their fossil collecting activities. According to Yang, the three of them were only allowed to use the tools brought by the team and thus were involved in their own scattered geological surveying and fossil digging. All vertebrate fossils they discovered had to be handed over to the Americans. However, the participation in the American expedition provided the Chinese members ample opportunities to learn the most advanced field techniques. For example, Yang learned to use diluted shellac (a natural adhesive) to glue and stabilize huge but fragile vertebrate fossils like dinosaur bones, and to wrap them up with plaster and linen before removing them from the sediments.³⁹ After returning to Beijing from Mongolia, Yang summarized the collecting and preparation techniques of vertebrate fossils in a small handbook published by the Geological Survey.⁴⁰ Besides practical training, Yang also considered the two-month exploration the 'most interesting experience' because the state-of-the-art field equipment, the camping meals, and even the entertainment facilities (such as the phonograph) that the American team brought with them to the Gobi made camping and surveying in the desert a pleasant experience. As Yang later commented, "To put it bluntly, the so-called "Sino-American collaboration" is how they take advantage of us, and how we take advantage of them."⁴¹

Wartime Research

After the Second Sino-Japanese War broke out in 1937, a new stage of research on paleontology in China began. Most Chinese scientists left occupied Beijing for the southwestern region. Only a few staff stayed in

³⁸ The model of joint expedition was first implemented in the Sino-Swedish Scientific Exploration to Northwestern China (Zhong-Rui xibei kexue kaochatuan) led by Sven Hedin, the famous Swedish explorer, in 1927. Hedin was under the pressure of the Chinese Association of Learned Societies to make an agreement to include Chinese members in his team to Xinjiang.

³⁹ Yang Zhongjian, *Xibei de poumian* (The cross-section of the Northwest) (Beijing, 1932), 87.

⁴⁰ Yang Zhongjian, *Jizhui dongwu huashi zhi caiji yu xiuli* (The collection and preparation of vertebrate fossils) (Beijing, 1930).

⁴¹ Yang, *Yang Zhongjian huiyi lu*, 69–71.

what was now the 'Peking branch' of the Geological Survey, while the main office had moved to Nanjing, Jiangsu and then Chongqing, Sichuan. The work of the Cenozoic Research Lab ceased and most of its foreign scientists left China for good. Yang and some of his colleagues migrated to Kunming, Yunnan and set up a local branch of the Geological Survey. It was a time of great difficulty for research due to scarcity of academic resources. However, the flocking of scientists to the southwestern frontier of the country prompted a 'paleontological renaissance' in the region.⁴² Yang managed to carry out surprisingly successful research, the best example of which was the discovery and examination of the Lufeng fossiliferous formations.

In the winter of 1938, Yang's assistant and colleague BIAN Meinian 卞美年 discovered a massive amount of vertebrate fossils in Lufeng, Yunnan. The lower level contained remains of dinosaurs and the upper level some primitive mammals. These fossils, collected in more than 50 boxes, were then shipped to Kunming for Yang to investigate. Without access to reference books, Yang had to consult his foreign colleagues abroad. He mailed his preliminary study to four people for consultation: his old mentor Broili, German paleontologist Friedrich von Huene, British paleontologist David Watson, and South African paleontologist Robert Broom. Huene, a dinosaur expert, not only confirmed Yang's identification of these fossils, but also sent him a copy of his out-of-print monograph and a number of related journals, which greatly facilitated Yang's study of the new materials.⁴³

Following Zittel's classification of sauropods, Yang believed that most of the fossils discovered in the lower level of the Lufeng formation belonged to a species that existed in the late Triassic period, which was confirmed by Huene. However, these bones did not match any specifications described by Zittel of known species.⁴⁴ In 1941, Yang reconstructed the bones and named the new genus *Lufengosaurus huenei* to honor Huene. This was the first complete dinosaur fossils discovered, studied, and reconstructed solely by the Chinese. During the war, the fossil dinosaur went on a tour exhibition in cities like Kunming, Beipei and Chongqing and created a sensation. In Chongqing, the exhibition even attracted more than ten thousand visitors daily.⁴⁵

⁴² Ronald Singer (ed.), *Encyclopedia of Paleontology*, 1 (Chicago, 1999), 261.

⁴³ Yang, *Yang Zhongjian huiyi lu*, 105.

⁴⁴ Yang Zhongjian, 'Lufeng konglong zhi chubu guan' (Preliminary observations of the Lufeng dinosaur) in *Dizhi lunping* (Geological review), 4/2 (1939), 94.

⁴⁵ Yang Zhongjian, 'Long' (Dinosaur/Dragon), *Wenshi zazhi* (Journal of literature and history), 5/3:4 (1945), 3.

The other significant discovery of the Lufeng fossils was two nearly complete skulls of *Bienotherium*. This rodent-like animal was a new species of the tritylodont family, appearing in the late Triassic and early Jurassic period. Yang studied the fossils and named the species after Bien Meinian, the original discoverer of the Lufeng formation. Similar tritylodont fossils were discovered in South Africa in the 19th century, but in a relatively fragmented state; the *Bienotherium* was the first such fossils found in the Asian continent. According to Yang, the Lufeng fossils, including the oldest sauropods and the oldest mammals ever found in China,⁴⁶ represented one of the most significant paleontological discoveries in China because they offered invaluable information on the evolution of dinosaurs and mammals.⁴⁷ Until the early 1950s, Yang's research had been mainly focused on studying and analyzing the Lufeng fossils, on which he published more than 20 articles and 3 monographs.⁴⁸

Teaching

After Yang returned to China with the completion of his graduate studies in Germany, he devoted himself to research while maintaining only a minimal teaching schedule. In 1929 he began to teach as a lecturer in the department of geology at Peking University, offering a course on vertebrate paleontology to seniors. It was the first time vertebrate paleontology was ever offered as a course in China. It also complemented Grabau's course focusing mainly on invertebrate fossils. His teaching was based on Zittel's textbook, supplemented by fossil specimens from the Cenozoic Research Lab.⁴⁹ Yang later offered another course for seniors on Cenozoic geology,

⁴⁶ It should be noted here that the classification of the tritylodont was controversial because it had both mammalian and reptilian characters. When Yang first studied the *Bienotherium* he identified it as the most primitive mammals, see C.C. Young, 'Preliminary Notes on the Mesozoic Mammals of Lufeng, Yunnan', *Bulletin of the Geological Survey of China*, 20/1 (1940), 93–111. However, during the early 1940s the tritylodontids were reclassified as the mammal-like cynodonts, a group of therapsids that gave rise to the ancestors of mammals. See G.G. Simpson, *The Principles of Classification and the Classification of Mammals*. *Bulletin of the American Museum of Natural History*, 85 (1945). In his later study, Yang followed the new classification and relabeled *Bienotherium* the 'mammal-like reptile'. See C. C. Young, 'Mammal-like reptiles from Lufeng, Yunnan, China', *Proceedings of the Zoological Society London*, 117 (1947), 537–97.

⁴⁷ The other two groundbreaking discoveries were the Peking Man fossils, the oldest hominid, and the Theromorpha reptiles, the most primitive reptiles discovered in China by YUAN Fuli during the Sino-Swedish expedition. See Yang Zhongjian, *Kangzhan zhong kan heshan* (Observations of rivers and mountains during the war) (1944), 140.

⁴⁸ ZHANG Junxiao, 'Yang Zhongjian de rensheng daolu' (The road of Yang Zhongjian) in *Zhongguo gujiezhu dongwuxue de dianjiren: ji jiechu de dishi gushengwuxue jia Yang Zhongjian*, 312.

⁴⁹ Yang, *Yang Zhongjian huiyi lu*, 169–70.

because the existing courses were limited to Paleozoic geology. The course was divided into 2 hours of lecture and 2 hours of lab work. Both courses were small, with between 2 and 20 students.⁵⁰

During the war, Yang taught vertebrate paleontology briefly in the department of geology at Chongqing University. In order to keep up with the most updated scholarship, his course framework was built on Alfred Sherwood Romer's advanced textbook *Vertebrate Paleontology* (Chicago, 1933).⁵¹ ZHOU Mingzhe 周明鎮, who later became a famous paleomammalogist, took Yang's class while studying at Chongqing University.⁵² However, due to lack of teaching resources, such as fossil specimens, no lab training was available. The course only lasted for a year.⁵³

In 1947, two years after the end of the war, Yang came back to Beijing and resumed his teaching at Peking University. He again offered two courses: vertebrate paleontology and continental geology. Both were open to juniors and seniors. However, this time the course only lasted for a few months, until he took the position as the president of Northwest University 西北大學 in Xi'an.⁵⁴

Although Yang Zhongjian was the only person who ever taught vertebrate paleontology at Chinese academic institutions from 1928 to 1949,⁵⁵ it cannot be said that Yang's influence in the field of Chinese paleontology was achieved through teaching in the classroom. It was rather through the field and the lab that he passed on his knowledge and experience and thus contributed to training future paleontologists. He once said that an accurate worldview and a sound foundation built the basis for scientific research. And for paleontology, the foundation meant diligent field work combined with theoretical knowledge. Moreover, maintaining an active role in the international academic circle, Yang also believed that it was necessary for Chinese scientists to master foreign languages, which formed the master tool of knowledge.⁵⁶

⁵⁰ Ibid, 170.

⁵¹ Romer sent Yang two of his publications in 1940, *Vertebrate Paleontology* and *Man and the Vertebrates* (Chicago, 1933), upon Yang's request. See YANG Xiaoxin, 'Yang Zhongjian yu Meiguo kexuejia de xueshu jiaoliu huodong' (The scholarly interactions between Yang Zhongjian and American scientists) in *Zhongguo gujizhui dongwuxue de dianjiren: ji jiechu de dishi gushengwuxue jia Yang Zhongjian*, 138.

⁵² Yang Xiaoxin, 'Yang Zhongjian yu Meiguo kexuejia de xueshu jiaoliu huodong', 138–9.

⁵³ Yang Zhongjian, *Yang Zhongjian huiyi lu*, 171.

⁵⁴ Ibid, 172.

⁵⁵ Ibid, 173.

⁵⁶ ZHEN Shuonan, 'Chunfeng huayu hui houren' (To instruct the later generations with spring breeze and rain) in *Zhongguo gujizhui dongwuxue de dianjiren: ji jiechu de dishi gushengwuxue jia Yang Zhongjian*, 210.

Before 1949, Yang's main research was done at the Cenozoic Research Lab and the Geological Survey. At the Zhoukoudian site, PEI Wenzhong 裴文中, who just graduated from the geology department at Peking University, was Yang's first assistant. Without formal training in paleontology, Pei taught himself the details of the Cenozoic formation and related knowledge on fossils through studying Zittel's textbook at night.⁵⁷ Before Pei left for France to pursue his doctoral education in 1936, he worked closely with Yang as a team. The two often had extensive discussions in the lab in the afternoon after the excavation work of the day was over.⁵⁸ Later, Pei, Bian, and JIA Lanpo 賈蘭坡 worked as Yang's assistants at Zhoukoudian. Yang also trained a group of technicians to carry out the excavations, as well as the more meticulous repair and preparation of fossils.⁵⁹ Pei, Jia, Bian and those trained technicians played a crucial role in setting up the groundwork for the development of Chinese paleontology. From 1953 to 1979, Yang was both the director of the leading Institute of Vertebrate Paleontology and Paleoanthropology 古脊椎動物與古人類研究所 (successor to the Cenozoic Research Laboratory) and the head of the Beijing Museum of Natural History. He helped train numerous professional vertebrate paleontologists, including LIU Dongsheng 劉東生 (environmental geologist), YE Xiangkui 葉祥奎 (vertebrate paleontologist specialized in fossil turtles), DONG Zhiming 董枝明 (dinosaurologist), SUN Ailing 孫艾玲 (vertebrate paleontologist specialized in Theromorpha reptiles), and ZHEN Shuonan 甄朔南 (vertebrate paleontologist and museologist).

International Networking

Between 1944 and 1946, Yang was among a group of scholars and engineers sent by the National Resources Commission, headed by Weng Wenhao, to visit America for more advanced training and study in industrial development.⁶⁰ Yang brought with him some fossils from the Lufeng formation and spent most of his time in New York's American Museum of Natural History repairing and studying them. He reunited with members of the Central Asiatic Expeditions, such as Roy Chapman Andrews, C. P. Berkey and F. K. Morris. He also traveled around the US and Canada

⁵⁷ Yang, *Yang Zhongjian huiyi lu*, 63. It might be Yang who recommended Zittel's textbook to Pei.

⁵⁸ *Ibid.*, 84. ⁵⁹ *Ibid.*, 86–8.

⁶⁰ In fact, four scholars were chosen for the field of geology: Yang, and WANG Yu, an invertebrate paleontologist, and two experts of mineralogy. Yang was rather surprised that the NRC considered paleontology an important discipline for national development. See *Ibid.*, 122.

to survey different geological formations and to visit major research institutions and museums. Among the renowned researchers in the field to whom Yang paid visits were Alfred Sherwood Romer of Harvard's Department of Zoology, Charles Gilmore of the National Museum of Natural History in Washington D.C., and Charles Camp of the University of California, Berkeley.⁶¹

As a consequence of the rapid westward expansion of the American frontier in the second half of the 19th century, the development of paleontology in North America accelerated with massive discoveries of fossils. It was fueled up by the 'bone wars' of dinosaur fossil hunts between the two leading paleontologists Othniel Marsh and Edward Cope.⁶² The development of American capitalism and the rise of consumer culture further added market value to vertebrate fossils and made fossil hunting a profitable enterprise, which in turn helped promote the development of the new science of dinosaur and vertebrate paleontology.⁶³ As a result, the center of paleontological research gradually shifted from Europe to North America. This trend culminated during World War II, when many refugee scientists fled from the European battlefield and resettled in America. Yang's visit to America witnessed the coming of age of American paleontology. While Zittel's *Textbook of Paleontology* remained the monumental textbook for students of vertebrate paleontology since its English publication in 1900 until the 1930s, it was replaced by Romer's *Vertebrate Paleontology*, published in 1933. As mentioned, even Yang adopted Romer's book as the textbook when he taught at Chongqing University. When Yang met Romer in 1946, Romer was preparing his manuscript of the expanded second edition. Romer showed him the manuscript, which included the recent discoveries from the previous decade. Yang was contented to see that both the Peking Man and the *Bienotherium* were listed and their significance discussed.⁶⁴

During the two years of his stay in America, Yang made many connections to American paleontologists and continued these friendships after he returned to China. When China was relatively isolated from the international scientific community during the Mao era, Yang maintained his connections with American academia through personal correspondence. Rachel Nichols, a scientific assistant in charge of the Osborn Library of Vertebrate Paleontology at the American Museum of Natural History,

⁶¹ Yang Zhongjian, *Xin yanjie* (New perspective) (Shanghai, 1947), 64, 108, 148–9.

⁶² Mark Jaffe, *The Gilded Dinosaur: The Fossil War between E. D. Cope and O. C. Marsh and the Rise of American Science* (New York, 2000).

⁶³ Lukas Rieppel, 'Prospecting for Dinosaurs on the Mining Frontier: The Value of Information in America's Gilded Age', *Social Studies of Science*, 45/2 (2015), 161–86.

⁶⁴ Yang, *Xin yanjie*, 156–7.

became a good friend of Yang during his stay in New York. Before he departed from New York, Yang left a small amount of money to Nichols and asked her to mail him some new journals and publications in the future. Nichols kept her promise. She also arranged exchanges of publications between Yang and the American scholars during the decades when official communication between China and America was halted.⁶⁵

Conclusion

The history of the development of vertebrate paleontology in Republican China demonstrates the entangled relations of scientific internationalism and nationalism. Fundamentally, however, the accomplishment and success in the research on vertebrate paleontology reflect the power and wealth of the nation. When Yang studied at Peking University in the early 1920s, China was a fruitful field for scientific exploration by foreign scientists. For these foreigners, such as Roy Chapman Andrews and Henry Fairfield Osborn (the president of the AMNH during the Central Asiatic Expeditions), scientific research was an international endeavor; the Chinese had no right to claim what was dug up from their land, since earth had a common history.⁶⁶ However, for nationalistic Chinese, paleontological science was always attached to a territorial sensibility. It was never universal, but 'local'.

In 1926, while working on his dissertation, Yang wrote an article entitled, 'Sciences with Local Characters and the Duty of Scientists'.⁶⁷ He divided the sciences into two groups according to the material they processed: those of a universal nature, like physics and chemistry, and those with local characters, like biology, geology and paleontology. For scientists who studied the second kind, their duty was not only to understand basic knowledge of the discipline, but also to discover and study local varieties. He then questioned the validity of 'science without boundaries', arguing that such a statement was merely an excuse for powerful countries to do research and to fetch resources from the territories of weak countries.

⁶⁵ Yang Xiaoxin, 'Yang Zhongjian yu Meiguo kexuejia de xueshu jiaoliu huodong', 142–4.

⁶⁶ During the fossil dispute with the National Commission for the Preservation of Antiquities, both Andrews and Osborn condemned Chinese anti-foreign nationalism for thwarting scientific research. See Roy Chapman Andrews, *New Conquest of Central Asia* (The American Museum of Natural History, 1932), 418; Henry Fairfield Osborn, 'Interruption of Central Asiatic Exploration by the American Museum of Natural History', *Science*, 70/1813 (Sept. 27, 1929), 291–4.

⁶⁷ Yang Zhongjian, 'Daiyou difangxing de kexue yu yanjiu cixiang kexue zhe yingyou de zeren' (Science with local characters and the duty of scientists), *Shengwu kexue* (Biological science), 1 (1926), 31–5.

He pointed out that the Germans, the French, the Americans, the British, and even the Japanese had come to China to conduct geological expeditions, but no Chinese scientist ever did the same thing in those countries. He concluded that it was crucial for Chinese scientists to learn the principles of foreign methods and tools and systematically educate their fellow citizens with such knowledge and methodology, so they would be able to conduct research on their own land and discover what was hidden beneath their own soil. 'It is not only an obligation we have for our motherland, but an obligation we have to advance the discipline [of local science]'.⁶⁸

What Yang described was the indigenization of paleontology. For him, paleontology was not only 'local', it had to be 'localized'. The localization of paleontology could only be achieved if the discovery, the excavation, the repair, the study, and even the reconstruction of the fossils were all done by local hands. As a Chinese, Yang never hesitated to return to China after the completion of his Ph.D. education in Germany, not only to fulfill his obligation to serve his country, but also because 'no matter how beautiful the mountains and rivers of Germany might be, this is not my land'.⁶⁹ Throughout his career, Yang kept a high international profile, and was eager to embrace foreign knowledge. Yet, science, at least for Yang, indeed had boundaries, and the boundary for paleontology was the boundary of the nation. His devotion to paleontology could not be separated from his deep identification with the place.

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⁶⁸ Ibid, 34.

⁶⁹ Wang, 'Yi wangshi: huainian qinren Yang Zhongjian', 36.