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TRANSLATION OF OTTO ZDANSKY'S "THE LOCALITIES OF THE *HIPPARION* FAUNA OF BAODE COUNTY IN NORTHWEST SHANXI" (1923)

Tuomas Jokela, Jussi T. Eronen, Anu Kaakinen, Liu Liping, Benjamin H. Passey, Zhang Zhaoqun, and Fu Mingkai

ABSTRACT

In honor of Will Downs and his example of making original research papers available to the scientific community, we present a translation of the classic study of the Baode area of Shanxi Province, China, written by Otto Zdansky in 1923. The translation preserves the idiosyncratic spelling and technical language of the original, in part a product of the times.

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INTRODUCTION

Otto Zdansky's classic 1923 paper "Fundorte der Hipparion-Fauna um Pao-Te-Hsien in NW-Shansi" (Bulletin of the Geological Survey, China, Volume 5, pp. 69-82) remains the only detailed description of the localities that have delivered much of the finest Chinese mammalian fossil material stored in museums in and outside China. In particular, the majority of the Chinese large-mammal fossils in the Lagrelius Collection in the Museum of Evolution in Uppsala, Sweden, and in the Frick Collection in the American Museum in New York, were collected in the Dragon Bone Mines of Jijiagou and adjacent gullies in Baode County, Shanxi Province. The mines were mapped and described by Zdansky during a prolonged stay in the area, in order to supervise the collecting and shipping of material destined for Uppsala.

The late Neogene Red Clay deposits (previously also known as Hipparion Clay) are widespread in north China covering an area similar to the overlying Pleistocene loess deposits. In recent years, research has demonstrated an eolian origin for the Red Clay, as for the overlying Pleistocene and Holocene loess.

During a field season in the Baode area in September 2004, we decided to translate Zdansky's German text for the benefit of team members unfamiliar with that language. It subsequently occurred to us that we ought to make the translation available to the scientific community at large, in the admirable spirit of Will Downs, whose many translations of Chinese publications into English are such a rare treasure for all international collaborations involving Cenozoic vertebrate fossils from China. We are happy to dedicate our translation to the sweet remembrance of our late friend and colleague "Mr. Dong" (Dong Weilin was Will's Chinese name.).

It should be emphasized that this translation is the work of happy amateurs, and although we have taken reasonable precautions to avoid mistakes, inaccuracies may well remain. The use of italics follows the original. We have used the established term "Hipparion Clay," although the correct translation of Zdansky's term "Lehm" would be loam, a better match for the lithology in question. Zdansky repeatedly used variants of the expression "die Lagerung is schwebend." This seems at first to suggest that he thought that the stratification was weak or vague ("floating"), but apparently "schwebend" in this context is actually an old miner's term meaning simply horizontal. The transcription of place names given by Zdansky is unchanged, with the modern pinyin equivalent given in brackets at the name's first occurrence in the text. The lack of citations and references is genuine.

Zdansky supplied a wonderfully detailed map of Baode County area (Pao Te Hsien), which we designate as our Figure 1. The labelling of illustrations and tables originally used by Zdansky was revised for convenience and compatibility with online viewing. In the original, there were four text drawings labelled as figures. In addition, there were five plates or "tables" at the end of the article, labelled with Roman numerals, of which tables I and II both comprised two photographs, then called Figure 1 and Figure 2, respectively. Tables III and IV were maps of the fossil mines. Herein, the figures and tables are referred to as successive figures with Arabic numerals, in the order in which they are discussed. The translation follows below.

HIPPARION-FAUNA FOSSIL LOCALITIES IN PAO-TE-SHIEN, NW-SHANSI

Otto Zdansky

Uppsala University, Sweden

TOPOGRAPHY

In northwestern Shansi, in the region of Pao-Te-Hsien [Baode county], is one of the centres of the trade of fossil bones in northern China. Pao-Te-Hsien itself is located eight days travel northwest from the provincial capital Tai-Yuan-Fu [Taiyuan city], on the Yellow River. The area considered is northeast of Pao-Te-Hsien and has its centre

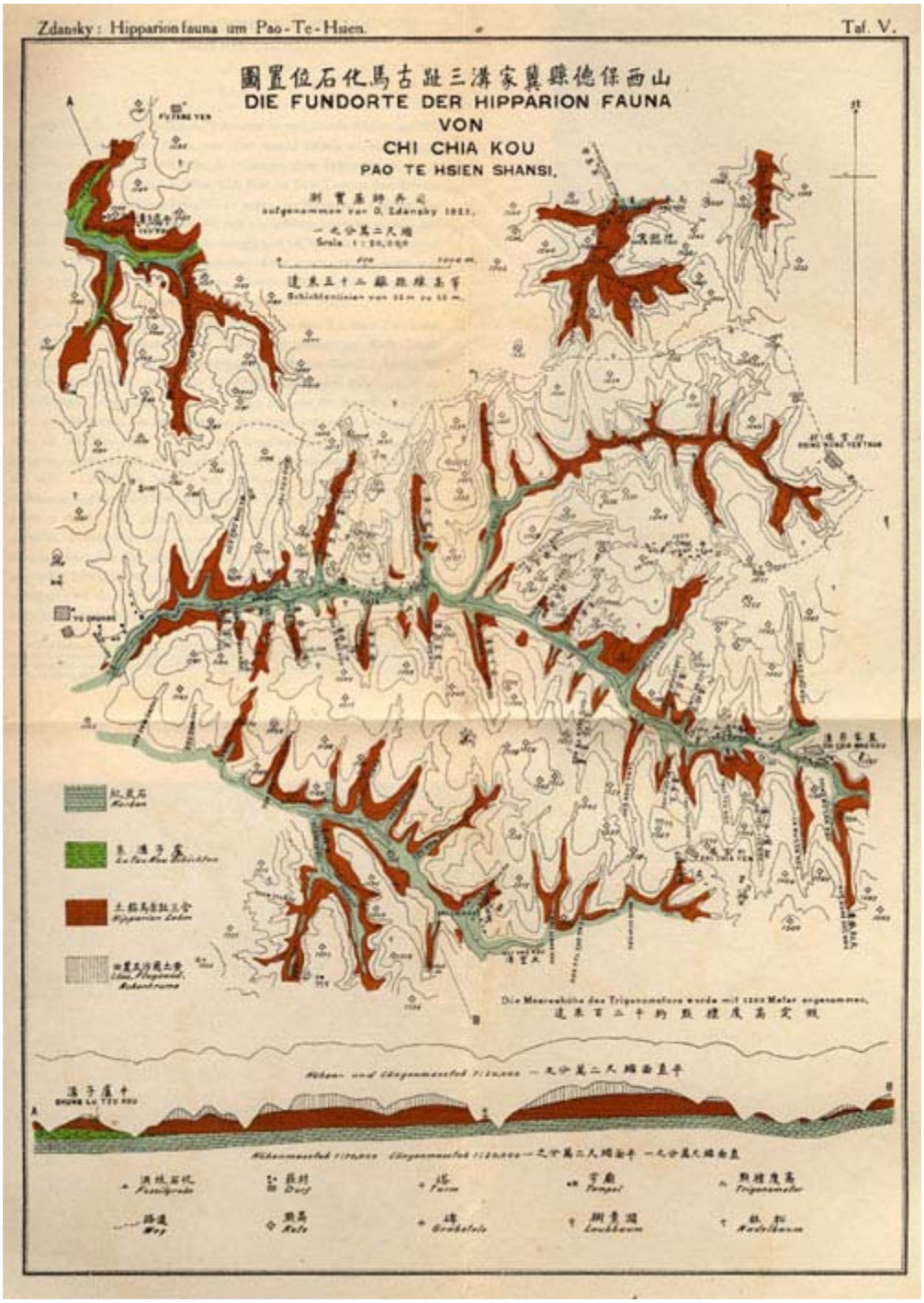

Figure 1. Originally Tafel V. 1:20,000 map of the Baode area.

approximately in Chi-Chia-Kou [Jijiagou], about 13 km to the northeast of the town.

The land is a plateau rising towards the east from the Yellow River on the west. It is, however, cut by ravines and gullies, giving the impression of a hilly landscape, until a view from a greater distance reveals the evenness of the overall rise.

The attached map shows the region's topography and geology. As can be seen, almost all the valleys reach the Carboniferous (base), in which the water has often carved canyons of 10-15 m depth. Coal can be found almost everywhere, and it is quarried from several mines, however, mostly for domestic use. In general, the Carboniferous lies horizontally, but locally the beds can also be slightly folded. At the boundary between the Carboniferous and the overlying Hipparion Clay, small springs are often to be found.

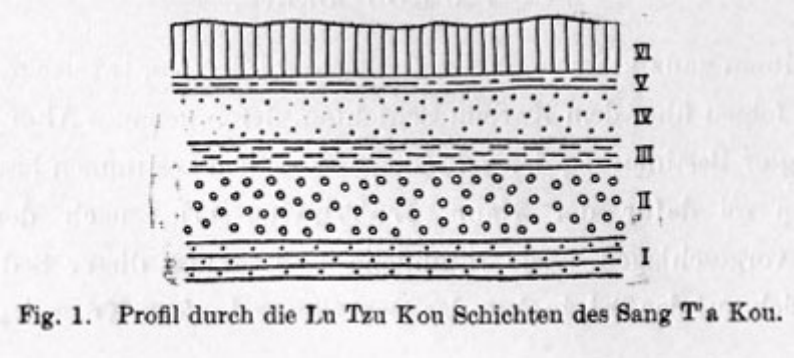

Fig. 1. Profil durch die Lu Tzu Kou Schichten des Sang T'a Kou.

Figure 2. Originally Figure 1. Schematic profile of the Lu-Tzu-Kou layers at Sang T'a Kou [Sangdagou].

LU-TZU-KOU SERIES

In a very small area (which can be partially seen in the northwest corner of the map) above the Carboniferous unit, there are layers, the precise age of which should be determinable after study of the collected fossils. For the time being, the name Lu-Tzu-Kou Series is proposed, according to the main locality. The geographical extent of these sediments is restricted to the valley where the village of Chung-Lu-Tzu-Kou [Zhongluzigou] is located, with its side valleys and the northern parallel valley. These sediments cannot be found either in the north, south, or east, but during a trip to Nan-Sha-Wa [Nanshawa] the author saw (about 30 km north of Chi-Chia-Kou) a 30-cm thick bed of quartz cobbles between the Carboniferous unit and the Hipparion Clay. This probably is part of the Lu-Tzu-Kou Series. Westward these extend as far as the Yellow River.

At Chung-Lu-Tzu-Kou [Zhongluzigou], the strata occasionally reach a maximum thickness of 25 to 30 m, although in the closest proximity, sediments of lesser thickness can also be found. The series begins above the Carboniferous unit with a layer of quartz shingle (a piece of jadeite was also found in it). The spaces between the clasts are filled with yellow and green quartz sand. Here and there, where the cementing is stronger, a massive bed of conglomerate occurs. Lenses of fine sand and fragments of green marl with fish remains occur as inclusions. These gravel layers include moderately rounded bone fragments and teeth of larger mammals. Among the finds were isolated teeth of an equid, a rhinocerid, and a rodent. Overlying the gravel follows the green-yellow marl and carbonaceous marl with freshwater molluscs and impressions of plants. Overlying these are cross-bedded fine yellow sands. A rhinoceros mandible was found in these. An important horizon consists of greenish-white, stratified, calcareous marl, which in places is quite filled with fish remains. Additionally, a smaller amount of molluscs can be found, although in many places in the same horizon, this can be quite the reverse (i.e., more molluscs than fish). Thus far, it can be stated that the molluscs are represented by two species of gastropods and lamellibranchiates each.

The most complete profile for describing the different components, although not the thickest, is described as follows. It comes from the eastern face of [the ravine]

Sang-T'a-Kou [Sangdagou], which opens in the main valley southeast of Chung-Lu-Tzu-Kou [Zhongluzigou]. It can be seen in Figures 2 and 3.

VI. More than 4 m of reddish, loess-like material with bone splinters and tooth fragments of rhinoceros in a layer with calcium carbonate concretions at the base.

V. 1.3 m of greenish-white, stratified, calcareous marl with plenty of bone splinters of larger mammals and molluscs.

IV. 4.5 m of fine yellow sands with crossbedding. Mandible of Rhinoceros.

III. 2.3 m of green-yellow marls and calcareous marls with fish fossils and molluscs.

II. 6.5 m of quartz cobbles, the interstices filled with yellow and green sands. In places iron-stained and hardened. Contains lenses of green sand and blocks of marl. Includes rounded bone fragments and teeth of mammals.

I. CARBONIFEROUS.

The red sediment that caps this sequence cannot, as so often happens, be distinguished either from loess or from Hipparion Clay with certainty. Because of this, this profile does not give a satisfactory answer to the question of the relationship of the Lu-Tzu-Kou series to the Hipparion Clay, but the problem is solved through a profile of Ch'I-Tzu-Kou [Qizigou], which is a parallel valley of

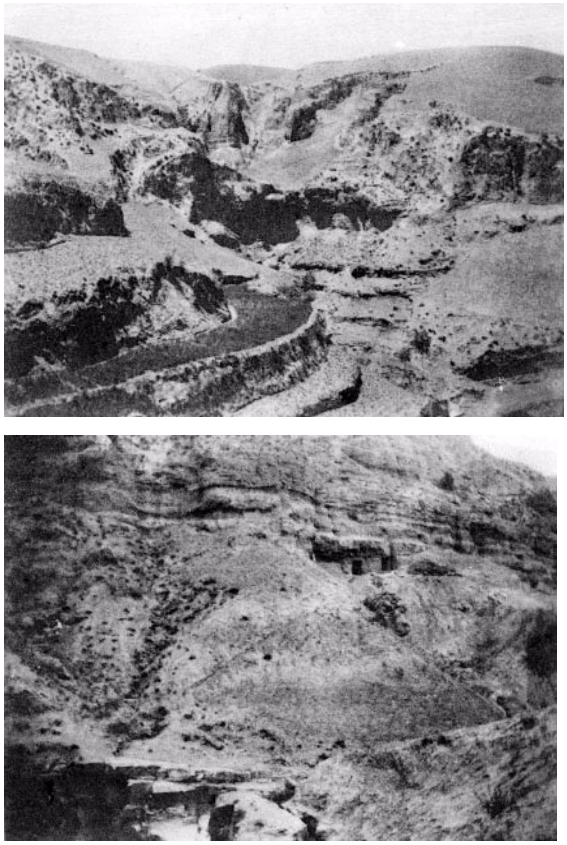

Figure 3. Originally Taf. I, Figs. 1, 2. Exposures of the Lu Tzu Kou lithology at Sangdagou.

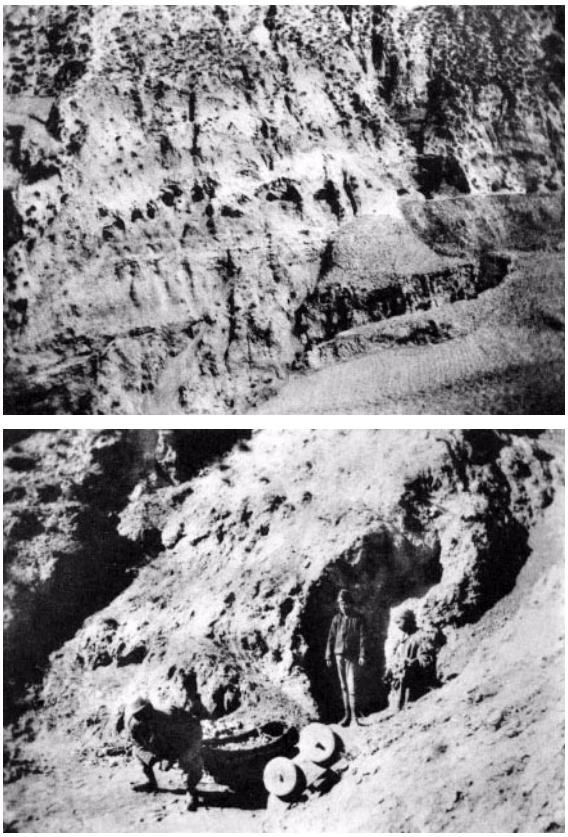

Figure 4. Originally Taf. II, Figs. 1, 2. Lu Tzu Kou lithology at the local valley Qizigou.

Lu-Tzu-Kou [Luzigou]. The latter can be seen in Figure 4. The abandoned cave dwellings, the two entrances of which can be seen, are still situated in the deposits concerned. In this particular place, these deposits form a harder carbonate bank that is rich with fish fossils. But overlying this, with a sharp contact, is the Hipparion Clay, recognised as such not only by its clearly distinguishable petrographic nature, but also through its fossil content.

In Lun-Ch'üh-Kou [Lunqugou?] (visible on map), a layer of greenish carbonate marl, rich in gastropods and with some fish fossils, appears in a red clay, that appears extremely similar to the Hipparion Clay. Until the fossil material is studied, preliminary survey and geological considerations suggest a Miocene age for the Lu-Tzu-Kou series. The stratification is horizontal.

HIPPARION CLAY

The above mentioned deposits are, however, absent from most of the area studied. The Carboniferous is covered by the Hipparion Clay, sometimes directly. Most often, however, there is a conglomerate bed of varying thickness (sometimes up to 4 m thick). The cobbles and the matrix are of calcium carbonate. The stratification is horizontal. Nonetheless, the conglomerate formed before the Hipparion Clay. Fossils cannot be found in it. Topographically the conglomerate can be recognised because it forms a layer between the highest slate-like members of the Carboniferous unit and the red clay. Being harder than either of these, it forms a frequently undercut projecting cliff in the ravines. It is noteworthy that its calcareous matrix is grey, while the carbonate layers in the Hipparion Clay are cemented by the red clay.

Above this lies the Hipparion Clay, red clay similar to that of Pikermi in every respect. The maximal observed thickness is about 65 m. A subdivision into different horizons cannot a priori be carried out because the commonly occurring shingle beds are not sufficiently continuous. However, they demonstrate that a horizontal stratification is present. Layers of carbonate concretions occur sparsely. A fossil-rich horizon appears in this clay about 1150 m (cf. the map). It is mined by the local population. The fossils of the fauna characterized by *Hipparion Richthofeni* Schl. appear in "nests," in which usually a great number of bones of the most different forms occur together in a restricted space, typically from 0.5 to 2.0 cubic meters in volume.

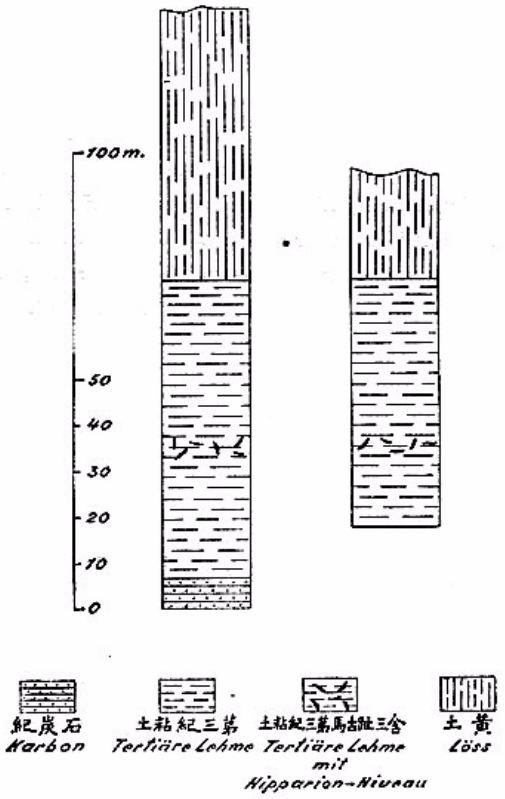

Fig. 2. Generelle Profile durch die Hipparion Ablagerungen.
A. Chi Chia Kou und Nan Sha Wa.
B. Wu Lan Kou.

Figure 5. Originally Fig. 2. Two observed sections illustrating the general profile of the *Hipparion* fauna fossil level.

Complete skeletons were not found, but more or less complete limb bones and parts of vertebral columns are present. Also, carnivore skulls appear with their mandibles attached, and this is also the case with the rhinocerids. These fossils are quite heavily mineralised, the marrow cavities are usually filled with crystals of calcite, and the surface appears pure white. The clay is infiltrated and hardened by calcite in the immediate vicinity of the fossil "nests." At times small sand lenses are embedded in the clay. They usually contain small fragments of bone. Often a certain stratification can also be recognised within the fossil "nests." In addition to the shingle layer, the clay also contains isolated cobbles of small size.

As already mentioned, the fossil "nests" all lay at one level, although there can be vertical variation of about 5 m, and, indeed, two fossil nests may lay one directly above the other, separated by a 1 m gap. Of the total thickness of Hipparion Clay, 25 m thus lie under and 35 m above the fossil level (see Figure 5). As for the fossil content of the nests, it is everywhere the same, i.e., no forms are limited to certain localities only. However, it must be noted that especially locality 30 at Tai-Chia-Kou [Daijiagou] contains almost exclusively larger ruminants and carnivores, in addition to rhinocerids, which are common everywhere. In Yang-Mu-Kou [Yang-Mu-Gou], locality 49, a fossil nest unusually rich in carnivore fossils was found. On another occasion, the remains of at least four pigs, which are otherwise quite rare, were found together in the smallest of spaces. The west-east extent of the region is 5.5 km, and the north-south extent is 5.0 km. The clay is covered by loess, which can reach a very considerable thickness. Once it covered the whole region, but in the course of time, the post-Tertiary streams have carved themselves in, so that the topography has by-and-large remained unchanged (see profile A-B, Figure 5). In support of this argument, it can be stated that in the side valleys, which are naturally younger, the contact between the Hipparion Clay and loess is always parallel to the modern surface. Fossils are not known from the loess in this region. Finally, the hill-tops are mostly covered with eolian sand, a circumstance explained by the proximity of the Ordos Desert.

FORMATION OF FOSSIL NESTS

The question of the formation processes of the fossil nests in the Hipparion Clay is difficult to answer. It is to be kept in mind that the localities lie in one horizon, where differences in the level of nests can be up to 5 m. This indicates that at the time of deposition, the surface in the region was almost horizontal. That the process of deposition was affected by running water can be seen from the way the fossil nests are situated, separated by unfossiliferous spaces in-between, with the occurrence of small sand lenses as well as levels of bone fragments. The preservation of the fossils indicates they have not been transported over long distances. And now the author must thank Dr. J.G. Andersson for making the author aware of his observations of how variable the flow of (temporary) water channels is today in the Mongolian steppe. It is thus quite possible, that in the region, which was almost flat at the time of deposition of the fossil beds, the conditions were similar, so that in the course of years, maybe even during a single rainy season, the fossils were transported together from nearby areas by the shifting water channels. Thus, all the nests cannot be strictly contemporaneous, which also explains the differences in level already mentioned, likewise the appearance of two nests above each other. Finally, as for the con-

strained distribution of the fossil occurrence to only a fraction of the entire red clay deposit, also here the author wants to refer to personal communication with Dr. Andersson. According to Dr. Andersson, some areas in the steppe at certain times could, through a favourable combination of topographic and climatic conditions, support an especially lush vegetation, which naturally caused a concentration of animals in these areas. In the surroundings of Chi-Chia-Kou, we would thus see the remains of such an oasis. The assumption of a catastrophe, as proposed for example by Prof. O. Abel for the Pikermi deposits, is not considered likely by the author, because of the absence of fractures in the remains and the topography at the time deposition. Neither can the reason for the deposition be a larger watercourse. Although this could be argued in the case of locality 30, the irregular distribution of the localities and the fact that in single mines there are no continuous fossil layers, cannot be brought into harmony with such a view.

CHARACTERISTICS OF THE FAUNA

Hereby an attempt will be made to characterise the fauna, as far as possible, before preparation of the collections. Attention will also be paid to the material collected earlier by Dr. Andersson's Chinese collectors. The *perissodactyls* are represented by the already mentioned and quite common *Hipparion Richthofeni*, *Anchitherium*, and *rhinocerids*, which are classified to six different species according to a letter from Prof. Wiman. Four of them belong to the genus *Teleoceras*, one to the genus *Aceratherium*, and finally the most interesting form to *Sinotherium Lagrelii*, Ringström. The rhinocerids, because of their size and abundance, are by far the most notable element of the fauna. The *artiodactyls* are well represented both in the number of species and of individuals. There are *cervicorns* of various sizes; however, they are not so common. A host of different *antelopes* occurs in great quantities; one form of *pellicorn* was named *Chilinotherium Tingii* by Prof. Wiman. The *bunodonts* are represented by two species of pigs, one being the same size as *Sus erymanthius* of Pikermi, the other being considerably smaller. The number of carnivore species is quite significant. A gigantic hyena is the most common. Viverrids are not uncommon. *Felids* are also found, including the rare *Machairodus*. There is also a skull that belongs either to *Hyaenarctos* or *Arctocyon*. Of *mustelids,* there are at least two species, and finally a skull resembling that of a badger should be mentioned. Elephants are represented by Mastodon, Stegodon, and Elephas. Of rodents there are only two species: a beaver-like mandible and a skull of the size of *Sciurus*.

Of bird fossils, only the pelvis of a *struthionid* is known. It is considerably larger than that of the recent African Ostrich.

Of reptiles there are at least two species of tortoises, one *testudinid* and one *emydid*.

FOSSIL EXCAVATION METHODS

The excavation of fossils for medical use constitutes a source of income for the people. It is hard to tell how long it has been practiced; one estimate is 60-70 years. However, when the large number of abandoned mines and the length of some still in use are taken into account, an older age of the practice can be considered. The quarrying commences in such a way that where conditions appear promising, for example at a site where fossils occur on the surface, a horizontal tunnel about 90 cm wide and high is excavated. Where a larger fossil concentration is found, the tunnel can be enlarged into a chamber. If the nest, which at the beginning of the activity was productive or in later phases of the activity was recently being worked, is exhausted, excavation is continued arbitrarily in any direction, in which activity only the common hardening of the clay in the vicinity of the fossils can give an indication of the outcome of the chosen direction. There are no deviations from the horizontal level, if small exceptions are ignored. People often dig for four to five days or for one week until another fossil nest is found. This working method explains the irregularities and branching of the tunnels (see Figures 6, 7). The tools used are generally simple (see Figure 8). A relatively heavy pickaxe with a short handle is the general tool used in the work. A small hatchet is used for separating the fossils from the matrix and the teeth from the jaws. For transportation of the material, a small wooden cart with four small wheels is used. It is 1.3 m long, 60 cm wide, and 35 cm high. A flat basket on the cart contains the excavated material. People especially trained for this task pull the cart on all fours, using a harness that runs between the legs and over one shoulder. Oil lamps typical for the region and placed in specially carved niches or standing on suitable iron rods driven into the clay, are used for illumination. In spring, the buyers for the Chinese drugstores come and buy the available stock. One catty of bones is worth 6 cash [no units in original], and 1 catty of teeth is worth 6-8 copper cents. During the summer, mining activities usually cease because of farming.

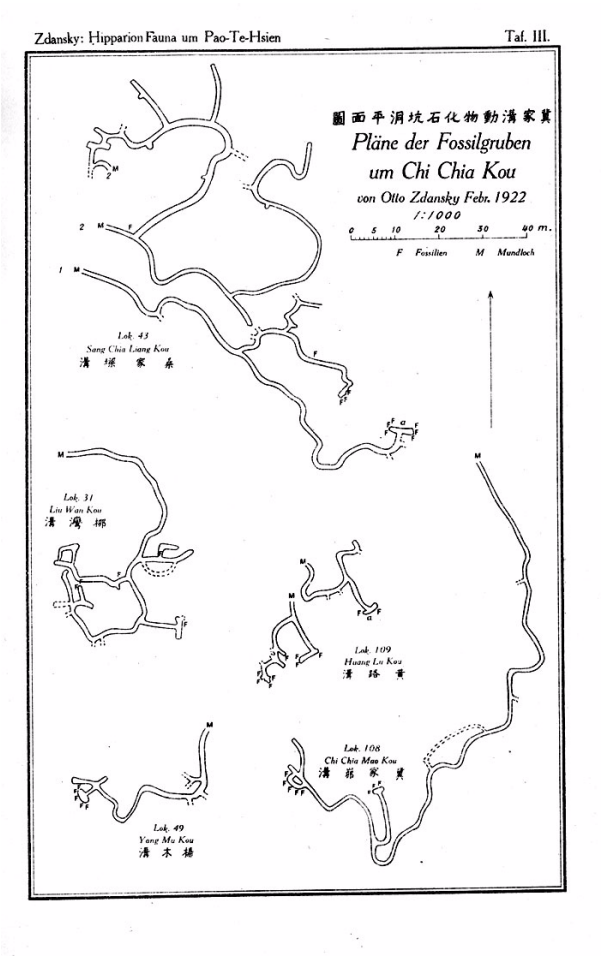

Figure 6. Originally Tafel III. The dashed line indicates old tunnels that are not presently accessible. FF = Places where fossils could be seen at the time of observation. Loc. 43: a.) Two layers with small bones, each 2 cm thick, between which are others, irregularly dispersed. Loc. 109: a.) Layers with bone fragments the size of hemp seeds.

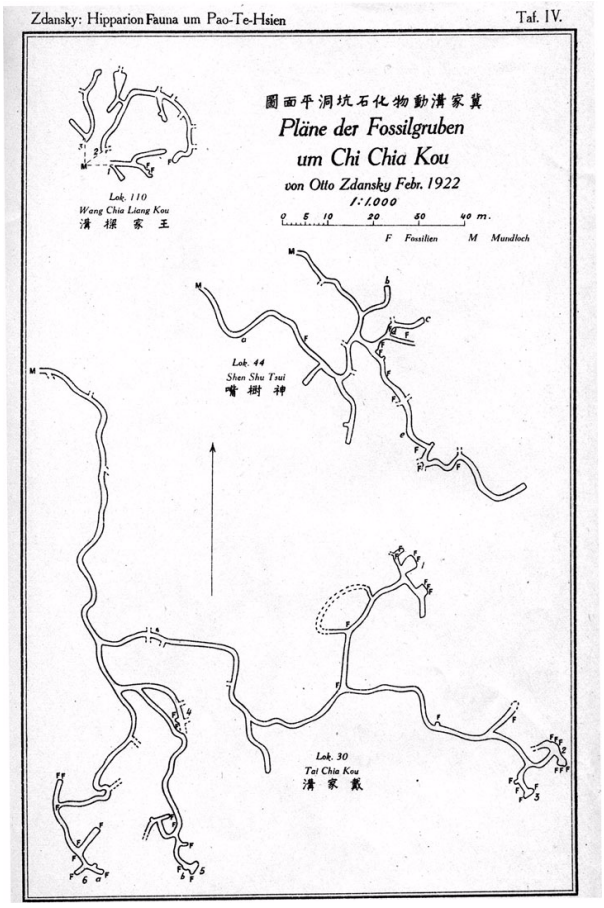

Figure 7. Originally Tafel IV. Symbols as in Figure 6. Loc. 110. The tunnels lie immediately below a cobble layer. Loc. 44: a.) Lenses of sand and bone fragments 12 cm thick, b.) Lens of sand and bone fragments, c.-e.) Sand lenses.

OTHER LOCALITIES

During his travels, the author also visited Nan-Sha-Wa in the region of Ho-Ch'ü-Hsien [Hequ County], 140 li [=70 km] north of Chi-Chia-Kou. There, also, the people excavate the fossils of the Hipparion fauna. The fossil nests there seem to be larger, but less filled with bones. However, the number of the mines is too small (three, of which only two are being used) to allow any significant conclusions to be made. The matrix there is sandier, and the immediate proximity of the bones is seldom infiltrated by calcium carbonate. As in Chi-Chia-Kou, the tunnels are situated 25 m above the Carboniferous layer and are covered by about 30 m of barren clay. See illustration [Figure 5]. They are 1 m high and up to 3 m wide. The reason for this is partly explained by the softer matrix and

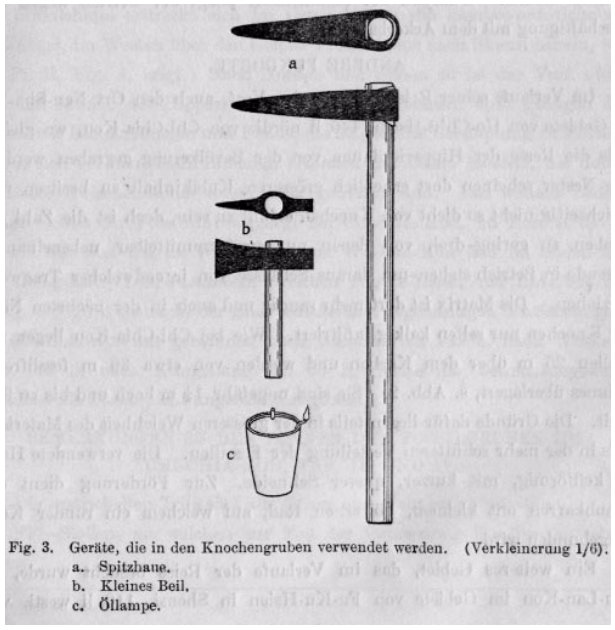

Fig. 3. Geräte, die in den Knochengruben verwendet werden. (Verkleinerung 1/6).
a. Spitzhaue.
b. Kleines Beil.
c. Öllampe.

Figure 8. Originally Fig. 3. Tools used in digging fossils.

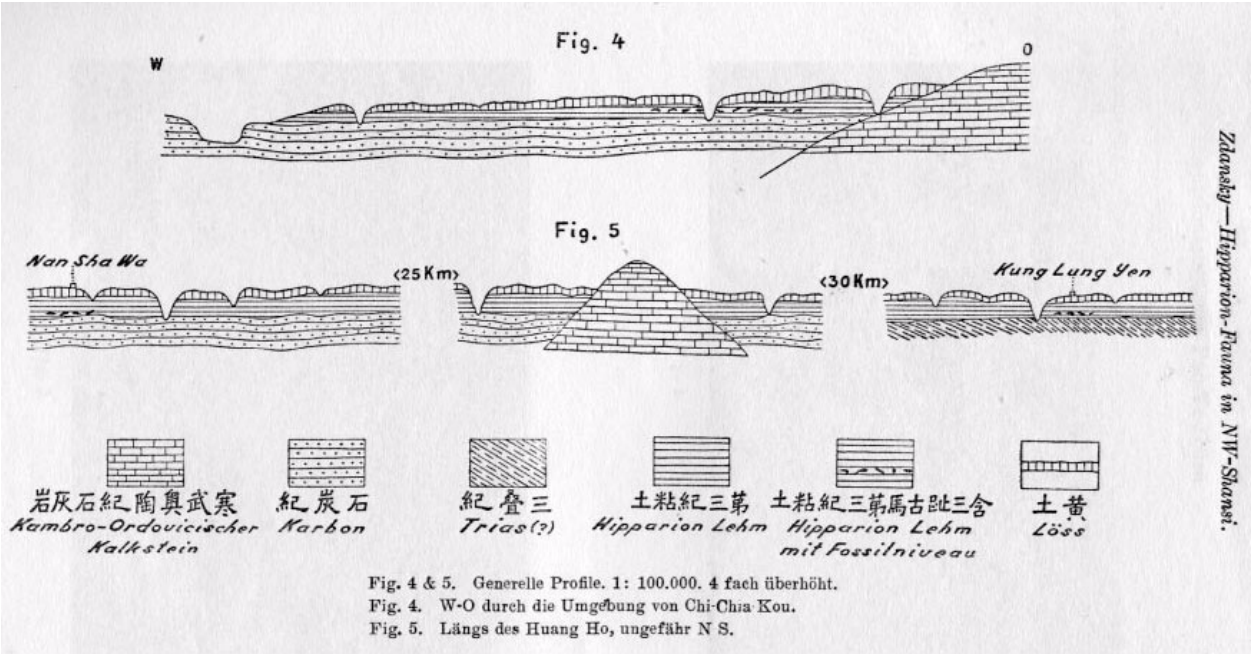

Figure 9. Originally Fig. 4, Fig. 5, combined. General stratigraphic profiles in the Baode area (drawn at 1:100,000, vertical exaggeration of 4 times). Fig. 4 is a West-East section at Chi-Chia-Kou; Fig. 5 is exposures along the Yellow River.

partly by the sparser distribution of fossils. The pickaxe used is wedge-shaped, with a short, straight edge. For transportation, a small wheelbarrow on a wooden wheel with a basket tied to it is used.

A further region that was visited during travel is Wu-Lan-Kou [Wulangou] in the region of Fu-Ku-Hsien [Fugu County] in Shensi, 110 li [=55 km] west of Pao-Te-Hsien. A host of tunnels is situated there, all in a very restricted space in a side ravine. The significance of the fact that they all lie at the same height would not have been noted, had this not also been noticed in Chi-Chia-Kou. Also there the material is sandy/clayey, and the bones in contrast are more fragile than in Chi-Chia-Kou. Above the fossil horizon, there is about 35 m of barren clay. The height above the Carboniferous could not be established. Thus, it seems that the total thickness of the Hipparion clay is the same in all three regions, and the position of the fossil horizon is the same in each case. The working methods are the same as those used in Chi-Chia-Kou.

SUMMARY

Now, a short summary will be made. The extent of the Hipparion Clay in the east is up to the Cambro-Ordovician limestone hills and in the west to the Yellow River towards Shensi, as seen in the profile of Figure 9. To the north and south, the author has not crossed the border of the Hipparion Clay, but observations and findings support the reasoning that the fossil-bearing regions are former oases, separated by areas devoid of fossils. By far the most important fossil-bearing region is situated in Chi-Chia-Kou. Northwards from Chi-Chia-Kou, it is in Nan-Sha-Wa; in the west, it is in Wu-Lan-Kou; and in the south, it is in the Kung-Lung-Yen [Kunlunyan] (not visited), halfway between Pao-Te-Hsien and Lin-Chia-Yü [Linjiayu] (see Figure 9). Taking into account the notable distances between the regions from Chi-Chia-Kou—Nan-Sha-Wa being 145 li away, Wu-Lang-Kou 135 li, and Kung-Lung-Yen being 60 li away—the vision of them as oases is not without foundation.

ACKNOWLEDGEMENTS

Our fieldwork in Baode was supported by The National Geographic Society, The Academy of Finland, and The Chinese Academy of Sciences. C. Badgley kindly made numerous improvements to the text, and L.L. Jacobs wrote the splendid plain-language summary. We are grateful to the editors for all their help and for this opportunity to pay tribute to Will Downs. Figure 10 shows our friends Will and Qiu Zhuding enjoying a meal and pleasant company in China.

Figure 10. Dong Weilin (Will Downs) and Qiu Zhuding at dinner in China.