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ON THE CARNIVORA FROM LOCALITY 1 OF CHOUKOUTIEN

BY

PEI WEN-CHUNG

PLATES I-XXIV AND 47 TEXT-FIGURES

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PALÆONTOLOGIA SINICA

On the Carnivora from Locality 1 of Choukoutien

By

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With Plates I-XXIV and 47 Text-figures

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ERRATA

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,,	44	,,	3	for rudimnary read rudimentary
,,	110	,,	18	for *avernensis* read *arvernensis*
,,	116	,,	8	for **utima** read **ultima**
,,	123	,,	22	for Charnivoren read Carnivoren
,,	154	,,	22	for Pliocone read Pliocene
,,	155	,,	19	for carvasial read carnassial

ON THE CARNIVORA FROM LOCALITY 1 OF CHOUKOUTIEN

By Pei Wen-chung

INTRODUCTION

The material described in the present Memoir has been obtained in the course of the excavations made by the Cenozoic Research Laboratory of the Geological Survey of China in the *Sinanthropus* site, or Locality 1, of the Choukoutien fossiliferous deposits, during the years of 1927-1933. The collections of 1932 and 1933 are not yet entirely unpacked, but according to my field examination, only a few specimens of the Carnivora group would require a special examination. One half, at least, of Locality 1 deposits is still untouched and will be excavated in the coming years. If, as it has to be expected, this further work leads to supplementary discoveries, these will be described in a subsequent fascicle of the same series in Palæontologia Sinica.

Closely associated topographically with the Locality 1 are the so-called stalagmitic "Cap" preserved on the top of the Choukoutien hill a little south of the *Sinanthropus* site, and the loess-like deposit filling the "Upper Cave", above Locality 1 itself.[1] Both have been excavated by me in 1930, 1931, 1933 and found to be fossiliferous. Because the fossils from the "Cap" are possibly of the same age as those collected in the Main Deposits, their description has been given here (*vide infra*). The fossils from the Upper Cave, on the contrary, because they look much younger geologically, will be studied later.

The geological age of the Locality 1 deposits, and more generally of the entire Choukoutien formation proper, is actually regarded as Lower Pleistocene (Upper Polycene of Dr. Grabau[2]) as a whole, because no substantial faunistic change has been detected so far between

1 vide Black, Teilhard, Young and Pei, 1933.

2 In the present paper we keep the way of calling the Choukoutien formation "Upper Polycene" as in Young's Memoir on the Artiodactyles. But we must observe that this usage is somewhat questionable; for in Dr. Grabau's views, the Polycene should end at the beginning of the European glaciations, that is, should not be extended above the English Forest Beds. But, so far, it is not possible to prove that the Choukoutien beds do not correspond to some later times; and we suspect that they might even correspond with the Mindel glacial or Mindel-Riss interglacial period of Europe (Black, Teilhard, Young and Pei, 1933).

the base and the top of the sediments. Such changes, however, have to be expected, and even are suspected, on the basis of possible evolution to be observed in the cultural levels. For this reason, special attention has been given here in reporting the exact levels from which the described fossils have been collected. The classification of the stratigraphical layers for Locality 1 is the one already elucidated in several earlier publications (vide Teilhard and Young, 1929, and Black, Teilhard, etc., 1933).

The fossiliferous deposits of Choukoutien were discovered in 1921 by Dr. J. G. Andersson of Sweden, who was then undertaking an extensive research work on the Cenozoic in North China. In the following year Dr. Otto Zdansky started excavating the site of Locality 1 and brought a large amount of mammalian fossils to the Palæontological Laboratory of Upsala. Six years later his elaborate work on the Choukoutien mammalian fauna was published,[1] but in this monograph only eight forms of Carnivora were recorded.

Since 1927 a systematic study and excavation of the site has been carried on by the Cenozoic Laboratory of the Geological Survey of China. During these five years the number of the collected fossils has been greatly increased. In the Carnivora group alone, 21 new forms unknown or not determined by Dr. Zdansky have been gradually discovered. And the others, which were already known, are now represented by much better specimens allowing a better determination. Determining the new type and revising the old ones is the task undertaken here. The necessity of this study will be readily appreciated by the mere inspection of the following table giving the complete list of the Carnivora actually recognized in the locality compared with the form known and named by Dr. Zdansky.

Fossil Carnivora actually recognized in Locality 1.	Determination by Zdansky in 1928.
Canis lupus L.	X
Canis lupus var. *variabilis* Pei (var. nov.)	*Canis* cf. *dingo* Blumenb.
Canis cyonoides Pei (sp. nov.)	X
Canis (*Nyctereutes*) *sinensis* Schlosser	X
Vulpes cf. *vulgaris* L.	X
Vulpes cf. *corsac.* Pallas	X
Cyon alpinus Pallas	X
Canidae indet	X

1 vide Zdansky, 1928.

Fossil Carnivora actually recognized in Locality 1.	Determination by Zdansky in 1928.
Ursus angustidens Zdansky	*Ursus angustidens* Zdansky
Ursus arctos L.	*Ursus arctos* L.
Ursus spelæus Blumenb. var.	X
?*Ailuropus*	X
Meles leucurus Hodgson	X
Mustela cf. *sibirica* Pallas	X
Mustela sp.	X
Gulo sp.	X
Lutra melina Pei (sp. nov.)	X
Hyæna ultima Matsumoto	X
Hyæna sinensis Owen	*Hyæna sinensis* Owen
Hyæna zdanskyi Pei (sp. nov.)	X
Machairodus sp. Zdansky	*Machairodus* sp.
Felis cf. *tigris* L.	X
Felis youngi Pei (sp. nov.)	X
Felis cf. *pardus* L.	*Felis acutidens* Zdansky
Felis sp. 1.	X
Felis teilhardi Pei (sp. nov.)	X
Felis sp. 2.	X
Felis cf. *microtis* M.-Edwards	*Felis* sp.
Cynailurus sp.	?*Felis* sp.

For the completion of the present work I am much indebted to a number of friends, and I wish to express to them my warmest thanks.

To P. Teilhard de Chardin for the personal assistance he gives me with his wide knowledge on the Cenozoic geology. To Dr. W. H. Wong, the Director of the Survey, for entrusting me with the field work of Choukoutien since 1929 and for asking me to describe a part of the collected material. To Dr. Davidson Black, the Director of the Cenozoic Laboratory, for having kindly and constantly directed me both in the field and in the Laboratory. To my Professors A. W. Grabau and J. S. Lee for the fundamental training I received from them in geology and palæontology. To Dr. V. K. Ting for his repeated encourage-

ment and advice. To Dr. C. C. Young, my associate and friend in the field and in the Laboratory for constant help. To Dr. B. Bohlin and to Mr. M. N. Bien, my field collaborators, for their aid in collecting the materials.

To Dr. W. Granger of the American Museum of Natural History and to P. E. Licent of the Musee de Huangho et Peiho in Tientsin for their kindness in giving me access to their valuable collections.

For the preparation of the specimens and the printing of my manuscript, as well as for the sketches and the photographic plates of this Memoir, I have been also greatly helped by Mrs. O. H. Gowen of the Department of Anatomy of P.U.M.C.; by Mr. T. C. Chow of the Survey; by Mr. L. P. Chia of the Cenozoic Laboratory; by Messrs. K. H. Hsu and S. C. Li of the Survey; by the Photographic Bureau of the P.U.M.C.; and by Mr. S. Y. Wang, artist of the Geological Survey. To all of them I wish to acknowledge my sincerest gratitude.

DESCRIPTION OF SPECIES

Order **CARNIVORA** Gray

Family **CANIDÆ** Gray

Sub-family **CANINÆ**

Genus **CANIS** L.

Canis lupus L.

Pl. I, Fig. 1.

This species of *Canis* rather uncommon in the Choukoutien deposit, is represented by three incomplete skulls, a broken upper jaw with P^3—M^2, six broken mandibles with more or less number of teeth, ten isolated M^1 and nine isolated M_1.

DESCRIPTION

Skull.

Although partly broken, either posteriorly or anteriorly (Pl. I, Fig. 1) the collected skulls can be fairly well studied. Compared with the living *Canis lupus* L. from Manchuria and Mongolia they look slightly smaller. Otherwise the cranial characters are exactly the same and therefore do not need any special description.

Upper teeth.

P^1—P^2, entirely wolf-like.

P^4 (upper carnassial), distinctly longer than M^1+M^2. Antero-external corner of the protocone of the tooth protracted forwards. Deuterocone rather anterior in its position. Frontal border strongly concave. The three latter characters are not observed on the wolf of Mongolia and Manchuria used for comparison, but judging from Miller's figure (Miller, 1912, p. 310, Fig. 61) they occur on the European wolf.

COMPARATIVE MEASUREMENTS (in mm.)

	Canis lupus L.					*Canis chihliensis* Zdansky			
	Recent			Fossil from Choukoutien					
	Europe[1]	Manchuria[2]	Mongolia[3]	Skull (Pl. I Fig. 1)	Skull	Nihowan (form typique)[5]			Huailaihsien[7]
P^4 length	24.0	24.0	24.4	23.8	-	22.0	23.0	24.0	23.9
breadth	11.0	9.8	10.0	9.5	-	7.0	8.0	7.0	13.8
M^1 length	16.5	16.0	15.2	14.8	15.3	15.0	15.0	15.0	16.6
breadth	20.0	19.1	17.5	18.2	19.5	19.0	20.0	19.0	22.0
M^2 length	8.5	9.0	9.0	9.1	8.8	8.0	8.0	8.0	9.4
breadth	14.5	12.5	11.2	12.2	12.0	12.0	11.0	12.0	15.1
M_1 length	26.0	26.9	26.3	26.3[4]	25.7[6]	23.0	27.0	25.0	-
breadth	10.5	10.5	11.0	10.2	9.6	-	-	-	-
M_2 length	12.0	11.8	10.5	11.5	10.5	10.0	13.0	11.0	-
breadth	7.5	9.0	8.2	8.3	7.6	-	-	-	-
M_3 length	5.0	5.0	5.4	-	-	-	-	-	-
breadth	5.0	5.0	5.4	-	-	-	-	-	-

1 After Mivart (Mivart 1890, p. 17).

2 Cat. No. 454

3 Cat. No. $\frac{C}{O.3}$

4 Specimen 30:8:6

5 Specimen 1929: m4.

6 After Teilhard and Piveteau (Teilhard and Piveteau 1930, p. 36).

7 After Zdansky (Zdansky 1924, P. 11).

M^1, slightly variable in shape and in size. The metacone is smaller and lower than the paracone. Protoconule well developed with the exception of two specimens in which it is rudimentary. Metaconule prominent. Hypoconal ridge well formed and never distinctly subdivided by a furrow.

M^2, of a common wolf type, except that the metacone is almost as large as the paracone.

Lower teeth.

Premolars (P_1—P_2) of a common wolf type. P_4 is relatively short and thick; a useful, differential character from *Canis cyonoides* Pei (*vide infra*).

M_1 (lower carnassial), very constant in size and in character. Shape not specially elongated. The endoconid, though smaller than the hypoconid, is well developed in comparison with *Canis cyonoides*. A small accessory cusp (hypoconulid) is occasionally developed between the metaconid and the endoconid.

M_2, slightly elongated in shape and with three distinct cusps.

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien; Layers: 5, 9 (Carnivora layer) and Lower Cave. Cat. Nos. C. L. G. S. C. $\frac{C}{C1498}$ $\frac{C}{C1525}$.

COMPARISON

As observed above, the here described form is hardly distinguishable from the living *C. lupus* of North China, Manchuria, and Mongolia. The slight differences, observed in the shape of its upper carnassial and molars, and its rather small size do not seem to reach the grade of a specific distinction. From *Canis lupus* var. *variabilis* Pei (*vide infra* pp. 13-18) it differs by a decidedly larger size; and from *C. cyonoides* Pei (*vide infra*, pp. 18-21) it can be separated by a series of clear features: premolars more elongated; metaconid stronger and heel less cutting at M_1; M_2 more elongated; metaconule larger at M^1, etc.

Within the Choukoutien area, all the *Canis* remains so far collected outside of Locality 1, e.g. in Localities 6, 3 and 9, have to be referred not to this typical wolf, but to its variety *variabilis*.

In North China, the genus *Canis* is probably not recorded, so far, before the Nihowan times, since *C. antonii* Zdansky and *C. chihliensis* Zdansky seem to have been found not in

the true *Hipparion* red clay, but in Sanmenian deposits (vide Zdansky 1924). *C. antonii* is a very special type, characterized by a quadratic shape of M^1 and a relatively large M^2. In the type specimen of *C. chihliensis* which was collected in Huailaihsien, not far from Nihowan, the carnassial seems to be shorter, as compared with M^1+M^2, and M^2 is larger and transversely more elongated than in a true wolf (vide measurements on p. 11). The dogs described under the same name (*C. chihliensis*) from Nihowan by Teilhard and Piveteau are, on the contrary, very much wolf-like and possibly identical with *C. lupus variabilis* of Choukoutien (*vide infra*).

A true wolf occurs in the Upper Pleistocene (Sjara-osso-gol sands) of Ordos (vide Boule and Teilhard, 1928).

Canis lupus var. **variabilis** Pei (var. nov.)

Pl. I, Figs. 2-4, Plate II, Figs. 1, 3 and 4.

1928 *Canis* sp. cfr. *dingo* Blumenb., Zdansky. Die Säugetiere der Quartärfauna von Choukoutien. Palæontologia Sinica, Ser. C, Vol. V, Fasc. 4, pp. 27-30, Taf. I, figs. 59 and 60; Taf. II, figs. 1 and 2, 1928.

1930 *Canis* sp. Young. On the mammalian remains from Chikushan, near Choukoutien. Palæontologia Sinica, Ser. C, Vol. VII, Fasc. 1, pp. 7 and 8, Pl. I, figs. 1 and 2, 1930.

Nyctereutes being excepted, the present form is the most common type of dog found in the *Sinanthropus* site at Choukoutien. No less than eight partly broken skulls, 37 broken maxillæ, 198 mandibles and numerous isolated teeth and skeletal bones are present in our collection.

DESCRIPTION

Skull.

The skull differs from the correspondent part of a common wolf by the following characters: size smaller (about 175.0 mm for the total length of the skull[1]), muzzle more slender; sagittal crest weak or absent.

Upper Teeth.

In spite of the relatively small size of the skull, the upper teeth (I^1—M^2) are scarcely smaller than in a living Manchurian wolf. P^3, rather simple, with a singular posterior accessory cusp. P^4 (upper carnassial) rather elongated. For 63 specimens its length ranges between

1 Specimen K16:29:8 which is one of the largest in our collection.

22 and 24 mm and its breadth between 10 and 8 mm, the ratio length-breadth ranging from 2.4 to 2.07. Deuterocone weak or distinct, and situated anteriorly, or posteriorly, or on the same level with the protocone. Antero-external corner of the protocone sometimes projecting anteriorly and sometimes gently rounded. M^1, variable both for the general shape (small and narrow, or on the contrary large and expanded, vide Pl. I, figs. 2-4,) and for the characters of the cusps: metaconule strong (Pl. I, fig. 2) or indistinct (Pl. I, fig. 4); hypocone not (Pl. I, fig. 2) or slightly subdivided (Pl. I, fig. 4). But these differences occur irregularly and independently so that they are apparently individual. Two specimens however show more divergent features: metaconule very indistinct, paraconule absent, hypocone subdivided into two parts. But since they are right and left maxillæ found from the same level (Carnivora Layer) they belong possibly to the same but abnormal individual. M^2, variable in shape: either elongated 11.5×7.2 mm, vide Pl. I, figs. 1 and 2) or quadratic (10.6×8.4 mm, vide Pl. I, fig. 3)— its posterior border being as usual variably shortened or excavated (vide Pl. I, fig. 4).

Lower Teeth.

As it is generally the case in Canidæ, the lower premolars of this form have or have no posterior accessory cusp (metastylid). For instance, on 17 lower jaws the cases are as follows: no posterior accessory cusp on P_2 nor on P_3, 5 specimens; posterior accessory cusp on both P_2 and P_3, 3 specimens; posterior cusp present on P_3 but absent on P_2, 12 specimens.

M_1 (lower carnassial) as in a wolf. The size, taken on 50 specimens, varies from 21.0 ×8.5 mm to 25.0×9.3 mm. Accessory cusp between metaconid and endoconid present or absent. Hypoconulid weak or absent.

M_2, with trace of the trigonid but generally without a distinct endoconid (a trace of it is only recognizable on 12 out of 59 observed specimens). Shape more or less rounded or elongated. The dimensions of the rounded type vary from 9.0×7.3 mm to 10.2×8.2 mm for 10 specimens observed; and the dimensions of the elongated type from 9.6×6.4 mm to 11.4 ×7.5 mm for 32 specimens.

M_3, much reduced. A single main cusp generally prominent, followed by a weak posterior cusp on a few specimens.

Shape of the lower jaw.

As clearly expressed by the table below (p. 17) the mandible is much shorter than in a wolf. Two types are recognizable: a shorter one with crowded premolars; and a longer one

with well spaced anterior premolars. A rather long diastema between P_2 and P_3 is however rather constant and possibly characteristic of this form (vide Pl. II, figs. 3 and 4).

The lower border of the mandibular bone generally is slightly concave. But of some specimens it is strongly convex as in a dog (Fig. 1, A). In the case of an old individual, the ramus becomes thicker along the alveolar border; but its shape remains essentially the same (Fig. 1, C).

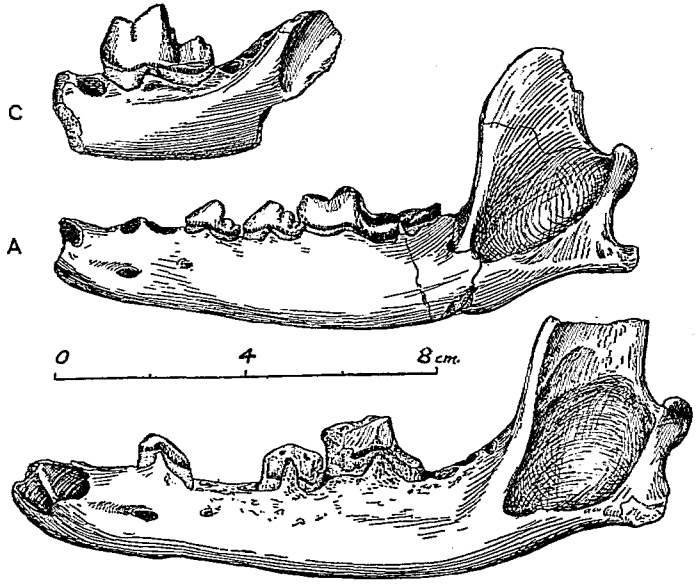

Fig. 1. Mandibles of *Canis lupus* var. *variabilis* Pei (var. nov.). × 1/1.
A, with the curved lower border of mandible;
B, with teeth greatly worn down;
C, with the mandibular bone shallow and thick.

An interesting fact noticeable on the jaws belonging to old individuals is a peculiar wearing-down of the whole tooth row, suggesting for this form an omnivorous diet, as in *Nyctereutes*.

In one specimen the mandibular bone is exceptionally thick and shallow (vide Fig. 1, C); but the carnassial is exactly the same as in the common type.

MEASUREMENTS (in mm)

Broken skull A.

Length from the inter-orbital region to the occiput	94.0
Interorbital breadth (minimum)	31.5
Maximum breadth of brain case	55.0
Maximum depth of brain case	54.4
Length and breadth of M^1	13.0 and 16.0

Broken skull B.

Length from I^1 to M^2	100.4
Length from I^1 to P^3	65.4
Palatal breadth between M^1	27.0
Breadth of muzzle at the middle portion of M^2	32.0
Length and breadth of P^4	20.5 and 10.4
Length and breadth of M^1	10.0 and 10.1
Length and breadth of M^2	10.0 and 7.3

Broken maxilla I.

Length from I^1 to M^2	105.5
Length from I^1 to P^3	66.0
Length and breadth of I^1	6.0 and 4.4
Length and breadth of I^2	6.3 and 6.0
Length and breadth of I^3	8.2 and 6.5
Length and breadth of C	11.0 and 7.0
Length and breadth of P^1	7.0 and 5.0
Length and breadth of P^2	13.0 and 5.1
Length and breadth of P^3	14.5 and 6.1
Length and breadth of P^4	23.0 and 11.0
Length and breadth of M^1	14.5 and 18.0
Length and breadth of M^2	8.0 and 6.4

Three broken maxillæ.

	X.	Y.	Z.
Length from I^1 to P^3	66.0	64.4	67.2

THREE MANDIBLES

	Specimen in Pl. II, figs. 4a and 4b	Specimen in Pl. II, figs. 3a and 3b	Specimen in Pl. II, figs. 1a and 1b
Length from I_2 to condyle	144.0	. . . . .	. . . . .
Length from I_2 to M_2	98.5	105.5	. . . . .
Length from C to P_4	65.0	61.0	53.5
Length and breadth of P_1	5.5 and 4.2	6.2 and 4.0	. . . . .
Length and breadth of P_2	10.5 and 5.0	11.6 and 5.0	10.4 and 6.4
Length and breadth of P_3	12.0 and 5.0	13.0 and 5.6	. . . . .
Length and breadth of P_4	13.4 and 6.2	14.8 and 6.4	13.5 and 6.0
Length and breadth of M_1	24.0 and 9.5	24.2 and 9.1	22.0 and 8.3
Length and breadth of M_2	9.8 and 7.2	11.0 and 7.6	9.3 and 6.6
Length and breadth of M_3	. . . . .	. . . . .	4.5 and 4.5

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien. Layers 3, 4, 5, 6, 7, 8, 9, Lower Cave and Kotzetang Cave. Most abundantly in Lower Cave and layers 8 and 9 (Carnivora Layer). Cat. No. C.L.G.S.C. $\frac{C}{C.\ 1638} - \frac{C}{C.1658}$.

VALIDITY OF THE NEW VARIETY AND COMPARISON

Although no sharp line can be traced between the above described *Canis* and a true *C. lupus*, the marked differences found in the size, and in the cranial characters, seem to be sufficient for creating, at least, a new variety, *Canis lupus variabilis* for the Choukoutien Locality 1 small wolf, inasmuch as (*vide supra*) the same animal occurs in Localities 6, 3, and 9.

As noted above, we also feel inclined to separate from the type of *C. chihliensis* Zdansky, the specimens from Nihowan attributed to the latter species by Teilhard and Piveteau, and to refer them to present Choukoutien form. By their strong carnassial teeth and their small size, the Nihowan wolves differ from *C. chihliensis* as described by Zdansky, but correspond closely to our *C. lupus variabilis*.[1] On the skull of the Nihowan wolf (vide Teilhard and Piveteau, 1930, Pl. XIX, fig. 1a), as in our *Canis lupus variabilis*, the sagittal crest is not very strong.

To *Canis lupus variabilis*, have possibly to be referred, in addition, the specimens described by Zdansky (vide Zdansky 1925 and 1927) from Chiamusu (Zdansky, 1927, pp. 6 and 7) and from Changchihhsien (Zdansky, 1927, p. 10).

Any close comparison with the Dingo (*Canis dingo* Blumenb.), as suggested by Zdansky, does not seem geographically probable and would be difficult to prove, since the Dingo is too much a typical dog for being racially identified by a few osteological or dental features. From the Dingo the Choukoutien form differs, in any way, by its wolf-like carnassial tooth, although some dog characters might be recognizable in the shape of skull and of the lower jaw.

Canis cyonoides Pei (sp. nov.)

Pl. I, Figs. 5 and 6; Pl. II, fig. 2.

In addition to the two above described form of *Canis lupus*, a rather exceptional type of wolf is found at Choukoutien, which we regard as a distinct species, although it is only represented in our material by the anterior part of a skull, with the lower jaw in connection (type specimen), and a small series of minor specimens: 9 fragmentary mandibles, six isolated M^1 and six isolated M_1.

DESCRIPTION

Skull and mandible (vide Fig. 2).

The skull, slightly compressed, is broken posteriorly (Fig. 2 and Pl. I, fig. 5). The right zygomatic arch, a part of the brain case, and both maxillæ (showing the right P^3—M^2

1 The Nihowan *C. chihliensis* var. *palmidens* T. and P. would correspond with our specimen shown in Fig. 3 on Pl. IV, and the Nihowan *C. chihliensis* var. *minor* T. and P. with our specimen in Fig. 1, A.

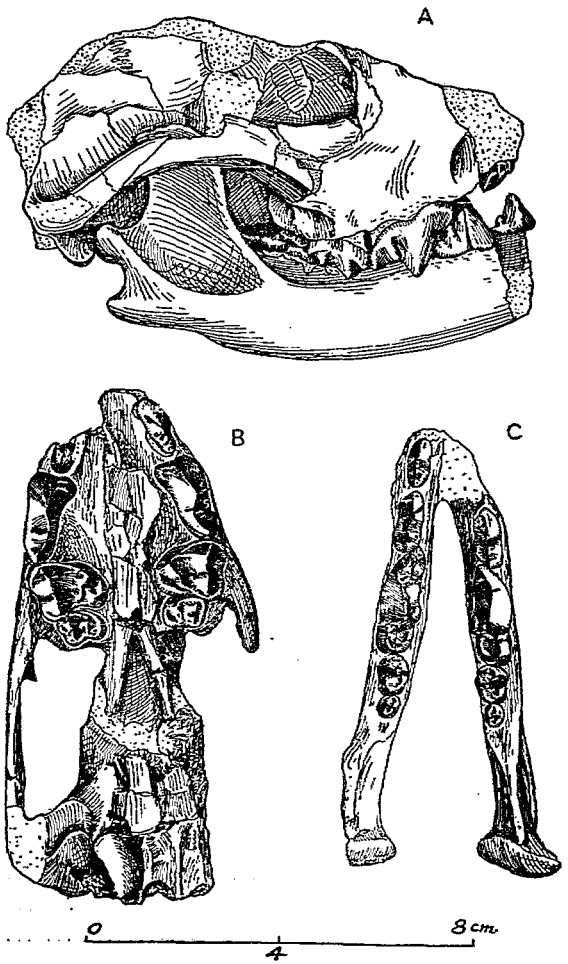

Fig. 2. *Canis cyonoides* Pei (sp. nov.), × 1/1.
A, lateral view of skull and mandible;
B, palatinal view of skull;
C, top view of mandible.

and the left P^3—M^2) are preserved. On the mandible (Fig. 2 and Pl. I, fig. 6, Pl. II, fig. 2) P_3—M_3 of right side and P_4—M_3 of left are present. Judging by the slender shape of the mandibular bone and the sharpness of the teeth, the specimen belongs to a still young, but mature, individual. This condition may partly account for the size, which in spite of the strongly built teeth, is remarkably small.

Upper Teeth.

P^3, with a strong parastyle and another small accessory posterior cusp above the cingulum.

P^4, longer than M^1+M^2. Deuterocone rudimentary and set in a rather anterior position.

M^1, with strong protocone; paraconule and metaconule remarkably weak; hypocone flat. On the type specimen and 3 isolated specimens, the cingulum is practically non-existent between the anterior part of the hypocone and the protocone.

M^2, with metacone a little smaller than the paracone and with a protocone relatively strong.

Lower Teeth.

P_3—P_4, somewhat more elongated as in *C. lupus*.

M_1, highly characteristic by the sub-trenchant shape of the heel; the hypoconid forms a prominent cutting edge and the endoconid is reduced either to an inconspicuous ridge (type specimen), or to a very weak cusp.

M_2, more rounded than in *C. lupus* of the same locality, but with a strong protoconid.

M_3, rounded and bicuspid; the side cusp is very small.

MEASUREMENT (in mm.)

Mandible (type specimen).

Length measured from P_4 to the condyle	79.0
Length measured from the hind border of M_3 to condyle	32.3
Depth of the ramus measured behind M_1	13.2
Depth of the coronoid process, measured from the highest point of the coronoid process to the lower border of the jaw bone	42.4

UPPER TEETH

Specimen	Left side of the type specimen				Isolated tooth
Tooth	P^3	P^4	M^1	M^2	M^1
Length	12.1	20.9	13.0	7.0	12.2
Breadth	5.1	7.3	15.1	9.6	14.6

LOWER TEETH

Specimen	Left side of the type specimen					Isolated tooth
Tooth	P_3	P_4	M_1	M_2	M_3	M_1
Length	11.0	12.5	23.2	9.0	4.8	21.0
Breadth	5.0	6.0	8.5	6.7	4.4	7.8

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien. The type specimen was collected from the Lower Cave; and the isolated teeth were partly found in Layer 9 (or *Sinanthropus* Locus C) and partly in Lower Cave. Cat. No. C.L.G.S.C. $\frac{C}{C.\ 1526}$ — $\frac{C}{C.\ 1535}$.

COMPARISON

As expressed by its specific name, *C. cyonoides*, the here described *Canis*, although clearly distinct from a *Cyon* by its dental formula (M_3 present), the preservation of an endoconid on M_1, and the size of the hypocone on M^1, shows a distinct convergency to the *Cyon* type by the cutting shape of the heel of lower carnassial, the reduction of the metaconule and the cingulum on M^1, and the highly trenchant general shape of the teeth.

For the same reasons, it stands clearly apart from any living or fossil wolves known in China.

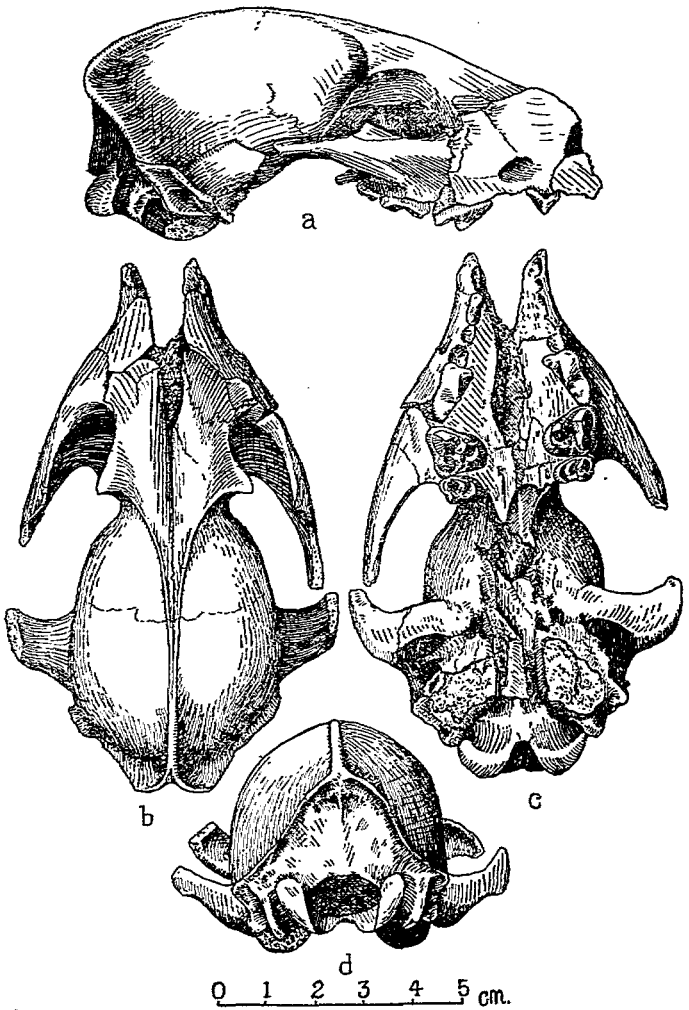

Fig. 3. Four views of a skull of *Canis* (*Nyctereutes*) *sinensis* Schlosser, × 1/1.

Canis (Nyctereutes) sinensis Schlosser

Pl. III, figs. 1, 2, 4, 5, 6, 8 and 10; Pl. IV, figs. 1-3.

1903 *Vulpes sinensis* Schlosser. Die fossilen Säugetiere Chinas nebst einer Odontographie der recenten Antilopen. Abhandl. Bayer. Akad. Wiss. München, Bd. XXII, pp. 24-25, Taf. I, fig. 6.

1927 ?*Vulpes sinensis* Schlosser, Zdansky. Weitere Bemerkungen über fossile Carnivoren aus China. Palæontologia Sinica, Ser. C, Vol. IV, Fasc. 4, pp. 8-10, Taf. 1, figs. 8-9.

1930 *Canis* (*Nyctereutes*) *sinensis* Schlosser, Teilhard and Piveteau. Les mammiferes fossiles de Nihowan (Chine), Annales de Paléontologie, T. XIX, Paris, pp. 88-95, Pl. XVII, figs. 1-3; Pl. XVIII, figs. 2, 3, 5, et 5a.

With the exception of *Hyæna*, *Canis* (*Nyctereutes*) *sinensis* Schlosser is the most abundant Carnivora in the *Sinanthropus* site at Choukoutien. But the complete specimens are rare. A single skull is fairly complete and a few mandibles show a complete tooth row. Nevertheless, using some ten incomplete skulls and numerous fragmentary lower jaws, a complete review of the cranial and the dental characters is possible.

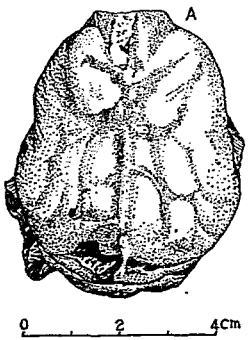

Fig. 4. Brain case of *C.* (*Nyctereutes*) *sinensis* Schlosser. × 1/1. A, supra-orbital sulcus.

DESCRIPTION

Skull.

The skull (Fig. 3 and Pl. III, fig. 1), slightly smaller than the Sanmenian Nihowan specimens (*vide infra*), is distinctly larger than in the living *C.* (*Nyctereutes*) *procyonoides* Gray. But the general shape is typically the same, including the thick and low sagittal crista, and the wrinkled surface of the parietal bones. Between the palatal incisure, the palatal bones extend

backward as far as 4.5 mm behind M^2, a very characteristic feature according to Huxley (Huxley, 1880, p. 274).

Brain case (Fig. 4) narrower and higher than, for instance, in the common fox. By this character and by the way in which the cerebral hemispheres, after expanding rapidly just behind the supra-orbital sulcus (Fig. 4, A), are tapering off posteriorly, the *Nyctereutes* have, according to Huxley (Huxley, 1880, pp. 245-248), to be separated from the Alopecoid and put into the Thooid group. The same conclusion is supported by the presence of the frontal sinus, easily observed on our specimen.

Mandible.

Amongst a series of *Canis* mandibles, a *Nyctereutes* lower jaw is immediately located by the presence of a subangular process or lobe at the posterior end of the horizontal ramus. Although always recognizable, this lobe is subject to great variation. For instance, a very strong lobe is observed on the rather small jaw 30:12:1 (Fig. 5, A, and Pl. III, fig. 5). On the contrary specimen 29:19:29:C (Fig. 5, B, and Pl. III, fig. 2) is scarcely lobated. Distinct inflections of various shapes or grades are observable along the lower mandibular border on specimens 30:24:4 (Fig. 5, C and Pl. IV, fig. 3) and 9:62:34 (Fig. 5, D and Pl. IV, fig. 2). In connection with this unequal development of the subangular lobe, the lower border of the horizontal ramus is either straight (Pl. IV, fig. 1), concave (Pl. III, figs. 4 and 5; Pl. IV, fig. 2), or convex (Pl. IV, fig. 3).

The same variations occur in C. (*Nyctereutes*) *procyonoides*, judging from Mivart's figures (Mivart, 1890), and from the specimens collected in the early historical site of Anyang (*vide infra*).

Upper Teeth.

Incisors, canines, and anterior premolars as in common *Canis*; not so slender as in *Vulpes*.

P^4 (upper carnassial), of a typical microdont type, that is distinctly shorter than $M^1 + M^2$, low crowned and massive. Deuterocone large and distinctly separated from the protocone, or small and indistinct. The cingulum and the commissure in front of the protocone are also variable without any relationship with the size of the deuterocone. When the deuterocone and the frontal cingulum are strong the contour of the tooth becomes strongly asymmetrical.

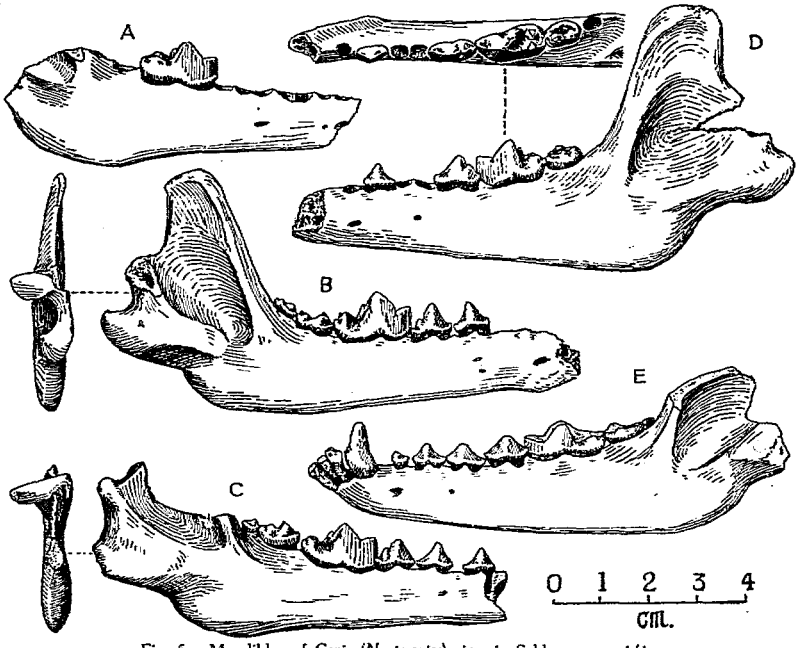

Fig. 5. Mandibles of *Canis* (*Nyctereutes*) *sinensis* Schlosser, × 1/1.

M^1 and M^2, broad, sub-quadratic (chiefly M^2) with low and complicated cusps and more or less wrinkled enamel. Two extreme types of M^1 occur:

a) *a simpler one*: paraconule and metaconule simple; hypocone non-divided; anterior cingulum on front of protocone and metacone weak (Pl. III, fig. 10).

b) *a most complex one*: paraconule ridge-like; metaconule sub-divided into two or three distinct cusps (Pl. III, fig. 8); hypocone sub-divided by one or more furrows (in an exceptional case by five furrows); anterior cingulum strong (Pl. IV, figs. 6 and 8).

Two extreme types of M^2 also occur:

a) *a simpler one*: with only four main cusps, moderately developed (Pl. III, fig. 1b).

b) *a complex one*: paraconule ridge-like, distinctly separated from protocone; metaconule well developed; protocone subdivided into 2 cusps; hypocone subdivided into three cusps (Pl. III, fig. 6).

No clear rule seems to exist connecting the complexity of the carnassial and of the molars. It seems only: 1) that the presence of large deuterocone on P^4 is generally associated with more simple molars, and *vice versa* (Pl. III, fig. 10); 2) and that the simplest M^2 are generally, but not always, associated with a simple M^1.

Considerable variation in size occurs, which is indicated below in the table of dimensions (p. 27).

Lower teeth (vide Fig. 5, p.25).

With the exception of the first premolars, which are well spaced along the alveolar border (between P_1 and P_2 the diastema may be as large as 2.5 mm), the back teeth are set very close together or even overlapping each other; a feature possibly in correlation with the shape of the jaw.

I and C, of *Canis* type.

P_1, often with a small anterior cingulum. Posterior accessory cusp (metastylid) variable on P_2—P_4.

M_1 (lower carnassial) is generally most characteristic on account of its low trigonid, strong and well separated metaconid, broad and wrinkled talonid. But these characters, just as it happens for the upper teeth, are subject to variation. For instance, so far as the outline of the crown is concerned, two extreme types can be distinguished: in the first and most common one, the tooth is relatively short and the talonid broad (Pl. III, figs. 2b, 4b, and 5b, and Pl. IV, fig. 2b); in the second and much rarer one, the tooth is elongated, and the talonid scarcely broader than the trigonid (Pl. IV, figs. 1b and 3b). On the other hand, the endoconid is generally sub-divided into 2 or 3 cusps (Pl. III, fig. 4b and 5b); but it may also be simple (Pl. IV, fig. 3b).

M_2, of the ordinary *Canis* type, but with a metaconid occasionally stronger or even subdivided into 2 and 3 cusps.

M_3, generally rounded, sometimes elliptic. The tooth can be small with a single cusp (specimen 29: C, Pl. III, fig. 2b; and fig. 5b) or larger with two distinct cusps (specimen 30:20:4, Pl. IV, fig. 3b; and fig. 5f).

No strict connection seems to exist between these several variations. In the same jaw the complication of the different teeth seems to work independently.

MEASUREMENT (in mm).

A. Measurements of 12 Upper Carnassial and Molars of *C. (Nyctereutes) sinensis* from Choukoutien

Specimen number	C. 1275	C. 1266	C. 1270	C. 1267	C. 1263	C. 1265	C. 1264	C. 1262	C. 1269	LC; 470	C. 1268	C. 1219
a. Length of P^4	14.0	14.1	12.1	13.8	12.4	12.8	13.2	13.0	13.2	13.3	13.5	12.2
b. Length of M^1+M^2 *	17.3	16.4	16.1	16.5	17.0	16.3	19.0	16.5	17.8	17.2	16.9	16.8
Width of P^4	7.2	6.0	6.3	7.4	6.8	7.0	7.5	7.0	7.1	7.1	6.3	7.1
Length of M^1	10.4	10.7	9.6	10.3	10.1	10.5	11.5	10.1	11.1	10.5	10.5	10.0
Width of M^1	11.4	12.0	10.5	12.1	11.4	11.2	12.0	10.7	11.9	11.5	10.6	11.0
Length of M^2	7.3	6.0	6.2	7.0	6.9	6.1	7.8	6.4	7.0	6.9	6.6	6.6
Width of M^2	8.3	7.4	7.0	8.0	7.6	7.3	7.9	7.6	8.1	8.2	7.0	7.3
Index $\frac{a}{b} \times 100$	80.9	85.9	75.9	83.6	72.9	78.5	69.5	78.5	74.1	77.3	79.8	72.1
Remarks on the teeth	M^1 & M^2 complicated, P^4 with small deuterocone	P^4 with deutero-cone in a forward position, M^1 com-plicated, M^2 simple	Teeth small, P^4 with large deutero-cone, M^1 and M^2 compli-cated.	P^4 with deutero-cone in a same line with pro-tocone, M^1 and M^2 simple	P^4 with large and anteriorly situated deu-terocone, M^1 and M^2 worn.	Teeth worn	Teeth worn	Teeth much worn	P^4 with large deuterocone, M^1 of inter-mediate type, M^2 simple.	P^4 with large deu-terocone, molar worn.	P^4 with deu-terocone small, but located rather forward. M^1 and M^2 simple.	Teeth worn

* Measurements taken on the teeth in the maxillæ. They are somewhat smaller than the value measured upon M^1 and M^2 separately.

B. Measurements of Upper Carnassial and Molars for *C.* (*Nyctereutes*) *sinensis* from localities other than Choukoutien and for some other allied species.

		Canis (*Nyctereutes*) *sinensis* Schlosser					*Canis* (*Nyctereutes*) *procyonoides* Gray					*Canis* (*Nyctereutes*) *megamastoides* Pomel*
		Zdansky's specimen from Honan	Specimen from Nihowan				Huxley's specimen				Mivart's specimen	
P^4	length	12.3	13	13	15	14	9.7	10	10	11	9.0	13
	breatdh	6.0	—	—	—	—	—	—	—		4.0	6.0
M^1	length	9.5	10	11	11	11	8	8	8.5	9	8.0	10.5
	breadth	10.6	—	—	—		8.2	8.6	—	9	9.0	11.5
M^2	length	6.5	7	7	8	7	5	5	5	5	5.0	7.0
	breadth	7.6	—	—	—	—	6	6	—	6	7.0	9.0
Index $\frac{P^4}{M^1+M^2}\times\frac{1}{100}$		$\frac{12.3}{9.5+6.5}\times 100=76.8$	76.5	76.5	72.2	78.9	74.6	—	—	78.5	69.2	66.6

* after Boule (1889).

C. Measurement of a skull (Pl. III, fig. 1)

Length from the level of posterior orbital processes to occiput	61.4
Length of upper tooth row (P^1 by alveolus)	47.0
Breadth, inter-orbital	23.4
Breadth of brain case (maximum)	44.6
Height of brain case	39.6
Length of P^4	13.0
Breadth of P^4	6.9
Length of M^1	10.4
Breadth of M^1	12.0
Length of M^2	6.0
Breadth of M^2	7.0

D. Measurements of some mandibles (in mm).

	C C. 1225 29:C	C C. 1228 LC:645	C C. 1227 30:20:4	C C. 1224	C C. 1229 9:62:34	C C. 1226 30:15:1	 30:12:1
Length from P_1 to condyle	—	89.3	87.2*	—	—	—	—
Length from P_1 to M_3	72.3	—	—	—	—	—	—
Length from P_1 to M_2	52.3	50.7	50.7	71.0	—	—	—
Thickness of ramus behind P_2 behind P_4 behind M_1	 6.7 8.1 8.4	 6.1 7.4 7.4	 7.0 8.1 8.2	 7.1 8.5 8.4	 5.7 6.6 6.9	 — 8.6 8.7	 6.0 7.6 8.2
Depth of ramus behind P_2 behind P_4 behind M_1	 13.0 15.0 17.4	 11.0 14.5 16.0	 12.8 14.0 16.3	 13.6 15.0 18.5	 10.0 12.0 15.0	 — — 18.8	 9.8 13.3 18.0
Length Breadth } of C Height	6.7 5.2 12.2	— — —	— — —	— — —	— — —	— — —	— — —
Length Breadth } of P_1	3.6 2.7	3.4 2.1	— —	— —	— —	— —	— —
Length Breadth } of P_2	7.1 3.2	6.2 2.8	— —	6.1 3.2	7.0 3.1	— —	— —
Length Breadth } of P_3	8.0 3.8	7.1 3.0	7.3 3.3	— —	7.5 3.4	— —	— —
Length Breadth } of P_4	10.0 5.0	8.3 4.0	9.0 4.2	9.5 4.5	9.0 4.1	— —	— —
Length Breadth } of M_1	16.3 7.0	14.2 6.3	15.4 6.5	15.2 6.5	16.2 6.3	16.5 6.9	16.0 7.2
Length Breadth } of M_2	7.9 5.8	7.4 4.4	8.3 5.5	8.0 5.3	8.3 5.0	— —	— —
Length Breadth } of M_3	3.0 2.8	— —	5.1 4.0	— —	3.6 3.2	— —	— —

* P_1 by alveolus

E. Measurements of the lower teeth for C. (*Nyctereutes*) *sinensis* from localities other than Choukoutien and for some other allied forms (in mm).

	C. (*Nyctereutes*) *sinensis*			C. (*Nyctereutes*) *procyonoides*								C. (*Nyctereutes*) *megamastoides*
	Nihowan		Zdansky 1924 Honan	Specimen from Anyang			Huxley's specimen				Mivart's specimen	
Length of P_1 to M_3	57	62	61 (?15)	42.5	41.9	42.5						
Length	15	21	?16 (?15)	12.6	12.6	12.3	11.0	12.0	12.0	12.0	11.0	13.5
Breadth	—	—	?6.5 (7)	5.0	4.8	5.0	—	—	—	—	4.0	5.5
Length	8	8	7.5	—	—	6.3	6.0	6.0	6.0	6.5	7.0	8.5
Breadth	—	—	?5.3	—	—	4.4	—	—	—	—	4.0	5.0
Length	8	8	3.3	—	—	—	3.0	—	—	3.0	2.0	4.5
Breadth	—	—	2.3	—	—	—	—	—	—	—	2.0	3.5

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien. C. (*Nyctereutes*) *sinensis* is very abundant in the Lower Cave and the Carnivora Layer. It is also found in Layers 5, 6, 7 (very rare) and in the Kotzetang Cave. Cat. No. C.L.G.S.C. $\frac{C}{C.\ 1217} - \frac{C}{C.\ 1289}$.

COMPARISONS AND HISTORY OF THE *NYCTEREUTES* GROUP

That the here described dog (*Nyctereutes*) is the same as both the ?*Vulpes sinensis* described by Zdansky in 1924 (vide Zdansky, 1924) and *Canis* (*Nyctereutes*) *sinensis* re-described in 1930 by Teilhard and Piveteau (vide Teilhard and Piveteau, 1930) from a large material collected in Nihowan by P. Licent, is quite clear. Now, that "?*Vulpes sinensis*" of Zdansky is really the same as the form originally named by Schlosser (Schlosser, 1903) from fragmentary mandibles, of uncertain stratigraphical position, on which the most decisive part, namely the subangular part of the jaw, is missing, is less certain, but practically of no importance. As in the case of several other Chinese forms first described on an insufficient material, such as *Rhinoceros sinensis* Owen, *Hyæna sinensis* Owen, etc., the present species had to be recasted and re-defined: which was done by Zdansky.

The history of the *Nyctereutes* group in China is long and continuous. The precise level from which Zdansky's specimen was collected is not clear but apparently later than the Pontian. In any case, a skull of C. (*Nyctereutes*) *sinensis* had been found in Northwest Shansi by Teilhard and Young (vide Teilhard and Young, 1931, p. 56) on the top of the Red Hipparion clays (Pontian), or at the very base of the Middle Pliocene "Reddish Clay" (*Prosiphneus intermedius* beds of Teilhard and Young, etc.). Then the species becomes very common, almost dominant, either in the Late Pliocene (Sanmenian) deposit of Nihowan or in the Early Pleistocene of Choukoutien. Its presence has also been recognized by a lower jaw in the Tangshan fissure, approximately of the same age (vide Pei, 1930 b). The Choukoutien specimens are a little smaller in average than the Nihowan ones. In later times, the size is still decreasing, gradually reaching the small features of the living C. (*Nyctereutes*) *procyonoides* Gray. Two mandibles of this reduced type were recently discovered in 1933 in the Late Palæolithic deposits ("Upper Cave") capping Locality 1 at Choukoutien[1]; and also by P. Licent in the Sjara-osso-gol sands (Late Pleistocene) of the Yulin area[2], and finally a large number of similar jaws have been unearthed by Dr. Li Chi from the early historical deposits at Anyang[3].

The East-West geographical extension of the group was formerly very great, since a species hardly distinguishable from C. *sinensis*, namely *Canis megamastoides* Pomel, is common in the Late Pliocene (Villefranchian) formation of Central France. But the type has never been recorded from South China, nor from India.

Across such a range of time and space, the morphological features of the group are remarkably constant. For instance, if we try, following Huxley and Boule, to check the various values of the index ratio $\frac{\text{Length } P^4}{\text{Length } M^1 + M^2} \times 100$, we find that for 12 specimens of the large C. *sinensis*, the index varies from 69.5 to 85.9 (vide Measurement A, p. 27) and for the small C. *procyonoides* from 69.2 (Mivart, 1890) to 78.5 (Huxley, 1889).

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1. Those mandibles of *Nyctereutes* collected in the Upper Cave of Choukoutien are decidedly smaller than in the typical *N. sinensis* occurring in the Choukoutien Formation proper.
2. Personal communication from Père E. Licent.
3. They will be described by Père Teilhard de Chardin and Dr. C. C. Young, together with the rich, queer and possibly partly imported or domesticated fauna of the same locality (Tiger, *Elephas*, Tapir, *Elaphurus*, *Hydropotes*, *Buffelus mephistopheles*, and *Rhizomys*, etc.) in a forthcoming publication.

Genus **VULPES** Oken

Vulpes cf. **corsac** L.

Pl. II, figs. 5 and 6; Pl. III, figs. 3,7,9 and 11.

Fox remains are very abundant in the Choukoutien deposits, but highly fragmentary: about 15 maxillæ, 120 more or less incomplete mandibles, several hundreds of isolated teeth and many skeletal bones, but no skull. A few of these specimens seem to be referable to the common fox (*Vulpes vulgaris*) and are described below. But the most part belongs to a smaller and more slender type, which waiting for further data, we shall place in the Corsac group.

DESCRIPTION

Upper Teeth.

P^1 — P^3, of a common fox type.

P^4, elongated, with deuterocone always well developed and situated a little anteriorly to the protocone.

M^1 and M^2, smaller than in *V. vulgaris*, transversally elongated, and constricted in their median portion.

Lower Jaw and Teeth.

The lower jaw can be chiefly characterized by its slenderness. The horizontal ramus is distinctly less deep and less thick than in *V. vulgaris*, although deeper and thicker than in *V. chikushanensis* Young (*vide infra*). Lower border gently concave. Condyle situated at the same level as (or even at a lower level than) the tooth row.

Lower premolars of a common dog type. Metastylid sometimes present, but weak on P_3; constant and strong on P_4. On some specimens P_4 shows a somewhat posteriorly expanded heel, or an accessory cusp over the cingulum.

Length of M_1 varying between 13 to 15 mm. Accessory cusp (hypoconulid) between hypoconid and endoconid never distinct. Accessory cusp (endoconulid) between metaconid and endoconid found on about one third of the specimens. Both those latter characters seem to be variable and insufficient for distinguishing either the genus *Vulpes* from the genus *Canis*, either the *Vulpes* specifically.

M_2 and M_3 rather variable. The M_2 preserving a distinct metaconid are more regularly associated with a two cuspid, than with a single cuspid, M_2.

DP_4, observable on a specimen (Pl. III, fig. 7) differs from a permanent carnassial, as generally in Canidæ, by a stronger metaconid and a more narrow talonid. The dimensions, compared with the DP_4 of a wolf and a domestic dog, are as follows:

	Vulpes cf. *corsac* L. Fossil from Locality 1 of Choukoutien	*Canis familiaris* L.	*Canis lupus* L.*
Total length	9.3 mm	11.0 mm	—
Length of Prd. measured from outside	2.0 mm	2.2 mm	3.0 mm
Length of Prd	4.0 mm	5.5 mm	6.1 mm
Length of talonid	3.4 mm	4.5 mm	4.4 mm
Maximum width	3.3 mm	4.2 mm	4.9 mm

MEASUREMENTS

Measurement (A)

(Broken maxillæ, in mm.)

Specimen		29:9:6:4	9.17:1	2C/10
P^1	Length	—	—	4.4
	Breadth	—	—	2.4
P^2	Length	—	—	7.3
	Breadth	—	—	3.0
P^3	Length	8.8	—	8.0
	Breadth	3.0	—	3.0
P^4	Length	13.0	—	12.0
	Breadth	6.1	—	5.1
M^1	Length	9.1	9.1	8.1
	Breadth	10.8	10.4	9.6
M^2	Length	5.4	5.2	5.1
	Breadth	6.8	6.6	6.4
Index $\frac{P^4}{M^1 + M^2} \times 100$		89.6	—	90.9

Measurement (B)

(isolated M^1, in mm.)

Specimen	9:1:6	1	2	9:1:1	C2/10	9.17.1	29.9:6:4
Length	8.8	9.0	8.4	8.0	8.0	8.0	8.7
Breadth	11.1	11.2	11.0	10.2	10.3	10.0	10.6
Specimen	3	2:1:1	30:33	9:5:13	a		
Length	8.6	7.8	7.5	8.4	8.5	8.1	
Breadth	10.9	10.8	10.6	10.9	10.9	10.5	

* Cat. No. $\frac{C}{C.\ 48}$

Measurement (C)
(lower teeth, in mm.)

	(a)	9.1.5	26:2	9:15:1	30:1:1:	9.4:7	27.9:15:1	9:29:1	193	(X)	3:1:1
Length from M_3 to I_1	66.6	—	—	—	—	—	—	—	—	—	—
Length from M_3 to P_1	51.5	51.8	—	—	—	—	—	—	—	—	—
P_1 length breadth	4.0 2.2	4.0 2.2	— —	— —	— —	— —	— —	— —	— —	— —	— —
P_2 length breadth	7.8 3.0	7.8 2.8	— —	7.6 3.0	— —	— —	— —	— —	— —	— —	— —
P_3 length breadth	8.3 2.6	8.3 2.9	9.0 —	8.3 3.0	8.6 3.0	8.6 3.1	— —	— —	— —	— —	— —
P_4 length breadth	9.0 3.5	8.5 3.5	9.4 3.8	8.8 3.5	9.0 3.3	— —	— —	— —	— —	— —	— —
M_1 length breadth	15.0 5.1	15.0 5.1	13.8 5.3	14.1 5.3	13.6 5.2	13.5 5.1	14.1 5.2	13.5 5.5	13.0 5.0	13.2 5.1	13.0 5.1
M_2 length breadth	6.8 5.0	6.3 4.8	6.4 4.9	6.8 5.0	5.1 4.2	6.5 4.6	6.2 4.5	— —	— —	— —	— —
M_3 length breadth	2.8 2.6	3.0 2.6	— —	3.4 3.0	— —	— —	2.6 2.8	— —	— —	— —	— —

Measurement (D)

(Comparative measurements of the mandibular bone of some species of *Vulpes* and of *Nyctereutes sinensis*, in mm.)

	V. chikushanensis from Locality 6 of Choukoutien.				*Vulpes vulgaris* recent from Europe	*Vulpes vulgaris* fossil from Locality 3 of Choukoutien	*Vulpes* cf. *vulgaris* fossil from Locality 1 of Choukoutien				*Vulpes corsac* recent from Mongolia	*Vulpes* cf. *corsac* fossil from Locality 1 of Choukoutien			*Canis (Nyctereutes) sinensis* fossil from Locality of Choukoutien (p. 23).			
	A.	B.	C.	D.	Cat. No. 137.		9.17.1	9:1:3	9:25:9	FFFSDC		9.1.5	(a)	9.15.1	C C.1229	C C.1228	C C.1227	C C.1224
Height of mandible behind P_2	8.6	8.0	—	—	11.6	11.3	11.9	11.2	11.3	—	10.0	11.2	10.2	11.0	10.0	11.0	12.8	13.6
behind P_4	10.3	10.4	11.2	10.6	13.3	14.4	13.4	13.2	12.7	13.2	11.3	11.5	11.2	11.7	15.0	16.0	16.3	18.5
Width of mandible behind P_3	3.8	4.3	—	—	5.6	5.6	—	6.1	5.5	—	5.1	5.4	5.1	5.8	5.7	6.1	7.0	7.1
behind P_1	3.7	4.7	5.2	5.6	6.1	6.5	6.4	6.5	5.4	7.5	5.1	5.5	5.4	6.0	6.9	7.4	8.2	8.4

HORIZON AND LOCALITY: Upper Polycene of the *Sinanthropus* site at Choukoutien; Layers 3, 5, and 6; especially abundant in the Carnivora Layer and in the Lower Cave. Cat. No. C. L. G. S. C. $\frac{C}{C.\ 1442}$ to $\frac{C}{C.\ 1487}$.

COMPARISON

In the absence of any skull, the attribution of the here described fossil fox to the Corsac group is somewhat dubious. For instance, in the case of two specimens (vide Measurement A, p.33) the index $\frac{\text{Length P}}{\text{Length M}^1+\text{M}^2} \times 100$ is 89.6 and 90.9, a value close to the number found by Mivart for the Corsac (Mivart, 1890) but slightly different from the Huxley's observation $\frac{11 \times 100}{7+4} = 100$ (vide Huxley, 1889). In any case, the form is distinctly smaller than a common fox. It would stand closer to *V. lagopus* L; but in the latter form, the mandibular bone is deeper and the molars more slender and more "pricky".

Now, compared with the fossil foxes of China, the Locality 1 *V. cf. corsac* seems, rather unexpectedly, to differ specifically from the small *V. chikushanensis* Young, the large brained and slender muzzled form, so abundantly found in Locality 6 (Chikushan) of the same Choukoutien region. At least the lower jaws of fox found in Locality 1 are never so slender as the jaws obtained from Locality 6.

As other fossil *Vulpes* recorded in China we can mention:

a) A broken mandible from Chiamusu (Zdansky, 1927, p. 7, figs. 6 and 7, Pl. I), not so slender as our Choukoutien specimens.

b) Another jaw (Zdansky, 1927, p. 12, Pl. I, figs. 12 and 5 and Zdansky, 1925, p. 6) distinctly larger and probably referable to *V. vulgaris*.

c) The specimen collected by E. Licent in Nihowan beds (Teilhard and Piveteau, 1930) probably identical with *V. chikushanensis* (cf. Young, 1930, p. 13).

No traces of fossil *Vulpes* are known so far from any pre-Sanmenian deposit. A closer comparison should be interesting with the small "preglacial" fox from Central Europe described by Kormes (1932).

OBSERVATION OF THE CORSAC SKULLS IN THE "UPPER CAVE" OF LOCALITY 1

In the gray sediments of a post-Choukoutien age filling, what we have called the "Upper Cave" of Locality 1, have been found several skulls of a small fox which can be referred to *V. corsac* for the two following characters: size smaller than the common fox; nasal bones not overlapping posteriorly the maxilla (a character for *V. corsac* according to Mivart,

1890). Judging by their association with *Hyæna ultima* and a Palæolithic looking industry those remains would be of a Late Pleistocene (Loessic) age.

Vulpes cf. **vulgaris** L.

To the common fox, or its Chinese equivalent, we refer a small series of specimens, such as one broken maxilla with P^4 and M^1, and 15 more or less fragmentary mandibles. They differ by several features from the above described *V.* cf. *corsac*: 1) mandibular bone much thicker and deeper (*vide supra*, Measurement D. p.35); 2) lower carnassial larger; 3) upper teeth longer and chiefly broader in the medium portion than the longest ones of *V.* cf. *corsac*.

On M^1, the paraconule (present in *C. sinensis*) is absent; but the hypocone is subdivided into two faint cusps by a deeper furrow (as often in *C. sinensis*). The length of M_1 is rarely under 15 mm.

MEASUREMENTS

A. Comparative Measurements of Upper Teeth (in mm.)

	V. cf. *vulgaris* from Locality 1 of Choukoutien	*V.* cf. *corsac*[1] from Locality 1 of Choukoutien	*V. chikushanensis*[2] from Locality 6 of Choukoutien		*V. vulgaris*[3]	*V. lagopus*[4]	*V. corsac*[4]
			A.	B.			
P^4 length	13.2	13.0	12.0	12.0	13.2	13.0	12.0
P^4 breadth	7.5	6.1	5.0	5.0	7.0	6.5	6.0
M^1 length	9.6	9.1	8.0	8.0	9.5	9.0	8.0
M^1 breadth	11.3	10.8	9.0	10.0	11.5	12.0	10.0

1 *Vide supra*, p. 33, Measurement A.

2 After Young (1930, p. 10).

3 Cat. No. 137.

4 After Mivart.

B. Measurements of Lower Teeth (in mm.)

Specimen	9:1:3	9:17.1	1930	30:8:7	9:1:1	FFF SDC	9:25:9
Length of M_3-P_1	—	—	—	—	—	—	56.0*
P_1 length	—	—	—	—	—	—	4.0
P_1 breadth	—	—	—	—	—	—	2.3
P_2 length	8.0	—	—	—	—	—	8.3
P_2 breadth	3.1	—	—	—	—	—	3.0
P_3 length	9.3	8.5	—	—	—	—	—
P_3 breadth	3.6	3.0	—	—	—	—	—
P_4 length	9.6	9.1	9.4	9.1	—	—	—
P_4 breadth	4.2	4.1	4.1	4.2	—	—	—
M_1 length	15.8	15.6	15.6	15.5	15.2	16.2	15.3
M_1 breadth	5.6	5.5	5.5	5.8	5.7	6.1	5.7
M_2 length	—	7.0	7.0	6.3	7.0	—	—
M_2 breadth	—	5.3	5.2	4.6	5.2	—	—
M_3 length	—	—	—	—	—	—	—
M_3 breadth	—	—	—	—	—	—	—

* by alveolus.

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site or Locality 1 of Choukoutien deposits, Lower Cave and Carnivora Layer. Cat. No. C.L.G.S.C. $\frac{C}{C.1427}$ to $\frac{C}{C.1441}$.

SUMMARY

Within the Choukoutien area, fox remains are known from three localities, namely, Locality 1, Locality 3 and Locality 6. The fossil *Vulpes* from the Locality 1 are referable to two species, *V. corsac* and *V. vulgaris*. The fox from Locality 6, *V. chikushanensis* Young, differs from the two other forms in the following characters: skull small, but with a broad braincase, and a lyrated sagittal crista; muzzle, mandible, and teeth slender.

Several skulls, found in Locality 3, show the following characters: skull longer than in *V. chikushanensis*, with moderately broad brain case; mandibular bone deeper; teeth larger. Size larger than in *V. corsac*. Nasal bones overlapping the posterior end of the maxilla (Mivart, 1890). We refer this form to the *V. vulgaris*.

Genus **CYON (CUON)** Hodgson

Cyon (Cuon) cf. **alpinus** Pallas

Pl. IV, Figs. 4-9.

This interesting genus is only represented in the Choukoutien deposit by a few broken upper and lower jaws, and some isolated teeth, all of them found in the *Sinanthropus* site or Locality 1.

In common, those pieces show as fundamental and generic characters: 1) the small size of the deuterocone on P^4; 2) the absence of a distinct hypocone on the upper molars; 3) the

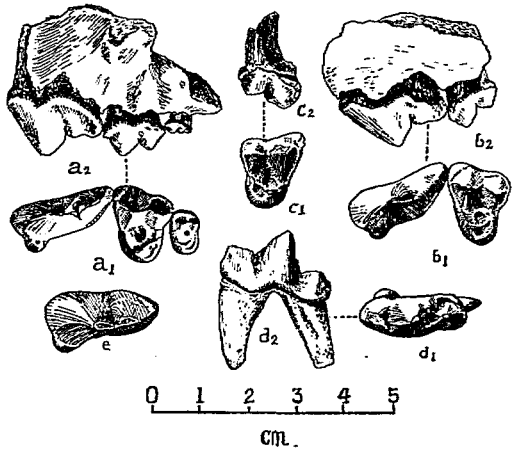

Fig. 6. *Cyon* cf. *alpinus* Pallas, × 1/1.
a, P^3—M^2; d, M_1;
b, P^4 and M^1; e, P^3.
c, M^1;

reduction of the metaconid, the absence of the endoconid and the enlargement of the hypoconid on M_1. But we have no specimen sufficiently preserved for demonstrating the absence of M_3—the most characteristic feature for the genus *Cyon*.

Studied more in detail, our specimens show a rather large range of variation. Tentatively they can be distributed into three groups:

Group I—1 broken maxilla with P^4—M^1 (specimens A, Pl. IV, fig. 6); a broken mandible with P_4 and M_1 (specimen B, Pl. IV, fig. 4); two isolated M_1 (specimens C and D, fig. 6).

Group II—1 broken maxilla with P^4 and M^1 (specimen E, Pl. IV, fig. 7); one M^1 (specimen F); one M^3 (specimen G); a broken mandible (specimen H, Pl. IV, fig. 5); and one M_1 (specimen I).

Group III—2 isolated teeth: one P^4 (specimen J, Pl. IV, fig. 9) and one M_1 (specimen K, Pl. IV, fig. 8).

DESCRIPTION

Group I.

P^4—slightly longer than the specimens of *C. alpinus* described by Mivart (Mivart, 1890) and Boule (Boule, 1926) and relatively slender; deuterocone distinct, set slightly behind the frontal border of the tooth. Total length: medial breadth=22:7.5=2.93.

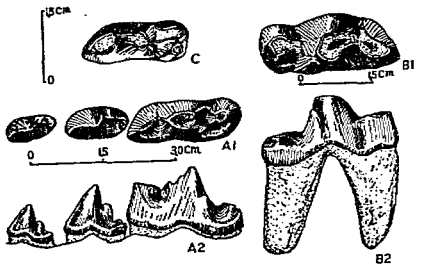

Fig. 7. *Cyon* cf. *alpinus* Pallas, and *Canis lupus variabilis* × 1/1.
A, P_3—M_1, *Cyon* cf. *alpinus*;
B, M_1, *Cyon* cf. *alpinus*;
C, crown view of M_1 of *Canis lupus variabilis*.

M^1—larger than the specimen described by Boule, but shorter than in the Mivart's specimen; cingulum ridge (hypocone) short, not reaching forward to the middle of protocone.

M^2—with three distinct roots. Paracone and protocone rather large.

P_4 (specimen B, Pl. IV, fig. 4)—of an ordinary *Canis* type. Metastylid present.

M_1 (specimens C and D)—rather slender, smaller than in Mivart's specimen but larger than in the specimen of Boule. Metaconid distinct. Paraconid no longer than talonid. Endoconid-ridge distinct and not interrupted.

Group II.

P^4 (specimen E, Pl. IV, fig. 7)—with deuterocone vestigial, set far behind the frontal wall of the tooth; medial breadth greater than in Group I. Total length: medial breadth= 22.5:8.9=2.65.

M^1 (specimen F, Pl. IV, fig. 7)—with the inner lobe smaller and shorter than in Group I; protocone small and low; cingulum-ridge (hypocone) long, distinct, reaching the middle of the protocone.

M^2 (specimen G)—with only two roots; paracone and protocone small.

P_4 (specimen H, Pl. IV, fig. 5)—as in Group I but slightly larger.

M_1 (specimens H and I)—larger than in Group I; metaconid vestigial; paraconid longer than talonid; endoconid-ridge as in Group I.

Group III.

P^4 (specimen J)—this tooth is referable to *Cyon* on account of its breadth and of the indistinct shape of the deuterocone which is reduced to a rather long, but flat and uneven projection of the antero-internal corner of the tooth. Total length: medial breadth= $\frac{24.2}{10}$ =2.42.

M_1 (specimen K)—a worn tooth, slightly longer than in the wolf of Locality 1. Metaconid vestigial. Talonid with only one ridge-like cusp.

Judging from its geographical position, the Choukoutien *Cyon* has probably to be referred to *Cyon alpinus*, a form still living in northern Asia, rather than to the southern *C. javanicus* Desmarest from which, in addition, our specimens differ possibly by a greater size and a greater transversal elongation of M^2.

This is the first fossil *Cyon* known in North China. In the Late Pliocene (or Lower Pleistocene) fissure deposits of Szechuan another *Cyon, C. antiquus* Matthew and Granger, has been discovered in 1921 by the Third Asiatic Expedition of the American Museum. This form, briefly described so far, seems to be based chiefly upon the preservation of a distinct metaconid on M_1. But this character, still occurring in both *C. alpinus* and *C. javanicus* is perhaps insufficient for defining a new species.

MEASUREMENT (in mm.)

Specime		*Cyon* from Choukoutien											*C. javanicus* D.	*C. alpinus* Pallas	
		Group I				Group II					Group III		After Mivart	After Mivart	After Boule
		A	B	C	D	E	F	G	H	I	J	K			
P^4	length	22.0	—	—	—	22.4	—	—	—	—	24.2	—	19.0	21.0	20.0
	breadth	10.7	—	—	—	10.7	—	—	—	—	12.5	—	10.0	—	—
M^1	length	14.0	—	—	—	13.4	13.5	—	—	—	—	—	11.0	15.0	12.0
	breadth	14.9	—	—	—	15.0	15.2	—	—	—	—	—	15.0	—	—
M^2	length	6.0	—	—	—	-	—	5.3	—	—	—	—	6.0	7.0	5.0
	breadth	9.0	—	—	—	—	—	8.5	—	—	—	—	8.0	—	—
Length of M^1+M^2		—	—	—	—	—	—	—	—	—	—	—	18.0	—	18.0
M_2	length	—	—	—	—	—	—	—	11.1	—	—	—	9.0	—	—
	breadth	—	—	—	—	—	—	—	5.0	—	—	—	—	—	—
P_4	length	—	12.2	—	—	—	—	—	13.4	—	—	—	11.0	—	—
	breadth	—	6.0	—	—	—	—	—	6.5	—	—	—	—	—	—
M_1	length	—	21.5	22.8	21.7	—	—	—	23.8	23.7	—	29.2	20.0	23.0	20.0
	breadth	—	8.4	8.6	8.4	—	—	—	8.6	10.2	—	11.5	7.0	—	—

HORIZON AND LOCALITY: Upper Polycene of the *Sinanthropus* site at Choukoutien; Layers: Lower Cave.

Cat. No., C.L.G.S.C. $\frac{C}{C.\ 678} - \frac{C}{C.\ 680}$.

It should be important, in any way, to establish a closer comparison between the Choukoutien and the Szechuan fossil *Cyon*. (1) If the two forms prove to be identical, then the *Cyon* would be one of the very rare type found in the Late Cenozoic deposits *on both sides* of the Tsingling Range. And the question then would be to decide whether *C. antiquus* represents a southern extension of the *C. alpinus*; or, on the contrary, the Choukoutien *Cyon* a northern extension of the *javanicus* group. (2) If they prove to be different, then *C. antiquus* would have to be held as a probable relative of the southern *javanicus* and the Choukoutien *Cyon* would be left, as already done above, on the *alpinus* side.

Canidæ gen. et sp. indet.

Pl. III, fig. 12.

Two maxillæ with P^3 and P^4 and one isolated P^3, found in the lower level of Locality 1, show some remarkable features which require a special description (*vide* fig. 8).

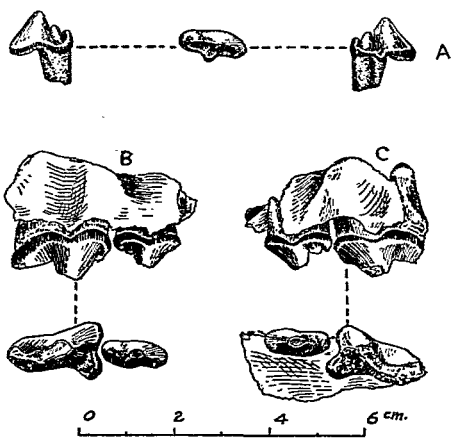

Fig. 8. *Canidæ* gen. et sp. indet., × 1/1.
A, three views of P^3;
B, broken maxilla with P^3 and P^4;
C, broken maxilla with P^3 and P^4.

P^3, with an incipient postero-internal cusp (deuterocone) corresponding with an indistinct root, still fused with the main posterior root of the tooth (*Viverra* character), two equally

developed posterior accessory cusps and one small anterior accessory cusp, situated much more internally than in ordinary *Canis*.

P^3, with a rudimnary but distinct parastyle (*Viverra* or *Felis* character) and a large deuterocone.

That these "Viverroid" characters are not an individual abnormality seems probable, since the two specimens were collected in two different places, and are perfectly similar. But no definite place nor precise name can be given to this as long as a more complete material has not been discovered.

MEASUREMENTS (in mm.)

	Specimen	A (Pl. III, fig. 2)	B (fig. 8, B)	C (fig. 8, A)
P^3	length	14.1	14.9	13.1
	breadth	5.3	5.2	6.0
P^4	length	21.2	—	—
	breadth	11.6	11.5	—

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site of Choukoutien deposits; Carnivora Layer and Lower Cave. Cat C.L.G.S.C. $\frac{C}{C.\ 1810}$.

KEY TO THE CHOUKOUTIEN CANIDÆ

A) P^4, without parastyle.

a) P^4 with a strong deuterocone, M^1 with a well developed hypoconal ridge, M_1 with two main cusps (hypoconid and endoconid) on talonid.

1. Incisors and canines rather massive, cheek teeth less cutting, size large or moderate . . . . . *Canis* . . P. 10.

* M^1 with a strong metaconule, M_1 with strong hypoconid and a strong endoconid, and with accessory cusps on talonid.

** Cheek teeth macrodont, mandible without prominent subangular lobe.

*** Size large, M^1 more than 25 mm and P^4 more than 25 mm in length . . . . . *Canis lupus* . . P. 10.

*** Size moderate, M_1 varies from 22-24 mm in length . . . . *Canis variabilis* . . P. 13.

** Cheek teeth microdont, mandible with strong subangular lobe . . . . . C. (*Nyctereutes*) *sinensis* . . P. 23.

* M^1 with a weak metaconule, M_1 with a strong hypoconid, a weak endoconid and without accessory cusp on talonid . . . . . *C. cyonoides* . . P. 18.

2. Incisors and canines slender, cheek teeth more cutting, size small . . . . . *Vulpes* . . P. 32.

* (Nasals not overlapping the mixilla), mandible very slender. . . *V.* cf. *corsac* . . P. 32.

* (Nasals extending as far back as the hind termination of maxilla), mandible less slender . . . . . *V.* cf. *vulgaris* . . P. 37.

b) P^4 with a weak deuterocone, M^1 with a reduced hypoconal ridge, M_1 with only one main cusp on talonid . . . . . *Cyon* (*Cuon*) . . P. 39.

* M^2 large . . . . . *C.* cf. *alpinus* . . P. 39.

B) P^4 with a rudimentary but distinct parastyle . . . . . Canidæ gen. et sp. indet . . P. 43.

Family **URSIDÆ** Gray

Genus **URSUS** L.

Ursus angustidens Zdansky

Pl. V, figs. 6 and 7; Pl. VI, fig. 3; Pl. VII, fig. 8; Pl. VIII, fig. 4; Pl. IX, figs. 3-8; Pl. X, figs. 5, 8, and 11.

1928 *Ursus angustidens* Zdansky. Die Säugetiere der Quartärfauna von Choukoutien. Palæontologia Sinica, Ser. C, Vol. V, Fasc. 4, pp. 39-42, Taf. III, figs. 3-9.

In addition to the larger bears described below, a very characteristic small *Ursus* is found in Choukoutien. This species, recognized by Zdansky in 1928 on a few isolated teeth, is actually better known and has to be re-described here.

Belonging to this form, we have presently: (1) 7 fragments of the upper jaw, including the fore part of a muzzle with premolars, canines and incisors *in situ*; 6 P^4, 5 M^1 and 10 M^2; (2) 18 fragmentary lower jaws, 9 P_4, 6 M_1, 12 M_2, 12 M_3; (3) the distal end of an humerus, and the proximal part of a radius.

DESCRIPTION

Upper jaws: (*vide* Fig. 9).

P^1—P^3, small and crowded in the very short interval separating the canine from the carnassial tooth.

P^4, very simple; the deuterocone never shows any accessory cusps, and no cingular cusp behind the tritocone. Deuterocone somewhat variable in position, anteriorly or posteriorly to its normal position (opposite to the cleft separating the protocone from the tritocone).

M^1, of the ordinary bear type, without any secondary complications. Accessory cusp between protocone and hypocone well formed. Para- and metastyle generally present, the latter one stronger than the former. No internal cingulum.

M^2, of the common bear type: crown flattened and posteriorly elongated. The two lingual roots may be fused, and the posterior lingual one divided into two. Accessory cusp between protocone and hypocone faint, but inner cingulum generally distinct. In some specimens the heel is rather narrow and short (not longer than 1/3 of the entire crown); but in some others, it looks just so broad and long as in a brown bear.

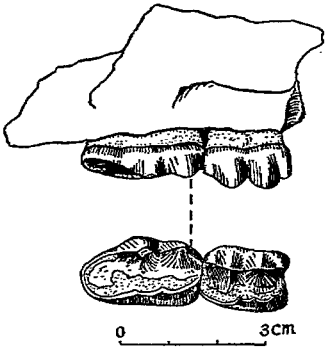

Fig. 9. *Ursus angustidens* Zdansky, broken maxilla with M^1 and M^2, × 1/1.

Lower jaw: (*vide* Fig. 10).

Mandibular bone moderately high with lower border usually slightly concave under M_1 and M_2 (Fig. 10). A deepening of the bone is noticeable (or not) under the symphysis. Angular process moderate, and subangular process relatively larger. Mental foramen very variable in size, position and number (1-4). Interval between C and P_4 short.

P_1—P_3, indicated by their alveoli on all our specimens; small and with a single root. Generally the alveolus for P_1 is large, and that for P_3 the smallest. The diastema is always longer between P_2 and P_1 than between P_3 and P_2 or P_2 and P_1.

P_4 with an anterior and two posterior edges (those latter ones producing a median furrow) on main cusp. The basal end of those three edges is generally marked by a very faint cusp.

M_1, somewhat variable in the minor features. In most cases, the metaconid shows an accessory anterior cusp, exceptionally a posterior one. The furrow separating the metaconid (and its accessory cusp) from the paraconid and protoconid group is very deep, and ends backward in the middle of the furcated hypoconid (not between the hypo- and the endoconid). Hypoconulid sometimes distinct.

M_2, of the ordinary bear type. No paraconid. Metaconid higher than protoconid and opposite to it, the two cusps being separated by a valley or, more usually, connected by a ridge. Two accessory cusps often present between the metaconid and the endoconid.

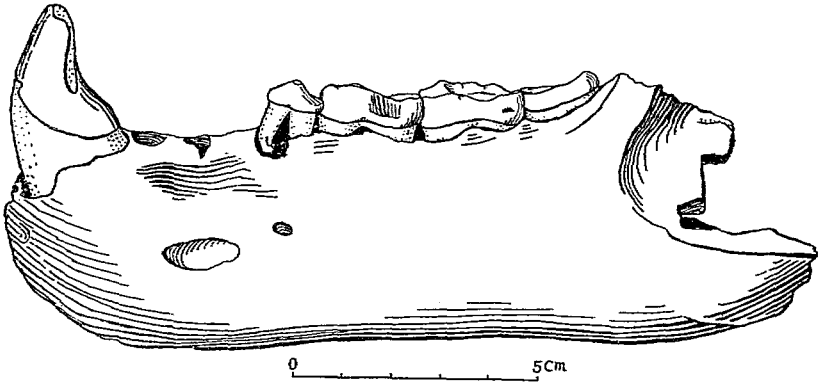

Fig. 10. *Ursus angustidens* Zdansky, outer side view of a mandible. × 1/1.

M_3, flat and corrugated, without distinct cusps. Unworn surface shown in Pl. IX, figs. 4 and 5.

Limb-bones.

Humerus, as in *U. arctos* but smaller. Maximum distal breadth, 66.0 mm. Breadth and height on the middle of the shaft: 26.5 and 27.5 mm.

Radius, much smaller than in *U. arctos*. The tubercle is not prominent, and the shaft rounded (instead of being flat).

Proximal breadth and height	32.4 mm and 22.3 mm.
Medial breadth and height.....	14.6 mm and 18.0 mm.

OBSERVATION

Two lower jaw specimens do not fit exactly with the above given description.

In the specimen (236:2) (Fig. 11, B), P_4 is abnormally larger (15.2 mm long, and 7 mm wide; *vide* Measurements) and shows a large anterior accessory cusp, the tip of which unfortunately is broken. In the other one (Fig. 11, A), the symphysis shows a strong downward process; P_4 is small and oval; and there are only two alveoli for the anterior premolars, the first one being set very close to the canine.

MEASUREMENTS (in mm.)

N.B. The size of *U. angustidens* being very variable, we only give here the dimensions obtained from two middle-sized specimens. The range of variations is analysed in a paragraph below.

Upper teeth	Specimen 55:88 (Pl. VI, fig. 3)	Specimen 76:34 (Pl. VIII, fig. 4)
Length from P^1 to M^2	74.5	—
Length of alveolus for P^1	6.4	—
Length of alveolus for P^2	5.0	—
Length of alveolus for P^3	4.4	—
P^4 length	11.4	—
breadth	8.0	—
M^1 length	17.2	18.0
breadth	13.2	13.1
M^2 length	28.0	25.3
breadth	15.0	14.1

Mandible and lower teeth	(specimen on Pl. IX, fig. 3).
Length from canine to M_3	124.0
Length of alveolus for P_1	8.0
Length of alveolus for P_2	5.6
Length of alveolus for P_3	3.3
Length of interspace between alveoli for P_1 and P_2	4.0
Length of interspace between alveoli for P_2 and P_3	3.8

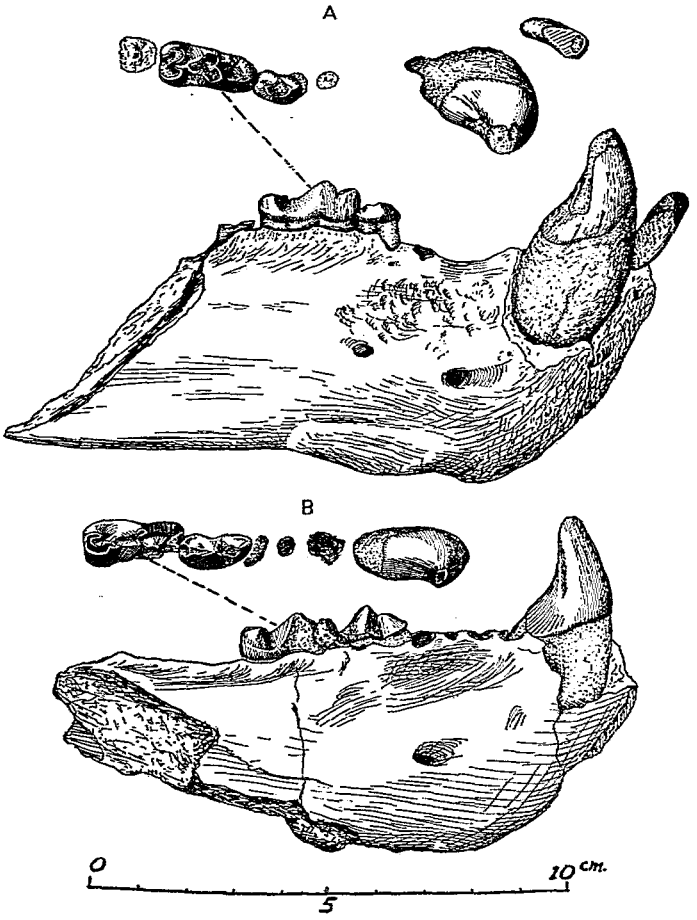

Fig. 11. *Ursus angustidens* Zdansky, two mandibles, × 1/1.
A, mandible with small P_4 but without P_3;
B, mandible with a large P_4.

Mandible and lower teeth	(specimen on Pl. IX, fig. 4)
Length of interspace between alveoli for P_3 and P_4	3.0
Height of mandibular bone anterior to P_4	46.5
Height of mandibular bone posterior to M_3	54.1
Lower canine length	21.4
breadth	14.4
P^4 length	11.6
breadth	7.0
M_1 length	21.0
breadth	10.0
M_2 length	20.5
breadth	12.0
M_3 length	17.3
breadth	11.5

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien; Layers 4, 5, 6, Lower Fissure and Lower Cave. In the Kotzetang Cave and in the upper levels (Layers 1-3) *U. angustidens* is rather rare. Cat. No. C.L.G.S.C. $\frac{C}{C.\ 1817} - \frac{C}{C.\ 1827}$.

VARIATION OF THE MOLAR TEETH OF *U. ANGUSTIDENS* IN SIZE AND SHAPE

In the adjoining figure (Fig. 12) we have reported on a diagram the breadth (vertical scale) and the length (horizontal scale) of all the fresh and complete lower or upper molar teeth of *U. angustidens* found in our collection. The mere inspection of this table, in which the points (representations of the teeth) do not form a distinct curve, but a scattered area of a rather large extent, shows how irregular on the variation and how unsafe, consequently, a specific determination for a bear would be made basing upon the dimension of a few isolated teeth.

In the figure (Fig. 12) on the other hand, we report the most remarkable case of variation observed in the shape of the same teeth. The variability, quite naturally, is maximum for the last teeth of each row (M^2 and M_3).

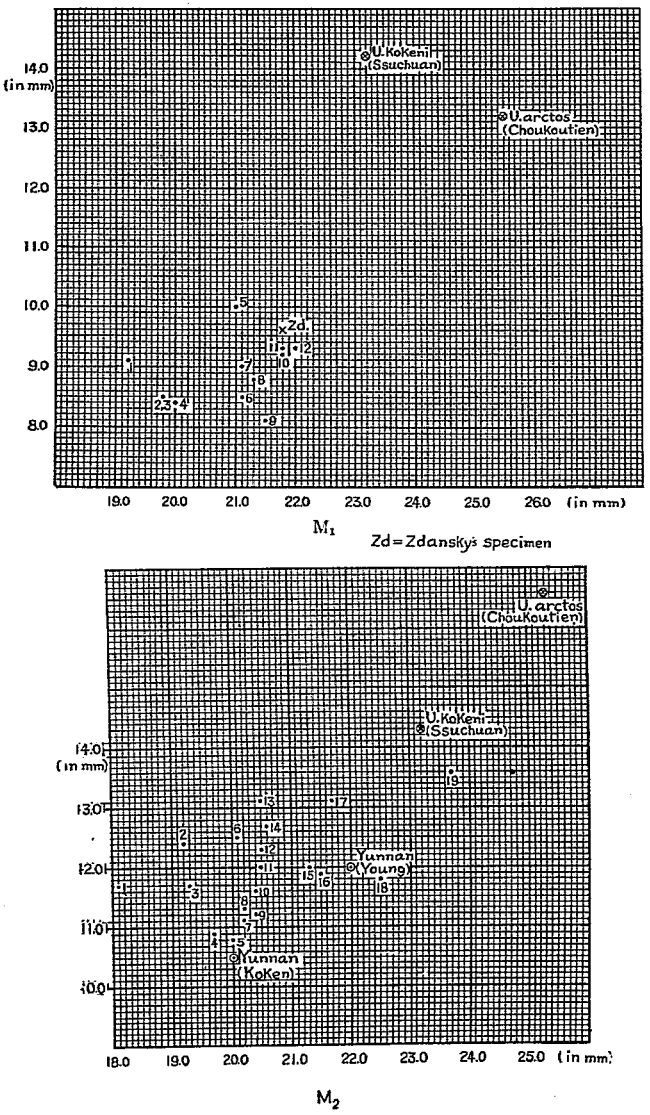

Fig. 12. A. Plotted diagram, showing the variation of M_1 and M_2 in *Ursus angustidens* Zdansky; vertical scale means the breadth and horizontal scale the length.

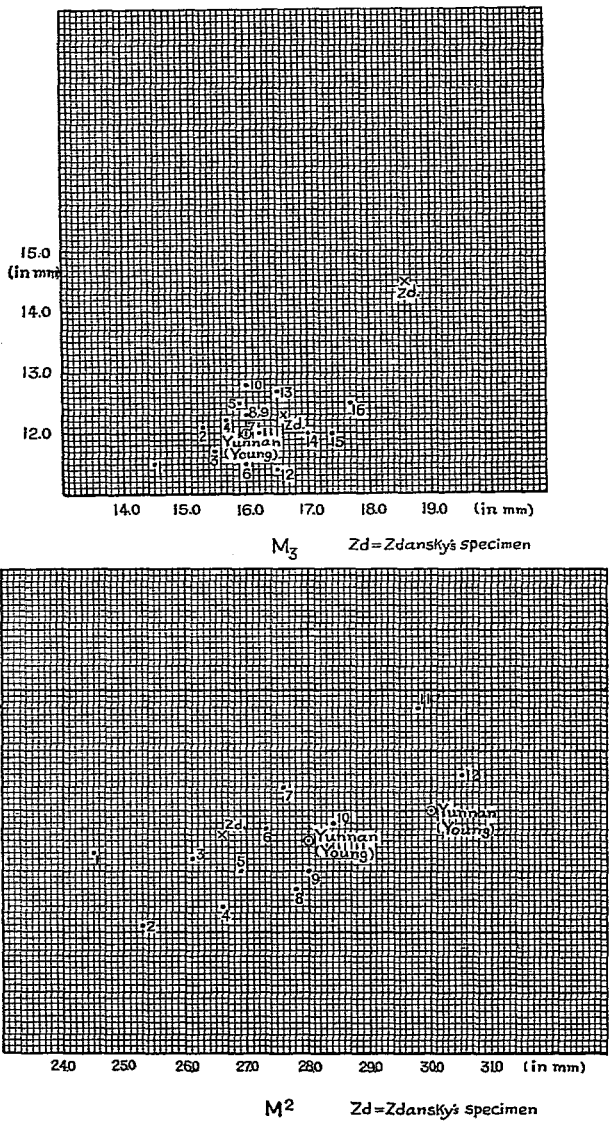

Fig. 12, B. Plotted diagram, showing the variation of M_3 and M^2 in *Ursus angustidens* Zdansky; vertical scale means the breadth and horizontal scale the length.

COMPARISON

The here described specimens (possibly with the exception of the two abnormal lower jaws alluded to above) belong undoubtedly to the same *U. angustidens* as described from Choukoutien by Zdansky in 1928.

Now, on the other hand, they are practically indistinguishable:

a) from the living *U. japonicus* (as represented by specimens kept in Heude's Museum, Shanghai) and from its Manchurian representative *U. ussuricus* (specimen kept in the Cenozoic Laboratory).

b) And also (as already noted by Zdansky) from the fossil *Ursus* cf. *japonicus* from Yunnan (*vide* Koken, 1885) re-discovered recently in a cave (Hoshantung, Fuminghsien) of Yunnan (*vide* Young, 1932).

We are inclined, therefore, if not to cancel the species *angustidens*, at least to consider it as a mere fossil equivalent of the actual Japanese bear.

A special difficulty is met with the fossil bear collected and described from the Late Pliocene of Szechuan by Dr. W. Granger. This form has been erected as a new species, *U. kokeni* Matthew and Granger and held by the authors as a synonym of the *U.* cf. *japonicus* of Koken. But our impression is that on account of the shape of M_2 ("rather short and wide, wider posteriorly than anteriorly") and of a larger size (length and breadth of M_1 23.5 mm and 10.5 mm; of M_2 23.2 mm and 14.3 mm)[1] Dr. Granger's specimen does not fit exactly with the type of *U.* cf. *japonicus* Koken (=*U. angustidens* Zdansky). It should therefore, represent a new and different form, unless it proves later to be an abnormal individual of *U. arctos* type.

The Sanmenian *U.* cf. *etruscus* from Nihowan described by Teilhard and Piveteau (1920, pp. 99-101) is larger than the Choukoutien *U. angustidens*.

Ursus arctos L.

Pl. V, figs. 2, 3 and 4; Pl. VI, fig. 1; Pl. VII, figs. 1, 3 to 7; Pl. VIII, figs. 1 to 3, 5 to 7; Pl. IX, figs. 1 and 2; Pl. X, figs. 2, 3, 4, 6, 7 and 9.

1928 *Ursus arctos* L., Zdansky. Die Säugetiere der Quartärfauna von Choukoutien. Palæontologia Sinica, Ser. C, Vol. V, Fasc. 4, pp. 30-39, Taf. II, figs. 3-16; Taf. III, figs. 1 and 2.

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1 Taken from the picture given by Matthew and Granger (1923).

Besides the small *U. angustidens*, the Choukoutien deposits contain traces of much larger bears, which, from the study of two well preserved skulls, seem to belong to two distinct types: one identical with *U. arctos*; the other close to *U. spelæus*. We are therefore going to describe those forms separately. But we must confess that, in separating the jaws, teeth, or limb-bones corresponding to the two types of skull respectively, our work is largely hypothetical. It has been done however chiefly basing upon the indication given by Reynolds (1906) for distinguishing the cave bear from the ordinary brown bear.

To the former *U. arctos* we refer:

an almost complete skull (type skull), with its complete lower jaw (both sides) preserved; both upper and lower teeth present, but greatly worn down;

the anterior part of a skull of a young individual, with its right mandible, milk teeth all preserved;

two skull fragments, four broken maxillæ with teeth more or less preserved;

one complete and 17 more or less broken, mandibles, with teeth more or less preserved;

many isolated unbroken teeth: 15 P^4, 12 M^1, 15 M^2, 7 P_4, 23 M_1, 15 M_2 and 23 M_3;

several limb-bones: 2 broken humeri; 1 broken radius; 2 complete tibiæ; and several phalanges.

DESCRIPTION

Skull (*vide* Fig. 13).

The type specimen is but slightly deformed; but the teeth are much worn down. Size a little larger than in a recent *Ursus arctos* from Manchuria (Cat. No. 489). Muzzle relatively low and broad. Inter-orbital region flat and wide. Post-orbital process very projecting and long. Sagittal crest strong, and forking into two well marked ridges a little before reaching the orbital region. Brain case ovate and rather shallow. Occiput, when viewed from behind, broad. Palatine decidedly curved upward. Anterior palatinal foramen small. Infra-orbital apertures small.

Upper teeth.

P^1—P^3—on the type skull P^3 (alveolus) is clearly present. On account of a break in the jaw, the presence of P^1 cannot be proved; but both P^1 and P^3 can be observed on two other specimens (the anterior part of a skull, and a broken left upper jaw). P^2 absent.

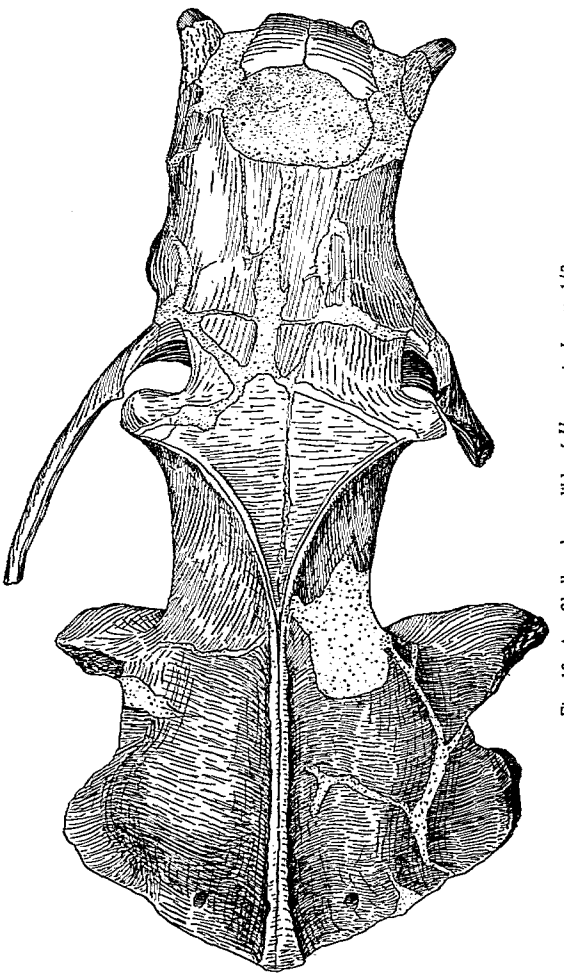

Fig. 13, A. Skull and mandible of *Ursus arctos* L., × 1/2.
Top view of skull.

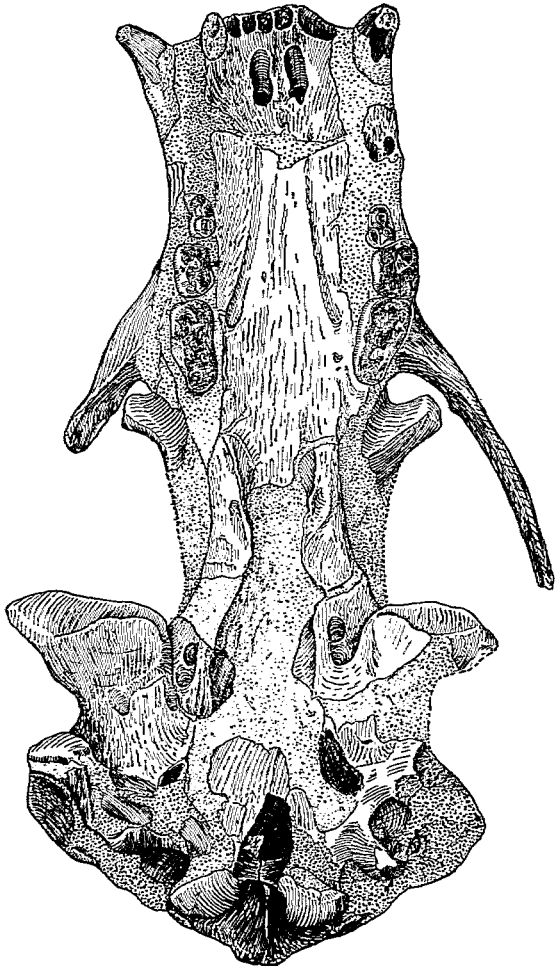

Fig. 13, B. Skull and mandible of *Ursus arctos* L. × 1/2.
Palatinal view of skull.

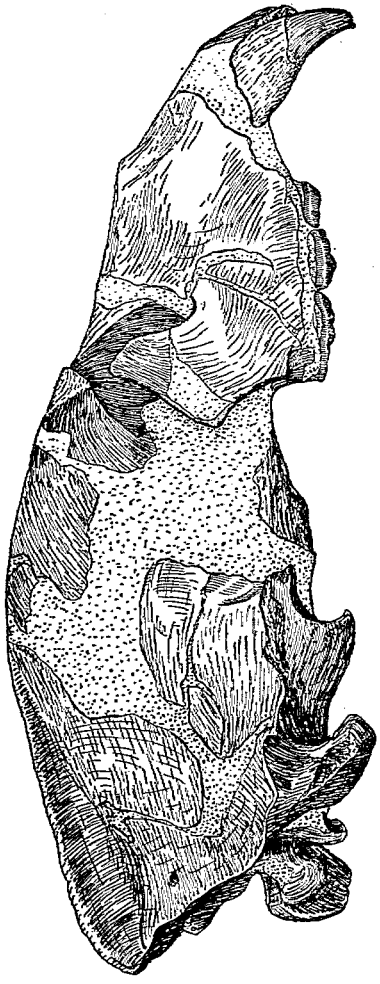

Fig. 13, C. Skull and mandible of *Ursus arctos* L. × 1/2. Lateral view of skull.

P^4—on the type skull is of a simple type: deuterocone forming a single cusp: no cingular cusp behind the tritocone. But, on the isolated specimens, the same tooth shows several complications never observed in *U. angustidens*: deuterocone with a small anterior and a small posterior, or with a single strong posterior accessory cusp; a cingular cusp behind the tritocone.

M^1—in what we hold as the common case (Pl. VII, fig. 1) the first upper molar shows the following features: shape rectangular; middle interior cusp (between proto- and hypocone)

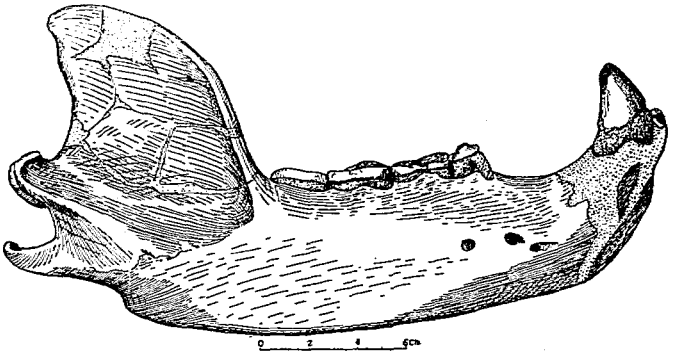

Fig. 13, D. Skull and mandible of *Ursus arctos* L., × 1/2. Lateral view of mandible.

indistinct; inner cingulum not well marked; parastyle, or metastyle, or both of them, rudimentary or absent. But several variations are observed, for example:

(1) Crown wider anteriorly than posteriorly; size large (Pl. V, fig. 3) or small (Pl. VII, fig. 3).

(2) Crown rectangular, but inner cingulum extremely weak.

(3) Crown almost rounded, the inner half being smaller than the outer one.

M^2—on the type skull, and on several other specimens (Pl. VII, fig. 3) the heel of M^2 is strongly constricted and pointed posteriorly; paracone not pitted; no distinct accessory cusp behind the hypocone. But, here also, several variations may be noted (*vide* Fig. 15), e.g.,

(1) heel constricted, but rounded posteriorly, size small or large (Pl. V, fig. 4)

(2) protocone with an expanded inner cingulum (Fig. 15, A).

(3) protocone pitted; hypocone high, and with a posterior accessory cusp (Pl. VII, fig. 4). But since the heel is not strongly constricted, this specimen might also be referred to *U. spelæus*.

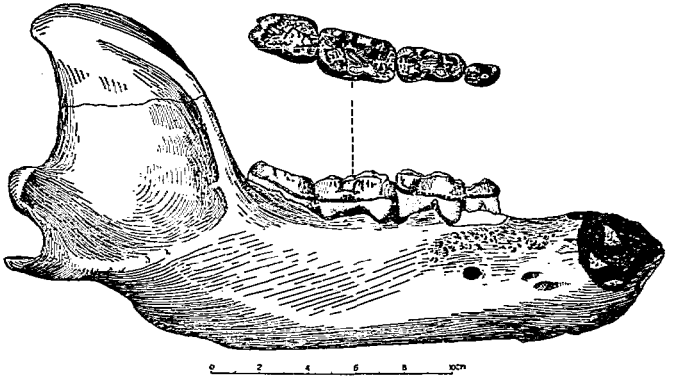

Fig. 14. Mandible of *Ursus arctos* L., × 1/2.

Mandibular bone.

Among our specimens two types of mandibles are recognizable:

a) mandibular bone deep and short, with smaller teeth; angular process larger; coronoid process less obliquely set on the ramus (Fig. 13, D, Pl. VIII, fig. 1);

b) mandibular bone less deep and rather long, but with larger teeth; angular process small; coronoid process pointing backward (Fig. 14 and Pl. IX, fig. 2).

If these two types are both referable to *U. arctos*, the type (a) stands more close to the living form than type (b).

Lower teeth.

P_1 and P_3 present (or indicated by alveoli) and are single rooted. P_2 absent.

P_4 variable in size. As commonly found in bears, the protoconid shows an anterior and two posterior longitudinal ridges (the latter enclosing a furrow). But the accessory cusps set at the lower end of those three ridges respectively are weakly or not at all developed, never as

strong in any way as in *U. spelæus* (*vide* Pl. VIII, figs. 1a and 7, and Pl. X, fig. 2; compare with Pl. VIII, fig. 8).

M_1—variable in size and shape, more complicated generally than in *U. angustidens*. Metaconid with an anterior, and sometimes also with a posterior accessory cusp; endoconid duplicated; central longitudinal furrow ending backward between endoconid and hypoconid, instead of forking into the hypoconid, as in *U. angustidens* (Pl. IX, fig. 1b and Pl. X, fig. 2).

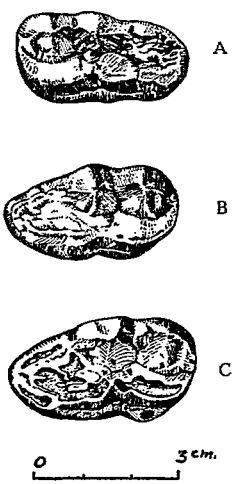

Fig. 15. Three M^2 of *Ursus arctos* L., × 1/1, showing the variation in character.

M_2—variable in size and shape. In the most complex type, there are six (Pl. VIII, fig. 5) or five (Pl. IX, fig. 1b) lingual cusps: namely, the metaconid with an anterior and a posterior accessory cusp, an intermediate accessory cusp and a duplicated or single endoconid; and three labial cusps: protoconid, intermediate accessory cusp and hypoconid. In a simpler type (Pl. X, fig. 2) the metaconid is only duplicated, and the endoconid is simple.

M_3—complicated, or even pointed posteriorly, crown coarsely corrugated; shape and size variable. Never bearing an outer sulcus.

Milk dentition (Pl. VIII, figs. 2 and 3).

DI^3—tip blunt, with a strong cingulum on the inner side of the crown.

DC (upper)—tip blunt and without noticeable cingulum around the crown.

DP^2—crown rounded and with a central cusp; root single and conical.

DP^3—two-rooted, single-cusped.

DP^4—with two outer cusps and one inner lobe. Paracone and metacone pointed; metacone slightly greater than paracone. Inner lobe crescent-shaped; formed by a longitudinal ridge (protocone) and a weak posterior cingulum.

DP_4—on the lower jaw only the canine and DP_4 preserved. DP_4 with a distinct large paraconid and a large protoconid. Metaconid distinct. Talonid cutting with a trenchant hypoconid and a weak endoconid.

MEASUREMENTS (in mm.)

	DI^3	DC (upper)	DP^2	DP^3
Length	6.5	8.0	—	6.7
Breadth	5.5	6.0	2.9	3.2
	DP^4	DC (lower)	DP_4	
Length	11.2	8.3	12.9	
Breadth	7.6	5.4	5.4	

Limb-bone.

The limb-bones of *U. arctos* are considerably variable in size. Distal end of humerus (Pl. X, fig. 9) 88.0 mm wide; proximal end of radius 49.0 mm wide (Pl. X, fig. 4) and 58.0 mm (Pl. X, fig. 7); the distal end (Pl. X, fig. 3) of radius 65.0 mm wide; and total length of tibia 282.0 mm and distal end 65.0 mm wide (Pl. X, fig. 6).

MEASUREMENTS (in mm.)

(skull)

Total length from the occiput to the anterior border of alveolus for I^1	385.0
Maximum breadth of the muzzle	97.5
Minimum breadth of the interorbital region	87.0
Maximum breadth of the brain case	125.0
Maximum depth of the brain case	122.0
Minimum breadth between the inner border of the two M^2	64.0

(mandible)

Total length from the condyle to the frontal border of I_1	265.0
Depth of mandible: in front of P_4	54.5
behind M_2	57.5
Length from I_1 to M_3	166.0
Length from P_4 to M_3	87.0
Length and breadth of P_4	14.6 and 9.0
Length and breadth of M_1	25.5 and 14.4
Length and breadth of M_2	27.1 and 16.3
Length and breadth of M_3	23.8 and 17.0

MEASUREMENTS (in mm.)
(mandible and lower teeth)

	HH:32 (Pl. IX, fig. 2)	DD:43 (Pl. IX, fig. 1)	CC:45
Length of the mandible measured from the condyle to the anterior border of I_1	270.0	——	——
Depth of the mandible behind M_2	57.0	——	——
in front of P_4	54.2	——	52.6
Length from P_4 to M_3	104.0	——	——
Length of P_4	15.0	——	——
Breadth of P_4	9.4	——	——
Length of M_1	29.7	29.0	30.3
Breadth of M_1	15.3	14.3	14.8
Length of M_2	32.4	27.4	30.3
Breadth of M_2	20.5	18.0	19.6
Length of M_3	27.1	——	——
Breadth of M_3	19.2	——	——

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien; Layers 3, 4, 5, 6, Carnivora Layer, Lower Cave and Kotzetang Cave. Cat. No. C. L. G. S. C. $\frac{C}{C.\ 1828}$ — $\frac{C}{C.\ 1848}$.

COMPARISON

The presence of *U. arctos* in Choukoutien was already recognized by Zdansky, but based on a much scantier material. We refer to his paper for a full discussion and comparison with living and fossil forms.

In 1933, some skulls and limb-bones of *Ursus* were recovered from the "Upper Cave". They seem to be somewhat different from *U. arctos* L. collected in the true Choukoutien Formation, as described above.

Ursus spelæus Blumenb. var.

Pl. V, figs. 1 and 5; Pl. VI, fig. 2; Pl. VII, fig. 2; Pl. X, figs. 1, 7 and 10.

As already explained above, the presence in Choukoutien of a large bear related (or converging ?) to the Cave bear of Europe or to the American Grizzly is entirely based on the study of a skull (type skull). To the same form we refer tentatively two fragmentary lower jaws, several isolated teeth, and some complete or broken limb-bones.

DESCRIPTION

Skull (Fig. 16).

The type skull is broken on the left side in the post-orbital region, and the break extends up to the nasal area. The teeth are not preserved, with the exception of the posterior part of M^2. On the whole, however, it is not deformed, and its chief features are clearly recognizable.

Muzzle relatively deep and narrow. Inter-orbital region narrow, deeply concave; the frontal area, above, being abruptly convex. Post-orbital process blunt, and not projecting at all. Sagittal crest less strong, and forking into two faint ridges further from the frontal region than in *U. arctos*. Brain case deep and constricted, a feature very distinct of the skull is observed in norma occipitalis. Palatine flat; anterior palatinal foramen large. Infra-orbital aperture large.

Upper teeth.

P^1—P^2 absent.

P^3—present (alveolus, with a broken root).

P^4 and M^1 unknown.

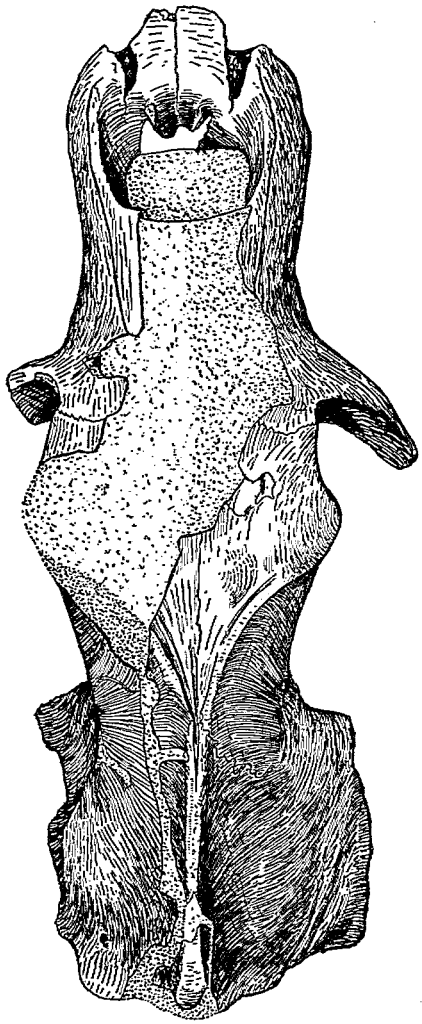

Fig. 16, A. Skull of *Ursus spelæus* Blumenb., var. × 1/2.
Top view.

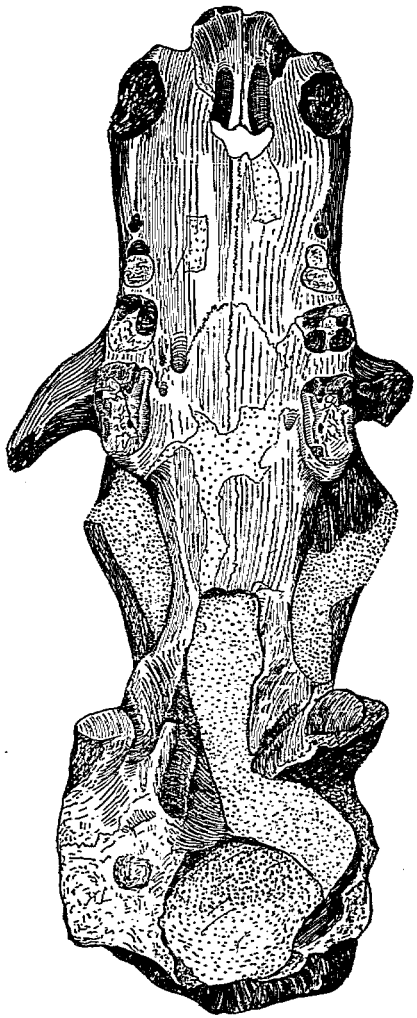

Fig. 16, B. Skull of *Ursus spelaeus* Blumenb., var. × 1/2. Palatinal view.

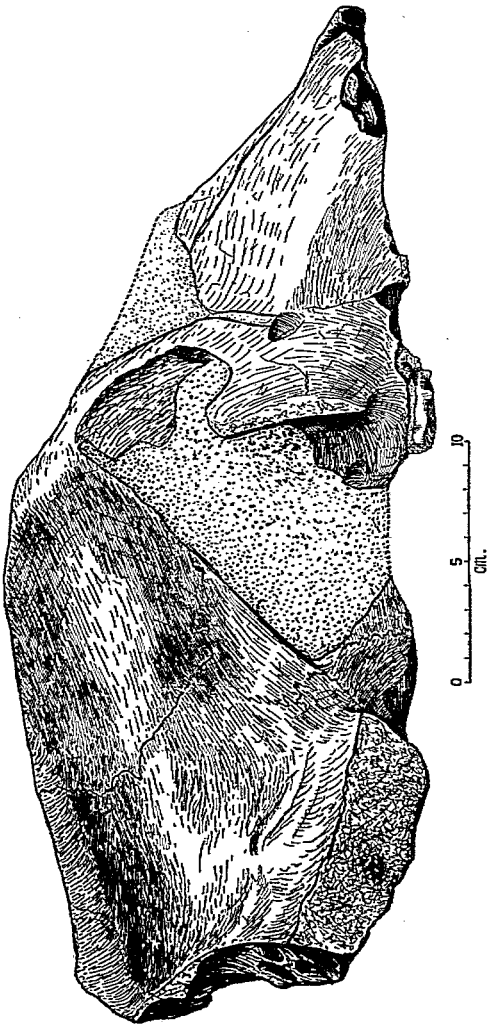

Fig. 16, C. Skull of *Ursus spelæus* Blumenb., var. × 1/2. Lateral view.

M^2 (type skull) with a posterior part (heel) not constricted, that is to say, just as broad as the anterior half of the tooth.

Lower jaw and teeth.

P_1—P_3 absent (no alveoli) on the type lower jaw (Pl. X, fig. 1).

P^4 with a strong anterior accessory cusp (Pl. X, fig. 1). Judging by an isolated specimen (Pl. VIII, fig 8) two well marked posterior accessory cusps are also present.

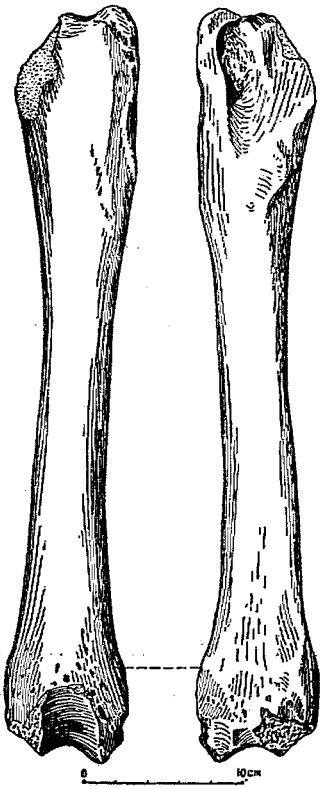

Fig. 17. Broken femur of *Ursus spelæus* Blumenb., var., × 1/3.

M_1 as in *U. arctos*, but the posterior part is more laterally expanded (Pl. X, fig. 1).

M_2 with enamel finely tuberculated. A strong outer sulcus is present (Pl. X, fig. 1).

M_3 also finely tuberculated and with a distinct outer sulcus (Pl. V, fig. 5). According to Reynolds (1906, p. 27) those two characters are very distinctive of *U. spelæus*.

Limb-bones.

An almost complete femur (Fig. 17) and a broken radius (Pl. X, fig. 7) and a humerus (Pl. X, fig. 10) are larger than in *U. arctos*, and perfectly comparable with the same bones of a European Cave bear.

MEASUREMENTS (in mm.)

(skull)

Total length from the occiput to the anterior border of alveolus of I^1.....405.0

Maximum breadth of the muzzle.....101.7

Minimum breadth of the inter-orbital region.....114.8

Maximum breadth of the brain case..... 99.6

Maximum depth of the brain case.....155.0

Minimum breadth between the inner border of the two M^2..... 66.0

(teeth)

P_4 (Pl. X, fig. 1)	M_1 (Pl. X, fig. 1)	M_2 (Pl. X, fig. 1)	M_3 (Pl. V, fig. 5)
Length.... 17.0	29.8	29.5	22.4
Breadth.... 11.1	15.6	19.5	17.3

(limb-bones)

Distal breadth of humerus.....121.0

Total length of femur.....487.0 (approx.)

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien; Layers in the Lower Fissure and the Lower Cave. Cat. No. C. L. G. S. C. $\frac{C}{C.\ 1849} - \frac{C}{C.\ 1853}$.

COMPARISON

Using the preceding observations, the differences between the *U. arctos* and *U. spelæus*, var. of Choukoutien can be summarized as follows:

	U. spelæus var.	*U. arctos*
(1)	Inter-orbital region, convave and sloping downward *abruptly* from the post-orbital region.	Inter-orbital region flat and sloping *gently* from the post-orbital region.
(2)	Brain case deep and narrow.	Brain case low and broad.
(3)	Post-orbital process blunt and without angular projection.	Post-orbital process well developed and with long and angular projection.
(4)	Palatine flat.	Palatine concave.
(5)	M^2 scarcely constricted posteriorly.	M^2 strongly constricted posteriorly.
(6)	M_3 with outer sulcus.	M_3 without outer sulcus.
(7)	P^1, P_1 and P_3 absent.	P^1, P_1 and P_3 present or indicated by alveoli.

Those differences seem to be sufficient for separating the two forms, at least provisionally, as long as the recovery of new specimens will not prove that the two types of skull pass into one another gradually.

Of course, the Choukoutien Cave bear differs from the typical European *U. spelæus* by a size slightly smaller, by a less abruptly convex forehead, and by the preservation of P^3. But the same reduced features occur also in the European specimen (for example, for the presence of P^3, *vide* Reynolds, 1906, p. 20).

This association in the Choukoutien Cave, exactly as in Europe, of a type *spelæus* with a type *arctos* can be interpreted in two different ways:

(a) either as a proof that *U. spelæus* and *arctos* are two "twin" Eurasiatic forms of bear, distinct specifically, but co-extending geographically.

(b) either as a suggestion that the *spelæus* type is only an exaggerative form of *arctos*, likely to develop as a race everywhere, under the same circumstances of like environment. We shall not decide.

A comparison of the Choukoutien *spelæus*-like bear with the Lower Pleistocene European *U. deningeri* Reichenau should be interesting, since this latter species, roughly contemporary with the Choukoutien fauna, is held as an ancestor of the Cave bear. But no sufficient data are available to us to start this comparative study.

Another, and possibly more promising, line of research would be to compare our Choukoutien form with the Grizzly bear of America, which displays approximately the same cranial and dental characters as *U. spelæus* (shape of the skull, reduction of the premolars, outline of the last molars). Chiefly at the end of the Cenozoic times (as in the Pontian), further researches in Chinese vertebrate palæontology will not have to look so exclusively to Europe, but also to America.

KEY TO THE SPECIES OF CHOUKOUTIEN *URSUS*

A) Size small; dentition $\frac{3.1.4.2.}{3.1.4.3.}$; mandible short and deep . . . . . *Ursus angustidens* . . . PP. 45-53

B) Size large; dentition $\frac{3.1.3.2.}{3.1.3.3.}$; skull with an inter-orbital region gently sloping down from the post-orbital region, with a flat and rather broad brain case, with a concave palatine and with flat and broad muzzle; M^2 constricted at its hinder portion; M_3 without outer sulcus . . . . . *Ursus arctos* . . . PP. 53-63

C) Size large; dentition $\frac{3.1.2.2.}{3.1.1.3.}$; skull with an inter-orbital region strongly convex; brain case high but narrow; muzzle deep and narrow; palatine flat; M^2 scarcely constricted at its hinder portion; M_3 with outer sulcus . . . . . *Ursus spelæus* var. . . . PP. 63-70

Genus **AILUROPUS** Milne-Edwards

? *Ailuropus* sp.

In our text-figure 18 there is illustrated the distal end of a humerus, identical on the whole with the humerus of a rather large bear, but remarkable by the presence of a well formed entepicondylar foramen, a character present in the American *Arctotherium*, but never recorded in the genus *Ursus*.

The presence of this foramen of course might simply be regarded as the accidental recurrence of a rare feature in an ordinary bear. But it might also indicate in Choukoutien the presence of the great Panda (*Ailuropus*) a Western Tibetan form not uncommonly found in the Lower Pleistocene fissure deposits of Szechuan (discovery of Dr. W. Granger of the Third Asiatic Expedition.[1])

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1 Here again we wish to thank Dr. Granger and the Field Museum of Chicago for the kind support they have always given our researches in China.

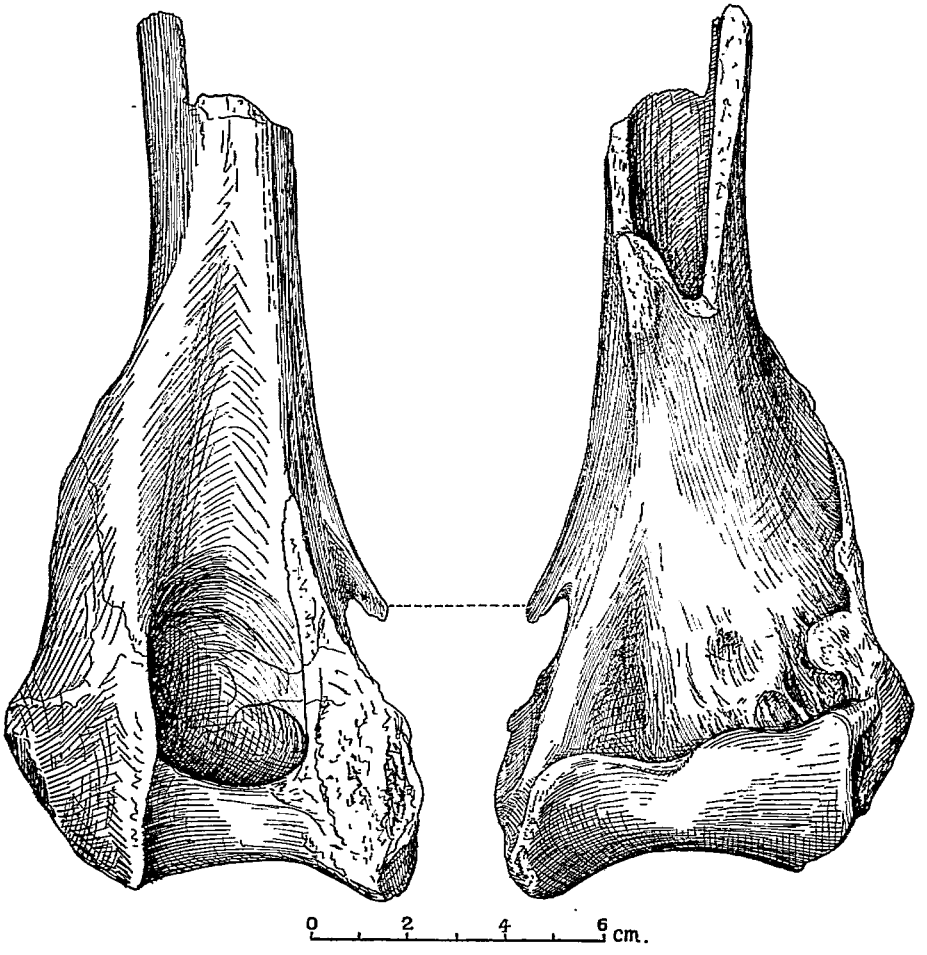

Fig. 18. ? *Ailuropus* sp., distal end of humerus, × 1/1.

Compared with several humeri of the fossil *Ailuropus* from Szechuan (in the American Museum of Natural History) and also with several humeri in the living giant Panda (in the Field Museum of Chicago), the Choukoutien specimen shows no sharp difference, but only a somewhat broader expansion of the external flange of the bone, and a higher position of the foramen along the shaft.

No other fossil has been found so far in Choukoutien which might be referred to the great Panda. The presence of this form would be of a great interest, since no faunistical link has been found up until now between the fossiliferous fissures of North and South China.

DIMENSION (in mm.)

Width of the distal end of the humerus (Fig. 18) 85.5

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien; Layer 5, (or *Sinanthropus* Locus A). Cat. No. C.L.G.S.C. $\frac{C}{C.\ 1854}$.

Family **MUSTELIDÆ** Swainson

Genus **MELES** Brisson

Meles cf. **leucurus** Hodgson

Pl. XI, figs. 1 and 3; Pl. XII, figs. 6, 9, 11, 13 and 14.

1847 *Meles leucurus* Hodgson. Journal of Asiatic Society of Bengal. p. 763, Pl. 29-31.

1925 *Meles leucurus* Hodgson, Zdansky. Quartäre Carnivoren aus Nord-China. Palæontologia Sinica, Ser. C., Vol. II, Fasc. 2, pp. 1-38.

1930 *Meles* cf. *leucurus* Hodgson, Teilhard et Piveteau, Les mammiferes fossiles de Nihowan (Chine). Annales de Paleontologie, T. XIX, Paris, pp. 108-109, Pl. XXI, figs. 1 et 1a.

1931 *Meles leucurus* Hodgson, Pei. On the mammalian remains from Locality 5 of Choukoutien. Palæontologia Sinica, Ser. C, Vol. VII, Fasc. 2, pp. 8-10. Pl. I, figs. 2 and 2a-2d.

In Locality 1 the Badger is represented only by a relative poor material: 2 much broken skulls; two fragmentary maxillæ (P^4—M^1); three isolated P_4 and eight M^1; a complete lower jaw (both sides); 16 more or less complete mandibles and 10 isolated M_1; skeletal bones: 2 complete humeri, one complete radius, one broken femur and one complete tibia, three astragali, seven calcanea. But much better specimens, collected in Locality 3 will be fully described in Palæontologia Sinica, Ser. C, Vol. VII. The latter will include an entire skeleton and several complete skulls.

DESCRIPTION

Skull.

No difference with the skull of a living *M. leucurus* as much as we can judge from our specimens.

Upper teeth (Fig. 19).

P^4 (carnassial), variable in size and also in shape, according to the more or less enlarged condition of the internal lobe. In most of the specimens there is a single deuterocone set (as it is the normal case for the Badger and Bear) very backward, slightly behind the protocone. But in a few others (3 specimens) a second cusp set forward, in the position of a dog's deuterocone, is observed, equal to (in two cases) or smaller (in one case) than the first one; so that the tooth reaches the structural stage of the upper carnassial in *Procyon* or in *Taxidea*. A similar, but not so strong, duplication of the deuterocone is reported by Miller (1912) in the case of *Meles taxus*.

M^1, very variable in size (from 11.6 mm to 13.8 mm in length, *vide* Measurement table), and somewhat also in secondary characters. For instance, along the ridge bounding the broadly expanded hypoconal area, the accessory cusps are found in any number between 1 and 8.

Lower carnassial.

Also variable in size: from 13.5 × 6 mm to 17.7 × 7.6 mm. A small accessory cusp is observed on the talonid.

Limb-bone.

The shape of the limb-bone is exactly the same as in the living *Meles*.

	Length	Proximal breadth	Distal breadth
Dimensions of the humerus	102.0 mm	23.8 mm	29.4 mm
,, ,, ,, radius	71.8 mm	10.8 mm	14.8 mm
,, ,, ,, femur	——	20.8 mm	17.6 mm

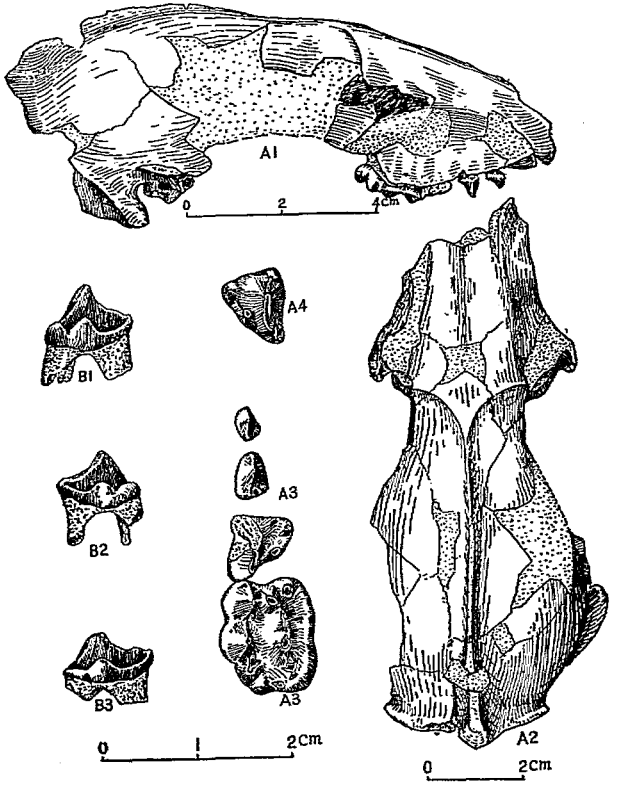

Fig. 19. *Meles* cf. *leucurus* Hodgson.

A, one incomplete skull and its upper teeth.
A1, right side view of skull, × 1;
A2, top view of skull, × 1;
A3, crown view of right upper teeth (P^2—M^1), × 2;
A4, crown view of left P^4, × 2.

B, inner side view of three isolated P^4, × 2.
B1, P^4 with a well developed second cusp on the inner angle.
B2, P^4 with a rudimentary secondary cusp on the inner angle.
B3, P^4 without a second cusp on the inner angle.

MEASUREMENTS (in mm.)

(Arranged according to the length in an order from smallest to the largest.)

P^4	length width	right 7.3 6.1 left [aa] 7.6 6.8	7.8 6.6	8.2 * 6.5	B 8.3 6.2
	length width	A 8.7 6.5	8.9 8.0		
M^1	length width		11.6 10.0	right 12.0 10.2 left [**] 11.5 —	12.4 11.5
	length width	12.7 10.0	13.0 11.2	13.2 11.0	13.4 11.0
M^1	length width	13.7 11.5 (?)	13.8 10.6		
	length width	13.5 6.0	13.9 6.0	14.0 6.6	14.1 6.8
	length width	14.2 6.3	14.2 6.5	14.0 6.5	14.6 6.9
	length width	14.6 6.3	14.7 6.5	15.0 11.6	15.1 7.0
	length width	right 15.4 6.8 left [**] 15.3 6.6	15.4 6.9	15.4 7.3	15.7 7.4
	length width	15.7 7.1	15.9 6.6	16.0 6.9	16.0 7.4
	length width	16.1 6.9	16.4 6.5	17.7 7.6	

* With a second cusp on the deuterocone.

[aa] P^4 bearing a second cusp on the deuterocone.

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien; Layers: 3, 5, 6, Carnivora Layer, Lower Cave and Kotzetang Cave Cat. No. C.L. C.S.C. $\frac{C}{C.\ 672} - \frac{C}{C.\ 679}$.

COMPARISON

The generic determination of the above described form is sure. For instance, on account of the shape of the skull, it cannot be referred to the rather southern *Arctonyx*[1].

The specific attribution to *leucurus* on the contrary is merely tentative, this name being chiefly adopted because *M. leucurus* is the most common Badger found in N. China. It is a known fact that the Badger species are practically indistinguishable by their bones, and chiefly by fragmentary bones only.

The question as to whether a single species of *Meles* or several are represented in Locality 1 also is still open. Provisionally however and because in our specimens the extreme difference in size or shape are gradually linked by intermediate types (Fig. 19, B), we will take the more conservative view, namely that only a single specific type is present.

Fossil *Melinæ* are first recorded in N. China from the Pontian Red Clay of Shansi (Zdansky) and E. Kansu (P. Licent's excavations); but, in those early times they are exclusively represented by distinctly primitive form, in which, for instance, the internal lobe of M^1 and the talonid of M_1 are never so developed as in the true *Meles*. The true *Meles* are first found in the Sanmenian deposits (Nihowan).

Sub-family **LUTRINÆ** Baird

Genus **LUTRA** Brisson

Lutra melina Pei (sp. nov.)

Pl. XI, figs. 5a and 5b; Pl. XII, figs. 1-4, 7, 8 and 10.

What seems to be a rather aberrant type of *Lutra* is represented in our material by four mandibles and one isolated right upper molar.

Upper molar (Fig. 20).

This tooth (Pl. XI, fig. 5), almost certainly referable to the same species as the lower jaws, differs from the corresponding tooth of a *Lutra vulgaris* by several important features. The parastylid, generally strong in the common Otter, is here very weak. The internal cingulum, instead of expanding posteriorly almost so far as the base of the metaconid, as in *L. vulgaris*, is built as a sharply limited lobe, separated from the metaconid by a linear wall

1 Fossil *Arctonyx* are found in the Yenchingkou deposit of Ssuchuan (*vide* Matthew and Granger, 1923).

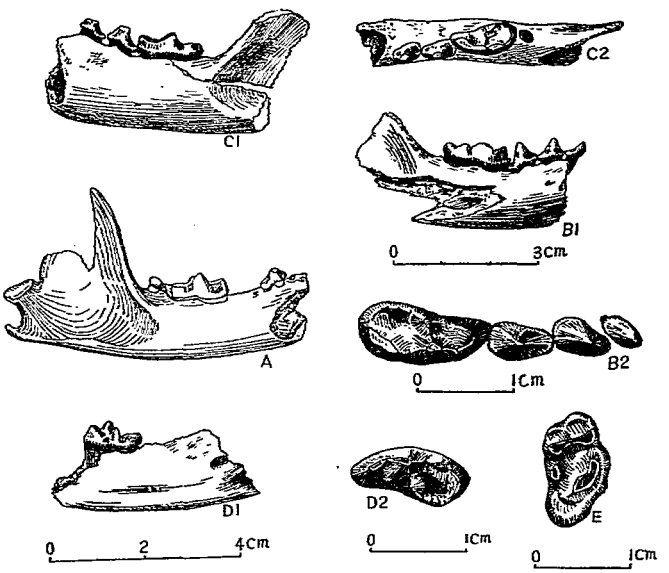

Fig. 20. *Lutra melina* Pei (sp. nov.).

A, outer side view of broken mandible with P_3, M_1 and M_2, × 1.....Cat. No. $\frac{C}{C.670A}$.

B, broken mandible with P_2-M_1.....Cat. No. $\frac{C}{C.669}$.
B1, outer side view, × 1.
B2, crown view of teeth, × 2.

C, broken mandible with P_3-M_1.....Cat. No. $\frac{C}{C.668}$.
C1, outer side view, × 1.
C2, top view, × 1.

D, broken mandible with M_1.....Cat. No. $\frac{C}{C.670B}$.
D1, inner side view, × 1.
D2, crown view of M_1, × 2.

E, crown view of M^1, × 2.....Cat. No. $\frac{C}{C.667}$.

of 3.5 mm long, a distinct cusp (metaconule?) being formed in this area. Anteriorly, the cingulum forms only a rudimentary lobe in the front of the protocone. On the whole, the outline of the tooth is much more elongated and lozengic than in an ordinary *Lutra*.

MEASUREMENTS

Maximum breadth, measured from paracone to hypocone	11.7 mm
breadth, measured from outer to inner border	9.3 mm
Diagonal length, measured from the anterior border of protocone to the posterior border of the inner cingular lobe	7.1 mm
Maximum length, of paracone + metacone	6.4 mm
Length, measured at the junction of the outer lobe (paracone and metacone) with the inner lobe (protocone and hypocone)	6.5 mm

Mandible and lower teeth (Fig. 20).

The mandible is strong, deep, with a lower border almost straight. Condyle slightly below the level of the tooth row. Ascending ramus forming an obtuse angle with the alveolar border.

P_2, set obliquely in the mandibular bone.

P_3, without any anterior cingular cusp, nor metastylid.

P_4, with its posterior part well rounded and without metastylid. This character is remarkable, since in common *Lutra*, the back of the protoconid is characteristically broadened, flattened, and bearing a metastylid (reacting to the protocone of the upper carnassial).

M_1, with a trigonid much more elongated than in the common Otter. On the talonid, the hypoconid, although distinctly cutting and somewhat dominant, is moderately developed, and not displaced towards the internal part of the tooth, so that (1) there is no external cingular area, and (2) the heel is clearly basin-shaped. Entoconid developed as a distinct ridge, ending near the metaconid, in two or three small cusps, the most anterior one being the largest. By both these characters (elongated trigonid and excavated heel) the tooth displays a curiously deceptive appearance of belonging to a *Meles*.

M_2, preserved on one specimen only: small and subcircular.

DIMENSIONS (in mm.)

		$\frac{C}{C.\ 668}$	$\frac{C}{C.\ 669}$	$\frac{C}{C.\ 670A}$	$\frac{C}{C.\ 670B}$
P_2-M_2	length	——	33.0	31.5	——
P_2	length	——	4.5	——	——
	breadth	——	3.0	——	——
P_3	length	5.9	6.0	5.5	——
	breadth	4.0	3.6	3.8	——
P_4	length	6.9	7.2	——	——
	breadth	4.2	3.7	——	——
M_1	length	14.0	13.7	12.5	12.3
	breadth	6.3	6.4	5.8	5.5
	length of trigonid	9.4	8.5	8.2	8.2
M_2	length	——	——	3.8	——
	breadth	——	——	4.0	——

Limb-bones.

To the same form we refer tentatively the distal part of a humerus (Pl. XII, fig. 7) and a radius (Pl. XII, fig. 8).

In its preserved part (especially by the flat shape of the ulnar facet and by the moderately deep anconeal fossa) the humerus shows distinct *Lutra* features. It looks rather small, of course, but such is also true of the teeth.

On the radius, (Pl. XII, fig. 8) the tubercle is well developed and the anterior ridge strong. But the shaft is relatively much longer, and more straight than in the common Otter; and here again, the resemblance to a Badger.

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien. All the four mandibles were collected in the sandy layer (Layer 7), in the Main Deposit. But

we have no record of the place where the isolated M^1 was found: perhaps also in the sandy layer, judging by the appearance of the matrix. Cat. No. C. L. G. S. C. $\frac{C}{C.\ 667}$ $\frac{C}{C.\ 671}$.

COMPARISONS

It should be impossible to refer the above described teeth and jaws to any other known family than that of *Lutrinæ* (e. g. the shape of M^1 and the relatively short heel of M_1 exclude the *Melinæ*). But among the Otters, the Choukoutien form represents a remarkably isolated type, which would have possibly, if we knew the shape of the upper carnassial, to be erected into a new genus.

At present, at least it has to be considered as a new species, for the following characters: M^1 with a well projecting, but short cingular expansion (hypocone); P_4 without metastylid nor posterior flattening of the protoconid; M_1 with elongated trigonid and basin-shaped talonid; radius relatively long and straight. To this new form, the name *L. melina* is proposed, as expressing the Badger-like appearance of the lower jaw.

Amongst the living *Lutra*, we do not know any species approaching the shape of *L. melina*. In *L. sumatrana* the upper molar has somewhat the same narrow, transversal outline. But the tooth of *L. sumatrana* is built differently, as indicated by the figure of Anderson[1]; the inner lobe of M^1 is not so expanded anteriorly as in our specimen, and there is no small cusp (metaconule) below the metacone on the same tooth.

With the fossil Otter of China, no interesting similarities can be detected. The Pontian species described by Zdansky (*L. aonychoides* Zdansky) is larger and belongs to the Aonyx Group. As for the Sanmenian *L. licenti* Teilhard and Piveteau, it differs still more from *L. melina* than *L. vulgaris* by the massive shape and the reinforced Otter characters of M^1 and M_1.

Sub-family **GULINÆ**

Genus **GULO** Storr

Gulo sp.

Pl. XI, figs. 6 and 7.

This form is new, but very rare in Choukoutien, being only recognized so far by an upper molar and a lower carnassial. Upper molar like in *G. luscus*, with the difference that

1 J. Anderson, 1878, Vol. II, Pl. XII, fig. 5.

the protocone, because both its anterior and posterior wings are equally extended, does not develop into a distinct cusp, but has the shape of a perfectly regular semi-circular ridge (Fig. 21, A, Pl. XI, fig. 7).

Lower carnassial (Fig. 21, B, Pl. XI, fig. 6) built exactly as in *Gulo luscus*, but a little more slender, and with every ridge or furrow more distinctly indicated. For instance, the rudimentary antero-internal lobe 1 (*vide* Fig. 21) is separated from the protocone by a clear sinus; and such is the talonid from the trigonid, along the inner border of the tooth.

MEASUREMENT (in mm.)

	Choukoutien *Gulo*	Living *Gulo luscus* Lin*
M^1	length of the inner lobe 6.8	7.0
	length at the junction of the inner with the outer lobe 5.7	5.8
M_1	length	
	a. paraconid 7.5	7.6
	b. protoconid 8.0	8.5
	c. talonid 4.7	3.9
	d. total 19.2	20.0
	ratio $\frac{a+b}{c}$ $\frac{7.5+8.0}{4.7}=3.29$	$\frac{7.6+8.5}{3.9}=4.18$
	breadth	
	maximum 8.2	8.8
	at junction of protoconid with the talonid. . . 6.6	7.0

* Cat. No. 135.

COMPARISON

The generic determination of the two above described teeth is sure[1]; but the specific attribution is more questionable. By the special shape of M^1 (protocone) and by the relative slenderness of the lower carnassial, the Choukoutien specimens differ slightly from the living *G. luscus*. If those features prove in future to be not individual, then a new species would possibly have to be established.

1 In *Mellivora*, the only other form which would approach our form, the M_1 is built differently; much lower, and with both internal and external cingulum much stronger.

By its geological age, the Choukoutien *Gulo* would correspond with the *G. schlosseri* Kormos recently described by Kormos from the "preglacial" beds of Hungaria (Kormos, 1932). But as far as we can judge from the pictures given, the carnassial of *G. schlosseri* does not show the antero-internal rudimentary lobe (Fig. 21, 1) so distinct in the Choukoutien species.

No fossil *Gulo* had yet been reported from China. But from the Pontian Red Clays, claose form, *Plesiogulo* Zdansky, is rather common: in Shansi (Zdansky), in E. Kansu (P.

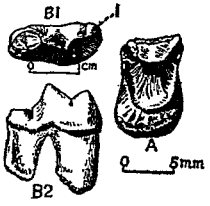

Fig. 21. *Gulo* sp.

A, crown view of M^1, × 2.....Cat. No. $\frac{C}{C.665}$

B, M_1, × 1.....Cat. No. $\frac{C}{C.666}$

B1, crown view. 1, antero-internal lobe.

B2, outer side view.

Licent). The M^1 of *Plesiogulo* is much more expanded in its internal cingular part than in *Gulo* and on the lower carnassial the talonid is less cutting (broader, with the hypocone more laterally and less centrally set.)

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien; Layer uncertain (Carnivora Layer ?). Cat. No. C.L.G.S.C. $\frac{C}{C.\ 665}$ and $\frac{C}{C.\ 666}$.

Sub-family **MUSTELINÆ**

To the Choukoutien deposits, the *Mustelinæ* are known by 3 different types[1]: two of them recovered in Locality 1 itself, the third one (*Martes* sp.) collected in the "Cap-Travertine".[2]

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1 Possibly a fourth form occurs in Locality 3 of the Choukoutien region.

2 *Vide* Teilhard and Young, 1929; and Black, Teilhard, Young and Pei. 1933.

On account of their strongly fixed characters, the members of this subfamily are almost as difficult as the Cats to determine by their osteological features only, and their classification has been somewhat obscured by modern zoologists. We shall here follow Miller's generic division, which is as follows:

* M_1 with a metaconid and with a narrow basin-shaped talonid..... *Martes*
* M_1 without metaconid, with a talonid edge-like.
** Tympanic bulla rounded, mastoid process not projecting..... *Mustela*
** Tympanic bulla triangular, mastoid process projecting..... *Putorius*

Genus **MUSTELA** L.

Mustela cf. **sibirica** Pallas

Pl. XI, figs. 2 and 4.

1930 *Mustela* (*Putorius*) sp. Pei. On a collection of mammalian fossils from Chiachiashan near Tangshan. Bull. Geol. Soc. China, Vol. IX, No. 4.

1931 *Mustela* (*Putorius*) sp. Pei. On the mammalian remains from Locality 5 of Choukoutien. Palæontologia Sinica, Ser. C, Vol. VII, Fasc. 2, p. 11, Pl. 1, fig. 3a.

This form is well represented in our series by the following materials: the frontal part of a skull, with the lower jaws in connection (teeth almost all preserved); the right lower part of another skull; two lower jaws belonging probably to one and the same individual; the distal part of a humerus; and an astragalus.

DESCRIPTION

Skull.

Size smaller than in *Putorius putorius* L. Tympanic bullæ moderately inflated and distinctly carinated in their fore half. The inner border is straight; the outer border slightly convex in the middle; the anterior border pointed near the inner edge (Fig. 22). Mastoid process not projecting. Post-orbital process weak, slightly directed backward. Inter-orbital area moderately convex, flattened in the middle. Post-orbital constriction weak. Infra-orbital foramen elongated, ovate in shape, and situated entirely behind the anterior rim of the orbit. Palatine moderately broad, its width between the molars being a little less than twice the labio-

lingual diameter of a molar; anterior palatal perforations, small, ovate, oblique, with a medium foramen relatively large, and ovate.

Upper teeth (Fig. 23, A).

Incisors and canines as in *P. putorius*.

P^2, relatively larger than in *Putorius putorius*, two-rooted, obliquely set on the alveolar border. Section oval. The main cusp rises abruptly on the anterior border.

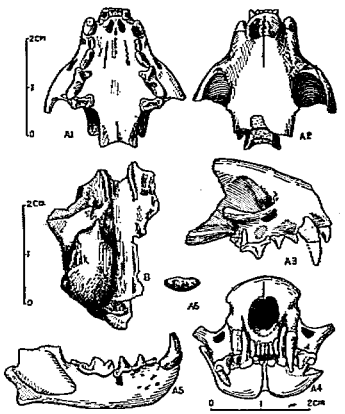

Fig. 22. *Mustela* (*Putorius*) cf. *sibirica* Pallas, natural size.

A, frontal portion of skull and mandibles.....Cat. No. $\frac{C}{C.\ 1201}$

A1, palatinal view of skull;
A2, top view of skull;
A3, right side view of skull;
A4, anterior view of skull and mandibles;
A5, side view of right mandible;
A6, crown view of right M_1.

B, basal view of broken skull, showing the shape of auditory bulla.....Cat. No. $\frac{C}{C.\ 1205}$

P^3, of an ordinary type, without metastyle.

P^4, (carnassial), more slender and cutting than in *P. putorius*. Parastyle developed only as an inconspicuous projection of the cingulum. Deuterocone as in *P. putorius*.

M^1, of the common *Mustela* or *Putorius* type, with an internal cingular rim (or lobe) moderately expanded.

Mandible.

The mandible is shorter and more massive relatively than in *P. putorius*. Coronoid process with a convex posterior margin.

Lower teeth (Fig. 23, B).

Lower premolars without metastylid. P_2 similar to P_1 and obliquely set also on the alveolar border.

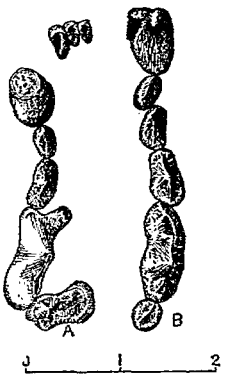

Fig. 23. Upper and Lower dentition of *Mustela (Putorius) cf. sibirica* Pallas, × 2. Cat. No. $\frac{C}{C.1201}$

A, Upper dentition, I^1—M^1,
B, Lower dentition, C—M_2.

M_1 (carnassial), slightly variable in size. Paraconid as long as the protoconid, but lower. Talonid formed by a median cutting hypoconid, slightly or not notched. No metaconid.

M_2, single rooted, slightly variable in size, with a weak longitudinal edge, slightly external in position.

MEASUREMENTS

Measurements of Choukoution *Mustela* and Manchuria living *M. sibirica* Pallas (in mm.)

(A)

	Choukoutien fossil *Mustela*		*M. sibirica* from Manchuria*
	E	A	
Skull:			
Minimum transverse diameter between the orbits	—	12.9	12.6
Transverse diameter between the canines	—	8.7	8.8
Transverse diameter of the palate between molars	—	9.6	10.3
Upper dentition:			
Width of 6 incisors	—	5.8	6.2
Length from canine to molar	—	23.2	23.9**
Length from P^2 to P^4	11.9	12.6	13.1**
Height of upper canine	—	8.5	9.1**
P^2 length	2.0	2.2	2.5**
width	1.3	1.4	1.4**
P^3 length	3.2	3.8	3.9**
width	1.7	1.8	1.9**
P^4 length	6.3	6.8	6.8**
width	3.0	3.5	3.8**
M^1 length	2.5	2.9	2.8**
width	4.5	5.2	5.0**

(B)

	Choukoutien fossil *Mustela*						*M. sibirica* Pallas* from Manchuria	
	D	C	C		A			
Mandible:								
Length from the condyle to the incisor	—	—	35.3		36.5		36.0	
Depth of the ramus under M_1	6.8	6.2	6.1		6.6		6.7	
	left	right	left	right	left	right	left	right
Lower dentition:								
Length from P_2 to M_2	—	11.0***	12.0***	11.8	—	12.3	12.4	12.4
Height of canine	—	7.0	—	8.4	8.1	8.0	8.2	8.2
P_2 length	—	—	—	2.4	2.3	2.3	2.4	2.5
width	—	—	—	1.4	1.4	1.4	1.6	1.5
P_3 length	3.3	2.8	3.1	3.2	3.0	3.1	3.2	3.3
width	2.0	1.8	1.9	1.8	1.8	1.8	2.0	2.0
P_4 length	4.3	3.6	3.8	3.9	4.2	4.1	4.2	4.4
width	2.3	2.0	2.1	2.1	2.2	2.1	2.2	2.2
M_1 length	8.0	7.1	7.4	7.6	7.7	7.5	7.8	7.8
width	3.0	2.6	2.7	2.6	2.7	2.6	2.7	2.7
length of talonid	2.2	1.9	1.9	1.8	1.9	1.8	1.9	1.9
M_2 length	1.9	—	1.7	1.6	—	1.9	1.7	1.8
width	1.9	—	1.7	1.5	—	1.9	1.7	1.8

* Cat. No. 377 ** Right side *** By alveolus or alveoli

HORIZON AND LOCALITY: Upper Polycene of the *Sinanthropus* site at Choukoutien. Layers: 5, Lower Fissure and Lower Cave. Cat. No. C.L.G.S.C. $\frac{C}{C.1201}$—$\frac{C}{C.1208}$.

COMPARISON

1. *Comparison with living forms.*

The fossil remains described above evidently (cf. the shape of M_1 and the tympanic bulla) belonged to the genus *Mustela* as defined by Miller, and very close indeed to the living *M. sibirica*.[1] For comparison with this latter species, we have been using in addition to the descriptions given by Radde (1862) and Milne-Edwards (1868-1874) five skulls collected in Manchuria and determined by Miss von Lude in Harbin. Between the living form and the Choukoutien fossil, the likeness is almost complete, both for the size and the shape. In the fossil *Mustela*, however, the hypoconal lobe of M^1 is distinctly less expanded, and the anterior half of the bulla is more carinated (triangular in section) than in the Manchurian form. *M. sibirica* is actually found in Siberia, Central China, and Japan (Gray, 1865). No other Asiatic *Mustelinæ* we know would approach our fossil more closely. In *Putorius eversmanni* Lesson, the post-orbital constriction seems to be more abrupt and more strong than in the Choukoutien form. In *P.* (*M.*) *alpinus* Gebler, *P. davidianus* M.-Edwards and *P. astutus* M.-Edwards the size is insufficient. *P. moupinensis* M.-Edwards, is also too small; and in addition, its bulla is more inflated, and more triangular in its contour than in our specimens.

With the *P.* (*Ictis* by Trouessart) *fontanieri* M.-Edwards from the Peiping area, no comparison is possible because the form was described only by skin.

2. *Comparison with fossil forms.*

In spite of the fact that their zoological type is apparently as old as the final Oligocene at least (true small *Mustelinæ* in which M_1 has no metaconid occur in the Agnitanian of France), no *Mustela* nor *Putorius* but only *Martes* (e.g. *Martes anderssoni* Schlosser), are reported so far in N. China in the Late Cenozoic (Pontian) deposits. *Proputorius minimus* Zdansky from Shansi (Zdansky, 1924) has a metaconid preserved on M_1, and consequetly is also a *Martes*-like species.

---

1 *Mustela sibirica* Pallas 1767, in *Spicilegia zoologica*. *Vison sibirica* Gray, 1865. *Putorius sibiricus*, M.-Edwards, 1868-1874. *Lutreola*, Trouessart, 1898-1905. The name *Mustela sibirica* seems to be generally adopted. However, several Russian authors, for some reason, prefer the name *Colonocus sibiricus* (personal communication from Miss von Lude of Harbin).

Mustela (or **Putorius**) sp.

The second type of Weasel found in Locality 1 is only represented so far by a single lower jaw, with P_3—M_1 preserved. On M_1 there is no trace of metaconid, and the trenchant talonid, rather long, is slightly notched. Size much smaller than in *M. sibirica*, somewhat the same as in *Foetorius vulgaris* Blaeius (= *Mustela nivalis* L., *vide* Miller, 1912, p. 403).

In the absence of any knowledge of the skull and of the tympanic area, even a precise generic definition of this form is impossible.

MEASUREMENTS

	P_3	P_4	M_1	talonid of M_1
length	1.5 mm. (?)	1.9 mm.	3.6 mm.	1.2 mm
width	0.8 mm.	1.0 mm.	1.2 mm.	——

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien. Layer: Lower Cave. Cat. No. C.L.G.S.C. $\frac{C}{C.1209}$.

Genus **MARTES**

Martes sp.

Two broken lower jaws belonging to the same individual of a *Martes* (Fig. 24) have been collected in the "Cap-Travertine", together with rich Chiroptera remains, on the hill top, south of Locality 1. M_1 with a well formed metaconid; talonid, less cutting and somewhat basin-like.

DIMENSION (in mm.)

	P_4	M_1
length	6.2	9.1
breadth	3.0	4.2

HORIZON AND LOCALITY: (?) Early Choukoutien formation (Upper Polycene). Layer: "Cap Travertine" on the hill top, south of the *Sinanthropus* site at Choukoutien. Cat. No. C.L.G.S.C. $\frac{C}{C.1855}$.

By the size and shape, this specimen stands very close to the fossil *M. anderssoni* from the Lower Pliocene of Chiton-Gol (Teilhard, 1926) and the Middle Pliocene of Ertemte (Schlosser, 1924). But it might just as well belong to some living form.

This is a noticeable fact that, whilst the small types of *Martes* have been spanning, practically without any change, the Pliocene times, such big forms as the Pontian *Mustela* (*Martes*) *palæosinensis* Zdansky and the Sanmenian *M.* (*Martes*) *pachygnatha* Teilhard and Piveteau have entirely disappeared at the beginning of the Pleistocene.

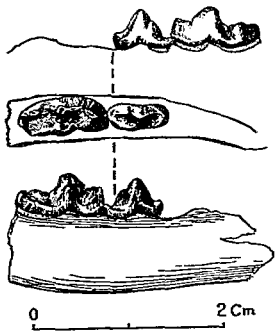

Fig. 24. *Martes* sp., broken mandible with P_4 and M_1 from the "Cap", × 2/1.

KEY TO THE CHOUKOUTIEN *MUSTELIDÆ*

(A) P^4 triangular in shape; inner cingulum of M^1 largely expanded and surrounding the protocone; M_1 with a strong metaconid, a trigonid transversely elongated, and a large basin-shaped talonid . . . . . *Meles leucurus* . . PP. 72-76

(B) P^4 unknown; inner cingulum of M^1 rather large, but not extending in front of the protocone. M_1 with a metaconid moderately strong, a trigonid somewhat triangular in shape, and a talonid relatively cutting . . . . . *Lutra melina* . . PP. 76-80

(C) P^4 elongated in shape; inner cingulum of M^1 weakly expanded; M_1 with a weak or without metaconid.

(a) M_1 without metaconid and with a talonid more or less cutting.

1) M_1 with a talonid less cutting, size large . . . . . *Gulo* sp. . . PP. 80-82

2) M_1 with a talonid very cutting and size small.

* size relatively large . . . . . *Mustela* cf. *sibirica* . . PP. 83-87

* size small . . . . . *M.* sp. indet . . P. 88

(b) M_1 with a metaconid and with a talonid basin-like . . . . . *Martes* sp. . . PP. 88-89

Family HYÆNIDÆ

Genus HYÆNA L.

Before starting a detailed study of the Choukoutien Hyænas, we have to make the following preliminary observations:—

(1) A phylogeny of the *Hyæna* has been tried several times by distinguished palæontologists such as Professor Boule (1893) and Dr. Pilgrim (1932, Pl. X). Useful as they are, those attempts to reduce the fossils forms to a few linear series leading to the living *H. crocuta, striata, brunnea,* prove more and more to be too simple. Almost every type of *crossed* combinations can be found in the genus for dental characters such as: relative length of the carnassial blades, reduction in size or cutting shape of the lower carnassial's heel, persistence or disappearance of the metaconid. The Hyænas (as every zoological group richly represented) should be figured diagramatically not as a "faisceau" but as a "net" of forms (cf. Teilhard and Piveteau, 1930, p. 103).

(2) In such a net, it would be impossible, in most cases, to trace any isolated thread over a long period. More easy and useful on the other hand is the distinction of some *morphological* stages which (because successively reached in time) seem to characterize the history of the genus *as a whole.* For our present purpose, three such stages are recognizable in Eastern Asia:

a) The *variabilis* stage (*H. variabilis* Zdansky), dominant in the entire group of the Pontian *Hyæna* of Europe and Asia: carnassial blades moderately expanded; molars and premolars relatively slender (metaconid present or absent, lower carnassial's heel long or short etc.).

b) The *sinensis* stage (*H. sinensis,* Choukoutien type), dominant everywhere in the Late Pliocene and Lower Pleistocene forms of China, India, and W. Europe (*H. perrieri, arvernensis, brevirostris,* etc.): carnassial blades moderately expanded; molars and premolars very thick (metaconid present or absent, heel long or short, cutting or not cutting).

c) The true *crocuta* group, typically Pleistocene, with much elongated carnassial blades (and heel not cutting on M_1).

N.B. In his recently published phylogeny of the Hyæna (a Table with no explanation) Dr. Pilgrim (1932, Pl. X) extends the *crocuta* group to the entire group of forms included by us in the "*sinensis* stage," a little diffusively we think. In the present paper we shall exclusively use the name in the restricted meaning indicated above in (c).

(3) Concerning the modifications of the lower carnassial tooth in the *Hyæna*, it has to be observed that the passage from the originally tricuspid ("Viverrine") heel to a trenchant heel is obtained in a rather peculiar way. The cutting edge of the heel is distinctly set not on the labial (as in dogs, cats, etc.) but on the lingual side of the tooth. As proved by an easy comparative study, this disposition is not due to an abnormal connection of the protoconid with the endoconid, but to a shifting of the hypoconid towards the lingual part of the heel. As a result of this readjustment, the vestigial metaconid becomes included in the posterior trenchant edge of the tooth, and a more or less extensive flat area ("external area") is produced labially, acting as an antagonist for the upper molar. This feature is especially clear in the milk teeth (DP_4).

Hyæna sinensis Owen (emend. Zdansky)

Pl. XIV, fig. 1; Pl. XV, figs. 3-5; Pl. XVI, figs. 2-4; Pl. XVII, fig. 1; Pl. XVIII, fig. 1; Pl. XIX. figs. 1-3; Pl. XX, figs. 1-6; Pl. XXI, figs. 1-8.

1925 *Hyæna ultima* Matsumoto, Zdansky (mandible). Quartäre Carnivoren aus Nord-China. Palæontologia Sinica, Ser. C, Vol. II, Fasc. 2.

1927 *Hyæna sinensis* Owen, Zdansky. Weitere Bemerkungen über fossile Carnivoren aus China. Palæontologia Sinica, Ser. C, Vol. IV, Fasc. 4.

1928 *Hyæna sinensis* Owen, Zdansky. Die Säugetiere der Quartärfauna von Choukoutien. Palæontologia Sinica, Ser. C, Vol. V, Fasc. 4, pp. 42-47; Taf. III, Figs. 10-21; Taf. IV, Figs. 1-4.

The remains of *Hyæna sinensis* Owen, one of the most typical forms in the Choukoutien main deposits, have been collected in an extraordinarily great number during the recent excavations made in the lower levels, such as Lower Cave and Lower Fissure. It is the most dominant animal in the Choukoutien deposit. Isolated teeth, isolated limb and foot-bones, broken mandibles and skulls are most numerous. Judging by the number of astragali, the collection represents at least two thousand individuals of different ages. In an excellent stage of preservation are: 1 almost complete skeleton (Fig. 31, p. 102), 8 skulls, more than one hundred undamaged lower jaws and some tens of complete limb and foot-bones.

DESCRIPTION

Skull (Fig. 25).

Skull large, with a broad muzzle and a remarkably narrow and deep brain case. Nasalia short and extended backward, not so far as the hinder termination of the maxillæ.

Pre-maxillæ in contact with frontal. Frontal area, as well as nasal, gently convex in adult. Postorbital process variable: generally short and pointed laterally (Pl. XVII, fig. 1b; and Pl. XVIII, fig. 1b) and sometimes long, slender (Fig. 25A), and somewhat pointed backward (Pl. XIV, fig. 1b). Sagittal crest and ridge usually high and prominent. Brain case extremely narrow and deep. Occiput narrow and high. Palatine broad and slightly concave.

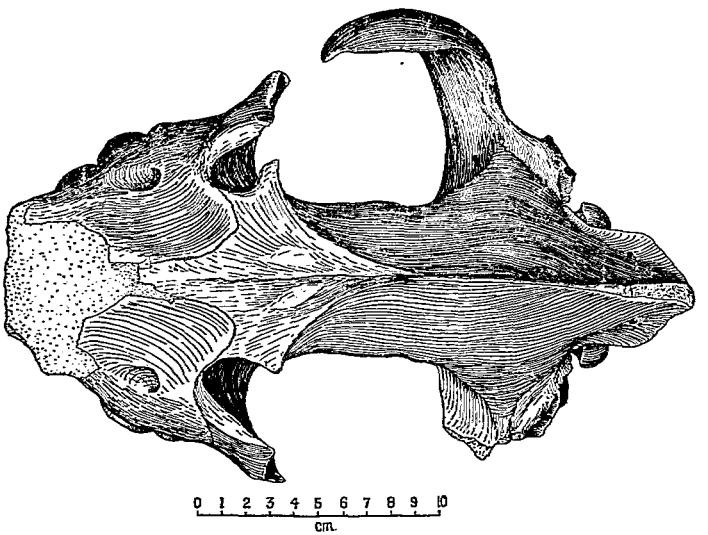

Fig. 25, A. *Hyæna sinensis* Zdansky, skull, × 1/2;
Top view.

Skull (juv.).

As noted above the skull of an adult individual is very characteristic in having a very narrow but deep brain case. In a young individual, the brain case is oval in shape, considerably broad and low (Pl. XIX, fig. 3a), the sagittal crest not yet developed. Other parts do not change very much with the age.

Upper Permanent Dentition (Fig. 25, B).

Incisors and upper canines of the ordinary *Hyæna* type; but size larger than in the living *Crocuta* and in *H. ultima* Matsumoto.

P^1, always present; transverse diameter greater than longitudinal; set at the middle of the space between P^2 and C, or behind.

P^2, with weak anterior and posterior accessory cusps; and with a faint inner cingulum

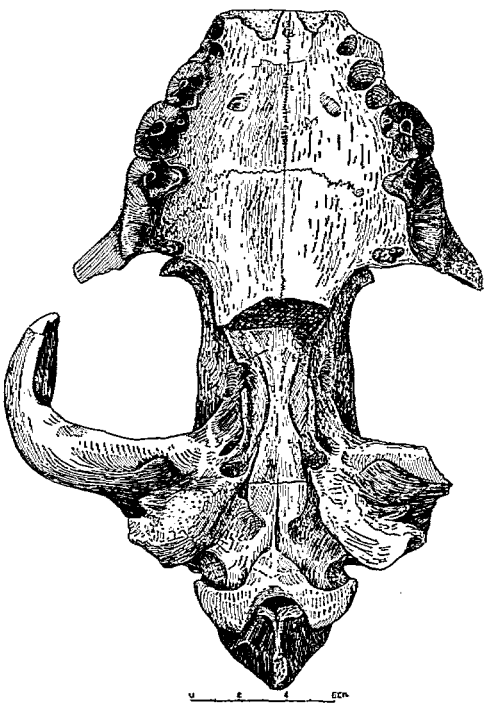

Fig. 25, B. *Hyæna sinensis* Zdansky, skull. × 1/2;
Palatinal view.

P^3, with anterior and posterior accessory cusps distinct and almost equally developed, without posterior cingulum; inner cingulum very weak.

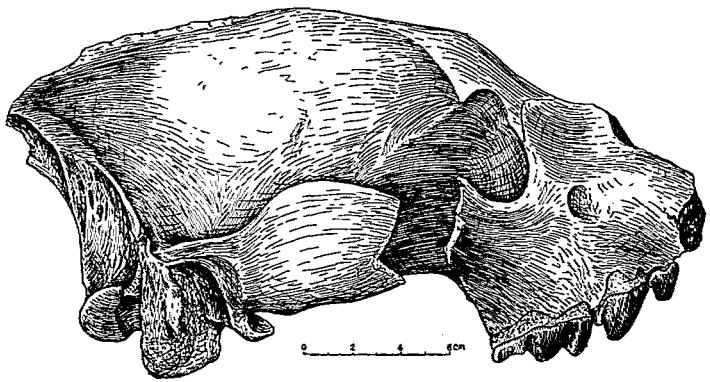

Fig. 25, C. *Hyæna sinensis* Zdansky, skull. × 1/2;
Lateral view.

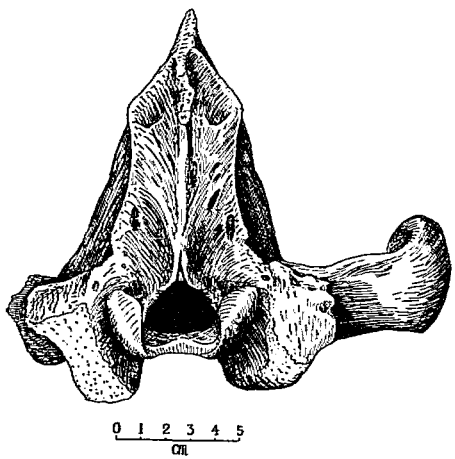

Fig. 25, D. *Hyæna sinensis* Zdansky, skull, × 1/2;
Occipital view.

P^4, strong, thick and short. Aside of the smaller relative variation checked below in Table F of measurements (pp. 107 and 108,) the dominant characters of the tooth are as follows: parastyle (first lobe) almost as long as the protocone (second lobe); tritocone (third lobe) scarcely longer than the protocone. Deuterocone relatively small.

M^1, with three distinct cusps; size and shape greatly variable as shown in Fig. 26.

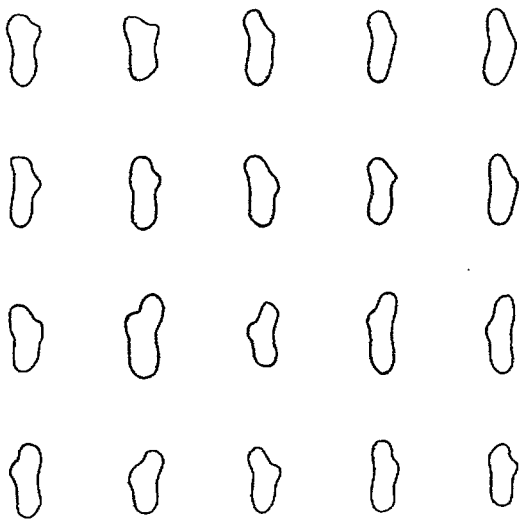

Fig. 26. *Hyæna sinensis* Zdansky. Outline of a series of M^1, showing the variation in shape. × 1/1.

Lower Permanent Teeth (Fig. 27).

The lower incisors and canines are of an ordinary *Hyæna* type, but the size is larger than in the living *Crocuta* and the fossil *H. ultima*.

P_1, always absent.

P_2, large; outline oval; anterior half scarcely smaller than the posterior one; main cusp large; anterior accessory cusp (parastylid) indistinct but somewhat large; posterior accessory cusp (metastylid) distinct but relatively small.

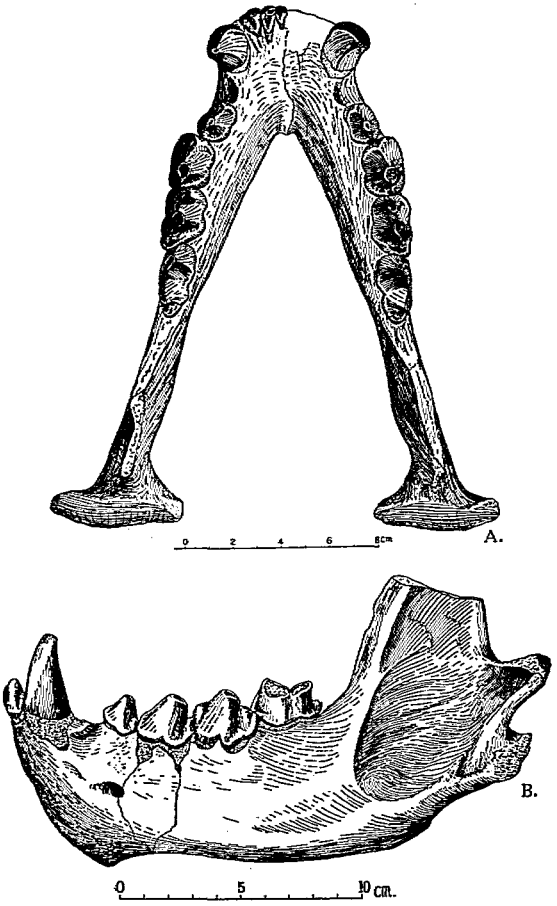

Fig. 27. *Hyæna sinensis* Zdansky. Mandible. × 1/2, showing the right M_1 with but the left one without a rudimentary metaconid.

A, top view;

B, lateral view.

P_3, with anterior accessory cusp (parastylid) small and indistinct, and with small posterior one (metastylid).

P_4, with both anterior and posterior accessory cusps distinct and larger; posterior cingulum faint.

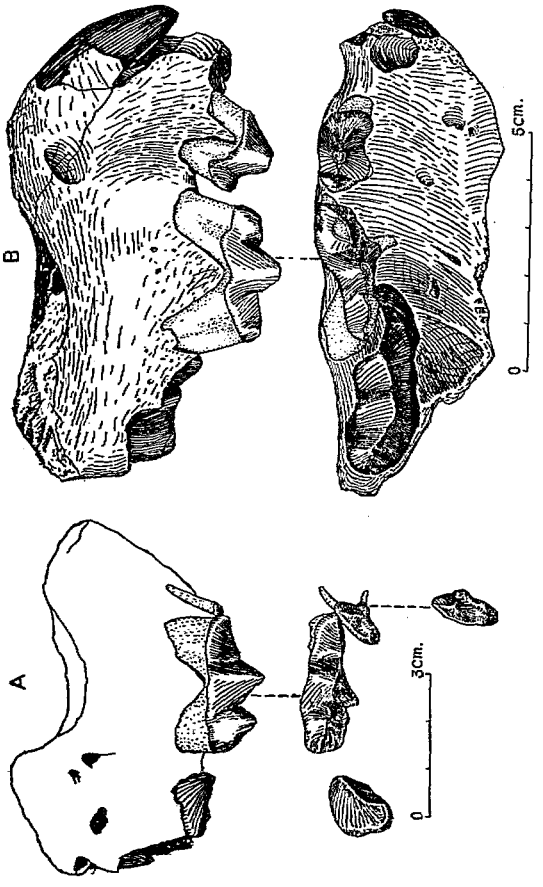

Fig. 28. *Hyæna sinensis* Zdansky. Two broken maxillæ with milk dentition, × 1/1.

M_1, with paraconid large and of the same size as the protoconid; protoconid relatively small and low; a vestigial metaconid exceptionally present (on about 5 specimens)[1]; talonid short and cutting, the hypoconid being the only distinct cusp. Posterior cingulum faint.

Upper Milk Teeth (Fig. 28).

DP^2, crown pointed backwards in an early stage of development (Pl. XIX, fig. 1; and Fig. 28A); gradually shifting; and pointed downward when grown up. Anterior accessory cusp (parastyle) indistinct and forming an antero-internal projection. Posterior accessory cusp (metastyle) distinct (Fig. 28B and Pl. XIX, fig. 3C).

DP^3, deuterocone absent, only a trace of it, supported by an inner root. Parastyle large and with an inner cingulum. Protocone lightly longer than parastyle and almost equal to tritocone. Tritocone low and cutting (*vide* Fig. 28 and Pl. XIX, figs. 1 and 3).

DP^4, shape and size very variable. Paracone and metacone forming an almost transverse ridge. Protocone (inner portion) forming a crescentic ridge; size large or small.

Lower Milk Teeth (Figs. 29 and 30).

DP_2, early stage as in DP^2, that is, with the tip first pointed backward and then gradually shifting upward. Shape similar to DP^2 but posterior accessory cusp (metastylid) less distinct.

DP_3, anterior accessory cusp (parastylid) large and distinct, posterior accessory cusp small and with a posterior cingulum.

DP_4, paraconid and protoconid equal in size, but the latter higher than the former; metaconid absent; *talonid cutting with only one central trenchant cusp* (hypoconid).

Skeleton bone[2] (Figs. 31 and 32).

As indicated by the measurement made for the complete isolated and adult specimens, the size of the skeleton bone of *Hyæna sinensis* is found rather constant (*vide infra*). On

1 In one specimen this vestigial metaconid is present only on one side of the jaws (Pl. XVI, fig. 2a and Fig. 27). Whenever this cusp is strongly developed, we refer the specimen to *H. zdanskyi* (*vide infra*).

2 Since a study of all the broken limb-bones belonging to the present form should have been impossible and unnecessary, I have restricted my investigations to the complete and adult specimens only: *complete*, that is, in which the three chief measurements (length, proximal and distal breadths) are possible; *adult*, that is, in which the epiphysis is fused.

another hand I did not notice on them any exceptional features, so that very little has to be said for their description, though they are represented by a great number of material.

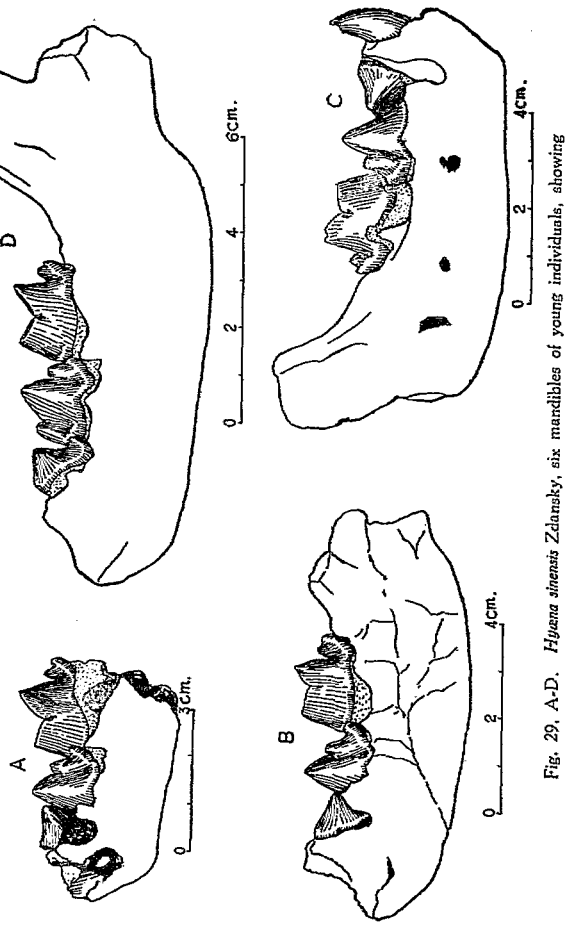

Fig. 29, A-D. *Hyaena sinensis* Zdansky, six mandibles of young individuals, showing the development stages (from A to F) of milk teeth, x 1/1.

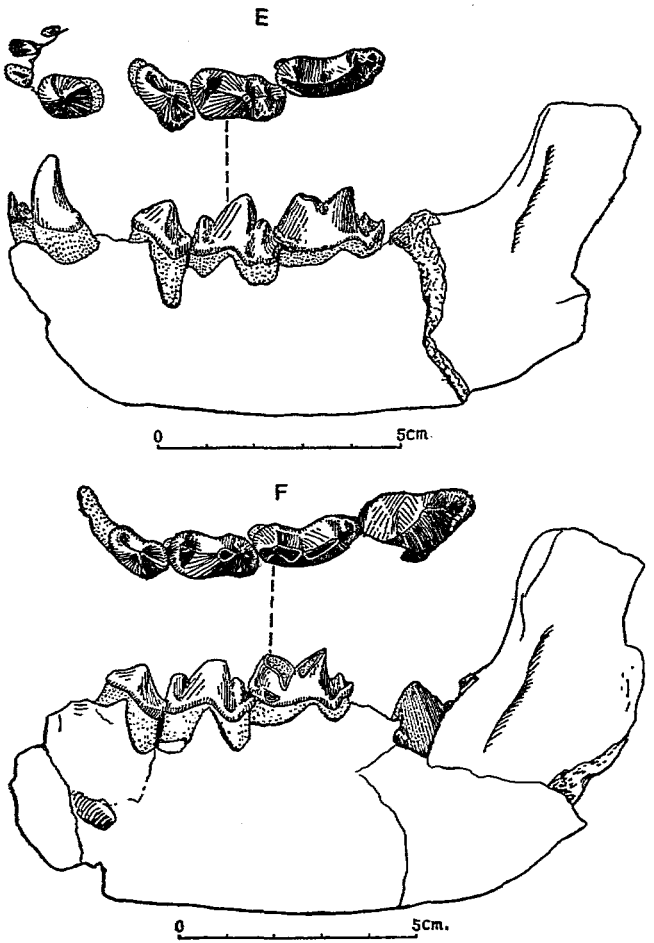

Fig. 29, E and F. *Hyæna sinensis* Zdansky, six mandibles of young individuals, showing the development stages (from A to F) of milk teeth, × 1/1.

Vertebræ: In addition to the atlas (Pl. XVI, fig. 4) and the axis (Pl. XV, fig. 5) belonging to the complete skeleton, 34 more or less complete specimens of the former and 12 complete ones of the latter have been found in isolated condition.

Scapula: 3 complete specimens: one reaches 267.0 mm in total length, and 54.6 mm in maximum diameter of the articular fossa for humerus (Pl. XXI, fig. 1).

Humerus (Pl. XXI, fig. 2): Besides the specimen belonging to the complete skeleton, the humerus is represented by 7 complete specimens. They vary from 270.0 mm to 295.0 mm in total length.

Ulna: One complete ulna of a young individual (Pl. XV, fig. 4) and 12 of adults were collected. The adult ones vary from 273.0 mm to 294.0 mm in total length (Pl. XXI, fig. 3).

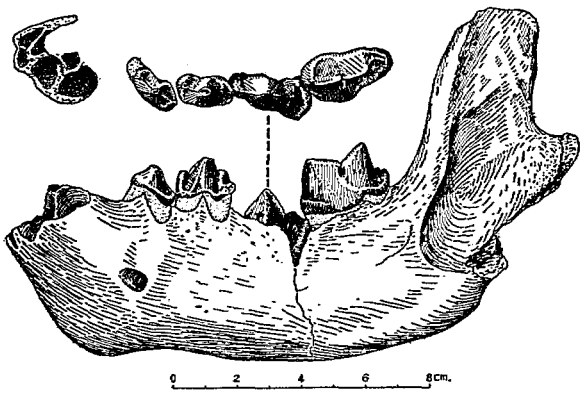

Fig. 30. *Hyæna sinensis* Zdansky, mandible with milk premolars and permanent molar, × 2/3.

Radius (Pl. XXI, fig. 4): Slightly variable in the shape of the upper and lower facet and of the shaft. 22 adult and complete specimens in our collection. Size variable from 243.0 mm to 265.0 mm in total length.

Innominate bone: Only represented by broken specimens (Pl. XXI, fig. 5).

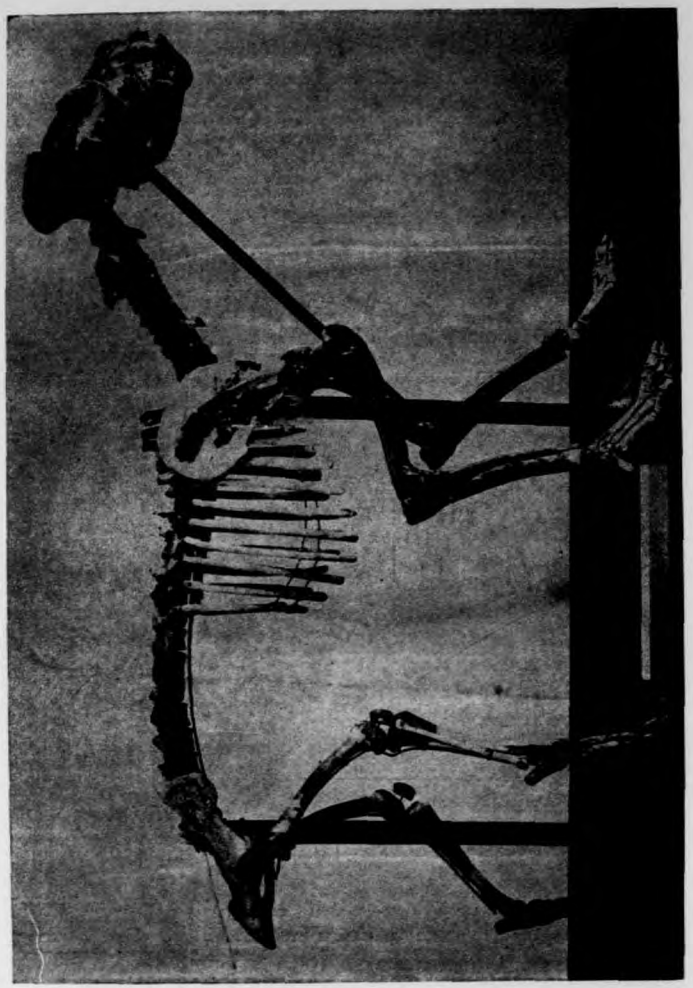

Fig. 31. *Hyæna sinensis* Zdansky, an almost complete skeleton, about 1/7.

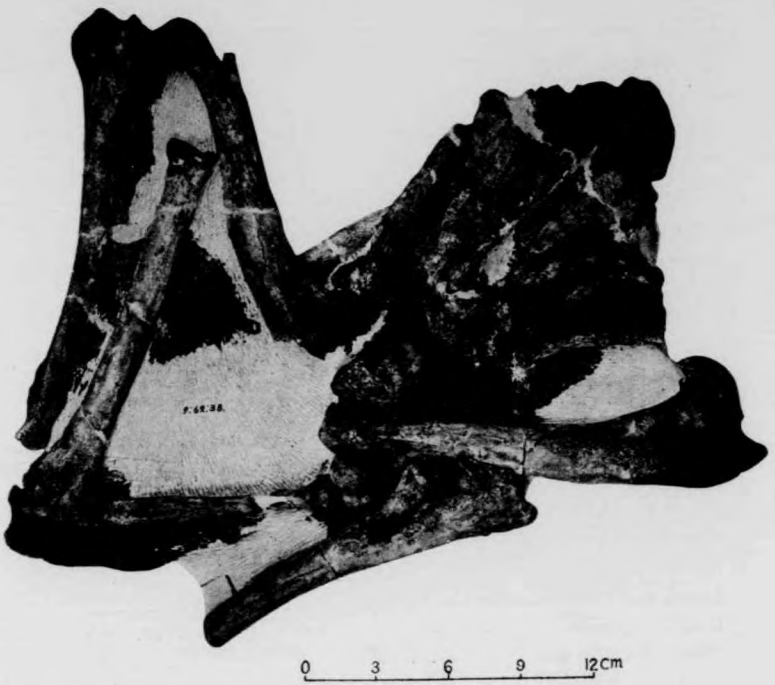

Fig. 32. *Hyæna sinensis* Zdansky, anterior limb-bones, × 1/2.

Femur (Pl. XXI, fig. 6): the curvature of the shaft and also the shape and position of the tubercles are slightly variable. 10 complete and adult specimens represented. The total length varies from 276.0 mm to 313.0 mm.

Tibia (Pl. XXI, fig. 7): 26 complete adult and isolated specimens. The total length varies from 209.0 mm to 228.0 mm.

Fibula: No complete specimen collected.

Calcaneum: Represented by 329 complete specimens. The total length varies from 66.0 mm to 78.0 mm.

Astragalus: Represented by 571 complete specimens. Length from 45.3 mm to 49.8 mm.

Metacarpus and Metatarsus: Represented by several complete feet; isolated bones numerous.

Carpus and Tarsus Bones: Known by several complete feet and numerous isolated pieces.

MEASUREMENTS (in mm.)

A. An almost complete skeleton (Cat. No. $\frac{C}{C.\ 1331}$, Fig. 31)

Skull (Pl. XIV, fig. 1).

Total length	351.0
Maximum breadth of the muzzle	85.0
Minimum breadth of the inter-orbital region ..... 35.0 × 2 =	70.0
Maximum breadth of the brain case	79.0
Breadth of palatine between P^4	88.0
Maximum depth of the brain case	119.0
Length from I^1 to M^1	149.5
Length and breadth of I^1	8.4 and 6.4
Length and breadth of I^2	10.6 and 9.0
Length and breadth of I^3	17.0 and 15.5
Length and breadth of C	21.0 and 17.0
Length and breadth of P^1	7.2 and 9.1
Length and breadth of P^2	20.5 and 14.4
Length and breadth of P^3	29.0 and 20.0
Length and breadth of P^4	44.1 and 25.5
Length and breadth of M^1	7.4 and 14.4

Mandible (Pl. XV, fig. 3).

Total length from I_1 to condyle	254.0
Length from P_2 to M_1	89.7
Length and breadth of I_1	7.3 and 5.2
Length and breadth of I_2	8.6 and 7.0
Length and breadth of I_3	11.0 and 9.8
Length and breadth of C	20.0 and 18.0
Length and breadth of P_2	18.0 and 13.2
Length and breadth of P_3	26.0 and 18.0
Length and breadth of P_4	28.0 and 17.1
Length and breadth of M_1	28.3 and 15.2

Vertebræ:

Axis, length	80.4
Atlas, length	63.0
Length from axis to 3rd dorsal vertebra	360.0

Limb-bones.

Scapula, length	270.0
Humerus, length	275.0
Ulna, length	294.0
Radius, length	293.0
Fore-foot, length	210.0
Femur, length	290.0
Tibia, length	215.0

B. Two skulls

	Cat. No. $\frac{C}{C.\ 904}$ Pl. XVIII, fig. 1.	Cat. No. $\frac{C}{C.\ 905}$ Pl. XVII, fig. 1
Total length	280.0	318.0
Maximum breadth between the zygomatic arches	205.0	—
Minimum breadth of the inter-orbital region	64.0	72.0
Maximum breadth of the brain case	79.0	85.3
Breadth of palatine between P^4	73.0	81.4

Maximum depth of the brain case	114.0	116.0
Length from P^1 to M^1	88.0	95.0
Length and breadth of P^1	—	7.2 and 9.0
Length and breadth of P^2	19.0 and 14.0	20.0 and 19.0
Length and breadth of P^3	26.0 and 19.0	28.0 and 20.2
Length and breadth of P^4	43.3 and 24.2	45.0 and 25.0
Length and breadth of M^1	8.6 and 14.2	8.0 and 15.0

C. A skull of a young individual (Cat. No. $\frac{C}{C.\ 1384}$, Pl. XIX, fig. 3)

Minimum breadth of the inter-orbital region	49.0
Maximum breadth of the brain case	72.6
Breadth of palatine between DP^4	67.7
DP^2, length and breadth	19.0 and 16.5
DP^3, length and breadth	28.0 and 10.8
DP^4, length and breadth	10.5 and 14.7

D. A mandible (Cat. No. $\frac{C}{C.\ 806}$, Pl. XVI, fig. 2)

Total length from I_1 to condyle	233.0
Length from P_2 to M_1	82.0
Length and breadth of P_2	18.0 and 9.0
Length and breadth of P_3	24.0 and 17.0
Length and breadth of P_4	27.3 and 18.0
Length and breadth of M_1	29.6 and 15.0

E. Milk dentition

Broken maxilla (Cat. No. $\frac{C}{C.\ 1337}$, Pl. XIX, fig. 1)

DP^3, length and breadth	28.4 and 9.5
DP^4, length and breadth	8.8 and 13.2

Mandible (Cat. C.L.G.S.C. $\frac{C}{C.\ 1340}$, Pl. XX, fig. 4).

DI_1, length and breadth	—	and —
DI_2, length and breadth	4.0	and 3.2
DI_3, length and breadth	4.3	and 5.3
DC, length and breadth	8.1	and 7.2
DP_2, length and breadth	14.6	and 8.0
DP_3, length and breadth	18.2	and 8.7
DP_4, length and breadth	20.6	and 8.0

Mandible (Cat. No. C.L.G.S.C. $\frac{C}{C.\ 1333}$, Pl. XX, fig. 5)

DP_2, length and breadth	15.0	and 8.2
DP_3, length and breadth	18.4	and 9.4
DP_4, length and breadth	20.1	and 8.3
M_1, length and breadth	29.2	and 16.3

F. Relative length of the three lobes of P^4

Amongst our thousands of specimens, 59 upper jaws with a complete series of premolars and molars, and 100 complete isolated P^4 were picked out and carefully measured. length and breadth of each tooth and the length of three lobes of P^4. The result of this investigation can be summarized as follows:

Total length of P^4:

Minimum amongst 159 specimens:

Total length of P^4	41.0 mm	(Cat. No. $\frac{C}{C.\ 750}$)
length of 1st lobe of P^4	13.0 mm	
length of 2nd lobe of P^4	13.5 mm	
length of 3rd lobe of P^4	15.0 mm	

Maximum amongst 159 specimens:

Total length of P^4	46.1 mm	(Cat. No. $\frac{C}{C.\ 794}$)
length of 1st lobe of P^4	15.5 mm	
length of 2nd lobe of P^4	14.5 mm	
length of 3rd lobe of P^4	16.2 mm	

Proportion of P^3:

Group I (1st lobe<2nd lobe)	14 specimens
Group II (1st lobe=2nd lobe)	77 specimens
Group III (1st lobe>2nd lobe)	68 specimens
Group A (3rd lobe>2nd lobe)	149 specimens
Group B (3rd lobe=2nd lobe)	9 specimens
Group C (3rd lobe<2nd lobe)	1 specimen
Group IA (1st lobe<2nd lobe and 3rd lobe>2nd lobe)	11 specimens
Group IB (1st lobe<2nd lobe and 3rd lobe=2nd lobe)	3 specimens
Group IIA (1st lobe=2nd lobe and 3rd lobe>2nd lobe)	71 specimens
Group IIB (1st lobe=2nd lobe and 3rd lobe=2nd lobe)	5 specimens
Group IIC (1st lobe=2nd lobe and 3rd lobe<2nd lobe)	1 specimen
Group IIIA (1st lobe>2nd lobe and 3rd lobe>2nd lobe)	67 specimens
Group IIIB (1st lobe>2nd lobe and 3rd lobe=2nd lobe)	1 specimen

From the above table we can learn that the most common case is the *Group IIA*, 71/159=44.7% and *Group IIIA*, 67/159=42.1%.

N. B. When the difference between two measurements is less than 0.5 mm, they are supposed to be *equal*.

HORIZON AND LOCALITY: Upper Polycene of the *Sinanthropus* site at Choukoutien; Layers: very abundant in Lower Cave and in Carnivora Layer of Lower Fissure. Also found in Layers 5, 6, 7, 8, 9 and Kotzetang Cave. Cat. No. C.L.G.S.C. $\frac{C}{C.\ 701}$—$\frac{C}{C.\ 908}$ and $\frac{C}{C.\ 1488}$—$\frac{C}{C.\ 1497}$.

COMPARISON

(1) *The species H. sinensis: history of the name and re-definition of the type.*

As in the case of several other Chinese fossil forms, the species *Hyæna sinensis* Owen was first erected on the basis of an insufficient material and consequently a series of specimens from different localities and different types were referred to the same type by later authors in a very confusing way. A short historical summary of the different meanings in which this name has been used is therefore necessary. The originals of Owen's specimens, a few uncharacteristic premolars, were probably collected somewhere in Ssuchuan; and soon after Koken (1885) described under the same name several teeth, including an upper and lower

carnassial, from Yunnan (possibly Ssuchuan). In 1903 Schlosser mentioned some *Hyæna* premolars, coming from an unknown locality and referred them to the same species. Later (1915) a new species, *Hyæna ultima*, was established by Matsumoto upon a P^4, probably found in the same area as Owen's type specimens of *H. sinensis* in Ssuchuan. When in 1923 Matthew and Granger made the preliminary study of their important collection of mammal fossils from Wanhsien, Ssuchuan, they mentioned without any special description, the presence of *H. sinensis*. In 1925 Zdansky described under the name *H. sinensis* some well preserved specimens of *Hyæna* from Shansi (Localities 105 and 106, Yuanchuhsien) and later he recognizes correctly the same type, first among excellent material from Changchihsien, Shansi (1927) and finally (1928) among some specimens collected in Choukoutien. In the meantime (1930) Teilhard and Piveteau described the Sanmenian *Hyæna* from Nihowan also as *H. sinensis* in the sense this name was used by Zdansky (not by Owen). This would now appear to have been incorrect (*vide infra*).

Using the knowledge of these several facts and the satisfactory material actually accumulated:

a) We consider that Owen's species is not valid because insufficiently defined, and we accept the species *Hyæna sinensis*, re-defined and re-described by Zdansky, on the material from Choukoutien, Yuanchuhsien, and Changchihsien in North China. The name used further on in this paper therefore will be *H. sinensis* Zdansky.

b) We are able now (*vide infra*) to recognize that the *Hyæna* from Ssuchuan referred by Matthew and Granger to *H. sinensis* Owen is the same as *H. ultima* as defined first by Matsumoto, and later (1925 and 1927) by Zdansky in a specimen found in Shansi. Of course if Owen's specimens were collected from the same horizon as the material of Matthew and Granger, Owen's uncharacteristic material of *H. sinensis* might belong to *H. ultima* too. But that can not be proved in a satisfactory way.

c) Koken's specimens from Yunnan are referable to a form very different from *H. ultima* and possibly rather close to the group of Indian fossil *Hyæna* (*H. sivalensis*); unless (*vide infra*) they have better be regarded as representing a *southern form* of *H. sinensis* Zdansky. In the present paper, we shall call the type: *Hyæna sinensis* Zdansky, *Southern race*.

d) The Sanmenian *Hyæna* from Nihowan determined by Teilhard and Piveteau as

H. sinensis, shows the characters of a new form ancestral to *H. sinensis* Zdansky and is redefined as a new species *H. licenti*[1] in this paper (*vide infra*, p. 120).

(2) *Differential characters of H. sinensis Zdansky from Choukoutien.*

On the whole this is a clearly defined form (understood with the new definition given by Zdansky, *H. sinensis*, as found for example in Choukoutien) well determined, clearly recognizable, and clearly separable from the other *Hyænas* of China. It differs:

From *H. ultima* Matsumoto (of the *crocuta* group, *vide infra*) by a much shorter blade in the carnassial teeth, and by a shorter and trenchant (not bicuspid nor tricuspid) heel of M_1.

From *H. zdanskyi* Pei (*vide infra*) by a smaller M^1, a smaller deuterocone at P^4, and probably also by very different DP_4 and M_1.

From *H. licenti* Pei (*vide infra*) by a larger size, and the shape of the heel of M_1 (longer and still tricuspid in *H. licenti*).

The closest analogy would probably be found with *H. sivalensis*. In *H. sivalensis* and *H. sinensis* not only the shape of the mandible and the outline of M^1 and P^4, but also the size of the accessory cusps of the premolars are the same.[2] In *H. sivalensis* as in *H. sinensis* (southern race of Koken) the metaconid of M_1 is still well recognizable; but even this character reappears occasionally on the Choukoutien specimens.

The European Upper Pliocene Hyænas, *H. avernensis*, *H. perrieri* and *H. brevirostris*, although belonging to the *sinensis* group, stand close to *H. licenti* by the presence of three small cusps on the talonid of M_1.

Hyæna zdanskyi Pei (sp. nov.)

Pl. XIII, fig. 1; Pl. XV, figs. 1 and 2; Pl. XVI, fig. 1;
Pl. XVIII, figs. 2 and 3; Pl. XX, fig. 7.

MATERIAL

The skull of a young individual with permanent premolars and molar (type skull), a broken upper jaw (paratype), another broken maxilla, several complete lower jaws (tenta-

1 I am very glad to dedicate this specific name to Pere E. Licent who collected the Nihowan fossils and who has been so kind as to allow me to study his collection.

2 According to Pilgrim, *H. sinensis* differs from *H. sivalensis* in the absence of P^1 (Pilgrim, 1932, p. 137), but all the specimens of our Choukoutien *Hyæna* bear a P^1.

tively referred to the same form), and possibly an isolated lower milk carnassial, represent a distinct form of *Hyœna*, closely related to *H. sinensis*, but different from it in some important characters.

DESCRIPTION

Skull (type) (Fig. 33).

The type skull of this new species differs from a skull of *H. sinensis* of the same age by a much smaller size and a much more "swollen" shape. Muzzle broad and short. Premaxilla not in contact with frontal. Nasalia somewhat rounded at the posterior end and not strongly widened anteriorly. Frontal flat and with wide inter-orbital region and weak post-

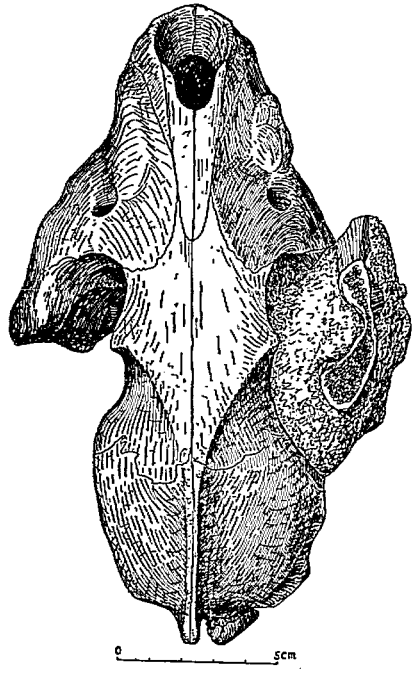

Fig. 33, A. *Hyœna zdanskyi* Pei (sp. nov.), skull (type specimen), × 2/3. Top view.

orbital process. Sagittal crest faint. Brain case large, ovate, and broad. Occiput low and broad. Palatine slightly concave and broad. Anterior palatinal foramen large.

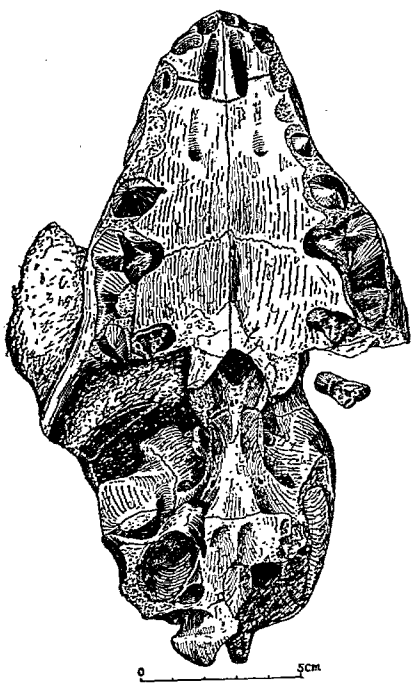

Fig. 33, B. *Hyæna zdanskyi* Pei (sp. nov.), skull (type specimen), × 2/3.
Palatinal view.

Upper teeth (Figs. 33 and 34).

P^1, present.

P^2, with an anterior and posterior accessory cusp relatively strong.

P^3, with an anterior accessory cusp weak and cingulum strong; a posterior accessory cusp weak and cingulum strong; a posterior accessory cusp strong and posterior cingulum weak.

P^3 (carnassial) short and broad. Deuterocone large. Parastyle strong. First lobe (parastyle) relatively long, lower than the 2nd lobe (protocone); 2nd lobe high and long; 3rd lobe (tritocone) short. On the paratype, however, the 3rd lobe is longer than the 2nd one.

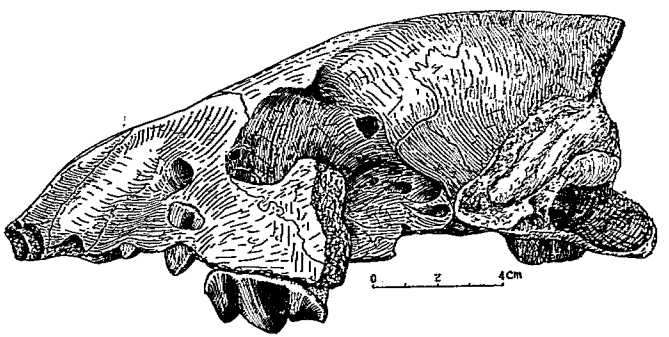

Fig. 33. C. *Hyæna zdanskyi* Pei (sp. nov.), skull (type specimen). × 2/3.
Lateral view.

The proportions of the three lobes are as follows:

	Holotype (skull) Pl. XIII, fig. 1	Paratype Pl. XVIII, fig. 2
Length of 1st lobe	12.0 mm	12.2 mm
Length of 2nd lobe	13.4 mm	12.4 mm
Length of 3rd lobe	12.2 mm	13.2 mm
Total length of P^3	37.6 mm	38.0 mm

M^1 of the type skull is remarkably large (*vide* Measurement) and with three cusps very distinct. On the paratype the metacone is still larger and more distinct than on the type.

Lower teeth.

Premolars as in *H. sinensis* from Choukoutien, but slightly smaller.

M_1, with a strong metaconid. Talonid larger, cutting with only one median cusp (hypoconid).

Lower Milk Carnassial (DP_4, Fig. 35).

A remarkable tooth, with a large but cutting talonid (Pl. XV, fig. 2). The shape is typically as in *Hyæna*, but the crown, and especially the "external area" of the heel (*vide supra*) are extraordinarily broad. The trenchant shape of the hypoconid is in striking opposition with the tricuspid heel of the milk carnassial in the *crocuta* group.

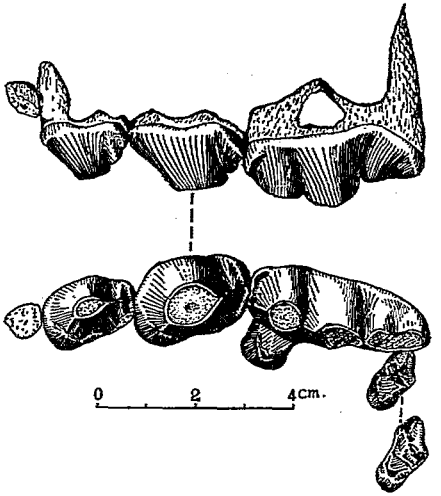

Fig. 34. *Hyæna zdanskyi* Pei. (sp. nov.), maxilla with P^2-M^1, × 1/1.

MEASUREMENT (in mm.)

Skull (type specimen Cat. No. C.L.G.S.C. $\frac{C.}{C.\ 1334}$).

Total length	203.4
Maximum length of nasalia	62.0
Maximum breadth of brain case	66.0
Maximum breadth of inter-orbital region	41.0
Breadth between P^1	43.4
Maximum depth of brain case	68.3
Length and breadth of P^1	38.0 and 24.4
Length and breadth of M^1	10.0 and 17.2

Maxillæ (holotype, Cat. No. C.L.G.S.C. $\frac{C}{C\ 712A}$, Pl. XVIII, fig. 2).

Length from P^2 to M^1	77.1
Length and breadth of P^2	18.5 and 12.3
Length and breadth of P^3	25.2 and 16.4
Length and breadth of P^4	37.6 and 24.2
Length and breadth of M^1	9.0 and 16.4

DP_4 (Fig. 35, and Pl. XV, fig. 2).

Length and breadth of DP_4	21.2 and 10.0

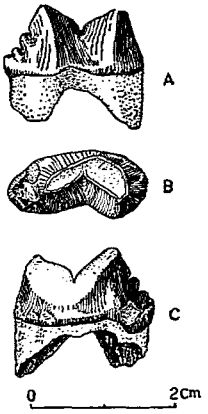

Fig. 35. *Hyæna zdanskyi* Pei. (sp. nov.), DM_1, × 3/2.

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien; the type skull was collected in the upper part of the Main Deposit and the paratype and mandibles partly come from Layer 5 and partly from the Carnivora Layer. Cat. No. C.L.G.S.C. $\frac{C}{C.\ 1669}$ — $\frac{C}{C.\ 1704}$.

COMPARISON

Unless we are deceived by an accidental accumulation of abnormal individual features, the above described form as characterized by its small and swollen brain case, strong deutero-

:one of P_4, large M^1, well developed metaconid of M_1 and quite peculiar DP^3, represents a very distinct and new form of *Hyæna*.

Judging by the general thickness of the teeth, and the moderate development of the carnassial blade, its place, however is still distinctly in the *sinensis* group or "stage" (*vide supra*).

From *H. licenti* Pei (=*H. sinensis* in Teilhard and Piveteau, 1930) of Nihowan, it differs chiefly by its larger M^1 and the shape of the talonid of M_1.

Hyæna utima Matsumoto

Pl. XII, fig. 5.

1915 *Hyæna ultima* Matsumoto. On some fossil mammals from Szechuan, China. Science Reports Tohoku Imperial University, Sendai, Japan, 2nd. Ser. Vol. III, No. 1, p. 2.

1927 *Hyæna ultima* Matsumoto, Zdansky. Weitere Bemerkungen über fossile Carnivoren aus China. Palæontologia Sinica, Ser. C, Vol. IV, Fasc. 4, pp. 20-22, Taf, II, Figs. 5 and 6.

In addition to *H. sinensis* and *H. zdanskyi*, a third species of *Hyæna*, belonging to a quite different type, is represented in our series by a single broken lower jaw with P_3—M_1 (Fig. 36). Two broken premolars and one incisor collected from the upper breccia (Layer 3) in 1932 are probably referable to the same species.

DESCRIPTION

P_3, relatively simple and slender. Along the antero-inner side of the protoconid, a ridge is connected with the cingulum, but without accessory cusp. Posterior accessory cusp not stronger than the cingulum. Protoconid slightly directed backward.

P_4, with anterior accessory cusp small; posterior accessory cusp large and divided into two ridges posteriorly.

M_1, absolutely characteristic by the relative slenderness and the *elongation* of both paraconid and protoconid; paraconid scarcely broader than the protoconid; *carnassial blade* highly *crescentic*; or present and taking the place of a normal endoconid; talonid small; hypoconid well developed and cutting; endoconid and hypoconid very small.

MEASUREMENT

	P	P_4	M_1
Length	23.6	25.0	31.4
Breadth	17.2	15.3	14.1

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien Upper Phase of the Main Deposits (and Upper Cave). Cat. No. $\frac{C}{C.\ 1856}$.

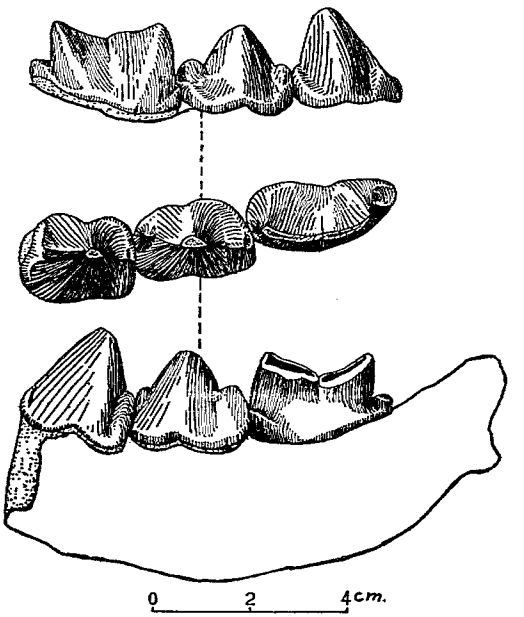

Fig. 36. *Hyæna ultima* Matsumoto, broken mandible with P_3—M_1, × 1/1.

COMPARISON

The lower jaw here described belongs undoubtedly to a typical "*Crocuta*" type, and differs at first glance from any representant of the *sinensis* group.

As belonging to this "*Crocuta*" type were already known in China:

(1) *H. ultima* Matsumoto, a form first recognized by Matsumoto, on an upper carnassial from Szuchuan, and more fully described by Zdansky on a skull (1925) and a lower jaw (1927) from Hsianhsien (Honan).

(2) *Hyæna* cf. *spelæa*, recognized by Boule and Teilhard in the Sjara-osso-gol (Upper Pleistocene) fauna.

Now from Zdansky's specimens of *H. ultima* the Choukoutien specimens differ only by secondary characters such as the absence of a vestigial metaconid (Zdansky, 1927). And such is also the case with the specimens of *H. ultima* collected by Dr. Granger in Szuchuan.[1]

On another hand, from the typical *H. spelæa* of Ordos and Europe, it can be distinguished: (1) by a distinctly shorter length of the lower carnassial's blade, (2) by a more cutting (not tricuspid) talonid at the same tooth.

We shall therefore refer it to *H. ultima* rather than to *H. spelæa*. More material has to be collected before we can decide that whether *H. ultima* is somewhat older geologically and a little primitive morphologically than the cave Hyæna, or whether it has only to be held as an Asiatic race of *H. spelæa*.

A close relation between *H. ultima* and *H. colvini* (from the Siwaliks) has been suggested by Pilgrim (1932, p. 747).

Two fragmentary lower jaws with M_1 have been collected from the "Upper Cave" at Choukoutien together with a Loessic-like fauna in 1933. One of them looks exactly the same as that described above from the Choukoutien Formation and the other bears a M_1 with a small metaconid in the place more or less as an endoconid. The latter one would approach very closely to that Zdansky has described under the name *H. ultima* (1927). By these new materials it would appear that the species *H. ultima* possibly survived from Choukoutien time up to Late Pleistocene.

A SHORT CATALOGUE AND DESCRIPTION OF THE FOSSIL *HYÆNA* IN CHINA

Fossil *Hyæna* recorded from China are already so numerous, and they have been described in so confused a way (especially in the case of *H. sinensis*) that we think it is desirable at this place to summarize our present knowledge on the subject.

1 In the Ssuchuan specimens the talonid of M_1 is cutting (hypoconid), the internal small cusp of the heel being formed by a retreating vestigial metaconid. But the talonid of DP_4 is typically *tricuspid*.

Hyæna variabilis Zdansky

1924 *Hyæna variabilis* Zdansky. Jungtertiäre Carnivoren Chinas. Palæontologia Sinica, Ser. C, Vol. II, Fasc. 1, pp. 93-103, Taf. XVIII, figs. 3 and 4, etc.

SPECIFIC CHARACTERS: P^4 with small deuterocone; 1st lobe smaller than 2nd, and 2nd smaller than 3rd. M^1 small; with two outer cusps (paracone and metacone) small and indistinct and protocone large. M_1 with anterior lobe small and low; posterior lobe (protoconid) relative large and decidedly high; metaconid absent; talonid generally not cutting and rather large, with a medium hypoconid and a small endoconid (but apparently more reduced on some specimens).

HORIZON AND LOCALITY: Hipparion Red Clay (Pontian or Lower Pliocene), of Shansi, N. Shensi, and Kansu.

REMARKS: *H. variabilis* is the typical and most common form of *Hyæna* found in the Hipparion Red Clay of North China. It corresponds more or less to *H. eximia* of Pikermi and Maragha; to *H. mordax* Pilgrim (1932); and to *H. carnifex* Pilgrim (1910 and 1913) from the Siwalik in India.

Hyæna honanensis Zdansky

1903 *Hyæna* sp. Schlosser. Die fossilen Säugetiere Chinas, nebst einer Odontographie der recenten Antilopen. Abh. Bayer. Akad. Wiss. München, Bd. 22, Abt. I, pp. 34 and 35.

1924 *Hyæna honanensis* Zdansky. Jungtertiäre Carnivoren Chinas. Palæontologia Sinica, Ser. C, Vol. II, Fasc. 1, pp. 103 and 107, Taf. XXIII, Figs. 1-6, etc.

SPECIFIC CHARACTER: This species is established by Zdansky using Schlosser's material from unknown horizon and some poorly preserved specimens collected by himself in Hsinanhsien and Mienchihhsien (Honan) in association with an archaic *Mustelide, Eomellivora wimani* Zdansky. The specific characters of this form, according to Zdansky's description, seem to be as follows: P^4 with a relatively large deuterocone and small 1st lobe (parastyle); M_1 with a small and low paraconid, high and larger protoconid, rudimentary metaconid, and well developed, not cutting, talonid (hypoconid strong, endoconid small) (Schlosser, 1903).

HORIZON AND LOCALITY: Hipparion Red Clay (Pontian or Lower Pliocene), Hsinanhsien and Mienchihhsien in Honan.

REMARKS: It is somewhat difficult to ascertain how much different this species is from *H. variabilis*. Better material seems to be needed for a definitive recognition of this form.

Hyæna gigantea Schlosser

1903 *Hyæna gigantea* Schlosser. Die fossilen Säugetiere Chinas, nebst einer Odontographie der recenten Antilopen. Abhandl. Bayer. Akad. Wiss. München. Bd. 22, Abt. I, pp. 35-37.

SPECIFIC CHARACTER: P^4: deuterocone extremely small, low (?) and situated very backward, that is behind the 1st lobe (parastyle); 1st lobe small and with a small tip; 2nd lobe (protocone) high and relatively large; 3rd lobe (tritocone) short (?) and low. M_1, paraconid small; protoconid large and high; talonid, large and with a weak middle cusp, an internal transverse ridge, and a large posterior cingulum. Total length: 37.5 mm. and breadth: 17.5 mm.

HORIZON AND LOCALITY: uncertain. According to Pilgrim (Pilgrim, 1932) a smaller variety is known from the Dhok Pathan stage of Hasnot in Siwalik.

REMARKS: The upper carnassial of this species is very large and special as compared with some ordinary *Hyæna*. So far, in China no more specimens referable to this species have been discovered.

Hyæna licenti Pei (sp. nov.)

1928 *Hyæna sinensis* Owen, Boule et Teilhard (Figure). Le paleolithique de la Chine. Archives de l'Institut de Paleontologie humaine, Mem. 4, p. 81, Fig. 19, B.

1930 *Hyæna sinensis* Owen, Teilhard et Piveteau. Les mammifères fossiles de Nihowan (Chine). Annales de Paleontologie, T. XIX, Paris, pp. 101-104, Pl. XX, figs. 1, 1a, 2 et 2a.

SPECIFIC CHARACTERS: P : deuterocone moderately large; 1st lobe (parastyle) considerably broader and slightly smaller than 2nd or 3rd lobe; 3rd lobe (protocone) low, large and approximately equal to 3rd lobe in length; 3rd lobe (tritocone) short and not very much larger than 1st lobe. The lengths of the three lobes are respectively: 1st lobe=11 mm; 2nd lobe=13 mm; and 3rd lobe=13.5 mm; while its total length equals 38 mm. (Teilhard and Piveteau, 1930, p. 102.) M^1, rather large, transversely elongated, with a metacone very small. M_1, anterior lobe (paraconid) moderately small and high; posterior lobe (protoconid) moderately large, and slightly higher than the anterior one; talonid relatively broad and long, with a large hypoconid, a well developed endoconid and a small but distinct hypoconulid

detailed description may be found in the monograph of Teilhard and Piveteau, 1930, pp. 101-104). DP_4 with heel strongly cutting.

HORIZON AND LOCALITY: Sanmenian of Nihowan or Upper Pliocene.

REMARKS: As noted above the Nihowan *Hyæna* referred by Teilhard and Piveteau to *H. sinensis* differs distinctly from Koken's and the Choukoutien specimens of *H. sinensis* Zdansky at least in having a small anterior lobe (paraconid), a relatively higher posterior lobe (protoconid) and broad talonid with three cusps (*vide supra*, Specific Characters) on M_1. It might be considered as ancestral to *H. sinensis* of Choukoutien.

Hyæna sinensis Zdansky (Southern Race)

1891 *Hyæna sinensis* Owen. On fossil remains of mammals found in China. Quart. Journ. Geol. Soc. London, Vol. XXVI, p. 422, Pl. 28, figs 5-7.

1885 *Hyæna sinensis* Owen, Koken. Ueber fossile Säugetiere aus China. Paleont. Abhandl., Bd. 3, Heft 2, pp. 72-78, Taf. VI. Figs. 5-12.

SPECIFIC CHARACTERS: P^4: deuterocone small; 1st lobe (parastyle) reduced, 2nd lobe (protocone) moderately high, 3rd lobe (tritocone) short and scarcely larger than 2nd lobe. Length of three lobes in mm: 11.5, 13.0, 13.0 and 10.0, 13.0, 14.0 for 1st, 2nd, and 3rd lobes respectively. M_1, anterior lobe (paraconid) large, and as high as the posterior lobe (protoconid); posterior lobe small and low; metaconid absent or rudimentary; talonid large with only one cusp and with a posterior cingulum.

HORIZON AND LOCALITY: Lower Pleistocene of Fuminhsien, Yunnan (Koken, 1885, and Young, 1932).

REMARKS: The M_1 of Koken's specimens is exactly the same as the majority of Choukoutien *Hyæna sinensis* but differs only from the latter in having a rudimentary metaconid. As noted above, I consider it provisionally as representing a southern type of *H. sinensis* Zd., apparently very close to the Indian *H. sivalensis*.

Hyæna sinensis Zdansky (Northern Race)

1925 *Hyæna ultima* Matsumoto, Zdansky (mandible). Quartäre Carnivoren aus Nord-China. Palæontologia Sinica, Ser., Vol. II, Fasc. 2, pp. 14-21, Taf. III, Figs. 1 und 2.

1925 *Hyæna sinensis* Owen, Zdansky. *Ibid.*, pp. 22 and 23. Taf. III, Figs. 3-5, etc.

1927 *Hyæna sinensis* Owen, Zdansky. Weitere Bemerkungen über fossile Carnivoren aus China. Palæontologia Sinica. Ser. C, Vol. IV, Fasc. 4, pp. 22-24.

1928 *Hyæna sinensis* Owen. Zdansky. Die Säugetiere der Quartärfauna von Choukoutien. Palæontologia Sinica, Ser. C, Vol. V, Fasc. 4, pp. 42-47, Taf. III, Figs. 10-21.

SPECIFIC CHARACTERS: P^4, large; deuterocone small; 1st lobe (parastyle) slightly reduced, 2nd lobe (protocone) higher and shorter than 3rd lobe, 3rd lobe (tritocone) moderately long. M^1, reduced but less transversely elongated. M_1, anterior lobe (paraconid) large and high; posterior lobe small and low, vestigial metaconid exceptionally present; talonid short, with only one trenchant cusp and a small posterior cingulum.

HORIZON AND LOCALITY: Lower Pleistocene (*Choukoutienian* or Choukoutien Formation) of Choukoutien and Pleistocene (?) of Changchihhsien of Shansi (Zdansky, 1927).

REMARKS: According to Zdansky (1925), *H. sinensis* is also found from Yuanchuhsien in the deposits probably of Sanmenian Age.

Hyæna ultima Matsumoto

1915 *Hyæna ultima* Matsumoto. On some fossil mammals from Sze-chuan, China. Science Reports Tohoku Imp. Univ., Japan, Vol. III, No. 1, pp. 28-30, Pl. I, figs. 1-5.

1925 *Hyæna ultima* Matsumoto, Zdansky (skull). *Ibid.*, pp. 14-21, Taf. II, figs. 7 and 8.

1927 *Hyæna ultima* Matsumoto, Zdansky (mandible). *Ibid.*, pp. 20-22, Taf. II, figs. 4 and 5.

SPECIFIC CHARACTERS: P^4, deuterocone relatively large: 1st lobe (parastyle) strongly reduced, 3rd lobe (tritocone) strongly prolongated. M^1, very reduced. M_1, elongated with a crescentic blade; anterior lobe (paraconid) large but low; posterior lobe (protoconid) large but low; talonid small, with hypoconid dominant and cutting, endoconid and hypoconulid very small, the metaconid if present taking the place of a normal endoconid.

HORIZON AND LOCALITY: Upper Phase of Choukoutien Formation (Lower Pleistocene) and Upper Cave of Choukoutien (Late Pleistocene); Lower Pleistocene of Ssuchuan (Matsumoto); Pleistocene (?) of Hsinanhsien of Honan.

REMARKS: A full discussion of this type has been given above on p. 116.

Hyæna crocuta spelæa Goldfuss

1928 *Hyæna crocuta* Erxl. race *spelæa* Gold., Boule and Teilhard. Le Paleolithique de la Chine. Archives de l'Institut de Paleontologie Humaine, Mem. 4, pp. 80-83, Pl. XVIII, Figs. 1 and 2.

SPECIFIC CHARACTERS: P^3 and M^1 known only by worn specimens. M_1 much elongated, anterior lobe (paraconid) large but narrow, posterior lobe large but lower than anterior lobe; metaconid present but very rudimentary; talonid small, distinctly tricuspid (endoconid, hypoconid and hypoconulid). DP_4 with heel tricuspid.

HORIZON AND LOCALITY: Late Pleistocene of Sjara-osso-gol in Ordos.

REMARKS: *H. ultima* Matsumoto is a form very close to the present form. So far as I can see, the difference between *H. ultima* and the present Sjara-osso-gol *Hyæna* is that the lower carnassial of the former is not so elongated as the latter and has a more cutting talonid. Later study perhaps could prove that they are actually the same form representing a Chinese (or Asiatic) race of the European Cave *Hyæna*.

Hyæna sp. Schlosser

1924 *Hyæna* sp. Schlosser. Tertiary vertebrates from Mongolia. Palæontologia Sinica, Ser. C, Vol. I, Fasc. 1, pp. 18 and 19, Pl. I, figs. 48-51.

SPECIFIC CHARACTERS: This form is only known by imperfect materials. M^1, similar in size to *H. sinensis*, but different in having large, instead of small, parastyle and in having two indistinct, instead of distinct, medium cusps (paracone and metacone).

HORIZON AND LOCALITY: Middle Pliocene of Olan Chorea and Tjaggan nor Tabool in Mongolia.

REMARKS: Considering its stratigraphical horizon (Middle Pliocene ?) this form of *Hyæna* might have to be referred to a type intermediate between *H. variabilis* and *H. sinensis*.

Hyæna sp. Zdansky 1924

1924 *Hyæna* sp. Zdansky. Jungtertiäre Charnivoren Chinas. Palæontologia Sinica, Ser. C, Vol. II, Fasc. 1, pp. 107 and 108, Taf. XVIII, figs. 5 and 6.

In his monograph of 1924 Zdansky described a broken P^4 of *Hyæna* from unknown locality. This is a very small tooth with large deuterocone, 32.5 mm long and 19.1 mm wide. The length of the three lobes is 7.8 (1st), 12.1 (2nd) and 11.4 mm (3rd) respectively. This specimen might be related with the small form of *Hyæna* described (from Nihowan) by Teilhard and Piveteau, 1930, p. 104.

A PROVISIONAL KEY FOR THE FOSSIL *HYÆNA* IN CHINA.

(A) Size abnormally large . . . . . *H. gigantea* . . P. 120

(B) Size normally large.

a) M_1 strongly elongated: metaconid absent or rudimentary, heel of DP_4 (and generally M_1) not cutting, but tricuspid (*crocuta* group).

*M_1 longer; heel of M_1 tricuspid . . . . . *H. spelæa* . . P. 122

*M_1 shorter; heel of M_1 sub-trenchant . . . . . *H. ultima* . . PP. 116 & 122

b) M_1 moderately elongated; talonid of DP_4 (and generally M_1) cutting.

*Anterior half of M_1 and premolars rather slender; talonid long or small; metaconid vestigial or absent . . . . . *H. variabilis* . . P. 119 (*H. honanensis*)

*Anterior half of M_1 and premolars very thick; talonid generally much reduced; metaconid generally vestigial or absent.

**M^1, very large; metaconid strong. DP_4 broad.

Skull short and swollen . . . . . *H. zdanskyi* . . PP. 110-116

**M^1, reduced; metaconid absent or rudimentary; DP_4 broad.

***Metaconid of M_1 generally absent.

1) Heel of M_1 strong; 3 cuspid . . . . . *H. licenti* . . P. 120

2) Heel of M_1 reduced; cutting; 1 cusp.

Skull large and narrow . . . . . *H. sinensis* . . PP. 91 & 121 (Choukoutien)

***Metaconid of M_1 rudimentary . . . . . *H. sinensis* . . P. 121 (Yunnan)

Family **FELIDÆ** Gray

Sub-family **MACHAIRODINÆ**

Genus **MACHAIRODUS** Kaup

1928 *Machairodus* sp. Zdansky. Die Säugetiere der Quartärfauna von Choukoutien. Palæontologia Sinica, Ser. C. Vol. V, Fasc. 4, pp. 47-48, Taf. IV, Fig. 5.

Machairodus remains are very rare in the Choukoutien deposits, but absolutely sure. From Locality 1 were collected, in addition to the upper canine described by Zdansky: a right and a left upper canine; the tip of another broken upper canine; two lower canines; a broken I^3; a broken P_4; and a slightly damaged M_1. From Locality 9, similar teeth though better preserved have also been recovered.

DESCRIPTION

Upper Canine (Fig. 37).

Of our two specimens of upper canine, the one (left side canine) is less slender and more curved than the other (right side), this latter one standing more close, for the shape, to Zdansky's type. These differences are probably individual. On the three specimens, the crown is serrated both along the internal edge and the external edge.

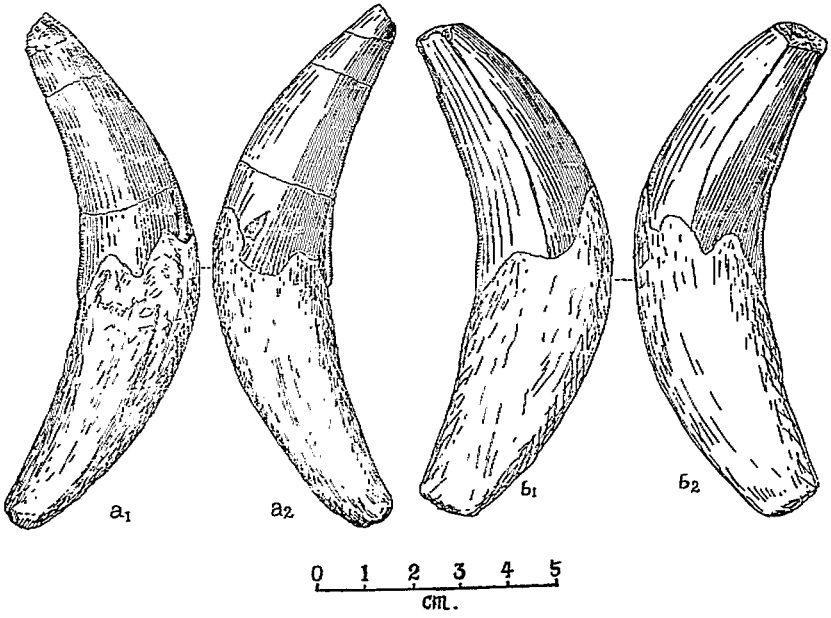

Fig. 37. *Machairodus* sp. two upper canines, × 1/1.

DIMENSIONS:

	left	right	Zdansky's
Total height of the crown	55.0	63.0	—
Maximum antero-posterior length	27.0	25.0	30.5
Maximum transversal width (or thickness)	12.0	11.0	12.0

I^3 (Fig. 38, C).

A broken I^3 shows both anterior and posterior accessory cusps at its base.

Height and length of the crown ..... 24. 0 mm. and 14. 8 mm.

Lower Canine (Fig. 38, B).

As usually in the genus *Machairodus*, the lower canine is rather small and slender with both anterior and posterior edges sharp. At the base an anterior cingular cusp is observed on our specimen (Fig. 39, B1-B3).

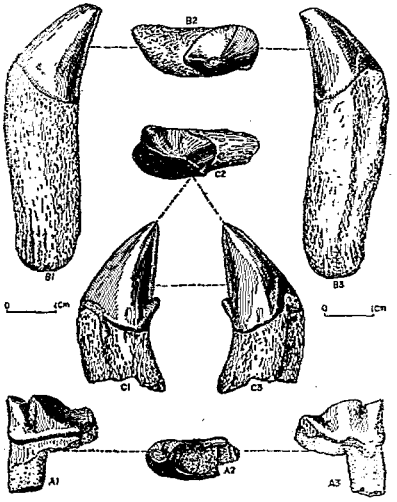

Fig. 38. *Machairodus* sp., × 1/1.

A, left broken P^4. B, left lower canine. C, right I^3 of young individual.

A1, outer side view; B1, outer side view; C1, outer side view;
A2, crown view; B2, crown view; C2, crown view;
A3, inner side view. B3, inner side view. C3, inner side view.

Height and maximum antero-posterior length of the crown, 22.0 mm and 15.2 mm.

Lower P_4 (Fig. 38, A, compare with Fig. 39, C).

A broken specimen, determined by comparison with a better specimen from Locailty 9.

Lower Carnassial (Fig. 39, A, compare with Fig. 39, B).

A rather worn specimen belonging to an old individual. The tooth, perfectly similar to a better preserved specimen of Locality 9 (Fig. 39, B) is of a typical *Machairodus* shape: the

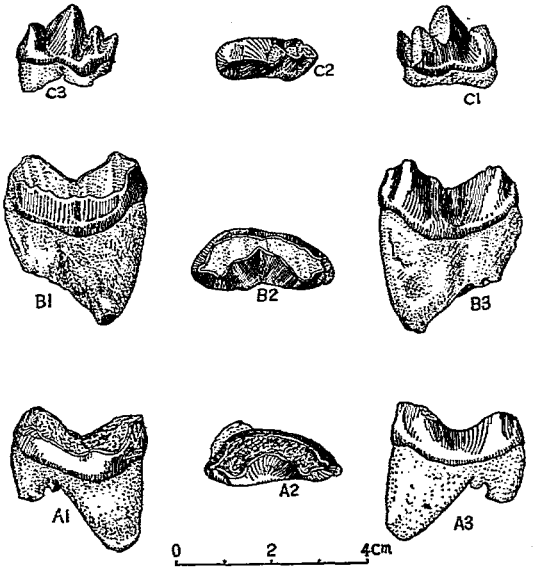

Fig. 39. *Machairodus* sp. from Locs. 1 and 9 × 1/1.

A, right M_1 from Loc. 1. A1, outer side view; A2, crown view; A3, inner side view.

B, right M_1 from Loc. 9. B1, outer side view; B2, crown view; B3, inner side view.

C, right P_4 from Loc. 9. C1, outer side view; C2, crown view; C3, inner side view.

paraconid and protoconid blades are separated, internally, by a wide concave area so that the outline of the crown is highly crescentic. Anterior part of the paraconid developing basally

a rudimentary front-lobe. Behind the protoconid, the basal cusp corresponding to the talonid is particularly weak.

Length and maximum breadth of the specimen from Locality 1 . . 28.0 and 11.0 mm.

Length and maximum breadth of the specimen from Locality 9 . . . 29.2 and 13.0 mm.

HORIZON AND LOCALITY: Upper Polycene of the *Sinanthropus* site at Choukoutien; Layers: 5, and Lower Cave. Cat. No. C.L.G.S.C. $\frac{C}{C1214}$ — $\frac{C}{C.1216}$.

COMPARISONS

Even if one does not admit the evidently superfluous number of genera created recently by Kretzoi (1929) and scarcely reduced by Pilgrim (Pilgrim, 1932), the *Machairodus* group is sufficiently complex for making useless any specific determination which would not be supported at least by the knowledge of the full dentition and the shape of the lower jaw.

Using our scanty material, therefore, we cannot do much more than to exclude the Choukoutien *Machairodus* from a certain series of Chinese types.

From the Sanmenian *H. nihowanensis* Teilhard and Piveteau, the Choukoutien form differs chiefly by a distinctly larger size.

From the much older (Pontian) *M. palanderi* Zdansky and *tingi* Zdansky, on the contrary, it stands apart on account of a smaller size. In *M. tingi*, in addition, the upper canine is probably smooth (not crenulated) anteriorly.

With *M.* (*Paramachairodus* Pilgrim) *maximiliani* Zdansky the distinction is still easier, since in this latter sub-genus, according to Pilgrim, the upper canine is relatively short and smooth; the lower canine is rather stout; the para- and metastylids of P_4 moderate; the lower carnassial with a vestigial metaconid.

In *M. horribilis* Schlosser, at least, (a practically useless form from its uncertain origin) the posterior cusp of M_1 (talonid, rather than metaconid) is much stronger.

With the forms of India, no close comparison is possible, because they are so far unsatisfactorily known (*vide* Pilgrim, 1932 and Matthew, 1929). Most of them besides seem not to have serrated canines.

When we know it better, the Choukoutien *Machairodus* will probably prove to be a new species. But so far, it seems more advisable not to give it a name.

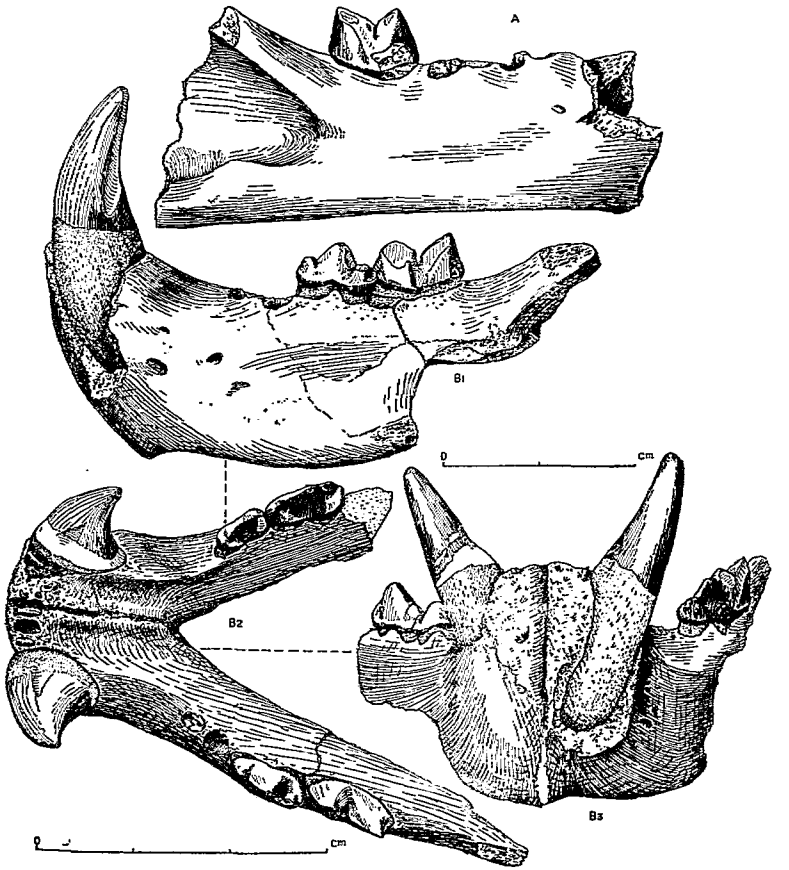

Fig. 40.

A. *Felis* cf. *tigris* L., mandible with M_1 × 2/3;

B. *Felis youngi* Pei (sp. nov.), three views of mandible (type specimen), × 2/3.

Sub-family **FELINÆ**

Genus **FELIS** L.

Felis cf. **tigris** L.

Pl. XXII, fig. 3; Pl. XXIV, figs. 1 and 6.

1928 *Felis acutidens* Zdansky. Die Säugetiere der Quartärfauna von Chou-K'ou-Tien. Palæontologia Sinica, Ser. C, Vol. V, Fasc. 4, 1928, pp. 48-50, Taf. IV, Figs. 6-13.

A large cat very close to the living Tiger is represented in our series by a broken naxilla with P^3—M^1, an isolated P^4, six more or less incomplete lower jaws, a few isolated eeth, and several limb-bones.

DESCRIPTION

Upper jaw (Fig. 41, A).

P^3 (one specimen), with a very weak anterior accessory cusp. This character (different rom the conditions observed in the skulls of the living tiger and lion used for comparison) is ound to be the same as that of a tiger skull recovered from the Anyang (N. Honan) early istorical site.

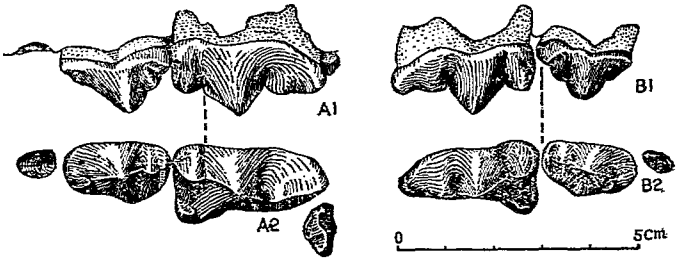

Fig. 41.

A, *Felis* cf. *tigris* L., maxilla with P^3—M^1, × 1/1.
B, *Felis* cf. *pardus* L., maxilla with P^3 and P^4, × 1/1.

P^4 (two specimens), the same as in the tiger skulls used for comparison. Differences from the two skulls of lion available for comparison are: a relatively strong development of the deuterocone; and the presence of a small but distinct cusp at the antero-external corner of the parastyle (first lobe of the tooth).

M^1, subtriangular, more closely similar to a tiger than to a lion molar in its shape.

Lower jaw.

All our specimens are very massively built (Fig. 40, A). The lower border of the mandibular bone is almost straight, as in the tiger, the usual convexity below M_1 and P_4, "ramal process", being scarcely noticeable.

P_3 (one specimen, on a broken jaw), relatively large; parastylid well formed.

P_4 (several specimens), similar in shape and size to tiger and lion.

M_1 (6 specimens, most of them observable on broken mandibles), like in tiger or lion. On the posterior border of the protoconid, the asperity representing a residual heel (or metaconid) is present or absent. The size also is rather variable ranging in length from 27.0 mm and breadth 13.4 mm to length 28.4 mm and breadth 15.6 mm. In the former and flatter specimen, there is no trace of a talonid (or metaconid).

Fig. 42. *Felis* cf. *tigris* L., DM_1. × 1/1.

A lower DP_4 (Fig. 42, Pl. XXIV, fig. 6), not associated with any permanent teeth is most probably referable to the Choukoutien tiger. This tooth differs from a DP_4 of *Hyæna* by a stronger metaconid and a much more piercing and slender talonid. The characteristic basin-like depression, generally observed on the *Hyæna* milk carnassial, between the cutting edge (hypoconid) of the talonid and the external wall, is absent.

Limb-bones.

As limb-bones referable to the same form, we have recognized: the proximal part of a humerus; a complete and a broken ulna; a radius; a calcaneum; an astragalus. Size and shape as in tiger.

MEASUREMENTS (in mm)

A. Mandible and teeth.

	F. cf. *tigris* from Choukoutien			Wanhsien Ssuchuan[1] *F.* aff. *tigris*	*F. tigris* from Anyang Honan
	C / C. 698 (Pl. XXIV, fig. 1)	C / C. 699	C / C. 681		
Length from P^3-M^1	72.0*	64.0?	—	63.3	63.0
Depth of mandible on front of P_3	48.6	43.5	—	38.5	42.2
Depth of mandible behind M_1	51.0	—	—	40.0	43.0
Length and breadth of P_3	20.3 × —*	16.0 × 8.2	18.5 × —*	— × —	15.6 × 8.0
Length and breadth of P_4	22.2 × —*	— × —	25.5 × 14.2	23.6 × 13.0	22.4 × 11.2
Length and breadth of M_1	28.0 × 14.5	— × 13.4	28.0 × 15.1	25.4 × 14.1	25.5 × 13.4
	C / C. 700 (Pl. XXIII, fig. 3)	C / C. 690			
Length and breadth of P^3	22.3 × 13.1	— × —	— × —	— × —	22.0 × 11.4
Length and breadth of P^4	33.0 × 17.2	33.0 × 18.0	— × —	36.6 × 19.2	33.5 × 17.2
Length and breadth of M^1	7.6 × 10.1	— × —	— × —	7.5 × 11.7	4.6 × 7.4

* by alveolus

1 measured on the specimen kept in the Survey.

B. Limb-bones.

Humerus: proximal breadth	76.0 mm
Radius: maximum length	267.0 mm
Ulna: maximum length	343.0 mm
Calcaneum: length and maximum breadth	86.0 mm and 45.0 mm
Astragalus: length and maximum breadth	51.0 mm and 47.0 mm

HORIZON AND LOCALITY: Upper Polycene of Choukoutien *Sinanthropus* site; Layers: Layers 1, 5 (*Sinanthropus* Locus A), 6, 7, 8, 9 (*Sinanthropus* Locus C), and Lower Cave. Cat. No. C.L.G.S.C. $\frac{C}{C.\ 681} - \frac{C}{C.\ 700}$.

COMPARISON

The attribution of the present form to the tiger rather than to the lion is chiefly based on the straightness of the lower border of the mandibular bone, where the ramal process is scarcely observable. But it is also the most veri-similar geographically.

Fossil tigers are already reported in China from the Lower Pleistocene (or *U. Pliocene*) fissure deposits of Wanhsien (Ssuchuan) and Fuming (Yunnan, Young 1932). The Ssuchuan specimen sent to our laboratory by Dr. W. Granger is somewhat smaller than the Choukoutien type: mandibular bone less deep; M_1 more slender. On the contrary, the M_1 from Fuming corresponds closely to our specimens.

Several large *Felidæ* are known from the Pontian Red clay of North China (Shansi). We wonder whether those forms regarded by Zdansky as new "genera" (*Metailurus, Dinofelis*) would not be just as well understood as close forerunners of the living tiger.

Felis youngi Pei (sp. nov.)

Pl. XXIII, figs. 1 and 4.

Among the *Felis* remains collected from Choukoutien deposits, one specimen (the anterior part of a complete mandible, with C—P_4 on right and C—M_1 on left), although isolated, is so exceptional in the stoutness of its symphysial part, that we consider it as representing a special and new form.

DESCRIPTION

Mandibular bone (Fig. 40, B, 127) apparently shorter than in living *F. leo*; both branches of the jaw more diverging posteriorly than in both lion and tiger. Lower border gently convex.

A ramal process seems to be present, anterior to M_1 in position. The two half branches of the mandible fuse into a massive and elongated symphysis, well proportionate to the large size of the canine.

Canine, thick and high, with an exceptionally short root.

P_3, of the ordinary *Felis* type; size as in lion.

P_4, relatively short, much shorter than in the lion's skull used for comparison.

M_1, slightly smaller than in *F.* cf. *tigris* of the same locality, although slightly smaller than in European Cave Lion (Dawkins and Sauford, 1864).

Basing on this relatively larger size of the lower carnassial, we refer tentatively to the same species two isolated upper carnassials (Pl. XXIII, fig. 4), somewhat larger than in the specimen of living and fossil tiger at our disposal. Length of these two specimens: 39.0 and 36.5 mm; maximum width, 20.4 and 18.6 mm. respectively.

MEASUREMENTS (in mm.)

	Felis youngi Pei (sp. nov.)	*Felis leo* Cat. No. 45
Total length of the symphysis	71.4	51.6
Width of the symphysis at the middle of the diastema (C—P_3)	63.0	52.4
Thickness of the mandible in front of P_3	30.8	20.7
Height of the mandible in front of P_3	54.6	45.4
Height of the mandible in front of M_1	51.5	76.1
Length from P_3 to M_1	73.2*	76.1
Height of crown of canine (outside)	46.0**	40.3**
Length and breadth of canine	25.2 × 20.8	24.4 × 17.0
Length and breadth of P_3	18.0 × 9.2***	18.1 × 9.2
Length and breadth of P_4	25.0 × 12.6	29.6 × 14.1
Length and breadth of M_1	28.4 × 15.1	29.2 × 16.0

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien; the unique mandible was collected from the Lower Fissure. Cat. No. C.L.G.S.C. $\frac{C}{C.1210}$.

*P_3 by alveolus on left side. **slightly worn. *** by right P_3.

COMPARISON

If it does not belong to an abnormally developed individual of tiger, the specimen above described indicates one new and rather characteristic type of the larger *Felis*, differing from *F. tigris* by a larger size and by a convex lower border of the mandible; from *F. leo* by a shorter appearance of the jaw, and a more anteriorly set ramal process; from both by the length of the symphysis and the larger size of the canine.

Judging from the descriptions given by Dawkins and Sanford, the close approach of the Choukoutien new *Felis* would be with the massive-jawed *F. leo* var. *spelæa* Goldfuss. But in both forms the jaw is differently balanced, since in the Chinese form the symphysis and canine are stronger, but the carnassial weaker than in the European Pleistocene lion.

A very striking analogy of size and shape can be observed between our fossil and the big *Felis atrox* Leidy from the American Pleistocene of Rancho la Brea (John C. Marian). (The skull and dentition of an extinct cat closely allied to *Felis atrox* Leidy are described in Bull. Univ. of Calif., Geology, Vol. 5, pp. 291-304, 1909).

I am glad to dedicate this new representative of the Choukoutien fauna to my colleague Dr. C. C. Young.

Felis cf. **pardus** L.

Pl. XXIII, figs. 2 and 5; Pl. XXIV, figs. 3-5.

1928 *Felis acutidens* Zdansky. Die Säugetiere der Quartärfauna von Chou-K'ou-Tien. Palæontologia Sinica, Ser. C, Vol. V, Fasc. 4, pp. 48-50, Taf. IV, Figs. 6-13.

Of this large Cat, chiefly distinguishable from the tiger by a smaller size and the shape of the mandibular bone, we have: 13 more or less broken lower jaws, an upper jaw fragment with P^3—P^4, several isolated upper and lower carnassials, and some limb-bones.

DESCRIPTION

Upper teeth (Fig. 41, B, p. 130).

P^3, slightly smaller than in a skull of the living *F. pardus* used for comparison, with parastyle strong, and protocone distinctly expanded lingually.

P^4, (five specimens) with deuterocone very variable in size and position. In a specimen for example, the deuterocone is so weak that it does not form a distinct conical cusp, and is set

so anteriorly as the front of the parastyle (first lobe). The proportion of the tooth is also somewhat variable (*vide* the table of measurements). But on the whole, the characters are exactly as in the common *Felis* type.

Lower jaw (Fig. 43).

The lower border of the mandible is not straight as in the tiger, but gently convex (*vide* Pl. XXIV, fig. 4a). Ramal process never so prominent as in *F. leo*.

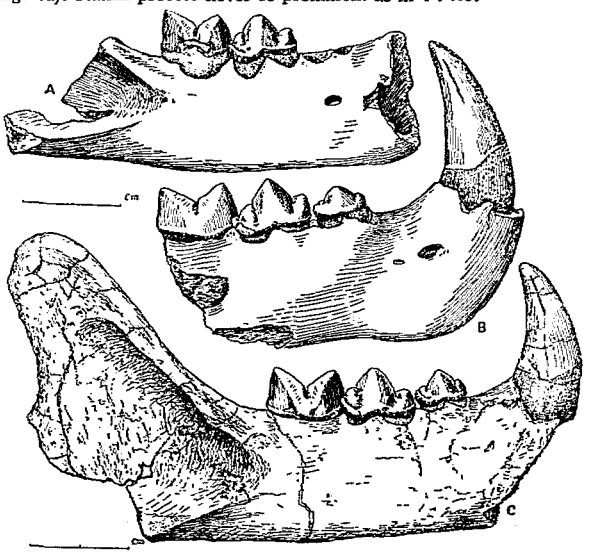

Fig. 43. *Felis* cf. *pardus* L., lateral view of three mandibles, × 2/3.

Incisors, canine, and premolars as in *F. pardus*, perhaps with the exception of P_3, which is somewhat larger and more elongated than in the skull used for comparison.

Lower molar sometimes more massive than in the living *pardus*, but not always. No trace of metaconid is ever recognizable. But, on two specimens, a talonid is clearly indicated by a weak asperity behind the protoconid.

Milk teeth

DP_3 and DP_4 (Fig. 44, p. 138) as in a living *pardus*. They differ from the milk carnassial above referred to *F. tigris* in having a stronger metaconid.

Limb-bones.

The few parts of the skeleton recovered so far are a proximal part of humerus, an innominate, three broken calcanea, five broken astragali, and some phalanges. Size smaller than in a tiger. Maximum thickness of the humerus head: 67.5 mm. Maximum length and breadth of the astragalus: 47.0 mm and 43.0 mm.

MEASUREMENTS (in mm.)

	Felis cf. *pardus* L. from Choukoutien.			Recent *F. pardus*	*Felis palæosinensis* Zdansky from Mienchinhsien, Honan (after Zdansky, 1924)
	C / C. 1211 Pl. XXIV, fig. 3	C / C. 1212 Pl. XXIV, fig. 4		Cat. No. 42	
Height of mandible in front of P_3	41.5	35.5	——	32.6	——
Height of mandible behind M^1	39.8	36.0	——	38.3	——
Diastema between C and P_3	17.0	——	——	24.9	16.2
Length from P_3 to M_1	62.0	38.2*	——	58.0	——
Length and breadth of P_3	16.3×9.0	——	——	14.6×8.2	14.7×7.7
Length and breadth of P_4	23.2×12.0	21.5×11.1	——	21.4×11.3	20.8×10.5
Length and breadth of M_1	24.0×12.2	22.0×10.7	——	23.0×12.1	21.0×11.0
Length and breadth of P^3	——	——	20.0×11.2	21.6×11.2	19.6×10.0
Length and breadth of P^4	——	——	30.0×15.5	32.1×15.2	30.2×16.4

* By alveolus.

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien; Layers: 5, 8, 9, and Lower Cave. Cat. No. C.L.G.S.C. $\frac{C}{C.\ 1211}$ — $\frac{C}{C.\ 1213}$.

COMPARISONS

The specific determination of the form here described is sure. From the specimen of living *F. pardus* used for comparison, the fossil one does not differ but in a slightly larger size and in possibly less reduced P_3.

The name *F. acutidens* Zdansky was proposed by Zdansky for a group of specimens collected from Locality 1 of Choukoutien during the first excavations: a lower carnassial, a fragment of lower jaw with P_3—P_4, a DP_4 and a P_3. It seems that those fossils are a heterogeneous complex, part of the specimens (the fragment of mandible) belonging to a *F. tigris*, part to *F. pardus*. Judging by the figure only, the milk carnassial could even belong to *Hyæna*. The species *F. acutidens* consequently would have to be neglected.

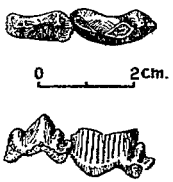

Fig. 44.
Felis cf. *pardus* L., DP_4 and DM_1. × 1/1.

Felis palæosinensis Zdansky (Zdansky 1924) from Lankou, Mienchihhsien (Honan) differs from the Choukoutien Panther by a slightly smaller size. We suspect that this fossil has been collected, not in the Pontian Red Clays, but in some Late Pliocene (Sanmenian) or Early Pleistocene (Choukoutien) level.

Another Panther, *F. cristata* Falconer and Cautley. (=*Panther cristata*, Pilgrim, 1932) is known from the Upper Siwalik (Pinjor stage, Pilgrim, 1932), but only described by the cranial characters,[1] so that no comparison with our form is available.

---

1 Matthew notes that two lower jaw fragments described by Bose and Lydekker as *Machairodus palæindicus* may belong to *F. cristata* (Matthew, 1929, p. 494).

Felis sp. 1

Pl. XXIV, figs. 2 and 7.

Following the descending order of the size, the next *Felis* from Choukoutien to be described, after *F. pardus*, is a medium size Cat represented in our series by a right upper jaw (C—P^4), the anterior part of a lower jaw (I—C left, I—P_4 right), an isolated P^4 and two M_1.

DESCRIPTION AND COMPARISON

Judging by the size, those specimens would come close to *F. pardina* or *F. uncia* but with a few special characters in the number and the shape of the teeth.

From *F. pardina* the Choukoutien cat differs by the presence of a P^2. With *F. uncia* (judging by a specimen from Central Asia kept in our Laboratory) the differences are as follows: P^2 smaller; P^3 with a stronger anterior cingular cusp and a wider posterior cingulum; P^4 (Pl. XXIV, fig. 7) more massive, and a stronger deuterocone; P_4 (Pl. XXIV, fig. 2) larger, and with a very distinct anterior accessory cusp; M_1 with longer protoconid and fainter talonid (no trace of metaconid).

Compared with two lower molars of *Felidæ* of uncertain locality (one from Shansi, the other bought in Tientsin) described by Schlosser (1903, pp. 39 and 40, Taf. 1, Figs. 11 and 11a), our specimen would agree for the size. But on Schlosser's fossils, the talonid seems to be longer, and the metaconid present.

Consequently, we have possibly to deal here with a new form. But in the absence of any decided specific character, and also since there is lacking a sufficient material for comparison, we refrain from giving it a new name, provisionally.

MEASUREMENT (in mm.)

Right upper jaw (Cat. No. $\frac{C}{C.693}$).

	Upper Canine	P^2	P^3	P^4
Length	14.8?	6.1	17.1	25.5?
Breadth	10.1?	4.5	9.5	14.3

1 According to the specimen referred to *F. pardina* by Boule and de Villeneuve, P^2 is missing in *F. pardina* (*vide* Boule and de Villeneuve, 1927, pp. 78-80).

Mandible (right side) (Cat. No. $\frac{C}{C.\ 691}$,

Pl. XXIV, fig. 2)

	I_1	I_2	I_3	C	P_3	P_4
Length	3.1	3.5	4.6	13.2	13.1	17.9
Breadth	2.3	2.9	4.1	9.9	7.0	9.0

Lower molars (Cat. No. $\frac{C}{C.\ 691A\ \&\ B}$)

Length .....20.0 .....20.0

Length .....10.0 .....10.1

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien; Layers: 5, 8 and 9. Cat. No. C.L.G.S.C. $\frac{C}{C.\ 691}$ — $\frac{C}{C.\ 693}$.

Felis teilhardi Pei (sp. nov.)

Pl. XXII, figs. 7-9.

Next to the *Pardina*-like *Felis* of Choukoutien, there comes another cat, of the common *Lynx* size, but probably not a *Lynx*. From this new form we know: an upper jaw (P^3—P^4), an isolated P^3, six more or less broken mandibles, 3 isolated M_1, and some incomplete limb- and foot-bones.

DESCRIPTION

1. *Upper jaw* (Fig. 45, C).

P^2, represented by alveolus.

P^3, without distinct anterior cingular cusp. Parastyle present, rather small; posterior cingular cusp weak.

P^4, with deuterocone relatively large, but parastyle distinctly small. Anterior border moderately concave. On the isolated upper carnassial referred to the same species, the size is smaller and the anterior border of the tooth deeply concave.

2. *Mandible* (Fig. 45, A and B).

Mandibular bone, somewhat slenderer than in *Lynx*, but not tapering off anteriorly as in the wild cat; with a lower border gently convex. No distinct ramal process. Judging by one specimen only, both the angular process and the masseteroid ridge are very weak.

P_2, with a distinct anterior cingular cusp (this cusp is not observed in *Lynx*).

M_1, most generally with a rudimentary talonid and an obliquely set posterior edge of the protoconid (*Lynx* characters). But those features are somewhat variable. For instance, on a mandible belonging to a young individual, the lower carnassial, perfectly fresh, shows no trace of talonid, and the posterior edge of the protoconid is almost vertical. On another hand, a weak metaconid is observable on an isolated specimen.

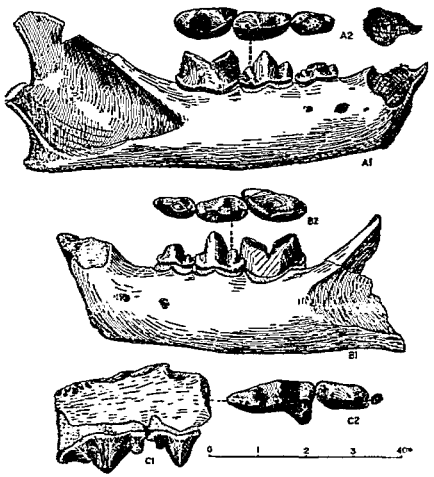

Fig. 45.
Felis teilhardi Pei (sp. nov.), × 1/1.
A, right mandible;
B, left mandible;
C, maxilla with P^3, P^4 and the aveolus of P^2.

3. *Limb-bones*.

To the present form we refer: the distal end of a humerus; the proximal end of a radius; three proximal ends of tibia. In common, those specimens look slightly smaller than in a recent *Felis* (*Lynx*) *lynx* L.

Humerus with shaft stouter and distal end less expanded than in *Lynx*. Maximum breadth of the distal articulation, 34.1 mm.

Radius as in *Lynx*, but with the tuberosity somewhat smaller, and the humeral facet more elongated. Maximum breadth of the proximal end, 75.2 mm.

Tibia, as in *Lynx*. Proximal maximum breadth 33.0-30.2 mm.

4. *Foot-bones*.

Three calcanea, and two astragali, slightly variable in size. Maximum length and breadth of the largest specimen of astragalus: 30.5 and 23.2 mm, of the medium sized specimen: 49.6 and 21.0 mm.

MEASUREMENT (in mm.)

Felis teilhardi from Choukoutien.

Specimen No.		$\frac{C}{C.\ 697}$ (Pl. XXII, fig. 9)	
P^3	length	11.0	—
	breadth	6.0	—
P^4	length	19.0	17.4
	breadth	9.0	8.2

Specimen No.	306:06	24:2	LC:369 (Pl. XXII, fig. 8)	(Young) (Pl. XXII, fig. 7)
Length fron P_3 to M_1	33.2	35.5	31.2	31.6
Height of the mandible in front of P_3	16.0	17.8	16.2	15.3
Height of mandible behind M_1	19.0	20.4	18.3	15.5
Length of the diastema C-P_3	—	10.5	8.0	—
C (lower) length	—	8.6	—	—
breadth	—	7.2	—	—
P_3 length	9.0	9.3	8.0	9.0
breadth	4.8	5.1	4.4	4.2
P_4 length	12.0	11.6	10.2	—
breadth	5.6	6.0	5.4	—
M_1 length	13.3	14.5	13.5	13.3
breadth	6.5	6.4	6.0	6.2

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien. Layers: 5, 8, 9 and Lower Cave and Kotzetang Cave. Cat. No. C.L.G.S.C. $\frac{C}{C.\ 696}$ $\frac{C}{C.\ 697}$.

COMPARISON

For the size and by the inclined position of the posterior edge of its carnassial protoconid, the here described form would fit perfectly with *Lynx* (Miller, 1912). But in the true *Lynx* P^2 is absent (Miller, 1912, etc.). For this reason, we have to leave it in the group *Felis felis* and give it a specific name.

The closest Chinese fossil forms to be brought in comparison would be the *Felis* sp. (a mandible and a lower jaw) described by Zdansky (1927) from Wushianghsien, Shansi, and another *Felis* sp. described by Teilhard and Piveteau (1930) from the Sanmenian beds of Nihowan.

But the former one, according to Zdansky, was collected from the Pontian Red Clays; and therefore likely to be excluded. And in the latter one P_3 is relatively larger than in the Choukoutien form, there is no talonid on M_1 and P_3 is perhaps absent.

I am very glad to dedicate this specific name of new *Felis* to P. Teilhard de Chardin, who has helped me greatly in my scientific work.

Felis sp. 2.

A lower jaw fragment with P_3 and P_4 represents a second undeterminable species of *Felis*. This specimen can not be referred to the *Felis* sp. 1, on account of the smallness of its teeth. And it differs from *Felis teilhardi* in several characters: jaw bone much higher and thicker; P_3 without anterior cingular cusp and with a broad posterior cingulum; P_4 more elongated.

The dimensions are as follows:

Height of mandible anterior to P_4	19.6 mm.
Width of mandible anterior to P_4	10.3 mm.
Length of P_3	9.0 mm.
Width of P_3	5.0 mm.
Length of P_4	12.6 mm.
Width of P_4	6.2 mm.

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien. The only specimen was collected from Layer 7. Cat. No. $\frac{C}{C.\ 1857}$.

No specific identification is evidently possible with such a scanty material.

Felis cf. **microtis** Milne-Edwards

Pl. XXII, Figs. 10-13.

1868-1874 *Felis microtis* A. Milne-Edwards. Recherches pour service a l'histoire naturelle des mammiferes. Paris, Tome I, pp. 221-223. Tome II, Pl. XXXI and Pl. XXXIB, fig. 1.

1928 *Felis* sp. Zdansky. Die Säugetiere der Quartärfauna von Choukoutien (Chou-K'ou-Tien). Palæontologia Sinica. Ser. C, Vol. V, Fasc. 4, p. 50, Taf. IV, figs. 16 and 17.

The smallest fossil cat found in Choukoutien has approximately the size of the common wild cat. Belonging to this form we have 5 upper jaws, 6 mandibles, several isolated teeth, a few limb-, and foot-bones. These specimens show a sufficiently great range of variation, both in size and in minor dental features, for being sub-divided into 2 groups, A and B. But these differences do not seem important enough for suggesting the presence of two different species.

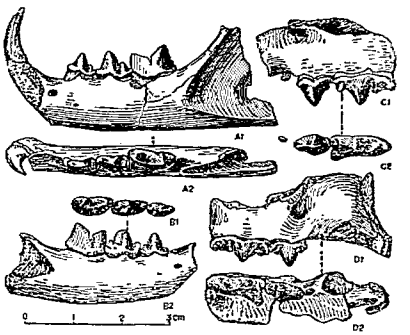

Fig. 46.

Felis cf. *microtis* M.-Edwards. × 1/1.

A, left mandible (Group A);

B, right mandible (Group B);

C, maxilla with P^2—P^4 (Group B);

D, maxilla with P^2—P^4 and alveoli for P^2, canine, etc. (Group A).

DESCRIPTION

In common the group A (4 upper and 3 lower jaws) and the group B (1 upper and three lower jaws and an isolated P^4) have their small size and the presence of (strongly reduced) P^2. The last character is one which separates them from *Lynx*. Between them, the differences are as follows:

Group A (Fig. 46, D and A, Pl. XXII, fig. 11).	Group B, (Fig. 46, C and B, Pl. XXII, fig. 12).
P^3, with strong metastyle; anterior cingular cusp weak; posterior one strong.	P^3, with weak metastyle; anterior cingular cusp absent; posterior one weak.
P^4, larger in size; deuterocone strong; occasionally and accessory cusp present at the antero-external corner of the parastyle (or first lobe).	P^4, smaller in size; deuterocone weak, no accessory "pre-parastyle".
Mandibular bone, gently convex.	Mandibular bone, strongly convex.
P_4, oval in outline; with a weak anterior cingular cusp, and an expanded posterior end.	P_4, elongated; with a strong anterior cingular cusp; posterior end not expanded.
M_1, larger in size, with a weak talonid and metaconid.	M_1, smaller, without talonid nor metaconid.

On a specimen belonging to group B, the P_3 is abnormal; obliquely set in the jaw, and with a downward projection of enamel, on its front.

MEASUREMENTS (in mm.)

Milk lower molar (Fig. 47).

Length and breadth of DP_4 . . . . . 7.5 & 3.0

Group A

Specimen $\frac{C}{C.\ 694}$

Length of tooth row (I^1—M^1)	38.0
Diastema (C^*—P^2)	1.8
Length of three premolars (P^2—P^4)	22.0
Length and breadth of P^3	8.0 & 4.0
Length and breadth of P^4	12.2 & 5.9
Length and breadth of M^1	2.0 & 3.4

* By alveolus

Specimen $\frac{C}{C.\ 695}$

Length from canine to M_1	34.8
Length of tooth row (P_3—M_1)	23.0
Diastema (C—P_3)	6.5
Length and breadth of canine	5.3 & 4.2
Length and breadth of P_3	6.0 & 3.0
Length and breadth of P_4	7.4 & 4.0
Length and breadth of M_1	9.6 & 4.0

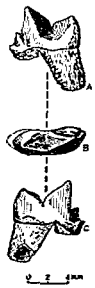

Fig. 47.
Felis cf. *microtis* M.-Edwards, DM_1, × 2/1.

Group B.

Specimen 30:53.

Length from P^{2*}—P^3	22.0
Length and breadth of P^3	6.3 & 3.6
Length and breadth of P^4	11.8 & 5.0

One isolated P^4.

Length and breadth of P^4	10.5 & 5.0

* By alveolus

Specimen 9.29.1

Diastema (C*—P_3)	4.2
Length from P_2 to M_1	21.0
Length and breadth of P_3	5.5 & 2.6
Length and breadth of P_4	7.8 & 3.4
Length and breadth of M_1	8.6 & 4.1

HORIZON AND LOCALITY: Upper Polycene of the *Sinanthropus* site at Choukoutien. Layers: 5, 8, 9 and Lower Cave. Cat. No. C.L.G.S.C. $\frac{C}{C.\ 694} - \frac{C}{C.\ 695}$.

COMPARISONS

The above described fossil material belongs most probably to some still living species of wild cat. But this group has been so much split up by zoologists according to the fur characters that no sure identification by the teeth and jaws alone seems possible. Therefore, we refer the Choukoutien form to *F. microtis*, only for geographical convenience, because *Felis microtis* is still living in the Peiping area, and approximately the same size as our fossil form. However it must be observed that by the shape of the lower jaw (inferior border strongly convex: symphysis short, and any appreciable downward process) our Group B is decidedly closer to *Felis catus* than Group A.

From Choukoutien Locality 1, Zdansky (1928, p. 50) has described a P_4 belonging apparently to the same form. From Locality 3 remains of a small *Felis* have also been collected of the same size but with P^3 larger, and M_1 smaller.

Very small cats occur in China since the Pontian Red Clays (one skull collected by P. Licent in the Hipparion beds of Kinyang), but are not described.

Genus **CYNAILURUS** Walger

Cynailurus sp.

Pl. XXIII, fig. 6.

1928 ?*Felis* sp. Zdansky. Die Säugetiere der Quartärfauna von Chou-K'ou-Tien. Palæontologia Sinica, Ser. C, Vol. V, Fasc. 4, pp. 50 and 51, Taf. IV, Figs. 14 and 15, 1928.

With some hesitation, we refer to the genus *Cynailurus*, a fragmentary lower jaw (with P_4 and M_1, the latter slightly damaged), illustrated in Pl. XXIII, fig. 6. This specimen

* By alveolus

differs from a true *Felis* and comes close to the *Cynailurus* (1) by the sub-equal development of the three cusps of P_4; (2) by the presence of a noticeable talonid at M_1. The validity of this determination is supported by the fact that from the Locality 1 Zdansky (1928, pp. 50 and 51) has described as ?*Felis* sp. another fragmentary jaw (with P_4—M_1) exhibiting exactly the same features as our own specimen.

Still more suggestive is the fact that an entire skeleton of *Cynailurus* has been recently discovered in the Late Pleistocene deposits of the "Upper Cave" at Choukoutien.

MEASUREMENTS

A. Comparative Measurements of three cusps of P_4 in *Cynailurus*, *Metailurus* and *Felis* (in mm.)

		Cynailurus sp. from Choukoutien[1]	*Cynailurus pleistocænicus* Zdansky		*Cynailurus jubatus* recent[4]	*Metailurus minor* Zdansky[5]	*Felis* sp. 1 from Choukoutien[6]	*Felis uncia*[7]
			from Yuanchuhsien[2]	Nihowan[3]				
Length of anterior accessory cusp		4.6	5.5	5.0	3.9	3.2	3.8	4.1
Length of main cusp		6.9	7.8	7.8	6.3	6.5	8.8	8.0
Length of posterior accessory cusp		6.3	6.5	6.3	4.8	3.5	5.5	5.5
Total length	calculated from the above measurement of 3 cusps	17.8	19.8	19.1	15.1	13.2	18.1	17.6
	measured from the figure	—	20.0	19.0	—	14.2	—	—
	actually measured from specimen	17.2	20.2	18.5	14.3	14.5	17.9	17.3

1 Cat. No. $\frac{C}{C.\ 692}$. Since the photograph of Zdansky's specimen on his plate is not clear enough, it does not permit me to take such a measurement on his material.

2 Measured from the photograph given by Zdansky, Taf. IV, Fig. 3, 1925.

3 Measured from the photograph given by Teilhard and Piveteau (Pl. XXI, fig. 4, 1930).

4 Cat. No. 37

5 Measured from the photograph given by Zdansky (Taf. XXX, Fig. 3. 1924)

6 Cat. No. $\frac{C}{C.\ 691}$.

7 Cat. No. 191.

B.

	Cynailurus sp. from Choukoution		*Cynailurus pleistocænicus* Zdansky		*Cynailurus brachygnathus*		*Cynailurus jubatus*
	$\frac{C}{C.\ 1858}$	Zdansky's specimen[1]	Nihowan[2]	Yuanchusien[3]	Siwalik[4]		
P_4 length	17.2	17.3	18.5	20.2	19.8	19.8	14.3
P_4 breadth	8.3	8.5	—	10.5	—	—	6.2
M_1 length	20.3?	18.8	20.0?	23.8	22.9	23.4	17.0
M_1 breadth	8.6	9.0	—	10.7	—	—	7.2

HORIZON AND LOCALITY: Upper Polycene of *Sinanthropus* site at Choukoutien; this only specimen in the present collection was found from Layer 5 or *Sinanthropus* Locus A Cat. No. C.L.G.S.C. $\frac{C}{C.\ 1858}$.

COMPARISONS

From the living *Cynailurus jubatus* the Choukoutien form is distinguishable by a large size, and by a more complex posterior part of P_4 (in C. *jubatus* the cingulum does not form accessory cusps, under the metastylid, as it is the case in the Choukoutien jaw).

From the fossil *C. pleistocænicus* Zdansky, on the contrary, a Sanmenian form found in S. Shansi (Zdansky, 1925) and in Nihowan (Teilhard and Piveteau, 1930) our fossil differs by a smaller size and by a less distinct talonid on M_1. And the same characters would probably help to separate it from *C. (Felis) brachygnathus* Lydekker since, according to Matthew (1929, p. 696), this Siwalik form might be put in synonymy with the Chinese *C. pleistocænicus*.

A new specific name therefore will probably have to be created some day for the Choukoutien hunting leopard; but we have to wait for more and complete material.

As an ancestor of the Chinese *Cynailurus* might perhaps be held the Pontian *Metailurus* Zdansky. In this genus the anterior cusp of P_4 is lower and the protoconid of M_1 longer than in the true *Cynailurus*.

1 After Zdansky, 1928, p. 51.

2 After Teilhard and Piveteau, 1930, p. 113.

3 After Zdansky, 1925, p. 25.

4 After Lydekker from Zdansky, 1925, p. 25.

5 Cat. No. 39.

Cynailurus is also reported from the Italian Val d'Arno: *C. etruscus* Compana (Compana, 1916). *C. etruscus* differs from the Choukoutien form by a larger size and the shape of P_4 and M_1.

The complete skeleton of *Cynailurus* recovered in 1933 from the Upper Cave has not yet been carefully studied, but looks closely allied to the living *C. jubatus* of India.

KEY FOR THE CHOUKOUTIEN FELIDÆ

(A) Upper canine laterally compressed and strongly developed as a blade: border of canine serrated: lower canine small and with accessory cusps..... *Machairodus* sp.....PP. 124-128

(B) Upper canine conical: lower canine larger; dentition $\frac{3.1.3.1}{3.1.2.1}$ ..... *Felinæ*.....PP. 129-150

a) M_1 with a weak, or without, metaconid and talonid; P_4 with a large main cusp ..... *Felis* .....PP. 129-147

* Size comparable with *tigris*

** Mandibular bone of ordinary *Felis* type ..... *Felis* cf. *tigris*...PP. 129-133

** Mandibular bone strongly thickened ..... *F. youngi* PP. 133-135

* Size comparable with *pardus* ..... *F. pardus* .....PP. 135-138

* Size comparable with *pardina* (*Lynx*) ..... *F.* sp. 1. indet.....PP. 139-140

* Size comparable with common *Lynx* (*L. lynx*).

** Mandible of a common *Felis* type; P^2 present; P_3 with a weak or distinct anterior accessory cusp; P_4 oval in shape..... *F. teilhardi* .....PP. 140-143

** Mandible deep and thick, P^2 unknown: P_3 without anterior accessory cusp; P_4 rather elongated in shape ..... F. sp. 2. indet .....PP. 143-144

* Size comparable with *F. catus* ..... *F.* cf. *microtis* ....PP. 144-147

b) M_1 with a small metaconid and talonid, P^4 with a small main cusp.... *Cynailurus* sp.....PP. 147-150

GENERAL OBSERVATIONS AND CONCLUSIONS

(1) PROPORTION AND DISTRIBUTION OF THE SPECIES OF CARNIVORA FOUND IN THE DEPOSITS OF LOCALITY 1.

Adopting the method already used by Dr. C. C. Young in the case of the Artiodactyla of Choukoutien (Young, 1932), we have tried to express the quantitative proportion of Carnivora met with in Locality 1 by the table below:

Very common (represented by thousands of individuals)	Common (represented by fifty to hundred or more individuals).	Rare (represented by ten to fifty individuals).	Very rare (represented by one to ten individuals)
Hyæna sinensis Zdansky	*Canis lupus variabilis* Pei	*Canis lupus* L.	*Cyon* cf. *alpinus* Pallas.
	Canis (Nyctereutes) sinensis Schlosser.	*Canis cyonoides* Pei	*Canidæ* gen. et sp. indet
	Vulpes cf. *corsac* L.	*Vulpes* cf. *vulgaris* L.	*Ursus spelæus* Blumenb. var.
		Ursus angustidens Zdansky	*Mustela* sp.
		Ursus arctos L.	*Gulo* sp.
		Meles leucurus Hodgson	*Lutra melina* Pei
		Mustela cf. *sibirica* Pallas	*Hyæna ultima* Matsumoto
		Hyæna zdanskyi Pei	*Machairodus* sp.
		Felis cf. *pardus* L.	*Felis* cf. *tigris* L.
		Felis teilhardi Pei	*Felis youngi* Pei
		Felis cf. *microtis* Milne-Edwards	*Felis* sp. 1 indet.
			Felis sp. 2 indet.
			Cynailurus sp. indet.

Passing now to the distribution of those Carnivora remains in the successive layers of the deposits, we may observe that such a repartition is especially interesting in the present group since most of the collected fossils belong apparently not to accidentally introduced animals, but to regular cave dwellers. For this reason, we have carefully reported above, in each case, the layer or layers from which each species was collected. From these data, a few points become especially clear and interesting:

(1) The extreme abundance of Carnivora remains belonging to both young and old individuals and of caprolithes in the Lower Cave and in a part of the Lower Fissure (Carnivora

Layer) suggests that those two places have been occupied for a long time by carnivorous mammals (such as *Hyæna sinensis*, *Ursus*, Tiger, *Nyctereutes*, and *Canis lupus variabilis*). On the other hand, the scarcity of Carnivora remains in the cultural level C (Quartz Horizon 2 or *Sinanthropus* Locus G) fits exactly with an occupation level of the primitive man.

(2) All the remains of *Lutra*, were collected in Layer 7 (or "sandy layer") of the Main Deposit. In addition to *Lutra*, the type specimen and a great part of co-types of *Bubalus teilhardi* Young, and some remains of *Castoridæ* have also been recovered from this sandy layer. Such an association of "aquatic" forms points possibly to a maximum of the water condition around the hill at this period.

(3) The single jaw of *Hyæna ultima* Matsumoto so far discovered in the true Choukoutien formation[1], was probably found in Layer 3, or at least somewhere in the top of the Choukoutien formation. In the lower zone of the deposits where the *Hyæna zdanskyi* and chiefly the *H. sinensis* are so abundant, not a single piece referable to this form was ever recognized. This fact would favour the idea that, in spite of several other appearances, a faunistical break will gradually be recognized in the deposits, as soon as more fossils, *specifically determinable*, will have been collected in the uppermost layers of Locality 1.

(2) Percentages of Living and Extinct Species in the Carnivorous Mammals in Choukoutien

Some years ago I have already tried to check the proportion of extinct and living species occurring in the Choukoutien deposits (Pei, 1931). Since the last study made by Dr. C. C. Young of the Choukoutien Artiodactyla, and after this present revision of the Choukoutien Carnivora, my former results have to be revised here.

The distinction between "living" and "extinct" species is, of course, in many cases largely hypothetical. In the following table five groups are distinguished: (1) extinct species; (2) probable extinct; (3) living; (4) probably living; and (5) species indet.

If we consider the "probably living" to be "living" and the "probably extinct" to be "extinct" the proportion found is as follows:

Living forms $\frac{12}{29}$ or 41.3%

Extinct forms $\frac{12}{29}$ or 41.3%

Forms indet. $\frac{5}{29}$ or 17.4%

1 Two jaws of *Hyæna ultima* have been found in 1933 in the "Upper Cave" deposits.

extinct forms	living	probably extinct	probably living	form indet.
Canis cyonoides Pei	*Canis lupus* L.	*Canis lupus variabilis* Pei	*Vulpes* cf. *corsac* L.	*Canidæ* gen. et sp. indet.
Ursus spelæus	*Cyon alpinus* Pallas	*Canis (Nyctereutes) sinensis* Schlosser	*Vulpes* cf. *vulgaris* L.	*Mustela* sp.
Lutra melina Pei	*Ursus arctos* L.	*Gulo* sp.	*Ursus angustidens* Zd.	*Felis* sp. indet. 1
Machairodus sp.	*Meles leucurus* Hodgson	*Cynailurus* sp.	*Felis teilhardi* Pei	*Felis* sp. indet. 2
Felis youngi Pei	*Mustela* cf. *sibirica* Pallas			?*Ailuropus* sp.
Hyæna ultima Matsumoto	*Felis* cf. *tigris* L.			
Hyæna ultima (Owen) Zdansky	*Felis* cf. *pardus* L.			
Hyæna zdanskyi Pei	*Felis* cf. *microtis* M.-Edwards			

N.B. In the above table *Martes* sp. from the "Cap Travertine" is excluded.

By this statistical method, the probability that the Choukoutien deposits have to be referred to a fairly Early Pleistocene age already becomes strong. More evidences can be drawn from a qualitative appreciation of the intermediate place filled by the Choukoutien Carnivora between the Sanmenian and the "Loess", in the general evolution of the Chinese Cenozoic fauna (*vide infra*).

(3) AN OUTLINE OF THE HISTORY OF THE CARNIVORA DURING THE LATE TERTIARY AND THE QUATERNARY OF NORTH CHINA

The genus *Canis*[1] is not surely recorded in North China before the end of the Pliocene times. But at the beginning of the Sanmenian period a Dog very close to the common wolf, *C. chihliensis* Zdansky, is already common; and the form can be traced, without any essential morphological changes up to the Choukoutien Epoch. Chiefly for stratigraphical convenience, I have adopted a new sub-specific name for the Choukoutien member of this group: *C. lupus variabilis*. Represented by numerous specimens, *C. lupus variabilis*, proves to be an animal exhibiting a great variation, not only in size, but also in tooth adaptation. The crushing portion of the upper molars shows frequently traces of complication and is often worn flat, a possible indication of an omnivorous diet. The form seems to have disappeared before the Late Pleistocene times.

Less commonly, another form, indistinguishable in shape and size from the living ordinary wolf, is also found in Choukoutien.

1 The genus (or sub-genus) *Nyctereutes* being excluded.

In decided and zoological opposition to the rather "omnivorous" *C. lupus variabilis*, two strongly carnivorous dogs, *C. cyonoides* and a true *Cyon* occur in the same levels.

C. cyonoides is characterised by the simple shape of the lingual portion of the upper molars, by an elongated upper carnassial, and by the almost cutting talonid of the lower carnassial. By those features, it approaches the conditions found in *Cyon*. But its connections either with Pontian or with Living *Canidæ* are still obscure.

For geographical reasons, the Choukoutien *Cyon*, known from fragmentary jaws only, has been referred by us to the northern living form *Cyon alpinus* rather than to the southern *C. javanicus*, to which on the contrary the fossil *Cyon* described by Matthew and Granger from the early Pleistocene of Ssuchuan (Matthew and Granger, 1923), is perhaps related. No traces of the genus are so far reported from older deposits in China.

Finally, still more apart from the common Dogs than the *Cyon*, a microdont type, *Nyctereutes* or "Racoon-dog" is abundantly found in Choukoutien. The Choukoutien *Nyctereutes* seems to belong to the same species, *Nyctereutes* (*Canis*) *sinensis*, as the *Nyctereutes* so common in the Sanmenian beds of Nihowan. But judging from the study of hundreds of specimens, it shows distinct tendencies to a complication of the molars and to a reduction of the size.

The first *N. sinensis* are recorded from the Middle (or Lower?) Pliocene of Shansi. A smaller form (with non-complicated molars) is still living in North China and Japan: *C.* (*N.*) *procyonoides*.

Family **MUSTELIDÆ**

In the Lower Pliocone (Pontian) beds of North China several archaic Mustelidæ occur, such as, *Sinictis* Zdansky, *Proputorius* Filhol, *Pleisogulo* Zdansky, *Parataxidea* Zdansky, and *Melodon* Zdansky. In Choukoutien, with the possible exception of the *Lutra*, nothing is left of those early types; but we have only to deal with modern genera: *Meles*, *Lutra*, *Putorius*, *Martes* and *Gulo*.

True Badgers are found as early as in the Sanmenian deposits in North China[1], with their complete generic characters. The Sanmenian *Meles* from Nihowan, for instance, is hardly distinguishable from *M. leucurus*, now living in North China. No wonder therefore if the Choukoutien remains of *Meles* have to be referred to the same living type.[2]

1 The *Meles from Ertemte* Mongolia (Middle Pliocene) described by Schlosser has probably to be removed from the modern genus *Meles* (Miller, 1928).

2 In South China the *Melinæ* group is known by a fossil *Arctonyx* discovered in the Early Pleistocene fissure deposits of Ssuchuan (Matthew and Granger, 1923). Although recorded from North China, this rather southern form is not to be found in the Choukoutien deposits.

Much more characteristic, but still very obscure in its relationships, is the *Lutra* which, on account of the Badger characters observable in the lower teeth, I have named *L. melina*. This form is not to be related with the Sanmenian *Lutra* from Nihowan (*L. licenti*), still less with the Pontian *Lutra* (*L. aonychoides*). The closest approach would perhaps be with the southern Asiatic living Otter, *Lutra sumatrana*.

The Choukoutien *Mustela* is practically identical with the recent *M. sibirica* now living in Manchuria. Although the genus is probably very old (Basal Miocene?) it is not yet recorded from earlier levels in China.

Martes remains were also collected on the top of the Choukoutien hill. But this genus is of little significance, since it is known as early as Lower Pliocene in the Dalai Nor beds (Teilhard, 1926) and as the Middle Pliocene in Ertemte, Inner Mongolia (Schlosser, 1924).

The rarest form of *Mustelidæ* observed in Choukoutien is a *Gulo*, which, if better known, would probably prove to be different from the living *Gulo luscus*. No remains of *Gulo* are known so far in the Sanmenian deposits. But, in the Pontian beds of Shansi and Kansu an archaic form, *Pleisogulo brachygnathus* Zdansky (*Lutra brachygnathus* Schlosser) is rather common.

Family **URSIDÆ**

In the Lower Pliocene of China the Ursidæ group is chiefly represented by primitive genera such as *Indarctos* and *Hyænarctos*. By their unreduced premolars, large carnvasial and small molars, those carnivorous, rather than omnivorous, forms differ widely from the true bears.

The earliest indication of the modern genus *Ursus* in China is encountered in the Sanmenian. The Sanmenian *Ursus* (Locality 105, Yuanchuhsien, Zdansky 1925 and Nihowan, Teilhard and Piveteau, 1930) is already very modernized, and hardly separable from the living *U. arctos*.

In Choukoutien, the group is still better represented by three distinct species: *U. angustidens* Zdansky, *U. arctos* L. and *U. spelæus*, var. *U. angustidens* is closely related to the living *U. japonicus* and possibly also the fossil *U. kokeni* from South China. *U. spelæus* var. may represent an oriental race, or equivalent of the European cave bear (*U. spelæus*) unless one prefers to compare it with the American Grizzly.

Hyænidæ

The Chinese Hyænidæ forms a rather complex series, which we have tried to make clearer above. Emerging, in the Pontian, in the middle of a rich group of Hyæna-like *Ictitherium*[1], their first representatives belong to rather slender forms, as *H. variabilis* Zdansky. In the Late Pliocene and Lower Pleistocene times, the dominant type (a rather stout animal, with thick premolars and rather short carnassial blades), first included under a single name, *H. sinensis* Owen, has been split in the present paper into several races and species: *H. sinensis* Zdansky (Southern type), *H. sinensis* Zdansky (northern type), *H. licenti* Pei (Sanmenian), *H. zdanskyi* Pei. Later (that is in the Later Pleistocene only), a new and well defined type occurs, with much elongated and cutting carnassial teeth: *H. ultima* and *H.* cf. *spelæa*.

Remains of *Hyæna* are exceptionally numerous in Choukoutien: *H. sinensis* (northern type) and *zdanskyi* at the base, *H. ultima* at the top of the deposits.

Family FELIDÆ

Although the fact is somewhat obscured by the creation of several new genera or rather sub-genera based on a few residual archaic characters, the presence of the true *Felis* is certain in the Chinese Pontian. Later, in the Sanmenian deposits (Nihowan, etc.) several Cats of an entirely modern type are common. Still later, in Choukoutien, owing largely to the favourable conditions of the deposits, no less than seven species have been recorded (*vide supra*). But since the characters of *Felis* are very conservative, this variety helps but little for the stratigraphical understanding of the geological formation.

Among the Choukoutien *Felis* two forms have to be mentioned, as particularly interesting, namely, *F. youngi* and *F. teilhardi*. The first one was a large beast, somewhat converging to the European cave lion (*F. leo spelæus*) or to the *F. atrox* Leidy by the great thickness of the mandible. The latter one would stand close to the common *Lynx* by the size and the shape, but has to be separated from the *Lynx* group on account of the preservation of P^2 and of some other dental features (*vide supra*).

The persistence of the archaic genus *Machairodus* is one of the most noticeable palæontological characters of the Choukoutien deposits. Unfortunately, the specimens so far collected are insufficient for allowing a distinct comparison with the representatives of the genus in China.

1 A *Hyæna* of the *variabilis* group is already found in the Miocene of Tung-Gur (Mongolia). Personal communication from Dr. W. Granger.

(4) THE PLACE OF THE CHOUKOUTIEN FAUNA IN THE STANDARD HORIZONS OF LATE CENOZOIC IN NORTH CHINA

In North China four standard stratigraphical and faunistical horizons are recognized so far in the Late Cenozoic Deposits:[1] The Lower Pliocene sands and red clays (Pontian); the Late Pliocene sands and reddish loam (Sanmenian); the Early Pleistocene fissure deposits and late loams (Choukoutien); the Late Pleistocene loess and sands (Loessic).

Nihowan (Upper Pliocene)	Choukoutien (Lower Pleistocene)	Sjara-osso-gol (Late Pleistocene)
Canis chihliensis Zdansky → (=*C. lupus variabilis* Pei)	*Canis lupus variabilis* Pei	†
†	*Canis lupus* L. →	*Canis lupus* L.
+	*Canis cyonoides* Pei	†
C. (Nyctereutes) sinensis Schlosser →	*C. (Nyctereutes) sinensis* Schlosser →	*C. (Nyctereutes) procyonoides* Gray
Vulpes sp. cf. *corsac* L. (*V. chikushanensis* Young) →	*Vulpes* cf. *corsac* L. →	(+)
†	*Vulpes* cf. *vulgaris* L. →	(+)
+	*Cyon* cf. *alpinus* Pallas →	(+)
	Ursus arctos L. →	(+)
Ursus cf. *etruscus* →	*Ursus angustidens* Zdansky →	(+)
+	*Ursus spelæus*	+
Meles cf. *leucurus* Hodgson →	*Meles leucurus* Hodgson →	(+)
Lutra licenti Teilhard and Piveteau	*Lutra melina* Pei	+
+	*Gulo* sp.	+
+	*Mustela* cf. *sibirica* Pallas →	(+)
+	*Hyæna ultima* Matsumoto →	*Hyæna spelæa*
+	*Hyæna zdanskyi* Pei	+
Hyæna licenti →	*Hyæna sinensis* Owen (Northern race)	+
Machairodus nihowanensis Teilhard and Piveteau	*Machairodus* sp.	+
+	*Felis youngi* Pei	+
Felis (Lynx) sp.	*Felis teilhardi* Pei	(+)
†	*F.* cf. *tigris* L.	(+)
†	*F.* cf. *pardus* L.	(+)
†	*F.* cf. *microtis* Milne-Edwards	(+)

1 Probably the Ertemte sands and the White beds of the Dalai Nor in Mongolia, and the lower reddish clay of Paote (Teilhard and Young) represent a fifth horizon, namely the Middle Pliocene deposit, but this term is not yet clearly separated.

We have tried in the above table to express how the above described Choukoutien carnivorous faunas fit between the two adjacent Sanmenian and Loessic faunas (the Pontian one being omitted, because of its much too archaic characters). In this table an arrow (→) indicates that a direct filiation is suggested between two forms and the cross + points to a form more probably absent. By the plus sign (+) we mean that a form is most probably present, although not yet actually discovered. The dagger sign (†) means a probable absence.

(5) ZOOGEOGRAPHIC ANALYSIS OF THE CHOUKOUTIEN CARNIVORA FAUNA

Although the real significance of the faunistical association met with in Choukoutien can not be fully appreciated except by taking into consideration the zoological elements *all together*, we can search here what successive pulsations, or lines, of migration can be recognized leading to the composition of the *Carnivorous group only*.

From this point of view, the above described forms may be distributed into the following categories:

1) Indigeneous types, already represented (at least by ancestral forms) in the Late Pliocene times (Sanmenian) in North China: *Machairodus*, *Hyæna sinensis*, *H. zdanskyi*, most of the *Felidæ*, *Mustela* and *Martes*, *Meles*, *Ursus*, *Canis*, *Corsac* and *Nyctereutes*. Those are the remains of a Late Pliocene extensive Eurasiatic (Palæarctic) faunistical sheet, in which some elements (namely, *Hyæna sinensis*, *Nyctereutes*, *Corsac*, *Ursus angustidens*) because restricted or modified in the East, represent for the Lower Pleistocene a true Asiatic group.

2) Newly immigrated (?) types, not yet recorded from the Sanmenian: *Hyæna ultima*, *Felis tigris* and *F. youngi*, *Gulo*, *Lutra melina*, *Cyon*. If really migrated those forms suggest the following faunistical relations:

a) *F. tigris* (known at the same time, or a little earlier, in Ssuchuan), *L. melina* (cf. *sumatrana* ?) *in the South*.

b) *H. ultima*, with the Southwest (the *crocuta* group is known in India and Syria as well as in Europe, in the Pleistocene).

c) *Cyon* (?), *Gulo*, *with the North and the West*.

(6) GENERAL CONCLUSION

From the above given review of the Choukoutien Carnivora we may conclude:

1. That their group marks a satisfactory stage between the Late Pliocene (Sanmenian) and the Late Pleistocene (Loessic) corresponding faunas, a new evidence supporting the assumption of a Lower Pleistocene age for the Choukoutien deposits.

2. That they represent a typical old palæarctic assemblage, showing marked traces of an eastern differentiation, with a few superimposed southern or northern influences.

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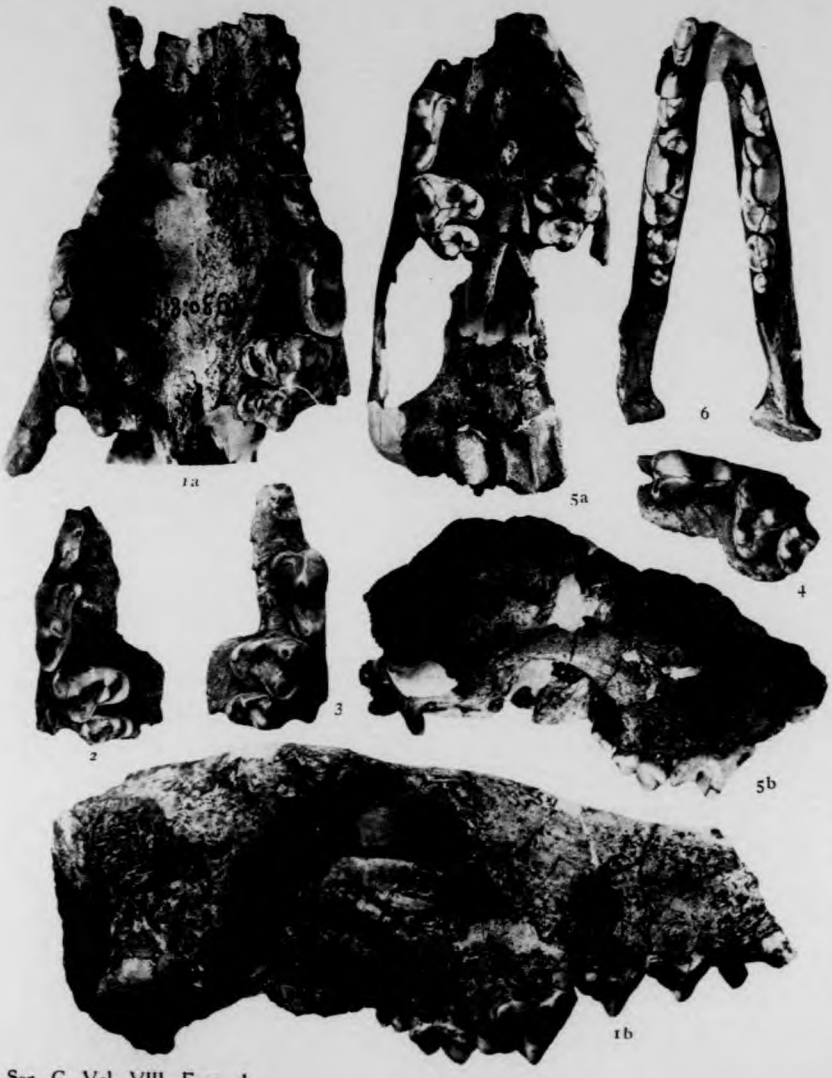

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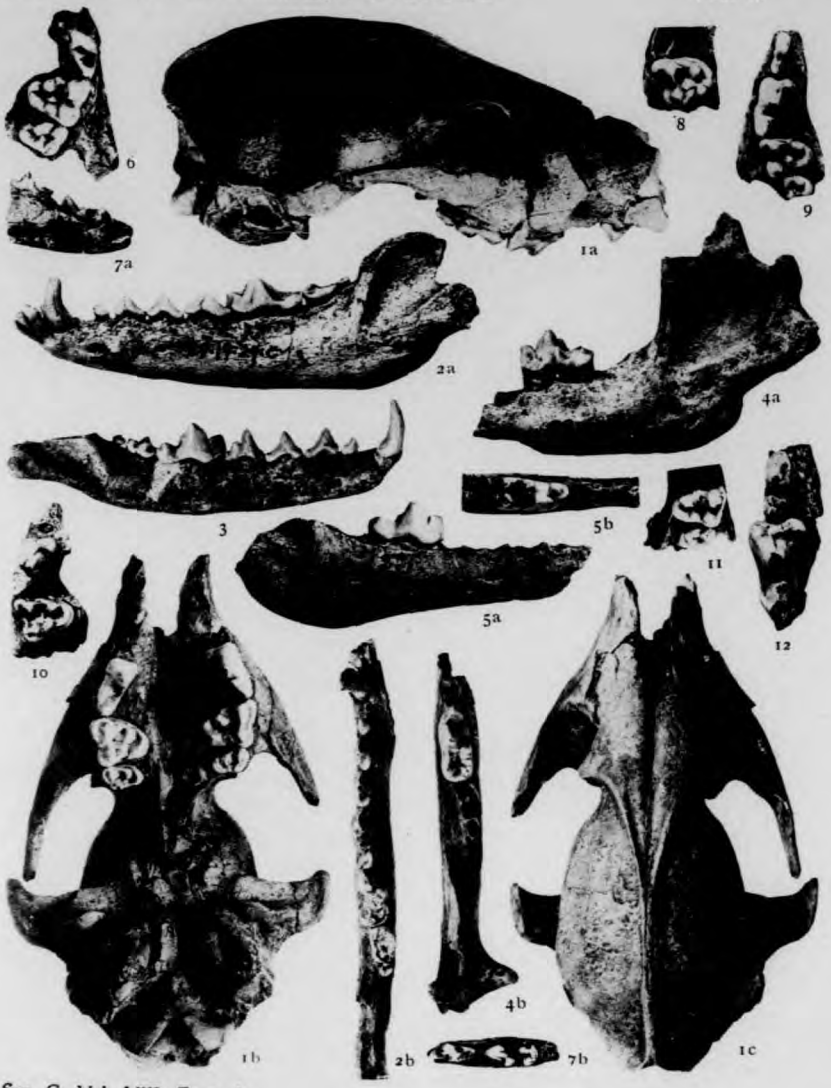

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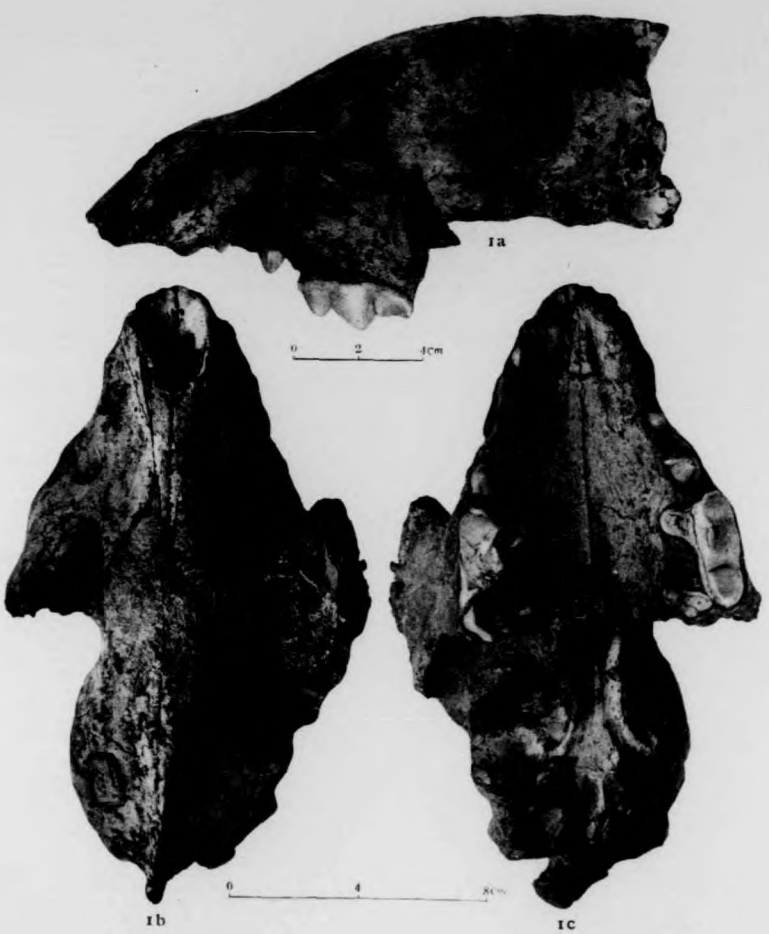

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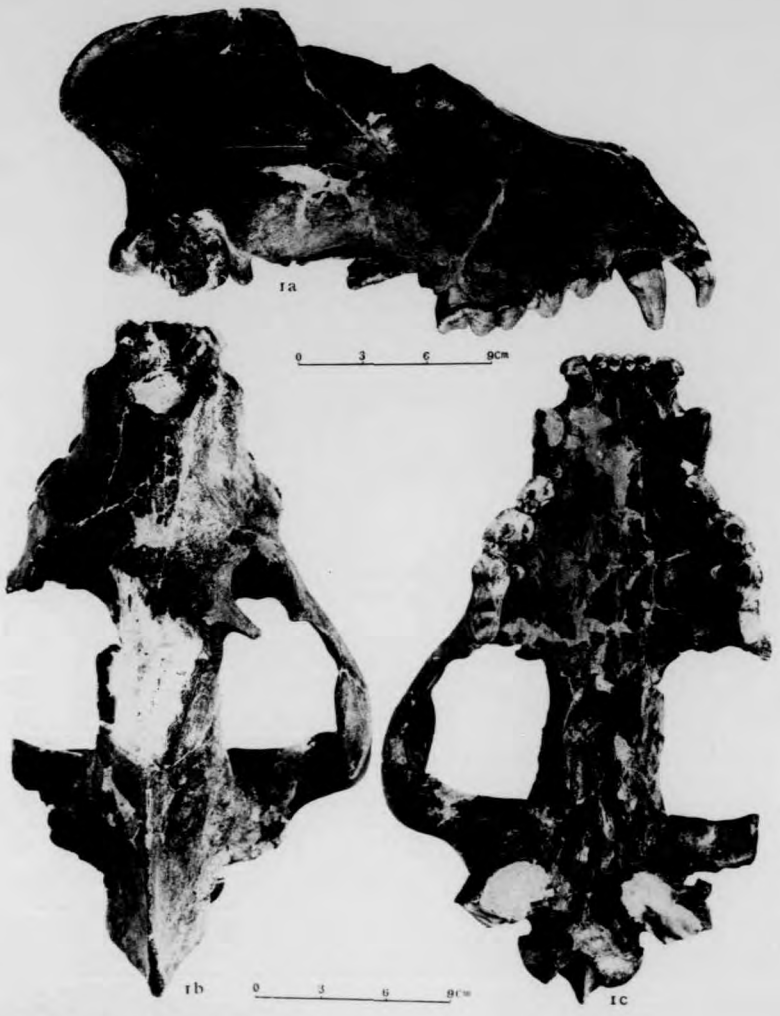

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Fig. 4. *Hyæna sinensis* Zdansky, atlas, (from the same individual as the skull on Pl. XIV), top view, × 2/3..... P. 91

W. C. Pei:—Carnivora from Locality 1 of Choukoutien Plate XVI

EXPLANATION OF

PLATE XVII.

PLATE XVII.

Fig. 1. *Hyæna sinensis* Zdansky, skull..... P. 91

1a, left side view, × 4/9;

1b, palatinal view, × 4/9;

1c, top view, × 4/9.

W. C. Pei:—Carnivora from Locality 1 of Choukoutien Plate XVII

EXPLANATION OF

PLATE XVIII.

PLATE XVIII.

Fig. 1. *Hyæna sinensis* Zdansky, skull ..... P. 91
1a, left side view, × 4/9;
1b, top view, × 4/9;
1c, palatinal view, × 4/9.

Fig. 2. *Hyæna zdanskyi* Pei (sp. nov.), left maxilla with P^2—M^1 ..... P. 110
2a, crown view, × 2/3;
2b, outer side view, × 2/3.

Fig. 3. *Hyæna zdanskyi* Pei (sp. nov.), broken left maxilla with P^3 and P^4 ..... P. 110
3a, crown view, × 2/3;
3b, outer side view, × 2/3.

W. C. Pei:—Carnivora from Locality 1 of Choukoutien

Plate XVIII

EXPLANATION OF

PLATE XIX.

PLATE XIX.

Fig. 1. *Hyæna sinensis* Zdansky, right maxilla of a young individual with DP_3—DM_1. P. 91
1a, outer side view, × 1/1;
1b, crown view, × 1/1.

Fig. 2. *Hyæna sinensis* Zdansky, tibia of young individual, anterior view, × 3/3. P. 91

Fig. 3. *Hyæna sinensis* Zdansky, broken skull of a young individual..... P. 91
3a, top view, × 2/3;
3b, right side view, × 2/3;
3c, palatinal view, × 2/3.

W. C. Pei:—Carnivora from Locality 1 of Choukoutien

Plate XIX

EXPLANATION OF

PLATE XX.

PLATE XX.

Fig. 1. *Hyæna sinensis* Zdansky, right mandible of a young individual, outer side view, × 1/1 ..... P. 91

Fig. 2. *Hyæna sinensis* Zdansky, left mandible of a young individual, outer side view, × 1/1 ..... P. 91

Fig. 3. *Hyæna sinensis* Zdansky, left mandible of a young individual ..... P. 91
3a, outer side view, × 1/1;
3b, top view, × 1/1.

Fig. 4. *Hyæna sinensis* Zdansky, left mandible of a young individual with milk dentition fully grown ..... P. 91
4a, outer side view, × 2/3;
4b, top view, × 2/3.

Fig. 5. *Hyæna sinensis* Zdansky, left mandible of a young individual with worn milk teeth and a half grown permanent M_1, outer side view, × 2/3 ..... P. 91

Fig. 6. *Hyæna sinensis* Zdansky, right mandible of a young individual with milk canine and premolars and a permanent M_1 ..... P. 91

Fig. 7. *Hyæna zdanskyi* Pei, (sp. nov.), left mandibular fragment with broken P_2, M_1 and complete P_4 inner side view, 1/1 ..... P. 110

W. C. Pei:—Carnivora from Locality 1 of Choukoutien

Plate XX

EXPLANATION OF

PLATE XXI.

PLATE XXI.

Fig. 1. *Hyæna sinensis* Zdansky, scapula, outer side view. × 4/9 ..... P. 91
Fig. 2. *Hyæna sinensis* Zdansky, humerus, posterior view, × 4/9 ..... P. 91
Fig. 3. *Hyæna sinensis* Zdansky, ulna, side view, × 4/9 ..... P. 91
Fig. 4. *Hyæna sinensis* Zdansky, radius, anterior view, × 4/9 ..... P. 91
Fig. 5. *Hyæna sinensis* Zdansky, innominate bone, outer side view, × 4/9 ..... P. 91
Fig. 6. *Hyæna sinensis* Zdansky, femur, anterior view, × 4/9..... P. 91
Fig. 7. *Hyæna sinensis* Zdansky, tibia, anterior view, × 4/9 ..... P. 91
Fig. 8. *Hyæna sinensis* Zdansky, part of fore foot, top view, × 4/9 ..... P. 91

W. C. Pei:—Carnivora from Locality 1 of Choukoutien Plate XXI

EXPLANATION OF

PLATE XXII.

PLATE XXII.

Fig. 1. *Machairodus* sp., right upper canine ..... P. 124
1a, inner side view, × 1/1;
1b, outer side view. × 1/1.

Fig. 2. *Machairodus* sp., left upper canine ..... P. 124
2a, outer side view, × 1/1;
2b, inner side view, × 1/1.

Fig. 3. *Machairodus* sp., left lower canine ..... P. 124
3a, outer side view, × 1/1;
3b, inner side view, × 1/1.

Fig. 4. *Machairodus* sp., right I^3 ..... P. 124
4a, outer side view, × 1/1;
4b, inner side view, × 1/1.

Fig. 5. *Machairodus* sp., right M_1 ..... P. 124
5a, inner side view, × 1/1;
5b, outer side view, × 1/1;
5c, crown view, × 1/1.

Fig. 6. *Machairodus* sp., broken left P_4 ..... P. 124
6a, outer side view, × 1/1;
6b, crown view, × 1/1;
6c, inner side view, × 1/1.

Fig. 7. *Felis teilhardi* Pei (sp. nov.), right mandible with P_3 and M_1 ..... P. 140
7a, outer side view, × 1/1;
7b, top view, × 1/1.

Fig. 8. *Felis teilhardi* Pei (sp. nov.), left mandible with P_3—M_1 ..... P. 140
8a, inner side view, × 1/1;
8b, top view, × 1/1.

Fig. 9. *Felis teilhardi* Pei (sp. nov.), broken right maxilla with P_3 and P_4 ..... P. 140
9a, outer side view, × 1/1;
9b, crown view, (the dark and rounded spot anterior to P_3 indicates the alveolus for P^2), × 1/1.

Fig. 10. *Felis* cf. *microtis* A. Milne-Edwards, right mandible with P_3—M_1 ..... P. 144
10a, outer side view, × 1/1;
10b, top view, × 1/1.

W. C. Pei:—Carnivora from Locality 1 of Choukoutien

Plate XXII

Fig. 11. *Felis* cf. *microtis* A. Milne-Edwards, right maxilla with P^3 and P^4..... P. 144
11a, outer side view, × 1/1;
11b, crown view, × 1/1.

Fig. 12. *Felis* cf. *microtis* A. Milne-Edwards, broken left maxilla with P^2—P^4 ..... P. 144
12a, outer side view;
12b, crown view.

Fig. 13. *Felis* cf. *microtis* A. Milne-Edwards, left mandible with cannie to M_1 and an abnormal P_3..... P. 144
13a, inner side view, × 1/1;
13b, top view, × 1/1.

EXPLANATION OF

PLATE XXIII.

PLATE XXIII.

Fig. 1. *Felis youngi* Pei (sp. nov.), anterior portion of mandibles ..... P. 133
1a, top view, × 2/3;
1b, base view, × 2/3;
1c, left side view, × 2/3.

Fig. 2. *Felis* cf. *pardus* L., broken right maxilla with P^3 and P^4 ..... P. 135
2a, outer side view, × 1/1;
2b, crown view, × 1/1.

Fig. 3. *Felis* cf. *tigris* L., broken left maxilla with P^3—M^1 ..... P. 129
3a, outer side view, × 1/1;
3b, crown view, × 1/1.

Fig. 4. *Felis youngi* Pei (sp. nov.), right P^4 ..... P. 133
4a, crown view, × 1/1;
4b, inner side view, × 1/1.

Fig. 5. *Felis* cf. *pardus* L., left P^4 ..... P. 135
5a, outer side view, × 1/1;
5b, crown view, × 1/1.

Fig. 6. *Cynailurus* sp., right mandibular fragment, with P_4 and M_1 ..... P. 147
6a, outer side view, × 1/1;
6b, crown view, × 1/1.

W. C. Pei:—Carnivora from Locality 1 of Choukoutien Plate XXIII

EXPLANATION OF

PLATE XXIV.

PLATE XXIV.

Fig. 1. *Felis* cf. *tigris* L., right mandible with M_1 ..... P. 129
1a, outer side view, × 2/3;
1b, top view, × 2/3.

Fig. 2. *Felis* sp. 1 indet. anterior portion of mandibles..... P. 139
2a, outer side view, × 1/1;
2b, top view, × 1/1.

Fig. 3. *Felis* cf. *pardus* L., right mandible..... P. 135
3a, outer side view, × 2/3;
3b, top view. × 2/3.

Fig. 4. *Felis* cf. *pardus* L., right mandible with P_4 and M_1..... P. 135
4a, outer side view, × 2/3;
4b, top view, × 2/3.

Fig. 5. *Felis* cf. *pardus* L., left mandibular fragment with DP_4 and DM_1..... P. 135
5a, outer side view, × 1/1;
5b, inner side view, × 1/1;
5c, crown view, × 1/1.

Fig. 6. *Felis* cf. *tigris* L., left DM_1..... P. 129
6a, inner side view, × 1/1;
6b, outer side view, × 1/1;
6c, crown view, 1/1.

Fig. 7. *Felis* sp. 1 indet, left P^4..... P. 139
7a, outer side view, × 1/1;
7b, crown view, × 1/1.

W. C. Pei:—Carnivora from Locality 1 of Choukoutien

Plate XXIV

Impr. Mémin - Tortellier Arcueil (Seine)

豹　*Felis* cf. *pardus* L.

種名不能鑑定之貍 1　*Felis* sp. 1

德氏野貍 (新種) *Felis teilhardi* Pei (sp. nov.)

種名不能鑑定之貍 11　*Felis* sp. 2.

野貍　*Felis* cf. *microtis* M. Edwards.

獵豹　*Cynailurus* sp.

本書之完成，得力於地質調查所顧問德日進先生之力頗多，特此誌謝。地質調查所所長翁文灝，新生代研究室主任步達生及名譽主任丁文江，吾師北京大學教授葛利普及李四光，諸先生均時加指導，盛意可感。此外同事楊鍾健步林卞美年諸君，亦時相切磋，與以指正。本書印刷事務，由同事周贊衡先生主持，並於印畢詳加校對，本書得以出版及無甚錯誤，皆周先生一人之力也。高韓娥寵夫人及賈蘭坡君於文稿起草之時，隨時幫助，當特加聲明，以表謝忱。插圖爲王松峪君所繪，圖版照像爲徐光熙及李時俊二君所攝，均誌此申謝。

民國二十二年十一月於北平。

洞熊 *Ursus spelæus* Blumenb. var.

猪熊 ? *Ailuropus*

鼬科（計六種） Family Mustelidæ Swainson

獾 *Meles leucurus* Hodgson

黃鼬（二種） *Mustela* cf. *sibirica* Pallas

Mustela sp. indet.

貂 *Martes* sp.

狼獾 *Gulo* sp.

水獺（新種） *Lutra melina* Pei (sp. nov.)

鬣狗科（計三種） Family Hyænidæ

洞穴鬣狗 *Hyæna ultima* Matsumoto

中國鬣狗 *Hyæna sinensis* Owen

鄂氏鬣狗（新種） *Hyæna zdanskyi* Pei

貓科（計九種） Family Felidæ Gray

劍齒虎 *Machairodus* sp. Zdansky

虎 *Felis* cf. *tigris* L.

楊氏虎（新種） *Felis youngi* Pei (sp. nov.)

之跡，而肉食類動物化石頗少，當人類寄居之頃，肉食類動物或被人類驅逐於一時。俯思人類之生存，國家之興替，個人之進取，不覺懔而生畏，苟不圖强，危亡立及，尙望國人各自勉之。

本文中所研究之肉食類化石三十種，其名稱列於下表。每種均詳加研究討論比較，已詳述於英文原文中，茲不贅。

周口店猿人化石產地之肉食類化石名稱表

犬科（計八種）　Family Canidæ Gray

狼	*Canis lupus* L.
變種狼（新亞種）	*Canis lupus* var. *variabilis* Pei (var. nov.)
豺狼（新種）	*Canis cyonoides* Pei (sp. nov.)
狸狼	*Canis* (*Nyctereutes*) *sinensis* Schlosser
狐（二種）	*Vulpes* cf. *vulgaris* L.
	Vulpes cf. *corsac* Pallas
豺	*Cyon alpinus* Pallas
種屬不能鑑定之犬科動物	Canidæ indet.

熊科（計四種）　Family Ursidæ

小熊	*Ursus angustidens* Zdansky
褐熊	*Ursus arctos* L.

，至二十二年止。此類化石，除一種採自山頂之頂蓋沉積中外，皆與中國猿人伴生。至山頂洞中所採之化石，因年代較晚，當另有專刊研究，茲未列入。

肉食類化石中，共有三十種，代表五科。民國十七年時，奧人師丹斯基曾有周口店第四紀之化石羣一書出版，中僅肉食類化石八種。本書數量上增加頗多，鑑定方面，亦間有與師氏稍有出入之處，蓋七年中所獲材料較豐，保存亦較完整，故鑑定較易而精確也。

本書所列三十種化石之中，計有新種五，新亞種一，種名不能鑑定者八，種屬均不能鑑定者一。至此三十種化石與現代生存之動物羣比較，約計有百分之四十一爲已滅絕之種，約百分之四十一與現代生存之動物同種（此外百分之十八爲不能確知者）。若再就此三十種動物之分佈地域而論，計皆爲歐亞大陸之土著動物，大半在東方自上新統之動物界演化而來，少量與北方或南方之動物界有所關連。以上所得結果，頗與周口店其他動物之由來相脗合，並能代表第四紀初期之華北動物界之特性。

肉食類化石之中，最多者爲鬣狗（Hyena），其數以千計，最少者爲劍齒虎（Machairodus）及獵豹（Cynailurus），僅有一二標本。生活之習性，多在洞穴之中，水中或近水生活者，僅有一種。大約在第四紀之初，周口店之洞穴中，概爲此三十種肉食類動物所棲止，其他有蹄類動物，多爲彼等所爭逐之食物。至周口店猿人產地之一部（即現在鴿子堂洞地方）則有人類（中國猿人）寄居

周口店猿人產地之肉食類化石

裴文中著

余於民國十七年時即參加周口店開掘化石工作，彼時負實際工作之責任者爲步林及楊鍾健兩君。十八年春，步林君辭職，楊君赴陝晉調查地質，周口店之開掘事務，遂由地質調查所所長翁文灝先生付余一人主持。光陰荏苒，瞬已五載，績效殊微，時深引愧。翁所長及新生代研究室主任步達生君，復屢囑余於主持開掘工作之外，再抽暇擔任一部份化石之研究，並指定哺乳動物中之肉食類爲余研究之範圍。自民國十九年起，即著手整理材料，迄今四載，始暫告一段落。惟因本人之學識及能力有限，國內比較材料及參考書亦復囿於方隅，是編欠缺之處，勢所難免。且現在開掘工作尚未停止，新材料仍在繼續發現之中，種屬鑑定，恐難完善。惟因急於付印，不遑補充增正之處，祇有期諸異日耳。

關於周口店猿人化石產地之地質地文諸學理之研究，已屢見地質調查所及中國地質學會出版之刊物。近地質調查所更有「中國原人化石」一書問世，學理上之討論研求頗詳，本書不贅。

本書僅就哺乳動物中之肉食類化石，加以詳細研究。研究之結果，亦與其他化石及地質學理論上所得之結果相同。即周口店猿人化石產地之年代，爲第四紀之初，介於華北泥河灣系及黃土時期（河套沙拉烏蘇河系）之間；亦即吾師葛利普教授分期中之多新統上部。

本書所採用之材料爲地質調查所在周口店猿人化石產地，歷年所採集者，計自民國十六年起

中國古生物誌丙種第八號

第一册

周口店猿人產地之肉食類化石

裴文中著

中華民國二十三年五月

實業部地質調查所
國立北平研究院地質學研究所印行
（學術研究與國立中央研究院國立北京大學兩廣地質調查所湖南地質調查所合作）

中國古生物誌丙種第八號

第一册

周口店猿人產地之肉食類化石

裴文中著

中華民國二十三年五月

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（學術研究與國立中央研究院國立北京大學兩廣地質調查所湖南地質調查所合作）