

山东宁阳早更新世哺乳动物化石¹⁾

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摘要 1999年,作者收到王元青博士转来胡长康老师未研究的一批哺乳动物化石。这些化石由山东省博物馆工作人员采自山东宁阳县伏山的裂隙堆积物中。根据化石围岩判断这批化石可归入同一动物群。该动物群包含12种:松鼠科1种(*Sciurotamias* sp.),兔科2种(*Brevilagus brachypus*, *Lepus* sp.),食肉目5种(*Pachycrocuta perrieri*, *Nyctereutes sinensis*, *Canis variabilis*, *Homotherium* sp. 和 *Meles* sp.),牛科2种(*Gazella* sp., *Ovibovinae* gen et sp. indet.),鹿科2种(*Cervus* sp., *Cervidae* gen et sp. indet.)。其中,*Pachycrocuta perrieri*个体明显小于桑氏鬣狗(*Pachycrocuta licenti*),p₂后附尖较发育,p₄前附尖高,m₁三角座窄。四川巫山原鉴定为桑氏鬣狗的标本中至少有一件下颌骨(重庆自然博物馆, CV877)应当归入此种。*Meles* sp. 具有较周口店第18点发现的 *Meles chiai* 及中更新世常见的 *Meles meles* 更原始的特征:前臼齿较少退化,咬肌窝浅,冠状突纵向窄等。*Nyctereutes sinensis*的个体小于甘肃灵台、山西榆社等上新世标本,与泥河湾及巫山的相近。*Canis variabilis*的个体小于中更新世的同种标本。结合新发现的头骨与下颌骨材料对中国北方“*Caprolagus brachypus*”做了重新修订,另立新属 *Brevilagus*。该属主要特征为:齿隙短,腭桥较内鼻孔宽,P₂具浅的前外褶沟和较深的主前褶沟,下门齿向后延伸至p₃或p₄的下部,p₃具后内褶沟或釉岛,前外褶沟浅,后外褶沟可伸至齿冠中线等。并将华北有关地点的同类标本归入该属。该属目前仅发现于中国北方晚上新世至早更新世地层中,具有较重要的生物年代学意义。

综合考虑各化石种类的演化水平及其地史分布,可初步推断该动物群的时代相当于早更新世泥河湾期。

关键词 山东宁阳,早更新世,哺乳动物,短吻兔

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FOSSIL MAMMALS OF EARLY PLEISTOCENE FROM NINGYANG, SHANDONG PROVINCE

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1 Introduction

In the autumn of 1999, Dr. Wang Yuanqing transferred to the present author some fossils from Dr. Hu Changkang. The materials were collected by colleagues of Shandong Museum from fissure-fillings of Fushan area, Ningyang County, Shandong Province. Judging from the matrix, the fossils (12 species of 12 genera) probably belong to a same fauna. The most interesting materials are two broken skulls of "*Caprolagus brachypus*", whose generic designation has been argued for more than 80 years. The *Pachycrocuta perrieri*, only recorded previously from Nihewan and Yushe basins in China, extends its geographic range to Shandong Province and South China (Wushan). The distribution in Europe and China of this species shows its great potential for biochronological correlation. A detailed revision of "*Caprolagus brachypus*" and brief descriptions on the other species (except a squirrel and a muntjac deer) are given below and the geological age of this fauna is discussed.

Abbreviation: L = Length; W = Width. All measurements are in mm.

2 Systematics

Order Carnivora Bowdich, 1821

Family Canidae Gray, 1821

Genus *Canis* Linnaeus, 1758

Canis variabilis (Pei, 1934)

(pl. I, 4)

Materials 7 broken lower jaws: left lower jaw with p2~m1 (V 12367.1), right with part of p2 and p4~m3 (V 12367.2), left with p1~p3 (V 12367.3), right with p2~p3 and broken p4 (V 12367.4), right with m1 (V 12367.5), left with m1 (V 12367.6), right with p3 (V 12367.7); 2 broken DP4 (V 12367.8~9); 7 P4 (V 12367.10~16); 9 M1 (V 12367.17~25); 3 M2 (V 12367.26~28); 4 m1 (V 12367.29~32); and 2 m2 (V 12367.33~34).

Measurements See table 1.

Description Mandible more slender than that of living *Canis lupus* of North China, with slightly concave lower border under the m1. Middle mental foramen

Table 1 Measurements of *Canis variabilis* (mm)

	m1		m2		P4		M1		M2		mandible depth under m1
	L	W	L	W	L	W	L	W	L	W	
N	7	7	3	3	4	1	6	6	2	2	3
Range	22.3~	7.9~9	83~	6.1~	20.3~	8.8	12.4~	14.8~	7.8~	11.8~	21.2~
	23.9		10.1	7.3	21.2		13.6	16.5	7.9	12	21.3
Mean	22.83	8.67	9.03	6.57	20.73	8.8	13.13	15.83	7.85	11.9	21.25

situated under p2, posterior mental foramen under p3. There is a diastema between p2 and p3. The lower carnassial (m1) has a high protoconid and a small but distinct metaconid; the hypoconid larger than the entoconid. Some specimens have very weak metastylid between metaconid and entoconid. The m2 is elongated, with protoconid slightly higher than hypoconid, no entoconid developed. The m3 is very reduced. Upper carnassial (P4) of rather small size, its protocone weak, with an isolated root, located anterior to the level

of the paracone. Molars as in the living *Canis lupus* except of smaller size.

Remarks By the characters of the mandible and teeth, the materials here described fit well with the *Canis variabilis* from CKT Loc. (Pei, 1934) and CKT Loc. 13 (Teilhard and Pei, 1941), but the size of teeth and depth of mandible are slightly smaller. The *Canis* cf. *C. chilihensis* from CKT Loc. 18 is much larger in size as fig. 1 shows, and possibly belongs to other species (Teilhard and Pei, 1941). It seems that *Canis variabilis* shows a trend of size increase with time. The smaller size of these materials may indicate that it is more primitive than those of the Middle Pleistocene

Nyctereutes Temminck, 1838~1839

Nyctereutes sinensis (Schlosser, 1903)

(pl. I, 2)

Materials 4 broken lower jaws: right with p1~m1 (V 12368.1), left with p2~m1 (V 12368.2), right with canine and p1~m1 (V 12368.3), left with m1~m2 (V 12368.8); 2 isolated m1s (V 12368.4~5); 2 broken skulls (V 12368.6~7).

Measurements Dental measurements see Table 2. Length of p1~m1: 45mm; p2~m1: 40.6mm; p1~p4: 30.7mm.

Description Only the nasals and part of the maxilla are preserved on the two broken skulls. The nasal protrudes far back to where the frontal-maxilla suture starts. The lateral edges of the nasals are parallel each other. The profile of the forehead is

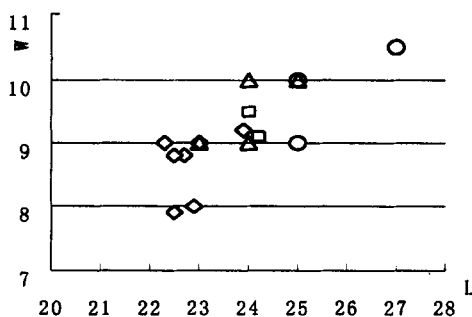


Fig. 1 Plotted diagram of m1: *Canis variabilis*:
◇ Ningyang, □ CKT Loc. 1 (Pei, 1934), △ CKT Loc. 13 (Teilhard and Pei, 1941); *Canis* cf. *C. chilihensis*: ○ CKT Loc. 18 (Teilhard, 1940)

Table 2 Dental measurements of *Nyctereutes sinensis* (L×W) (mm)

	V 12368.1	V 12368.2	V 12368.3	V 12368.8
p1	4.0×2.2		3.6×2.4	
p2	7.0×3.2	6.7×3.1	6.8×3.1	
p3	7.9×3.7		7.9×3.4	8.0×3.3
p4	9.4×4.4	8.8×4.4	9.5×4.5	
m1	15.4×6.1	15.1×6.4		14.8×6.1
m2	8.4×5.5			8.5×5.5
p1~p4	30.8		31.4	

flat with a sharp depression at about the proximal one third of the nasal.

p3 has a weak metastylid, which is much more developed on p4. m1 is low crowned, with a pronounced metaconid, a round shaped entoconid, an antero-posteriorly extended hypoconid, and a rectangular talonid. m2 is reduced. m3 single-rooted.

Remarks Since Schlosser (1903) did not designate holotype for the species or give detailed description, Tedford and Qiu (1991) selected Schlosser's "Kiefer A" as the lectotype, and recommended that the Nihowan sample of the *Nyctereutes sinensis* hypodigm should be used as the biological entity to which the name is attached for the purpose of comparison. The species has so far been found from Pliocene of Yushe (Tedford and Qiu, 1991), Lingtai (Zhang et al., 1999) and early Pleistocene localities such as Nihowan (Teilhard and Piveteau, 1930), Wushan (Huang et al., 1991) and Zibo (Zheng et al., 1997).

By the characters of lower teeth, the materials from Ningyang can be referred to this species. It is smaller in size than those from Lingtai and Yushe, comparable with those from Nihowan and Wushan.

Hyaenidae Gray, 1869

Pachyrocuta Kretzoi, 1938

Pachyrocuta perrieri (Croizet et Jobert, 1828)

(pl. I, 5a, b)

Materials 2 left broken lower jaws: one with broken canine, p3~p4 and trigonid of m1 (V 12366.1); another with canine and p2~m1 (V 12366.2).

Measurements See table 3.

Description The two mandibles here described both have relatively shallow horizontal branches. The depth under p2 is 34.3mm and 36.7mm, respectively. The mental foramen positioned high, beneath the p2. The canine conical-shaped. p1 absent. p2 small, with a rather developed posterior accessory cusp. p2 has wider posterior part. p4 has a relatively high anterior accessory cusp and an almost equal sized and elevated posterior accessory cusp. The paraconid of m1 not significantly large and bulky, the talonid has three cusps, the metaconid small but distinct, the hypoconid situated in the mid-line of the tooth and larger than the entoconid.

Table 3 Dental measurements of *Pachycrocuta perrieri* and comparisons with related taxa

		Ningyang		Wushan <i>brevirostrilis licenti</i> (Qiu, 1987)		<i>Pliohyaena brevisrostrilis</i> (Howell and Patter, 1980)		<i>Pachycrocuta perrieri</i> (Howell and Patter, 1980)		
		V 12366.1	V 12366.2	CV 877	V 7293	Nihowan	Range	Mean	Range	Mean
		(Type)								
p2	L		15.2	13.9	16.4		18~19	18.57	14~17.7	15.63
	W		10.4	10.2	12.1		12.3~14.5	13.2	9.3~12.2	10.73
p3	L	21.5	20.2	20.2	23.7	23.8	22.5~25.6	24.35	19.5~22.9	20.93
	W	14.5	13.7	13.7	16.7	16.0	15.6~19	17.7	13.3~16.6	14.52
p4	L	22.4	23.1	21.8	26.0	25.3	25.5~28.1	27.27	21.4~25.5	23.46
	W	14.7	13.1	13.7	16.8	16.1	16.2~17.8	16.77	11.8~16.1	14.62
m1	L		24.2	23.5			27.5~30	29.35	23.4~26.9	25.44
	W		12.0	12.9			13.2~15	14.42	10.8~14.6	12.80

Comparison and discussion By the pronounced talonid of m1, distinct metaconid and smaller size, the materials here described are evidently different from the *Hyaena sinensis* of North China, which was designated to *Pliohyaena brevisrostrilis* (Kurten, 1956; Qiu, 1987), and *Pachycrocuta brevisrostrilis sinensis* (Howell and Patter, 1980) respectively.

According to the restudy of *Pliohyaena brevisrostrilis licenti* by Qiu (1987), this animal from Ningyang has p2 with relatively larger posterior accessory cusp, p4 with more elevated anterior accessory cusp, m1 with paraconid narrower and not as bulky, and of smaller size as table 3 shows.

The dental dimensions of the materials and one mandible from Wushan (Huang et al., 1991), which is accessible to the author, fall completely into the size variation range of *Pliohyaena perrieri* (Qiu, 1987; Howell and Patter, 1980). The dental characters also fit well with the latter species by the elevated anterior accessory cusp on p4, the relatively narrower m1, etc. This species was only recorded from Nihowan and Yushe in China until now (Qiu, 1987).

The systematic position of this species is still in dispute. Werdelin and Solounias (1990) considered that there was not enough evidence for the resurrection of the genus *Pliohyaena* Kretzoi, and that *Pliohyaena* should remain a synonym of *Pachycrocuta*. The present author would rather use the genus *Pachycrocuta* for the time being, pending revision of this difficult group.

Mustelidae Swainson, 1835

Meles Brisson, 1762

Meles sp.

(pl. I, 3)

Materials 3 broken lower jaws: 2 right with m1s (V 12369.1~2), 1 right with p4~m1 (V 12369.3).

Description The m1 with short trigonid and well-developed talonid. Metaconid positioned slightly posterior to the protoconid. The hypoconid is situated slightly behind the entoconid, while in the living form it is almost at the same level as the entoconid or anterior to it. Premolars less reduced than in the living form. Mandible slender, with the posterior edge of the coronoid process curved inward. Masseteric fossa shallow and masseteric lines weak. Base line of horizontal part of the mandible straight and turning sharply towards the ramus. Angular processes narrow, with their bases less expanded transversely.

Remarks By the shape and structures of lower carnassial, the present material undoubtedly belongs to the *Meles* group. Of the Chinese Quaternary badgers found so far, *Meles chiai* from CKT Loc. 18 has a characteristic basin-shaped talonid and a forward pointing deutercone as Teilhard (1940) described. Although the materials are not accessible to the author, the mandibles in Teilhard's figures and descriptions give a clear impression that they have almost the same structure of mandibles with the living *Meles meles*. *Meles meles* so far found in CKT Loc. 1, 2, 3, 5, 6, 13, upper cave, and Sjara-osso-gol etc., has less reduced premolars, wide and strongly built coronoid process, very deep masseteric fossa, and prominent masseteric line.

The materials from Ningyang show some primitive characters: less reduced premolars; shallow masseteric fossa, less prominent masseteric ridges, and angular processes less expanded transversely at the base, suggesting that they probably represent a new species. However, with only three broken mandibles, the present author would prefer to name it as *Meles* sp. for the time being, pending further findings.

Felidae Gray, 1821

Homotherium Fabrini, 1890

Homotherium sp.

(pl. I, 1)

Materials 1 proximal part of an upper canine (V 12370.1); 3 lower canines (V 12370.2~4); 3 I3s (V 12370.5~7), 1 I2 (V 12370.8).

Description and discussion On the upper canine, the crown is serrated both along the internal and external edges. The size of the upper canine seems to be identical to that from CKT Loc.9, although only the tip of the canine preserved. The lower canine, also similar in size to those from CKT Loc.9, is smaller than those from CKT Loc.1.

The shape of the upper canine, with both sides serrated, as well as serrated incisors undoubtedly refer these materials to the genus *Homotherium*. In China, there are at least five species that have been described. Without carnassial teeth and more complete materials, it is difficult to designate these materials to any known species. However, the size and geographic area suggest that this animal may be close to *H.*

ultima, but this identification must remain tentative.

Lagomorpha Brandt, 1855

Leporidae Fisher de Waldheim, 1817

***Brevilagus* gen. nov.**

Genotype *Brevilagus brachypus* (Young, 1927).

Diagnosis Size small, with short diastema. Lower incisor extends posteriorly to the level under p3 or p4, across the symphysis. p3 with postero-internal reentrant or enamel island, antero-external reentrant shallow, postero-external reentrant about the half depth on the occlusal surface. The premaxilla-maxilla sutures weakly zigzagged, sectioning the incisor foramen into equal halves. Palate bridge wider than width of choana. P2 with two reentrants: labial one much shallower than the main reentrant. P3~M2 has weaker folds on the internal reentrants than in *Lepus*.

Geological age and distribution Late Pliocene to Early Pleistocene, North China.

Discussion In 1927, C. C. Young erected the species *Caprolagus brachypus* based on the materials from Lok. 60(CKT Loc. 18). Later on, Teilhard and Young (1931) and Young (1935) described with the same name some materials from Loc. 2 (Jingle) and Shouyang respectively. After comparison with *Hypolagus browni*, Schreuder (1936) thought this species should be in the genus *Hypolagus*. The p3s Young described have evidently different occlusal characters. The postero-external fold of p3 in *Caprolagus* almost reaches the internal side and has strong enamel folds. Bohlin (1942a) considered that this species did not belong to *Caprolagus brachypus*, nor to *Hypolagus*, and referred it to *Alilepus*. Fejfar (1961) put it in *Pratilepus* based on the existence of postero-internal enamel island. Qiu (1987) suggested a new genus for this special species but did not name it.

After restudy of all the mandibles found from Loc. 2 (Jingle), Shouyang, Zibo and especially from Ningyang, the author finds that they all share same characters: short diastema; incisor extending far posteriorly to the level under p3 or p4; p3 with postero-internal reentrant or enamel island. These characters distinguish these materials from all the leporids known until now. Compared with *Alilepus*, it has a shorter diastema, more posterior position of the end of incisor, and postero-internal reentrant or enamel island of p3 slightly folded. The p3s of *Trischizolagus* have anterior and antero-internal reentrants, and an evidently modernized mandible. It is easy to distinguish the materials from *Hypolagus*, by the latter genus lacking of postero-internal reentrants or enamel islands on the p3s. The p3 of *Pratilepus* has a well-developed postero-internal reentrant, but also features with an antero-internal reentrant and a strong fold on the posterior wall of postero-external reentrant and antero-external wall. *Nekrolagus*, *Oryctolagus* and *Lepus* have anterior reentrants on the p3s.

By the structure of p3, the present species is most similar to *Alilepus*, but the latter genus has a very progressive structure of the mandible. Incisors far posteriorly

extending are only found in *Ochotona* Bohlin (1942b) and in Paleogene leporids such as *Ordolagus teilhardi*, which has the end of incisor positioned below m1. This could therefore possibly be a primitive character. The new genus name *Brevilagus* is here given to this special species.

***Brevilagus brachypus* (Young, 1927)**

(fig.2; pl. II, 2a, b; 3a, b)

1927 *Caprolagus brachypus* Young, Young, Pal Sin, C, Vol. 5, Fasc. 3, Taf.3, Figs. 14~18

1931 *Caprolagus brachypus* Young, Teilhard and Young, Pal Sin, C, Vol. 9, Fasc. 1, Pl.5, Figs. 25~27

1935 *Caprolagus brachypus* Young, Young, Pal Sin, Vol. 9, Fasc.2

1936 *Hypolagus brachypus* (Young), Schreuder, Arch Neerl Zool, 2

1940 *Alilepus* cf. *A. annectens* (Schlosser), Teilhard, Pal Sin, New Ser C, no.9

1964 *Alilepus brachypus* (Young), Gureev, Fauna USSR, 3(10)

1976 *Hypolagus brachypus* (Young), Zheng, Vert PalAsiat, 14(2)

1996 *Alilepus* cf. *A. annectens* (Schlosser), Cheng et al., Pl. I, 12, Fig.3-5

1996 *Hypolagus* cf. *H. brachypus* (Young), Cheng et al., Pl. I, 13, Fig.3-6

Lectotype A pair of mandible from Lok. 60 near Beijing (Paleontological Museum of Uppsala University, UM 15010) (Young, 1927: Taf. III, Fig.14).

Emended diagnosis Same as the genus.

Referred Materials Loc. 2 (Jingle, Shanxi): a pair of lower jaw (RV 31038.1), 1 right lower jaw (RV 31038.2); Shouyang: 1 right lower jaw (RV 35016); Heshui (Gansu): 1 p3 (V 4775); Zibo (Shandong): 7 broken lower jaws with p3~m3 (V 10413, V 10414.1~6), 1 right p3 (V 10414.7), 2 lower molars (V 10414.12~13), 1 upper incisor (V 10414.14), 4 upper molars (V 10414.8~11); Ningyang: 2 broken lower jaws (V 12375.1~2), 2 broken skulls (V 12375.3~4).

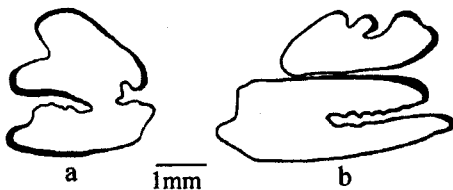


Fig.2 *Brevilagus brachypus* from Ningyang

a. occlusal view of left p3 (V12375.2);

b. occlusal view of right P2~P3 (V 12375.4)

Geological age and distribution Same

as the genus.

Description Size relatively small, upper diastema short (18.3mm), The premaxilla-maxilla suture weakly zigzagged, sectioning the incisor foramen into equal halves. Palatal bridge wider than the width of choana. P2 with two reentrants: labial one much shallower than the main reentrant. P3~M2 has weaker folds on the walls of internal reentrants than the *Lepus*.

Discussion On the p3s found until now, all have either postero-internal reentrant or enamel island, both persisting to the base of the tooth. No intermediate cases have been found. The existence of an enamel island could therefore for the time being be

interpreted as an individual variation.

The basic structure of the specimen from Zibo (Zheng et al., 1997) fits well with the diagnosis of *Brevilagus brachypus* except that the p3s have sharper and narrower trigonid.

Alilepus cf. *A. annectens* of Loc. 18 (Teilhard, 1940) has a short diastema and a strongly built mandible, with the lower incisor protruding to the base of p4, and should belong to this *brachypus* group.

The p3 (V 4775) from Heshui, Gansu (Zheng, 1976) has an enamel island and a folded postero-internal reentrant. By its size and basic structure, it is tentatively referred in this genus.

Cheng et al. (1996) named the specimen with a postero-internal reentrant on p3 to *Alilepus* cf. *A. annectens*, and those with enamel island on p3 to *Hypolagus* cf. *H. brachypus*. They are both here assigned to *Brevilagus brachypus* by the structure of the mandible and p3.

Geological age *Brevilagus brachypus* from Loc. 2 (Jingle) (Teilhard and Young, 1931) was discovered from the reddish clay Zone B, coexisted with *Siphneus arvicolinus*. According to Zhou (1988), the fauna is comparable to the MN18. The materials of Shouyang were discovered from a layer of sandstone of the Lower Sanmenian with *Siphneus* cf. *S. chaoyatseni* and *Elaphas* indet. *Brevilagus brachypus* from Heshui was found together with *Siphneus arvicolinus*, *S. chaoyatseni*, *S. hsujiapingensis* and *Ochotonoides complicidens*. Zheng (1976), based on faunal comparison, considered all these belonging to the same time period. The siphneids, *Siphneus arvicolinus*, *S. chaoyatseni*, *S. hsujiapingensis* are mainly found in the Middle and Upper part of Wucheng Loess (Liu et al., 1985), which is correlated to the Nihewan Formation (Sensu Stricto). Loc. 18 was referred to early Nihewanian on the base of the occurrence of *Episiphneus youngi* and the most primitive *Allophaiomys* (Tong et al., 1995). Fauna A from Zibo is comparable by its composition to CKT Loc. 18. The Zhoukoudian West Cave was correlated to Loc. 9 by the shared species *Ochotona nihewanica*, *Youngia tingi*, and *Lasiopodomys probrandti* (Cheng et al., 1996). In the recent work on the Lingtai sections, this species was found in the strata of late Pliocene (ca. 3.0 Ma) by wet washing (Zheng and Zhang, 2000). Hence, the *Brevilagus brachypus* has so far very limited time span, from Late Pliocene to Early Pleistocene and exclusively in North China.

***Lepus* Linnaeus, 1758**

***Lepus* sp.**

(pl. II, 1)

Material 1 left broken lower jaw with p3~m2 (V 12376).

Description and discussion p3 of typical *Lepus* structure, with anterior reentrant and two internal reentrants, of which the posterior one protrudes to the edge of the labial side; no external reentrants. Owing to the paucity of specimens, it is difficult to

designate it at the species level.

Artiodactyla Owen, 1848

Bovidae Gray, 1821

Gazella Blainville, 1816

Gazella sp.

(pl. II, 4)

Materials 2 broken maxillae: 1 right with P4~M3 (V 12372.1) and 1 left with M2~M3 (V 12372.2).

Description Hypsodont teeth. No basal pillars developed on lingual side. Styles strong on labial walls of upper molars. Ribs between parastyle and mesostyle are slightly developed on molars, while there is no rib between mesostyle and metastyle.

Ovibovinae gen. et sp. indet.

(pl. II, 5)

Materials 1 left p4 (V 12371.1) and 1 left m3 (V 12371.2).

Description Large size, very hypsodont teeth. The p4 with flat internal wall, metaconid and paraconid fused. The m3 with flat lingual wall, mesostylids weak, no basal pillars. Back flange protrudes backwards. The size and tooth characters above refer these materials to the Ovibovinae.

Cervidae Gray, 1821

Cervus Linnaeus, 1758

Cervus sp.

(pl. II, 6)

Materials A part of lower jaw with p2~m3 (V 12373.1), 1 P3 (V 12373.2), 2 P4 (V 12373.3~4), 3M1 / M2 (V 12373.5~7), 4M3 (V 12373.8~11).

Description Cervid of moderate size, mandible not pachyostosed, metaconid of p4 extending anteriorly and fused with paraconid. Upper molars have well-developed basal pillars, and anterior ribs more pronounced than the posterior ones. Length of p2~m3: 104.4mm, p2~p4: 42.4mm, m1~m3: 62.5mm.

3 Biochronology

Of the 12 species from Ningyang, *Brevilagus brachypus* has so far only been recorded from Late Pliocene to Early Pleistocene (Nihewanian stage) localities of North China. The earliest *Lepus* records are from late Early Pleistocene (Fauna B of Zibo; CKT Loc.9; Jiajiashan etc.) (Zheng et al., 1997). The *Canis variabilis*, by its smaller size, is probably earlier than those from Middle Pleistocene localities. *Nyctereutes sinensis* is smaller in size than those from Pliocene localities (Upper part of Gaozhuang and Mazegou formations in the Yushe basin and Lingtai), comparable with those from Early Pleistocene localities such as Nihowan and Wushan etc. The hyena *Pachycrocuta perrieri* recorded from Yushe and Nihowan and from European

localities shows a geological range from Late Pliocene to Early Pleistocene. The *Meles* sp., which is more primitive than common Middle Pleistocene species *Meles meles* also, suggests an Early Pleistocene age. In conclusion, the fauna from Ningyang is most probably of Early Pleistocene age.

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References

- Bohlin B, 1942a. A revision of the fossil Lagomorpha in the Paleontological Museum, Uppsala. Geol Inst Uppsala Bull, 30(6):117~154
- Bohlin B, 1942b. The fossil mammals from the Tertiary deposit of Taben-buluk, western Gansu. Part 1, Insectivora and Lagomorpha. Pal Sin, Ser C, 8:1~113
- Cheng J (程捷), Tian M Z (田明中), Cao B X (曹伯勋) et al., 1996. The new mammalian fossils from Zhoukoudian (Choukoutien), Beijing and their environmental explanation. Beijing: China University of Geoscience Press. 1~113 (in Chinese with English summary)
- Fejfar O, 1961. Die Plio-Pleistozanen Wubeltierfaunen von Hajnacka und Ivanovce (Slowakei), CSSR. III. Lagomorpha. N Jb Geol Palaontol, Mh, 5:267~282
- Howell F C, Petter G, 1980. The *Pachycrocuta* and *Hyaena* lineages (Plio-Pleistocene and extant species of the Hyaenidae)- their relationships with Miocene ichtitheres: *Palhyaena* and *Hyaenictitherium*. Geobios, 13(4): 579~623
- Huang W P (黄万波), Fang Q R (方其仁) et al., 1991. Wushan Hominid Site. Beijing: China Ocean Press. 105~109 (in Chinese with English summary)
- Kurten B, 1956. The status and affinities of *Hyaena sinensis* Owen and *Hyaena ultima* Matsumoto. Am Mus Norvit, (1764):1~48
- Liu D S (刘东生) et al., 1985. Loess and Environment. Beijing: Science Press. 113~141(in Chinese)
- Pei W C, 1934. On the Carnivora from Locality 1 of Choukoutien. Pal Sin, Ser C, 8(1):120~121
- Qiu Z D, 1987. The Neogene mammalian faunas of Ertemte and Harr Obo in Inner Mongolia (Nei Mongol), China.-Hares and Pikas-Lagomorpha: Leporidae and Ochotonidae. Senckenbergiana Lethaea, 65(5/6):325~399
- Qiu Z X, 1987. Die Hyaeniden aus dem Ruscinium und Villafranchium Chinas. Munchner Geowiss Abh, Reihe A, 9:1~110
- Schreuder A, 1936. *Hypolagus* from Telegen Clay; with a note on recent *Nesolagus*. Arch Neerland Zool, 2:225~239
- Tedford Q H, Qiu Z X, 1991. Pleistocene *Nyctereutes* (Carnivora: Canidae) from Yushe, Shanxi Province, with comments on Chinese fossil racoon-dogs. Vert PalAsiat (古脊椎动物学报), 29(3):176~189
- Teilhard de Chardin P, 1940. The Fossils from Locality 18 near Peking. Pal Sin, New Ser C, 9:1~100
- Teilhard de Chardin P, 1942. New rodents of the Pliocene and lower Pleistocene of N. China. Public Inst Geo-Bio, 9:1~101
- Teilhard de Chardin P, Pei W C, 1941. The fossil mammals from Loc. 13 of Choukoutien. Pal Sin, New Ser C,

11:1~107

- Teilhard de Chardin P, Piveteau J, 1930. Les mammifères fossiles de Nihowan (Chine). *Ann Paléontol*, 19:101~105
- Teilhard de Chardin P, Young C C, 1931. Fossil mammals from the late Cenozoic of Northern China. *Pal Sin, Ser C*, 9(1):29~30
- Tong Y S(童永生), Zheng S H(郑绍华), Qiu Z D(邱铸鼎), 1995. Chinese Cenozoic mammalian stages. *Vert PalAsiat(古脊椎动物学报)*, 33(4):290~314(in Chinese with English summary)
- Werdelin L, Solounias N, 1990. Studies of fossil hyaenids: the genus *Adcrocuta* Kretzoi and the interrelationships of some hyaenid taxa. *Zool J Linn Soc*, 98:363~386
- Young C C, 1927. Fossile Nagetiere aus Nord-China. *Pal Sin, Ser C*, 5(3):56~65
- Young C C, 1935. Miscellaneous mammalian fossils from Shansi and Honan. *Pal Sin, Ser C*, 9(2):5~7
- Zhang Y X(张云翔), Sun D H(孙东怀), An Z S(安芷生) et al., 1999. Mammalian fossils from Late Pliocene (Lower MN16) of Lingtai, Gansu Province. *Vert PalAsiat(古脊椎动物学报)*, 37(3):190~199(in Chinese with English summary)
- Zheng S H(郑绍华), 1976. Small mammals of Middle Pleistocene in Heshui, Gansu. *Vert PalAsiat(古脊椎动物学报)*, 14(2):112~119(in Chinese with English summary)
- Zheng S H(郑绍华), Zhang Z Q(张兆群), 2000. Late Miocene-Early Pleistocene micromammals from Wenwanggou of Lingtai, Gansu, China. *Vert PalAsiat(古脊椎动物学报)*, 38(1):58~71(in Chinese with English summary)
- Zheng S H(郑绍华), Zhang Z Q(张兆群), Liu L P(刘丽萍), 1997. Pleistocene mammals from fissure-fillings of Sunjiashan Hill, Shandong, China. *Vert PalAsiat(古脊椎动物学报)*, 35(3):201~216(in Chinese with English summary)
- Zhou X Y(周晓元), 1988. The Pliocene micromammalian fauna from Jingle. Shanxi—a discussion of the age of Jingle red clay. *Vert PalAsiat(古脊椎动物学报)*, 26(3):181~197(in Chinese with English summary)

Explanations of plates

Plate I

- 1 *Homotherium* sp. (V123701), tip of upper canine, $\times 1$
- 2 *Nyctereutes sinensis* (V 12368.1), right lower jaw with p1~m1, labial view, $\times 1$
- 3 *Meles* sp. (V 12369.3), right lower jaw with p4~m1, labial view, $\times 1$
- 4 *Canis variabilis* (V 12367.2), right lower jaw with p3~m3, labial view, $\times 1$
- 5 *Pachycrocuta perrieri* (V 12366.2), left lower jaw with canine and p2~m1, $\times 1$
5a. occlusal view; 5b. labial view

Plate II

- 1 *Lepus* sp. (V 12376), left lower jaw, lingual view, $\times 1$
- 2 *Brevilagus brachypus* (V 12375.1), right lower jaw, $\times 1$
2a. labial view; 2b. lingual view
- 3 *Brevilagus brachypus* (V 12375.4), frontal part of a skull, $\times 1$
3a. dorsal view; 3b. ventral view; 3c. lateral view
- 4 *Gazella* sp. (V 12372.1), right maxilla, occlusal view, $\times 1.3$
- 5 *Ovibovinae* gen. et sp. indet. (V 12371.2), left m3, labial view, $\times 1$
- 6 *Cervus* sp. (V 12373.1), right lower jaw, labial view, $\times 0.95$



