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甘肃党河地区第三纪中期的跳鼠化石[1)]

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摘要 描述了产自甘肃省党河地区第三纪中期的跳鼠化石 3 属 7 种。其中 5 种(*Parasminthus asiae-centralis*, *P. tangingoli*, *P. parvulus*, *Heterosminthus lanzhouensis* 和 *Litodonomys* cf. *L. huangheensis*)产自狍牛泉组上部,时代为晚渐新世。产自早中新世(?)铁匠沟组中部的 2 种是中间异蹶鼠(新种)(*Heterosminthus intermedius* sp. nov.)和西水简齿鼠(新种)(*Litodonomys xishuiensis* sp. nov.)。*Heterosminthus intermedius* 的主要特征是:M2 的前齿带较短而低,m1 的下次脊较向前斜伸,与下中尖前的下外脊相连;在颊齿的宽窄比例和其他一些特征上介于 *H. orientalis* 和 *H. lanzhouensis* 之间。*Litodonomys xishuiensis* 的主要特征为:下臼齿比例上较宽短,下外脊位于纵中线附近;下中脊在 m1 中长,在 m2 中无;m2 和 m3 下前边尖很发育,但孤立;m3 下中凹和下外凹明显缩短等。探讨了 *Heterosminthus* 和 *Litodonomys* 的进化趋势和铁匠沟组中部的时代。

关键词 甘肃省党河地区,渐新世,中新世,跳鼠科
中图法分类号 Q915.873

甘肃省西部南缘的党河地区第三纪地层中的跳鼠化石,Bohlin (1946)曾做过详细的描述。但他所报道的跳鼠化石的时代仅限于晚渐新世,而且由于党河地区的地层构造很复杂,其产出的层位并不清楚。1999 年和 2001 年中国科学院古脊椎动物与古人类研究所、甘肃省考古所和甘肃省博物馆联合组队对党河地区进行了考察。这次考察不但对该地区新生代地层层序有了较清楚的认识,把该地区新生代地层划分为渐新统、中新统、中新 - 上新统和更新统四套岩层,确认了产化石的地点和层位,而且还发现了更多的哺乳动物化石(王伴月等,2003),其中以跳鼠化石最丰富。我们不但发现了 Bohlin (1946)报道过的跳鼠化石的所有种类,确认了它们的产出层位,而且还发现了新层位和新的跳鼠种类。

文中描述所用术语依 Wang (1985)和 Qiu (1985、1996)。文中所用缩写:DH,党河;IVPP,中国科学院古脊椎动物与古人类研究所;IVPP Loc. 中国科学院古脊椎动物与古人类研究所野外地点号;IVPP V 中国科学院古脊椎动物与古人类研究所脊椎动物化石编号。文中所用分数,分母代表已观察的标本数,分子代表具该描述特征的标本数,如 3/5 表明在观察的 5 件标本中有 3 件具描述的特征。标本测量是在 WILD W7A 显微镜下进行的。

1 系统描述

跳鼠科 Dipodidae Fischer de Waldheim, 1817

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副蹶鼠 Parasminthus **Bohlin, 1946**

中亚副蹶鼠 Parasminthus asiae-centralis **Bohlin, 1946**

(图 1, G～I)

标本 1 枚左 P4(IVPP V 13593.1), 2 枚右 M1(V 13593.2～3), 1 枚右 M2(V 13593.4)和 2 枚 m3(V 13593.5～6)。

产地和层位 甘肃省阿克塞哈萨克族自治县燕丹图沟[= Bohlin (1946)的 Yindirte] IVPP Loc. DH 199904A 地点;晚渐新世狍牛泉组上部。

记述 上述标本除 P4 外,都或多或少破损。但从保存的部分看,P4 具主尖和后齿带,M1 原尖前臂伸达齿的前外角,前齿带低弱,具 4 齿根,M2 具双原脊,m3 下后尖不前移,下原尖后臂伸达齿的舌侧缘等均与 *P. asiae-centralis* 的相似,而且颊齿的尺寸也在该种的变异范围内。测量(长 ×宽,单位:mm):P4, 0.84 ×0.86; M1, - ×1.25; m3, 1.6 ×1.2, 1.45 ×1.0 + 。

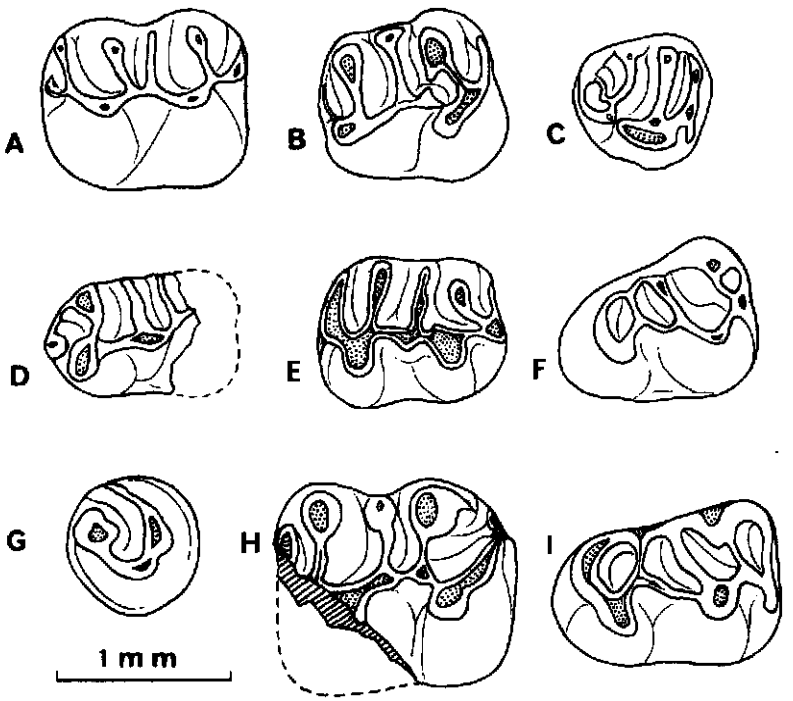

图 1 副蹶鼠颊齿冠面

Fig. 1 Occlusal view of cheek teeth of *Parasminthus*

A～F. **党河副蹶鼠**(*P. tangingoli*): A. 左(left) M1(V 13594.1), B. 右(right) M2(V 13594.4), C. 右(right) M3(V 13594.6), D. 左(left) m1(V 13594.9), E. 右(right) m2(V 13594.13), F. 右(right) m3(V 13594.19); G～I. **中亚副蹶鼠**(*P. asiae-centralis*): G. 左(left) P4(V 13593.1), H. 右(right) M1(V 13593.2), I. 右(right) m3(V 13593.6)

党河副蹶鼠 Parasminthus tangingoli **Bohlin, 1946**

(图 1, A～F)

标本 2 M1(IVPP V 13594.1～2), 2 M2(V 13594.3～4), 4 M3(V 13594.5～8), 2 m1

(V 13594.9～10),5 m2 (V 13594.11～15)和 5 m3(V 13594.16～20)。

产地和层位　甘肃省阿克塞哈萨克族自治县燕丹图沟 IVPP Loc. DH 199904A 地点;晚渐新世狍牛泉组上部。

记述　上述颊齿的冠面形态结构与 *P. tangingoli* 的很相似。其重要的相似处为:M1 和 M2 的后缘在次尖和后边脊间有明显的凹缺,具四齿根;M1 的后脊与次尖后臂或后边脊连;M2 具双原脊,只是原脊 I较低弱或不完全,后脊与次尖前臂连;m1 下前齿带连接下前边尖和下后尖;m2 的下中凹中只有一条发达的横脊,或为下原尖后臂伸达下中附尖,下中脊很短或无(2/4),或为下中脊,由下中尖伸达下中附尖,下原尖后臂很短而游离(2/4);m3 无下中脊。此外,它们的尺寸(见表 1)也在 *P. tangingoli* 的变异范围内。上述标本似应归入 *P. tangingoli* 种。测量(见表 1)。

表 1　党河副蹶鼠颊齿测量

Table 1　Measurements of cheek teeth of Parasminthus tangingoli　(mm)

	N	Min	Max	Aver	SD	CV
M1 L	1			1.3	0	0
M1 W	1			1.1	0	0
M2 L	2	1.1	1.2	1.15	0.05	0.043
M2 W	2	1	1.05	1.03	0.025	0.024
M3 L	4	0.8	0.9	0.86	0.042	0.048
M3 W	3	0.85	0.95	0.92	0.047	0.051
m1 W	1			0.82	0	0
m2 L	1			1.18	0	0
m2 W	3	0.85	0.95	0.9	0.041	0.045
m3 L	3	1.1	1.23	1.15	0.056	0.048
m3 W	3	0.83	0.97	0.9	0.057	0.064

表中缩写(abbreviations):L,长(length);W,宽(width);N,所测标本数(number of specimens measured);Min,最小值(minimum);Max,最大值(maximum);Aver,平均值(average);SD,标准误差(standard deviation);CV,变异系数(coefficient of variation)。

小副蹶鼠 Parasminthus parvulus **Bohlin, 1946**
(图 2)

标本　9 M1 (V 13595.1～9),4 M2 (V 13595.10～13),1 M3 (V 13595.14),1 件右下颌骨具 m1-2 (V 13595.15),9 m1 (V 13595.16～24),2 m2 (V 13595.25～26)和 5 m3 (IVPP V 13595.27～31)。

产地和层位　甘肃省阿克塞哈萨克族自治县燕丹图沟 IVPP Loc. DH 199904A 地点;晚渐新世狍牛泉组上部。

记述　M1 和 M2 的后缘在次尖和后边脊连接处平直,无凹缺,具四齿根。M1 的后脊与次尖连。M2 的原脊单一,后脊与次

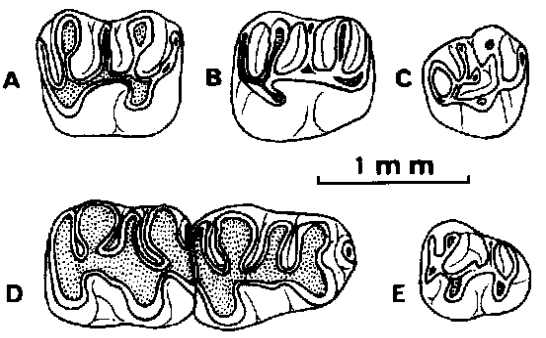

图 2　小副蹶鼠颊齿冠面

Fig. 2　Occlusal view of cheek teeth of *Parasminthus parvulus*

A. 右(right) M1 (V 13595.7);B. 左(left) M2 (V 13595.10);C. 右(right) M3 (V 13595.14);D. 右(right) m1-2 (V 13595.15);E. 左(left) m3 (V 13595.29)

尖或次尖前臂连。上述基本特征都与 *P. parvulus* 的相似。而且它们的尺寸都很小,均在 *P. parvulus* 的大小的变异范围内(测量见表 2)。所不同的是,这次我们采集的 M3 (V 13595.14)具中间间断的原脊 Ⅱ,而原脊 Ⅰ相对较细,这在已知的 *P. parvulus* 的 M3 中并未见到。因它的其他特征与已知的 *P. parvulus* 的 M3 是一致的,笔者将上述差异暂作种内个体变异考虑。因此,上述标本均归入 *P. parvulus* 种。

表 2 小副蹶鼠颊齿测量

Table 2 Measurements of cheek teeth of Parasminthus parvulus (mm)

	N	Min	Max	Aver	SD	CV
M1 L	7	0.95	1.07	1.02	0.038	0.038
M1 W	6	0.85	0.95	0.92	0.037	0.041
M2 L	4	0.85	1	0.94	0.054	0.058
M2 W	4	0.88	0.97	0.92	0.033	0.036
M3 L	1			0.75	0	0
M3 W	1			0.8	0	0
m1 L	5	1.05	1.15	1.1	0.042	0.038
m1 W	6	0.74	0.9	0.82	0.051	0.062
m2 L	3	1.04	1.1	1.07	0.025	0.023
m2 W	4	0.8	0.95	0.89	0.054	0.061
m3 L	5	0.75	0.8	0.78	0.024	0.031
m3 W	5	0.66	0.78	0.72	0.039	0.055

缩写同表 1(For abbreviations see Table 1)。

异蹶鼠 Heterosminthus Schaub, **1930**

兰州异蹶鼠 Heterosminthus lanzhouensis **Wang and Qiu, 2000**

(图 3,A、B)

标本 右 m1 和左 m3 各 1 枚(IVPP V 13596.1～2)。

产地和层位 甘肃省阿克塞哈萨克族自治县燕丹图沟 IVPP Loc. DH 199904A 地点;晚渐新世狍牛泉组上部。

记述 m1 在尺寸和冠面结构形态上无异于 *Heterosminthus lanzhouensis*,如下后脊 Ⅱ为 V 形,下外脊呈折线,下中脊从下外脊的前、中部转折处伸达下后附尖,下外中脊从下中尖向前外方斜伸达下原尖,下内尖位置较下次尖靠前,横向的下次脊与下中尖后的下外脊连等。但 *H. lanzhouensis* 的 m3 还未报道过。这次在党河采集到一枚 m3 (V 13596.2)。它与 *Parasminthus* 的 m3 不同,其下后尖明显前移,比下原尖的位置明显靠前,靠近齿的前缘,前齿带的舌部很弱小,也无明显的下前凹。此外,它的下原尖后臂较发达,并与下后附尖连,下次脊和下中凹和下后凹较短小等。这些特征更像 *Heterosminthus*。但它与 *H. orientalis* 的 m3 又有明显的区别。主要是它的下跟座不如 *H. orientalis* 的退化,下次脊、下中凹和下后凹仍明显存在。它的冠面的这些特征更像下面将要描述的 *H. intermedius*(新种)的 m3,只是它的原尖前臂较低,下外脊在下后脊 Ⅱ和下次脊间仅留有痕迹。考虑到 V 13596.2 与归入 *H. lanzhouensis* 的 m1 (V 13596.1)产自同一地点和同一层位(上渐新统狍牛泉组上部),而且它的前部与 *H. lanzhouensis* 的 m2 的前部相似,因此暂将 V 13596.2 归

入 *H. lanzhouensis*。测量见表 3。

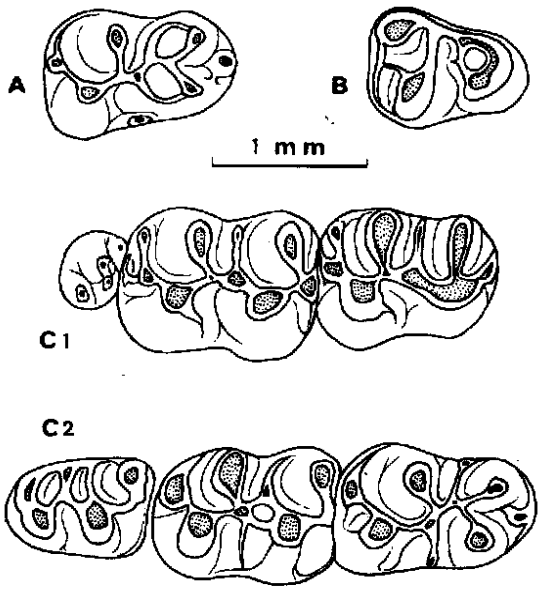

图 3　异蹶鼠颊齿冠面

Fig. 3　Occlusal view of cheek teeth of *Heterosminthus*

A～B. 兰州异蹶鼠(*Heterosminthus lanzhouensis*):A. 右(right) m1 (V 13596.1),B. 左(left) m3 (V 13596.2);C. 中间异蹶鼠(新种)(*Heterosminthus intermedius* sp. nov.),正型标本(holotype) (V 13597):C1. 左(left) P4-M2,C2. 右(right) m1-3

中间异蹶鼠(新种) Heterosminthus intermedius **sp. nov.**

(图 3,C)

正型标本　可能为同一个体的上颌骨具右 I2 和左、右 P4～M2,一段右下颌骨具 i2,m1～3 和一段左下颌骨具 i2 和 m1～2(IVPP V 13597)。

产地和层位　甘肃省阿克塞哈萨克族自治县铁匠沟 IVPP Loc. DH 199903 地点;早中新世(?)铁匠沟组中部。

特征　臼齿颊、舌侧主尖稍错位;M2/m2 比例上较宽短;M1 和 M2 原小尖和原尖后舌侧棱较发育,但无原附尖;M1 原尖后臂较发达,具前内凹;M2 的前齿带较短而低,原尖前臂较发达,后脊与次尖连;m1 的下中脊较发达,与下后附尖连,下外中脊较长,横向延伸,下次脊斜向前伸,与下中尖前的下外脊连;m2 下后尖较少前移,前齿带颊部和下中尖较发达,具弱的下外中脊;m3 稍退化,仍具下次脊、下中凹和下后凹。

名称来源　intermedius,拉丁文,中间的,指该种颊齿的特征介于 *H. orientalis* 和 *H. lanzhouensis* 之间。

描述　上颌骨颧弓前基部起于 P4 前外方。上颌骨腭面较宽,二颊齿列彼此近于平行。上门齿短,弯曲度大,后端起于颧弓前基部,横向较扁,横切面为窄长的扁叶形,唇侧较窄而平。釉质层覆盖在唇面、外侧面唇侧约 1/2 处和内侧面唇侧约 1/3 处。釉质层表面光滑,无明显的沟棱。下门齿较少弯曲,后端起自 m3 之后,其前部与 m1 间的齿缺短,比臼齿列的长度短很多。下门齿的横切面为窄长的卵圆形,唇面与外侧面的界线不明显,为连续的圆弧形面,与内侧面的界线明显。釉质层覆盖在下门齿的唇面和外侧面唇侧的 1/3 处,在内侧面很少延伸。釉质层表面无明显的沟棱。

颊齿为低冠的丘形齿,主尖发达,齿脊细弱。P4 冠面为卵圆形。主尖高大,位于中部稍靠前颊侧。其后舌侧还有一低的小尖,与主尖以浅沟分开。主尖的颊、舌侧各有一低而孤立的扁锥状小尖。舌侧者位于 P4 的前舌角,颊侧者位于齿的后颊角。二小尖大小界于主尖和其后舌侧的小尖之间,与主尖都有明显的沟分开。未见明显的齿带。单齿根。

M1 冠面约为长大于宽的长方形。前尖和后尖前后稍压缩,比原尖和次尖稍小,位置稍靠后,即颊、舌侧的主尖稍错位排列。原尖后舌侧棱明显,但未见原附尖的痕迹。原尖前臂一直伸达前附尖。原小尖(protoconule)[依王伴月、邱占祥(2000) = 邱铸鼎(1985、1996)的前边尖(anterocone)]发达,紧靠原尖。原脊稍向后舌方斜伸,与原尖后臂连,二者发育程度相近,在连结处形成明显的小尖。中尖大,紧靠次尖。中脊完全,由中尖伸达齿的颊侧缘,中附尖不明显。后脊与原脊近于平行,向后舌方斜伸达后边尖。次尖后臂也与后边尖连。内脊短而完全,为内凹的弧形,其中尖之前的部分较低。前齿带低而短,两端分别与前附尖和原小尖连形成封闭的小盆。后齿带高而长,发达的后边尖位于其中部。前凹和后中凹横向较宽,约为舌端向后伸的弧形。前中凹和后凹横向延伸,前者宽于后者。内凹较宽大,横向,其前部稍向前外伸,与前凹相对。前内凹很浅小,后内凹横向,比内凹短窄,其横宽与后凹相近。具四齿根。

M2 冠面为四边形,长大于宽,前缘宽于后缘。M2 的前半部与 M1 的相似,只是前缘较平直,原小尖比 M1 的更发达,将短的前齿带分成高而短的颊部和低弱的舌部。M2 的次尖也稍大于后尖,但该二尖约在同一横线上。后脊不向后舌方斜,而是横向或稍向前斜,与次尖相连。后边脊较高而短,由次尖伸达后尖的后舌侧,后内凹明显。前凹仍为后弯的弧形。前中凹也为横向,后中凹虽仍宽于前中凹,但向后的弯曲度较小。后凹向前舌方斜,其舌端与后中凹约在同一纵线上。内凹前后较短,明显向前颊侧斜伸,与前凹相对。前内凹浅,较开阔。具四齿根。

下臼齿主尖均向前倾,二齿根。m1 冠面为长卵圆形,下三角座稍窄于下跟座。下原尖稍大于下后尖,位置稍靠后。下原尖后臂和下后尖的后臂均较细,彼此相连形成尖端向后的 V 形的下后脊 II。该脊前视也呈下凹的 V 形。下前边尖相当发达,其后端与下后尖基部连,将下三角凹分隔成二部分:下前外凹比下前凹大,向后内方斜伸。下前齿带较低,沿前缘连续分布,连接下原尖、下前边尖和下后尖。下跟座的二主尖大于下三角座的二主尖,其中下次尖稍大于下内尖,位置明显靠后。下次脊明显向前斜伸,在下中尖前与下外脊连。下外脊稍呈 S 形弯曲,由下后脊 II向后外方斜伸达下次尖。下中脊[依王伴月、邱占祥(2000) = 邱铸鼎(1996)的下原尖后臂]完全,由下外脊前部近于横向地伸达下中附尖,并与下后附尖相连封闭下前中凹,在与下外脊连接处形成明显的小尖。下外中脊较下中脊发达,近于横向,连接明显的下中尖和下外中附尖。下次尖后臂向后伸至发达的下次小尖。下后边脊由下次小尖一直伸达下内尖。下后齿带颊部明显,封闭小而深的下后外凹。在舌侧的诸凹中,下后凹最大,为围绕下内尖的向前弯的弧形。下前、后中凹均横向,下后中凹较下前中凹宽,舌侧开口。下外凹的前、后二部均横向,前部与前中凹相对,较后部宽短,也比前、后中凹宽。

m2 冠面约为长方形。下原尖和下次尖较下后尖和下内尖大,位置明显靠后。下后脊 1 前斜,与下前边尖连。下原尖前臂也达下前边尖。下原尖后臂很发达,伸达下后尖基

部,其中部有一附属的小尖。下外脊完全,连接下原尖和下次尖。下中尖大,下中脊为很短的斜刺伸达下原尖后臂,封闭一中央小盆。下外中脊非常低弱,伸达低弱的下外附尖。该处有低矮的齿带伸达下原尖后基部,封闭下外凹前部。下次脊向前斜伸达下中尖。下前齿带较发达,在齿的前缘连续延伸,被下前边尖分成颊、舌二部分。下后边脊呈圆弧形,从下次尖伸达下内尖。下次小尖很发达。下前中凹和下后凹大小相近,均为向前弯的弧形。下后中凹和下前凹横向较直,较上述二凹短而窄。下外凹和下前外凹横向延伸,较开阔,前者较后者长,并被下外中脊分为短而浅的前部和宽大的后部。下后外凹浅。

m3 冠面约为前宽后窄的四边形,后缘向后圆凸。m3 的下三角座的结构与 m2 的相似,但下跟座明显退化。小的下内尖前移,与下原尖后臂连,通过后者并进一步与下后尖连(可惜下后尖舌侧在修理过程中破损!)。下次脊很短,横向。下次尖比下内尖大,但明显小于下原尖。下后边脊短,连接下次尖、下次小尖和下内尖。这样,m3 的舌侧从下后尖到下后边脊形成连续的纵脊封闭舌侧诸凹。下外脊短,呈向舌侧圆凸的弧形,连结下原尖和下次尖。无明显的下中尖、下中脊和下外中脊。下后凹为卵圆形,其长轴稍向后外斜伸,稍大于下中凹。后者为封闭的新月形坑,稍向前外方伸。下外凹稍向后内方伸,较短宽,与下前外凹大小相近。下后外凹为非常浅小的沟。

表 3　异跳鼠牙齿测量

Table 3　Measurements of teeth of Heterosminthus (mm)

		H. intermedius (V 13597, holotype)		*H. lanzhouensis* (V 13596.1～2)
		左(left)	右(right)	
P4	L	0.45	0.5	
	W	0.59	0.55	
	W/L %	131	110	
M1	L	1.45	1.4	
	W	1.08	1.05	
	W/L %	74	75	
M2	L	1.25	1.25	
	W	1.02	1	
	W/L %	82	80	
I2	L		1.15	
	W		0.47	
m1	L	1.4	1.45	1.31
	W	1.05	0.96	0.91
	W/L %	75	66	69
m2	L		1.25	
	W		1	
	W/L %		80	
m3	L		1.1	1.1
	W		0.8	0.85
	W/L %		73	77
i2	L	0.85	0.8	
	W	0.45	0.45	
m1-3L			3.65	

缩写见表 1(For abbreviations see Table 1)。

测量　(见表 3)

比较　党河的标本在颊齿为低冠齿,齿尖明显和齿脊弱,主尖左右错位排列,具中尖;M1 和 M2 具原尖后舌侧棱和中脊;m1 具下外中脊,m2 下原尖后臂伸达下后尖后侧等特征均与异跳鼠(*Heterosminthus*)的一致。显然,党河的标本应归入该属。*Heterosminthus* 目前已知 2 种:东方异跳鼠(*H. orientalis* Schaub, 1930)和兰州异跳鼠(*H. lanzhouensis* Wang and Qiu, 2000)。党河标本的形态特征几乎均界于该二种之间,故被命名为中间异跳鼠(新种)(*H. intermedius* sp. nov.)。*H. intermedius* 的颊齿的尺寸虽与该二种相近,但比例上(特别是 M2,其宽/长的百分比为 80,82)则宽于 *H. orientalis*(M2 宽和长的平均数的百分比为 70～74),而稍窄于 *H. lanzhouensis*(M2 宽/长比:85);颊齿的颊、舌侧主尖错位的程度也位于该

二种之间;M1 和 M2 的原尖后舌侧棱显然较 *H. lanzhouensis* 的发达,而较 *H. orientalis* 的弱,也未见原附尖的痕迹等。中间异鼠鼠颊齿的另一些特征分别与其中的一个种相似,而与另一种的不同:如它与 *H. orientalis* 区别还在于 M1 和 M2 的原小尖和 M2 原尖前臂均较发达,M1 的原尖后臂也较发达,具前内凹,m1 的下中脊较发达,伸达下中附尖,m2 具较发达的下中尖,下后尖较少前移,下前齿带颊部仍明显发育,m3 较少退化,下次脊、下中凹和下后凹仍明显存在;而与 *H. lanzhouensis* 的区别在于 M2 的后脊与次尖连,m1 下外中脊较长,横向延伸达齿的颊侧。此外,中间异鼠鼠与该二种的区别还在于 M2 的前齿带较短而低,和 m1 的下次脊较向前斜伸,与下中尖前的下外脊连等。

由上面的比较可以看出 *Heterosminthus* 的一些演化趋势:如颊齿由较宽短变得较窄长,颊、舌侧主尖错位排列的程度变得愈来愈明显;M1 和 M2 的原尖后舌侧棱由弱到较发达,原附尖由无到有;M2 的后脊由与次尖前臂连逐渐变为与次尖本身连;m1 的下外中脊由较短、前斜演变为较长,横向延伸,下中脊逐渐消失,下次脊由横向逐渐变为向前斜;m2 的下后尖逐渐前移,下前齿带舌部趋于退化、消失,m3 趋于退化、变小,结构变简单等。

简齿鼠 Litodonomys **Wang et Qiu, 2000**

黄河简齿鼠(相似种) Litodonomys **cf.** L. huangheensis **Wang and Qiu, 2000**

(图 4)

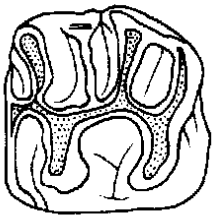

图 4 黄河简齿鼠(相似种)左 m2 冠面(V 13598)

Fig. 4 Occlusal view of left m2 of *Litodonomys* cf. *L. huangheensis* (V 13598)

标本 1 枚左 m2(V 13598)。

地点和层位 甘肃省阿克塞哈萨克族自治县燕丹图沟 IVPP Lov. DH 199904D 地点,晚渐新世狍牛泉组上部。

记述 m2 很宽短,牙齿冠面结构简单,齿脊发达,主尖压缩,无下原尖后臂,下外脊从下原尖斜向伸达下次尖前臂等都与 *L. huangheensis* 的相似。只是比例上更宽短些,约为长、宽相等的正方形。它的下中脊虽然退化变得很细而低,但仍较长,横向延伸几乎达下中附尖。下外脊较靠舌侧,约位于齿的纵中线处。下后尖和下后脊 I 较向前移,下前齿带舌部和下前凹变得较短小等与 *L. huangheensis* 的不同。这些区别特征可能为种内的个体变异,也可能为种间的区别特征,因标本太少,暂将它作为 *L. huangheensis* 的相似种。测量见表 4。

西水简齿鼠(新种) Litodonomys xishuiensis **sp. nov.**

(图 5)

正型标本 可能为同一个体的左、右下颌骨(IVPP V 13599)。

产地和层位 甘肃省肃北蒙古族自治县西水沟 DH 200105 地点;早中新世(?)铁匠沟组中部。

特征 下臼齿比例上较宽短,下外脊约位于齿的纵中线附近;m1 下中脊长,伸达齿的舌缘,m2 无下中脊的痕迹;m2 和 m3 的前齿带低弱,下前边尖很发达,但不与下后脊 II连,下后脊 II为前凹的弧形;m3 宽大于长,下中凹和下外凹明显缩短。

名称来源　西水为党河的支流,西水沟西岸为化石产出地点。

描述　左下颌骨保存较完整。下颌骨水平支较细,颊、舌面较平,下缘向下圆凸。i2 和 m1 间齿缺部分较长而细,其背缘明显凹下,背缘后部在 m1 前端下方近于垂直地往下延伸,前端稍低于颊齿齿槽缘。颏孔位于 m1 前齿根的前下方,稍靠近齿缺背缘。咬肌窝浅,其前缘达 m2 的下方,咬肌下嵴很发达,上嵴不明显。角突从门齿齿槽下方向后下方伸出,属松鼠型下颌骨。冠状突和髁状突高度相近,均较高。冠状突前缘在 m3 的外侧,近于垂直。髁状突上的关节面为前后伸长的、窄的卵圆形,表面圆凸。下齿式:/ 1003。

门齿细长,很窄,横切面为狭窄的卵圆形。门齿的前端特别上翘,约达冠状突和髁状突顶的水平,后端伸达下颌骨垂直支内。门齿的唇面和外侧面为连续的圆弧形面,釉质层覆盖在唇面、外侧面唇侧约1/ 2处和内侧面唇侧约 1/ 3 处。釉质层表面光滑,无明显的沟棱。

下臼齿齿尖不明显,齿脊较发育。m1 为下臼齿中最长者,冠面约为前窄后宽的四边形。下原尖和下后尖大小相近,但下原尖位置较下后尖的位置稍后。两尖的后臂后端相连形成的下后脊 II为向前开口的 V 形。无下前边尖,但从下后尖前缘有一弱脊向颊侧伸,几乎达下原尖,两者仅以弱沟分开。下外脊长,约位于齿的纵中线附近,由下原尖斜向后舌侧伸达下次脊,后端与下次尖前臂连。下中脊由下中尖向前舌方伸达下中附尖。下后附尖低小,与下中附尖连,而不与下后尖连。下次脊也呈前舌 - 后颊侧方向斜伸,但斜度较下中脊小,较横向,也较下中脊短。下次尖横向伸长,与下次脊和下后边脊长度相近。下后边脊较细,与下次尖相连续,舌端与下内尖连,封闭下后凹。未见前齿带。后齿带低弱,仅在颊侧存在,从次尖与下后边脊连接处向外下方伸。下外附尖很发育,几乎堵住下外凹的入口。下外凹很大,后部向舌侧延伸超过 m1 的纵中线,即其横宽大于 m1 宽度之半。三个舌侧凹中,下后凹和下后中凹横向较窄,宽度相近,下前中凹较宽,其宽度与下外凹的相近,也超过齿宽之半。下后中凹稍向后颊侧斜伸,其舌侧开口大,下前中凹比下后中凹更斜,其舌侧开口处基部被下后附尖所堵。

m2 冠面为长方形,比 m1 宽短。下原尖和下后尖大小相近,彼此相对排列,下后脊 II完全,约呈前凹的弧形。下前边尖很发达,位于较短而低的下前齿带的中部,不与下后脊 II连。下外脊也由下原尖向后舌侧斜伸达下次脊,并与下次尖前臂连,但较短。无下中尖和下中脊的痕迹。下中附尖低小而孤立。下次脊横向延伸。下次尖稍向后舌侧伸,与下后边脊相连,二者仅在后面以浅凹分

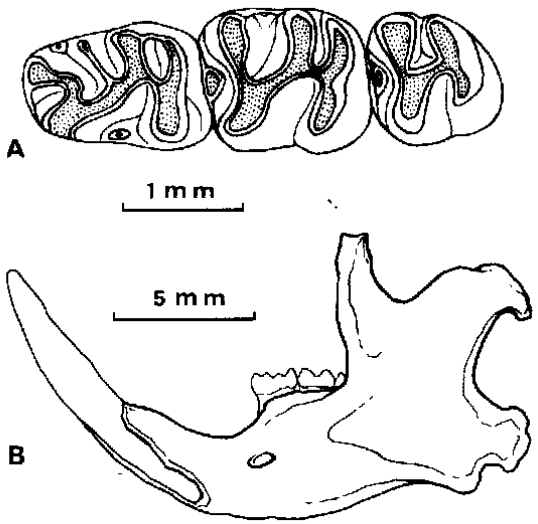

图 5　西水简齿鼠(新种)正型标本(V 13599)

Fig. 5　Holotype (V 13599) of *Litodonomys xishuiensis* sp. nov.

A. 左(left) m1-3 冠面观(occlusal view); B. 左下颌骨颊侧面观(buccal view of left lower jaw)

开。下次尖横向稍宽于下次脊和下后边脊。下后边脊舌端不达下内尖,下后凹舌侧开口。下中凹较宽,向前颊侧弯,其颊端也超过齿的纵中线。下外凹与 m1 的相似,只是前后较短,其颊侧开口处的下外附尖很低小。无下后齿带。

m3 为下臼齿中最短者,冠面为宽大于长的浑圆三角形。m3 的前部与 m2 的相似,只是下前齿带更短些,下后脊 Ⅱ的弯曲度较小。m3 的后部明显退化,下次脊和下后边脊完全愈合为一条横脊(这里统称为下后边脊),向前舌方斜伸。下外脊较短而斜伸。下中凹较短而窄,其舌部成为狭窄的沟。下外凹也较 m2 的短而窄。

表 4 简齿鼠牙齿测量

Table 4 Measurements of teeth of Litodonomys (mm)

		L. xishuiensis (V 13599, holotype)		*Litodonomys* cf. *L. huangheensis* (V 13598)
		左(left)	右(right)	
m1-3L		4.06	3.85	
m1	L	1.6	1.55	
	W	1.1	1.25	
	W/L %	69	81	
m2	L	1.45	1.35	1.2
	W	1.3	1.35	1.2
	W/L %	90	1	1
m3	L	1.1	1	
	W	1.2	1.5	
	W/L %	109	115	
i2	L	1.5	1.5	
	W	0.95	1	

缩写见表 1(For abbreviations see Table1)。

测量 (见表 4)

比较讨论 党河的标本在下臼齿比例上较宽短,齿尖不明显,齿脊较发育,冠面结构较简单,m3 下次脊与下后边脊融合等特征上均与简齿鼠 *Litodonomys* 的一致。但党河的标本与 *Litodonomys* 的已知种黄河简齿鼠(*L. huangheensis*)仍有明显区别:它们的下臼齿在比例上更宽短,下外脊的位置较靠舌侧,约位于齿的纵中线附近;m1 具完全的下中脊,m2 无下中脊;m2 和 m3 的下前边尖较发育,不与下后脊 Ⅱ连,下后脊 Ⅱ为前凹的弧形;和 m3 的后半部更加退化,变短。党河标本很可能代表不同于 *L. huangheensis* 的新种,我们称其为西水简齿鼠(*Litodonomys xishuiensis*)。

Litodonomys 属目前已知仅包括 2 个种(*L. huangheensis* 和 *L. xishuiensis*),而且已知的标本均为下牙。在跳鼠科的已知种类中,它们的臼齿冠面结构较简单的形态特征与亚洲晚始新世的 *Allosminthus* 有些类似。*Litodonomys* 是否有可能由类似 *Allosminthus* 的种类进一步演化而成,或者可能由类似 *Parasminthus* 的种类简化退化的结果,这还有待发现更多更好的材料。至于 *L. huangheensis* 和 *L. xishuiensis* 的关系,从它们产出的层位和时代来判断,前者产于狍牛泉组上部,时代为晚渐新世,而后者产于铁匠沟组中部,时代为早(?)中新世,很可能 *L. xishuiensis* 比 *L. huangheensis* 稍进步些。如果是这样,在 *Litodonomys* 属中似乎可以看到有如下的进化趋势:下臼齿进一步变短宽,下外脊逐渐向舌侧移,m2 和 m3 下中脊退化消失,m3 进一步缩短,后半部更加退化,下次脊和下后边脊融合为一等。

2 讨论和结论

综上所述,党河地区新生代地层中共发现 3 属 7 种跳鼠(*Parasminthus asiae-centralis*, *P. tangingoli*, *P. parvulus*, *Heterosminthus lanzhouensis*, *H. intermedius*, *Litodonomys*

xishuiensis 和 *L*. cf. *L*. *huangheensis*)。其中 *Parasminthus asiae-centralis*, *P*. *tangingoli*, *P*. *parvulus*, *Heterosminthus lanzhouensis* 和 *L*. cf. *L*. *huangheensis* 产自狍牛泉组上部,时代为晚渐新世。它们与党河已知晚渐新世跳鼠的成员基本相同(Bohlin, 1946;王伴月、邱占祥, 2000)。这进一步验证了这些种类在党河地区的产出层位和时代。*H*. *intermedius* 和 *L*. *xishuiensis* 产于铁匠沟组中部,这是在党河地区这套地层中首次发现的哺乳动物化石。这两个新种对于了解有关属的进化趋势和含化石地层的时代提供了有意义的信息。

简齿鼠(*Litodonomys*)过去仅知一种,即属型种 *L*. *huangheensis*,其时代为晚渐新世(王伴月、邱占祥,2000)。*L*. *xishuiensis* 比属型种 *L*. *huangheensis* 产出层位高,时代可能要晚些,即为早中新世或更晚些。*Heterosminthus* 目前已知的时代分布为晚渐新世—中中新世(邱铸鼎,1996,2000;王伴月、邱占祥,2000)。党河的 *H*. *intermedius* 显然要比中中新世的 *H*. *orientalis* 原始,而较晚渐新世的 *H*. *lanzhouensis* 进步,它的时代可能为早中新世。与 *H*. *intermedius* 和 *L*. *xishuiensis* 同产于铁匠沟组中部(层位稍高)的还有 *Phyllotillon* sp.。*Phyllotillon* 在亚洲已知仅分布于晚渐新世—早中新世。综合分析上述三种的时代,铁匠沟组中部的时代似以早中新世为宜。然而,根据党河地区西水沟剖面的古地磁的重新解释(王伴月等,2003),铁匠沟组下部的时代应为早中新世,而中部时代为中中新世。这与上述基于化石所推断时代有异。看来,这一问题真正解决,还需要做进一步工作。

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DIPODIDAE (RODENTIA, MAMMALIA) FROM THE MID-TERTIARY DEPOSITS IN DANGHE AREA, GANSU, CHINA

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Key words　Danghe area of Gansu, Oligocene, Miocene, Dipodidae

Summary

The fossil dipodids of the Danghe area, Gansu, were described by Bohlin (1946), allegedly from a single late Oligocene level. Due to the extremely complex tectonic disturbance of the strata in the study area, Bohlin's age determination needs to be verified stratigraphically. In 1999 and 2001 a joint team of Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences (IVPP), Cultural Relic Archaeology Institute of Gansu and Gansu Province Museum made a geologic survey of the Danghe area. As a result, a number of stratigraphic problems were clarified and some new mammalian fossils were collected from stratigraphically known levels (Wang et al., 2003). Among the fossils the dipodids are one of the most abundant, including not only the taxa described by Bohlin (1946), but also 2 new species from new levels.

1　Systematics

Dipodidae Fischer de Waldheim, 1817

Parasminthus **Bohlin, 1946**

Parasminthus asiae-centralis **Bohlin, 1946**

(Fig. 1, G～I)

Specimens 1 P4, 2 M1, 1 M2 and 2 m3 (IVPP V 13593. 1～6).

Locality and horizon IVPP Loc. DH 199904A, Yindirte, Aksay Kazak Autonomous County; Late Oligocene, the upper part of the Paoniuquan Formation.

Remarks P4 is composed of a main cusp and a posterior cingulum. On M1 the anterior arm of the protocone extends to the anterobuccal corner. M2 has double protoloph. The m3 has metaconid not shifting anteriorly and lacks mesolophid. All the features are identical with those of *P. asiae-centralis*. The size of the cheek teeth is within the range of the variation of this species (Dimensions see the Chinese text).

Parasminthus tangingoli **Bohlin, 1946**

(Fig. 1, A～F)

Specimens 2 M1, 2 M2, 4 M3, 2 m1, 5 m2 and 5 m3 (IVPP V 13594. 1～20).

Locality and horizon IVPP Loc. DH 199904A, Yindirte, Aksay Kazak Autonomous County; Late Oligocene, the upper part of the Paoniuquan Formation.

Remarks The cheek teeth are identical with those of *P. tangingoli* in the basic features: M1 and M2 have a distinct concavity between the hypocone and posteroloph on the posterior wall, and 4 roots; the metaloph of M1 joins the posterior arm of the hypocone or posteroloph; M2 possesses double protoloph, and metaloph meeting anterior arm of hypocone; on m1 the anteroconid connected with the metaconid by the anterior cingulum; m2 has only one transverse lophid between the metalophid and hypolophid; m3 lacks mesolophid; and the size is within the range of the variation of *P. tangingoli* (see Table 1).

Parasminthus parvulus **Bohlin, 1946**

(Fig. 2)

Specimens 9 M1 (V 13595. 1～9), 4 M2 (V 13595. 10～13), 1 M3 (V 13595. 14), one right lower jaw with m1-2 (V 13595. 15), 9 m1 (V 13595. 16～24), 2 m2 (V 13595. 25～26) and 5 m3 (IVPP V 13595. 27～31).

Locality and horizon IVPP Loc. DH 199904A, Yindirte, Aksay Kazak Autonomous County; Late Oligocene, the upper part of the Paoniuquan Formation.

Remarks M1 and M2 have 4 roots and flat posterior margin without concavity between the hypocone and posteroloph. On M1 the metaloph joins the hypocone. The M2 has single protoloph. The m1 has distinct and usually isolated anteroconid and complete mesolophid. On the m2 only the posterior arm of the protoconid is present between the metalophid and hypolophid. These features are identical with those of *P. parvulus*. In addition, the size of the cheek teeth is small and within the range of the size variation of this species (see Table 2). The only difference between M3 from the Danghe area and *P. parvulus* is that it has initial double protoloph, which was considered as infraspecific variation. The specimens from the Danghe area seem to be referred to *P. parvulus*.

Heterosminthus **Schaub, 1930**

Heterosminthus lanzhouensis **Wang and Qiu, 2000**

(Fig. 3, A, B)

Specimens One right m1 and one left m3 (IVPP V 13596. 1～2).

Locality and horizon IVPP Loc. DH 199904A, Yindirte, Aksay Kazak Autonomous County; Late Oligocene, the upper part of the Paoniuquan Formation.

Remarks The m1 is identical with that of *H. lanzhouensis* in size (see Table 3) and occlusal features, such as V-shaped metalophid Ⅱ, bending ectolophid, short and anterobuccally

oblique ectomesolophid. No m3 of *H. lanzhouensis* has been reported until now. Recently one m3 was collected from the same level of the same locality of m1 (V 13596.1). On the m3 the metaconid shifts anteriorly to the protoconid. The lingual part of the anterior cingulum is small and no distinct anterior fossettid is visible. The posterior arm of the protoconid is well developed. The hypolophid, middle and posterior fossettids are small. All these features are similar to those of *Heterosminthus* rather than to *Parasminthus*. The m3 seems to be referred to the genus *Heterosminthus*. However, it has a distinct hypolophid, middle and posterior fossettids, which indicate that the talonid is less reduced than that of *H. orientalis* and similar to that of *H. intermedius* sp. nov. (*vide infra*). Probably the m3 (V 13596.2) belongs to *H. lanzhouensis*, as well.

Heterosminthus intermedius **sp. nov.**
(Fig. 3, C)

Holotype A segment of upper jaw with right I2, left and right P4～M2, a segment of right lower jaw with i2 and m1～3, and a segment of left lower jaw with i2 and m1～2, which may belong to one of the same individual (IVPP V 13597).

Locality and horizon IVPP Loc. DH 199903, Tiejianggou, Aksay Kazak Autonomous County; early Miocene(?), the middle part of the Tiejianggou Formation.

Diagnosis Molars with slightly alternately arranged main cusps; M2/m2 proportionally wide and short; M1 and M2 with well-developed protoconule and posterolingual crest of protocone, but without anterostyle; M1 with developed posterior arm of protocone and distinct anterior sinus; M2 with short and lower anterior cingulum, developed anterior arm of protocone and metaloph joining hypocone; m1 with developed mesolophid meeting metastylid, long and transverse ectomesolophid, and anteriorly oblique hypolophid joining with ectolophid before mesoconid; m2 with slightly anteriorly shifting metaconid, rather developed buccal part of anterior cingulum and mesoconid, and weak ectomesolophid; slightly reduced m3 with hypolophid, middle and posterior fossettids.

Etymology intermedius, Latin: between. It implies that the features of the cheek teeth are between those of *H. orientalis* and *H. lanzhouensis*.

Description and dimensions (see the Chinese text)

Comparison The cheek teeth from the Danghe area are brachydont with distinct cusps and weak lophs; the molars have slightly alternately arranged main cusps and distinct mesocone; M1 and M2 have posterolingual crest of protocone and mesoloph; the m1 has a distinct ectomesolophid; the m2 has well-developed posterior arm of the protoconid. These basic features are identical with those of *Heterosminthus*. Obviously V 13597 belongs to *Heterosminthus*.

Heterosminthus is known to include two species, *H. orientalis* and *H. lanzhouensis*. V 13597 differs from the above two species in having a shorter and lower anterior cingulum on M2, and a more anteriorly oblique hypolophid joining the ectolophid before the mesoconid. It is similar to *H. lanzhouensis* but different from *H. orientalis* in M1 and M2 having a developed protoconule, M1 having rather developed posterior arm of protocone and distinct anterior sinus, M2 with well-developed anterior arm of protocone, m1 with prominent mesolophid meeting mesostylid, m2 with more developed mesoconid, less anteriorly shifting metaconid and distinct buccal part of anterior cingulum, and less reduced m3 with distinct hypolophid, middle and posterior fossettids. It is similar to *H. orientalis* but different from *H. lanzhouensis* in M2 having metaloph joining hypocone and m1 having long and transverse ectomesolophid. In addition, the proportion of the cheek teeth, particular M2, the degree of the alternate arrange of the main cusps and the degree of the development of the posterolingual crest of protocone are between those of the two species. It seems that V 13597 represents a new species in the intermediate stage between *H. orientalis* and *H. lanzhouensis*, named as *Heterosminthus intermedius* sp. nov.

Some evolutionary tendencies of *Heterosminthus* can be proposed based on the material of the 3

above mentioned species. The cheek teeth seem to change from wide and short to long and narrow in proportion. The main cusps become more and more alternatively arranged. The posterolingual crest of protocone of M1 and M2 evolves from weak to well developed, and the anterostyle from absent to distinct. The metaloph of M2 shifts posteriorly to join hypocone. On m1 the ectomesolophid changes from short and oblique anteriorly to long and transversely, and the mesolophid tends to disappear, the hypolophid from transverse to oblique anteriorly. The metaconid shifts anteriorly and the buccal part of the anterior cingulum tends to disappear. The m3 is reduced to smaller and simpler.

Litodonomys **Wang et Qiu, 2000**

Litodonomys **cf.** L. huangheensis **Wang and Qiu, 2000**

(Fig. 4)

Specimen One left m2 (V 13598).

Locality and horizon IVPP Loc. DH 199904D, Yindirte, Aksay Kazak Autonomous County; Late Oligocene, the upper part of the Paoniuquan Formation.

Remarks The m2 is wide and short in proportion. The occlusal structure is simple, with well-developed lophids and compressed main cuspids. The protoconid lacks posterior arm. The ectolophid extends obliquely from the protoconid to the anterior arm of the hypoconid. All of these features are similar to those of *L. huangheensis*. However, the m2 is square in occlusal view, with subequal length and width. The mesolophid is slender and long. The ectolophid is located near the middle part of the tooth. The metaconid and metalophid I shift anteriorly, so that the lingual part of the anterior cingulum and the anterior fossettid become small and short. These features are different from those of *L. huangheensis*. These distinct features may represent infraspecific or interspecific variations. The problem will be solved pending more specimens. Dimensions see Table 4.

Litodonomys xishuiensis **sp. nov.**

(Fig. 5)

Holotype Right and left lower jaws may belong to one of the same individual (IVPP V 13599).

Locality and horizon IVPP Loc. DH 200105, Xishuigou, Subei Mongol Autonomous County; early Miocene(?), the middle part of the Tiejianggou Formation.

Diagnosis Lower molars wide and short in proportion, ectolophid located near longitudinal middle line; mesolophid long on m1 but absent on m2; m2 and m3 with low and weak anterior cingulum, well-developed anteroconid not joining with anteriorly concave metalophid Ⅱ; m3 wider than long, with short middle fossettid and sinusid.

Etymology Xishui, a tributary of the Danghe River, where the fossils were discovered.

Description and dimensions(see the Chinese text)

Comparison The lower molars from the Danghe area are low and wide in proportion and simple in occlusal structure. The lophids are well-developed and the cuspids are compressed. The hypolophid and posterolophid are fused on m3. These features are identical with those of *Litodonomys*. The specimens from the Danghe area is different from the only species of *Litodonomys*, *L. huangheensis*, in some features. The lower molars from the Danghe area are slightly wider and shorter in proportion. The ectolophid is located near the longitudinal middle line of the teeth. The mesolophid is complete on m1 and absent on m2. The anteroconid of m2 and m3 is well-developed but does not join the metalophid, which is concave anteriorly. On the m3 the talonid is more reduced and shortens. Obviously V 13599 represents a new species distinct from *L. huangheensis*, named as *L. xishuiensis*.

Now the genus *Litodonomys* is known to include two species, *L. huangheensis* and *L. xishuiensis*. Both are known only from lower molars. Among the known dipodids *Litodonomys* seems more similar to *Allosminthus* from late Eocene of Asia in having simple tooth structures. Whether *Litodonomys* evolved from *Allosminthus*-like or *Parasminthus*-like forms must wait pending more and

better specimens.

L. huangheensis is known from late Oligocene and *L. xishuiensis* from early Miocene. The latter seems to be more advanced than the former in morphology. If it is true, some evolutionary tendencies in *Litodonomys* may be deduced: the lower molars become wider and shorter in proportion and the ectolophid gradually shifts lingually; the mesolophid gradually reduced on m2 and m3; the m3 becomes shorter, with more and more reduced talonid and fused hypolophid and posterolophid.

2 Discussion and conclusion

To sum up, the dipodids from the Danghe area include 7 species of 3 genera (*Parasminthus asiae-centralis*, *P. tangingoli*, *P. parvulus*, *Heterosminthus lanzhouensis*, *H. intermedius*, *Litodonomys xishuiensis* and *L.* cf. *L. huangheensis*). Among them *Parasminthus asiae-centralis*, *P. tangingoli*, *P. parvulus*, *Heterosminthus lanzhouensis* and *L.* cf. *L. huangheensis* were collected from the upper part of the Paoniuquan Formation, which is late Oligocene in our interpretation (Wang and Qiu, 2000). They are the same as described by Bohlin in 1946. This proves that the dipodids described by Bohlin (1946) were late Oligocene in age too. The other two species, *Heterosminthus intermedius* and *Litodonomys xishuiensis*, were collected from the middle part of the Tiejianggou Formation. They are the first mammalian fossils ever discovered from the Tiejianggou Formation. The 2 new species not only shed light on evolutionary tendencies of the two related genera, but also provide important evidence as to the geological age of the fossil-yielding deposits. *Litodonomys* was previously known only from the type species (*L. huangheensis*) of late Oligocene. As mentioned above, *L. xishuiensis* is more advanced than *L. huangheensis*. Its age can thus be later, probably early Miocene or even later. *Heterosminthus* is known from late Oligocene through middle Miocene. *H. intermedius* is more primitive than the middle Miocene *H. orientalis* (Qiu, 1996, 2000), but more advanced than the late Oligocene *H. lanzhouensis* (Wang and Qiu, 2000). Thus, it may be of early Miocene in age. It is interesting to point out that *Phyllotillon* sp. was also found from the middle part of the Tiejianggou Formation, but in a level slightly higher than that yielding the above 2 new species. *Phyllotillon* is known from late Oligocene through early Miocene in Asia. Based on the mammalian fossils, I may conclude that the age of the middle part of the Tiejianggou Formation is early Miocene. However, according to our reinterpretation of the paleomagnetic data of the Xishuigou section (Wang et al., 2003), the Tiejianggou Formation should be middle Miocene, thus slightly later than the age determination based on the mammalian fossils (early Miocene). A final solution of the contradiction needs further work in the Danghe area.

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