第30卷 第1期 古脊椎动物学报 pp. 17—38
1992 年 1 月 VERTEBRATA PALASIATICA figs. 1—5, pl. I—II

记山西榆社晚新生代鼠科化石新属种

吴 文 裕
（中国科学院古脊椎动物与古人类研究所）
劳伦斯·J·弗林
（美国自然历史博物馆；哈佛大学皮博迪博物馆）

关键词 山西榆社 晚新生代 鼠科

内 容 提 要

本文描述了山西榆社盆地晚新生代鼠科化石中的新属种：*Huaxiamys primitivus* gen. et sp. nov., *Huaxiamys downsi* gen. et sp. nov., *Micromys tedfordi* sp. nov., *Apodemus qiui* sp. nov., *Apodemus zhangwagouensis* sp. nov..

半个多世纪以来，榆社盆地晚新生代河湖相沉积物中盛产的哺乳动物化石一直被视为研究东亚陆生哺乳动物历史的基础。该盆地沉积物厚度大，跨时长，为建立精确的生物地层层序提供了良好的条件。1979 年以来，中国科学院古脊椎动物与古人类研究所多次组队，在邱占祥的领导下，对榆社盆地作了较详细的地层古生物工作。在此基础上，该研究所与美国自然历史博物馆合作，进一步开展了对山西榆社盆地的研究。在邱占祥和理查德·戴德福（Dr. R.H. Tedford）的领导下，由中国国家自然科学基金会和美国自然科学基金会资助，1987 年和 1988 年进行了两次野外考察。重点在云簇盆地作了系统的生物地层学工作，并开展了古地磁测年研究。本文作者与美国北亚利桑那州大学的威廉·唐斯（William. R. Downs）承担了作为项目主要组成部分的小哺乳动物化石的采集和研究工作。小哺乳动物化石中，除小部分由地面采得外，都由湿筛样品获得。新采集的材料中，鼠科化石最为丰富，计 411 件标本，分属 6 属 16 种及 3 未定属种，而且它们分布于云簇盆地整个剖面自下而上的大部分层位，都有准确地点和层位记录，因此具有重要的生物地层学意义。而以前在榆社盆地发现的鼠科化石甚少，唯一的报道是雅各布斯（L. Jacobs）与李传夔(1982)关于榆社日进鼠的文章。为此，我们首先研究了鼠科化石。本文仅报道其中的新属新种。全部材料的研究报告将在该合作项目的专刊上发表。

文中测量数据（单位：毫米）由 Wild M7A 双目立体显微镜测得。照片是在蔡氏（Zeiss）950 数字扫描显微镜上低倍摄制的。描述中采用 Storch（1987）的术语。

图 1 概括表示了云簇盆地的地层划分，各小哺乳动物化石地点的层位关系和本文所描述属种的地点和地层分布。

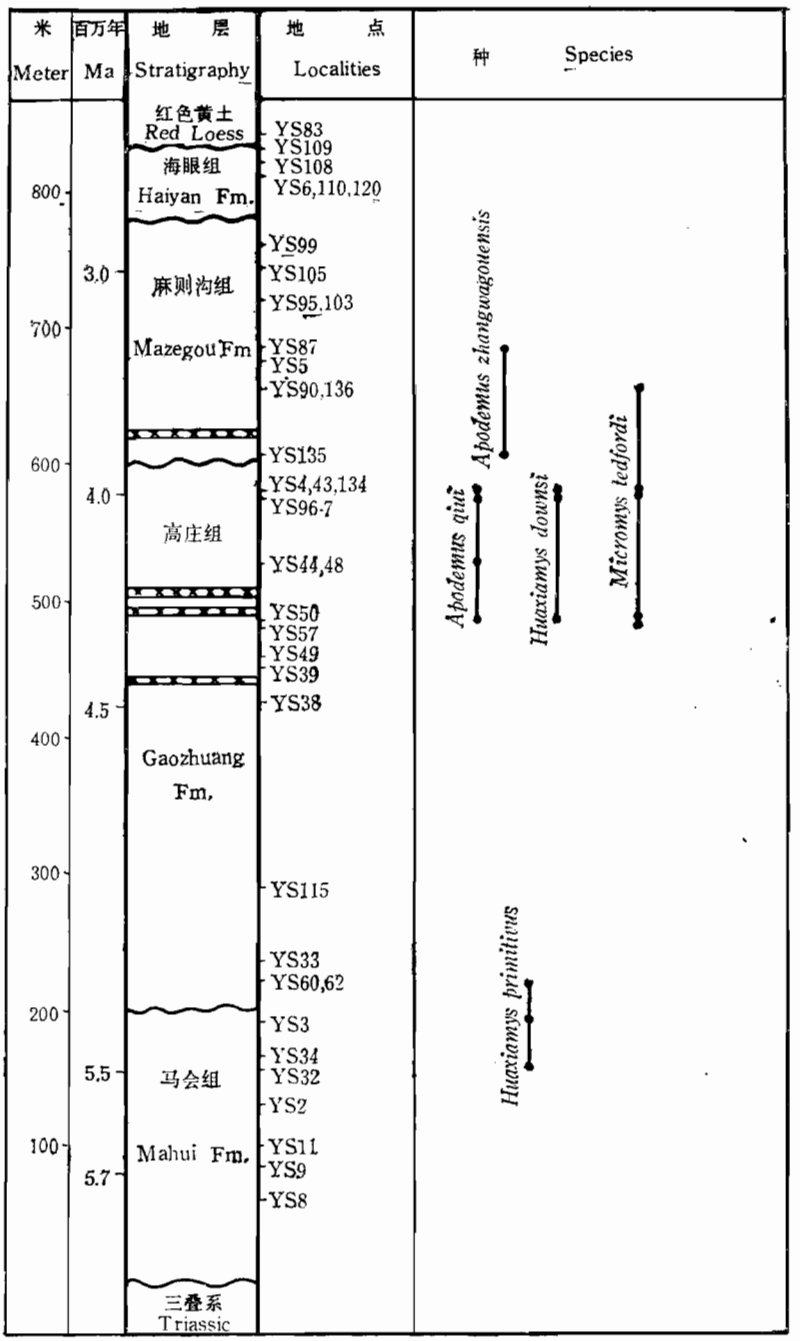


图 1 榆社云簇盆地综合地层剖面示意图。示小哺乳动物化石产地及鼠科新属种的地层分布

Fig. 1 Yuncu composite section, Yushe Basin, showing micromammal sites and the biostratigraphy of new murid taxa

标 本 记 述

鼠科 Family Muridae Gray 1821

华夏鼠(新属) *Huaxiamys* gen. nov.

属型种　*Huaxiamys downsi* sp. nov.

归入种　*Huaxiamys downsi* sp. nov., *Huaxiamys primitivus* sp. nov.

地点和层位　YS32, YS3 马会组; YS60, YS50, YS97 和 YS4, 高庄组。

时代　晚中新世至早上新世。

属名由来　"Huaxia", 中国的古称"华夏"的汉语拼音。

属征　具小型、低冠皇冠型臼齿,齿尖强烈倾向后方。M^1 的 t_2 前壁向前远伸, t_3 很后位, t_2 与 t_3 间的谷宽阔; t_2 与 t_1 连接成前唇—后舌向延伸的斜脊; 无 t_7。M_1 的前中尖(t_{ma})小或缺失; 舌侧下前边尖不同程度地前唇—后舌向膨胀,且较唇侧下前边尖更向前伸; 齿经磨蚀后前中尖与舌侧下前边尖相连; 唇、舌下前边尖与下后尖一下原尖对组成不对称的"X"型; 具发育不完全的中脊 (medial ridge)。唇侧附尖退化, M^1 三、M^2 四, M_1 和 M_2 两或三齿根。

唐氏华夏鼠(新种) *Huaxiamys downsi* sp. nov.

(图 3; 图版 I,8—15)

正型标本　左 M^1(V8855.7), 1.88 × 1.00。

副型标本　$20M^1$, $3M^2$, $2M^3$, $14M_1$, $7M_2$, $4M_3$; 5 支具 M_1 或 M_{1-2} 的不完整下颌骨(V8855.1-6, V8855.8-57)。

模式地点　山西榆社, YS4。

层位与时代　高庄组醋柳沟段,早上新世。

种名由来　对 William R. Downs 先生在中美榆社合作项目中所作的贡献表示敬意。

种征　进步的 *Huaxiamys*。M^1 的 t_2 前壁向前迅速变窄; t_3 和 t_6 较在 *H. primitivus* 中更后位; 无 t_{12}。M_1 的前中尖及 M_1、M_2 的后齿带 (CP) 和唇侧附尖通常退化至齿带状脊。M_1 和 M_2 具两或三齿根。

归入标本　YS97: $2M^1$ 和 $1M_1$(V8854.1-3); YS50: $1M^1$ (部分破损), $3M^2$ (一齿部分破损), $5M_1$ (4 齿部分破损), $2M_2$(V8853.1-11)。

归入标本的层位与时代　高庄组,南庄沟段及醋柳沟段; 早上新世。

描述　M^1 为发达的皇冠型齿,所有齿尖强烈倾斜。t_2 前壁向前远伸,迅速变窄。t_2 与 t_1 前唇—后舌向拉长,并彼此相连成脊状; 在一些标本上,该脊向前延伸超过 t_2 直至唇侧齿带 (cingulum)。t_3 位于 t_2 的后唇方,并以一细脊与其相连,两齿尖间为一宽深的谷(但标本 V8855.15 例外,其唇侧齿尖 t_3, t_6 及 t_9 并不明显后移),此谷在唇侧为一齿带封闭。t_4, t_5, t_6, t_9 及 t_8 彼此相连成环形。t_4 与 t_5, t_3 位于同一直线,但 t_3 与 t_4-t_5 脊分离。t_4 和 t_5 连成的脊平行于 t_1-t_2 脊。t_3, t_6, t_9 大小近等,位于唇侧缘,略小于其它齿尖。t_9 以一脊与 t_8 的

测 量 数 据

	范 围 Range	长 度 (Length) 均值 X	标准差 S	变异系数 C.V.	标本数 N	范 围 Range	宽 度 (Width) 均值 X	标准差 S	变异系数 C.V.
M^1	1.44—1.88	1.66	0.105	6	16/24	0.85—1.08	0.97	0.56	6
M^2	0.90—0.94	0.92	0.020	2	5/4	0.84—0.90	0.88	0.026	3
M^3	0.70—0.75	0.73	0.035	5	2/2	0.64—0.70	0.67	0.042	6
M_1	1.18—1.37	1.29	0.057	4	19/20	0.74—0.89	0.82	0.041	5
M_2	0.88—0.97	0.94	0.031	3	8/8	0.77—0.89	0.84	0.043	5
M_3	0.65—0.70	0.67	0.026	4	4/4	0.58—0.66	0.62	0.037	6

舌端相连。无 t_7 及 t_{12}。具三齿根(舌侧根及前后齿根)，前方齿根前伸，齿冠底面中央另有一小齿根突 (rootlet)。

M^2 圆方形。t_1 大，前后向延长，并转向唇方与 t_5 的前舌侧相连。t_3 很小。t_4，t_5，t_6，t_9和 t_8 彼此相连成环。t_9 小。t_4 与 t_1 近等或略大于 t_{10}。无 t_7 和 t_{12}。四齿根，有时另有一中央小齿根。

M^3 圆三角形。t_1 为一大的独立的圆形齿尖。无 t_3，t_5 位于唇侧，t_9 小或缺失。t_8 圆形，位于齿冠后部中央。三齿根(前根在根端分叉)。

M_1 前中尖小或在大部分标本中缺失，通常远低于齿冠嚼面。舌侧下前边尖前唇—后舌方向膨胀，并位于向前唇方向延伸的唇侧下前边尖之前。磨蚀后，前中尖与舌侧下前边尖相连。相对的唇、舌侧下前边尖与下后尖一下原尖脊组成不对称的“X”型、中脊总存在，但不完全。后齿带 (CP) 横向延长，约达齿宽的二分之一。近乎脊状。但在一枚产自 YS50 的 M_1 上，后齿带为明显的卵圆形。唇侧附尖退化为齿带状脊，但在 4 枚 M_1 上 C_1或 C_2 的痕迹明显可见。YS4 的标本中 11 例具两齿根，6 例具三齿根(一前两后)。在 11 枚具两齿根的 M_1 中，有两例的后齿根宽并带有纵沟。YS50 的两枚 M_1 都为两齿根的，其中一齿的后齿根宽并具纵沟 (图 2)。

M_2 圆方形。唇侧下前边尖为齿带状脊。有中脊，但不完全。唇侧附尖变弱并融为唇侧脊，前与脊形的唇侧下前边尖连接，向后伸至下次尖基部。后齿带呈卵圆形(3 例)或脊状(4 例)。两枚产自 YS50 的 M_2 都具有明显的卵圆形后齿带。具两齿根(共 4 例，其中一枚具宽的后齿根，一枚具带纵沟的后齿根)或三齿根(6 例)。

M_3 唇侧下前边尖缺失或很弱。下后尖和下原尖明显可辨。下次尖缺失或很弱。两齿根(图 3-2)。

原始华夏鼠(新种) *Huaxiamys primitivus* sp. nov.

(图 2, 3;图版 I, 16—19)

正型标本 右 M^1(V8850.1)；1.72 × 1.00。

副型标本 左 M_2(V8850.5)；0.90 × 0.80。

模式地点　山西榆社，YS32。

层位与时代　马会组，晚中新世。

种名由来　是该属两种中较原始的种。

种征　与 *H. downsi* 相比，具较不发育的皇冠型齿；M^1 的 t_3 较少后移；t_2 前壁前伸，但不迅速变窄；具 t_{12}。M_1 的前中尖和 M_1，M_2 的唇侧附尖较发育。下臼齿的后齿带为卵圆形。M_1 和 M_2 仅具两齿根。

归入标本　YS60：一右下颌支带 M_1-M_2(V8552)；YS3：$3M_1$（其中一枚破损），$1M_2$ (V8851.1-4)；YS32：$1M^1$，$1M^2$，$1M_1$(V8850.2-4)，均破损。

归入标本的层位与时代　马会组，高庄组桃杨段下部；晚中新世。

测　量　数　据

	范　围 Range	长　度 (Length) 均值 X	标准差 S	变异系数 C.V.	标本数 N	范　围 Range	宽　度 (Width) 均值 X	标准差 S	变异系数 C.V.
M^1		1.72			1/1		1.00		
M_1	1.21—1.28	1.24	0.036	3	3/4	0.71—0.81	0.75	0.043	6
M_2	0.89—0.90	0.88	0.015	2	3/3	0.76—0.80	0.79	0.023	3

描述　M^1（正型标本）t_2 前壁前伸，但不迅速变窄，t_3 与 t_2 靠近，其间的谷较 t_3 与 t_6 间的谷狭窄。t_3 的后缘与 t_5 的前缘约在同一位置。t_1 与 t_2 相连成前唇—后舌向延伸的脊，与 t_4-t_5 脊平行。有 t_{12}。

M^2 仅有的一枚 M^2 已破损，但仍可见一发育的 t_3。t_6 后缘与 t_8 的前缘约在同一位置或稍靠后。四齿根。

M_1 在四枚可观察的牙齿上前中尖小，但明显可见。舌侧下前边尖伸向前舌侧，并前唇—后舌向膨胀，而唇侧下前边尖呈前唇向延伸。前者位于后者前方。齿经磨蚀后前中尖与舌侧下前边尖相连。相对的舌侧和唇侧下前边尖与下后尖一下原尖脊连接成不对称的"X"图案。有中脊，但不很发育。后齿带卵圆形。唇侧附尖较 *H. downsi* 的发育，C_1总呈小圆尖状，C_2 呈小圆尖(三例)或呈齿带状(一例)，C_3 很小或呈齿带状。两枚带齿根的齿都为两根齿。

M_2 唇侧下前边尖明显，突向前唇方。有中脊。后齿带卵圆形，横向延长，但不及 *H. downsi* 的长。C_1 和 C_3 弱：在两枚齿中仍为明显的齿尖，在另一枚齿中减弱为齿带状脊。两枚带齿根的牙都为两根齿。

比较　新属 *Huaxiamys* 虽在尺寸小、M^1 的 t_2 前壁前伸和 M_1 的舌侧下前边尖很发育并向前伸等性状方面与 *Mus* 相似，但许多性状表明它们是不同的属。主要区别特征如下：*Huaxiamys* 的臼齿为皇冠型齿，齿冠低，齿尖强烈倾斜；M^1 的 t_3 很后位，t_3 与 t_2 间的谷宽阔，t_1 与 t_2 相连成斜脊；大部分 M_1 仍具有前中尖，所有 M_1 及 M_2 有唇侧附尖或齿带状脊。*Mus* 的臼齿为非皇冠型齿(M^1，M^2 的 t_6 与 t_9 从不连接，下臼齿无中脊)，齿冠较高，齿尖较直立。M^1 的 t_3 与 t_2 很靠近，因而 t_2 与 t_3 间的谷极窄，t_1 与 t_2 未连成斜脊；所有

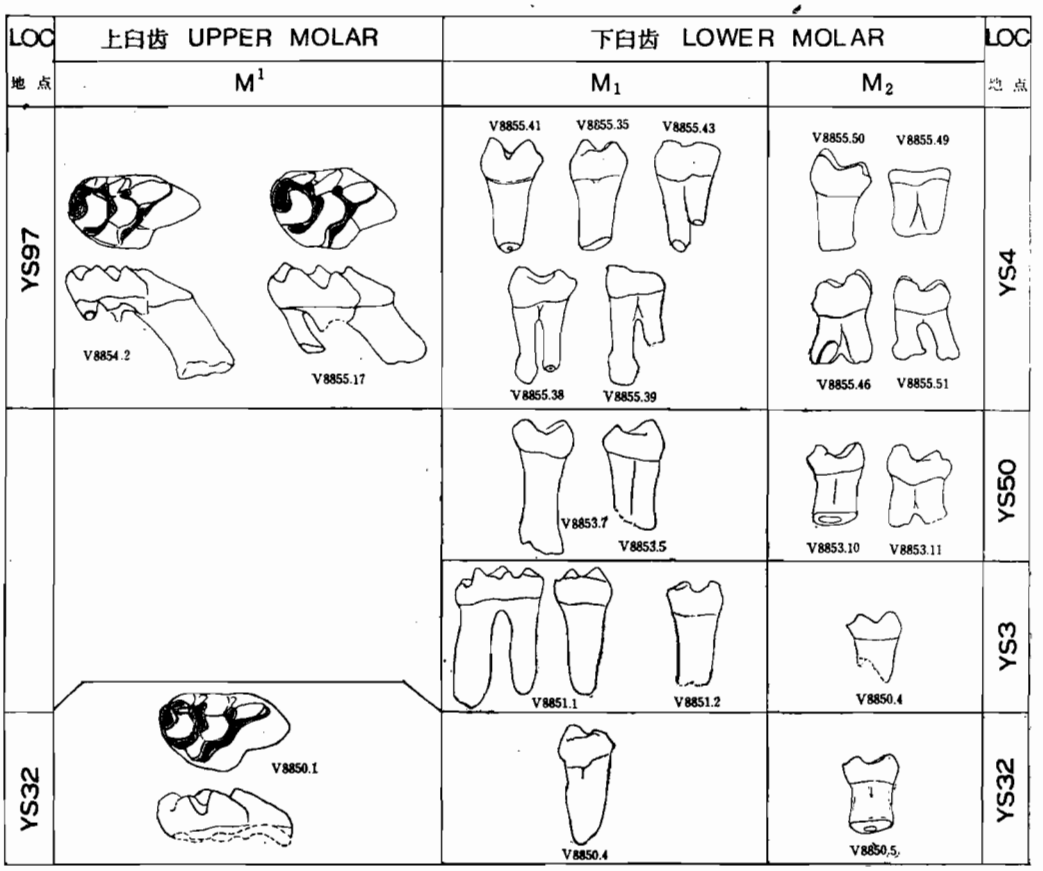


图 2 华夏鼠 (*Huaxiamys*) 的两个种 (*H. primitivus* gen. et sp. nov.) 及 (*H. downsi* gen. et sp. nov.) 的牙齿形态比较及进化趋势示意图

Fig. 2 Morphological comparison between *Huaxiamys primitivus* gen. et sp. nov. and *H. downsi* gen. et sp. nov., showing the evolutionary trends of this genus

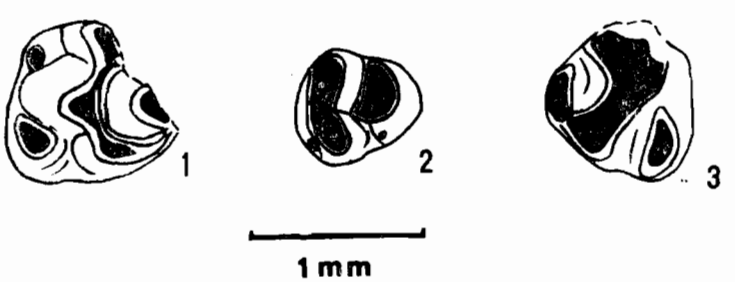


图 3 (Fig.3) 1.原始华夏鼠(新属新种) *Huaxiamys primitivus* gen. et sp. nov. 左 M^2(M^2sin), V8850.3, YS32; 2.唐氏华夏鼠(新属新种) *H. downsi* gen. et sp. nov. 左 M_3(M_3sin), V8855.54, YS4, 副型 paratype; 3.戴氏巢鼠(新种) *Micromys tedfordi* sp. nov. 右 M^3(M^3dex), V8861.15, YS4

的 M_1 都无前中尖，舌侧下前边尖特别大，远向前伸。下臼齿上无唇侧附尖或齿带状脊。

在榆社盆地中 *Huaxiamys* 出现于晚中新世至早上新世。在这段时间内(5.5 至4.0百

万年)两个相继产生的种表现出明显的进化趋势，彼此间易于区分(参阅图 2 与图版I，8—19)。

上臼齿的进化趋势：(i) M^1 的 t_2 前壁渐向前远伸并变窄；(ii) 随着唇侧尖 t_3，t_6 和 t_9 的后移及变小，t_2 和 t_3 间的谷加宽；(iii) t_{12} 趋于消失；(iv) 皇冠型形态强化。

下臼齿的进化趋势：(i) M_1 的前中尖（t_{ma}）变小或消失；(ii) 唇侧附尖变弱，最后呈齿带状脊；(iii) 卵圆形的后齿带（CP）渐趋横向拉长，甚或呈齿带状脊；(iv) M_1，M_2 的后齿根趋于二分。

下表为 *Huaxiamys primitivus* 与 *H. downsi* 的性状比较：

	H. primitivus	*H. downsi*
上臼齿 (M^1)	M^1 的 t_2 前壁不明显变窄 t_3，t_6，t_9 后位，但 t_2，t_3 间的谷窄 有 t_{12}（在仅有的一枚 M^1 上） 皇冠型形态弱	明显向前变窄并远伸 唇侧齿尖更后位，t_2-t_3 齿谷宽 无 t_{12} 皇冠型形态强化
下臼齿 (M_1-M_2)	M_1 的前中尖小，但明显 唇侧附尖明显 后齿带卵圆形 M_1，M_2 具两齿根	前中尖弱化或缺失 变弱或呈齿带状脊 通常变弱，侧向延长为齿带状脊 两或三齿根

当然，与许多其它物种一样，由于居群内各个体之间的变异以及在各个体中进步特征与原始特征的不同镶嵌组合，只有当样品达到一定数量时，种的鉴定才是可靠的。榆社的这两个种之间虽然有近一百万年的时间间断，仍明显地表现出两个种的特征的逐渐过渡性质。

地层分布　*H. primitivus* 出现于马会组、高庄组最下部桃阳段的 YS32，YS3 和 YS60 地点；时代为晚中新世。*H. downsi* 出现在高庄组中部和上部南庄沟段和醋柳沟段的 YS50，YS97 和 YS4 地点；时代为早上新世。在 *H. primitivus* 的最后记录与 *H. downsi* 的最早记录之间有近一百万年的间断。想必在 YS60 和 YS50 之间的沉积物中还记载有这两个种之间的转化形式。

巢鼠 *Micromys* Dehne, 1841

戴氏巢鼠(新种) *Micromys tedfordi* sp. nov.

(图版 I，1—7)

正型标本　一左下颌支带 M_1-M_2(V8859.3；M_1 1.56 × 0.96；M_2 1.14 × 1.00)。

副型标本　左 M^1(V8859.1，1.67 × 1.09)；右 M_2(V8859.2，1.09 × 0.94)。

模式地点　山西榆社，YS50。

层位与时代　高庄组，南庄沟段；早上新世。

种名由来　对 R. H. Tedford 在晚新生代脊椎动物进化研究方面，尤其是榆社盆地地层与古脊椎动物研究工作中作出的重大贡献表示敬意。

种征　大型 *Micromys*，具不很发育的皇冠型齿。颏孔位于齿骨侧面、齿虚背面的下方。M^1 总有 t_7 和 t_{12}，5 齿根。M_1 具小而明显的前中尖，两齿根，唇侧附尖不发育。个

别 M_2 具三齿根。

归入标本 YS50：一不完整下颌，带 M_1-M_2 V8859.4；YS4：9M^1，5M^2，1M^3，8M_1，6M_2 及两支带 M_1 的不完整下颌支（V8861.1-31）；YS57b：2M^1，1M_1(V8858.1-3)；YS97：2M_1(V8860.1-2)；YS90：一破残 M^1(V8862)。

归入标本的层位与时代 高庄组，麻则沟组；早—中上新世。

测 量 数 据

	长度 (Length)					宽度 (Width)			
	范围 Range	均值 X	标准差 S	变异系数 C.V.	标本数 N	范围 Range	均值 X	标准差 S	变异系数 C.V.
M^1	1.67—1.90	1.81	0.066	4	10/13	1.04—1.22	1.13	0.051	4.5
M^2	1.09—1.22	1.16	0.057	5	4/5	1.02—1.10	1.04	0.041	4
M^3		0.86			1/1		0.90		
M_1	1.51—1.71	1.58	0.059	4	12/13	0.86—1.06	0.93	0.049	5
M_2	1.04—1.23	1.12	0.057	5	8/8	0.90—1.01	0.96	0.035	4

描述 种型为一带 M_1-M_2 的下颌前段。颏孔位于齿骨外侧、咬肌脊前端前方。M_1 长，前端窄，其前中尖小但明显，随着牙齿的磨蚀而与舌侧下前边尖相连。舌侧下前边尖与唇侧下前边尖分别向前舌方及前唇方伸展，前者稍位于后者前方并稍大于后者。这对下前边尖与下后尖一下原尖脊连接，组成“X”图形。中脊存在，但不与下后尖一下原尖脊相连。后齿带很发育，卵圆形，位于偏舌侧。C_1 发育，前后向延长；C_2 及 C_3 很小，但明显。M_1 具有两主齿根及一位于唇侧的中央小根。M_2 具一中等大小唇侧下前边尖及一小而低的舌侧下前边尖(该尖在其它 M_2 中通常缺失)。有中脊，但不及 M_1 的发育。C_1 及后齿带的发育程度同 M_1。C_2 和 C_3 融合为唇侧齿带。

在两段采自 YS4 的不完整下颌支上，其颏孔位置较 YS50 的稍靠背面(图 4-2a-b)。

M^1：t_1 不同程度地位于 t_2 的后面，其后刺 (posterior spur) 的发育程度也各有不同。t_3 小于 t_1 和 t_2，紧挨 t_2，但较 t_2 稍靠后。t_3 的后刺缺失(2 例)、弱(5 例)、中等(3 例)或发育(3 例)。t_4 与 t_6 大致处于相当位置或位于 t_6 前方，略较 t_7 大并与其分离，只在标本V8858.2 (YS57) 中 t_4 与 t_7 相连，两尖几乎等大。t_9 略小于或相当于 t_6，随着牙齿的磨蚀，两尖相连。t_{12} 总存在。t_3 与 t_6 之间的谷宽浅。仅少数 M^1 具有 t_0 或前附尖 (prestyle)。具 5 齿根：前齿根、后齿根、两舌侧根和一唇侧根。

M^2：所有 M^2 产自 YS4。长大于宽。t_1 大，为双尖；t_3 较小，侧向延长；两尖均与 t_5 相连。t_4 与 t_6 大致处于相当位置或稍靠后。t_6 显然较 t_9 长，随着牙齿的磨蚀两尖相通。t_7 小于 t_4，并与后者分离；在两例中为脊形。t_{12} 很发育。三例中有两例具有 5 齿根(唇侧三根，舌侧两根)，一例具 6 齿根(后唇侧根双分)。

M^3：仅有的这枚 M^3 磨蚀深。t_1 大，侧向延长，与 t_5 前方相连。无 t_3。t_4，t_5，t_6，t_9 组成一向前凸的脊。t_8 圆，位于齿的后方中央。无 t_7 和 t_{12}。具三齿根。

M_1：前中尖小，但明显。随着牙齿的磨蚀前中尖或与唇侧下前边尖，或舌侧下前边尖，

或与两尖的结合部相连。唇、舌侧下前边尖总与下后尖一下原尖脊相连，组成"X"图形。有中脊，但不与下后尖一下原尖脊相连。后齿带很发育，呈横向延长的卵圆形，位于偏舌侧。C_1 在 11 例中呈前后向延长的齿尖，在另外两例中呈脊状。C_2 融合在"唇侧齿带"中(9 例)或是呈齿带上一小而明显的齿尖(5 例)。C_3 通常为脊形，并与"唇侧齿带"相连；仅在少数标本上呈明显但很小的齿尖。采自 YS57b 地点的时代最早的一枚 M_1 具有两粗壮齿根及一细小的中央齿根，该中央齿根在时代较晚的采自 YS50 及其它地点的 M_1 上渐移向唇侧。

M_2：唇侧下前边尖大，齿带状，突向前方。除正型标本外，舌侧下前边尖通常缺失。C_1 在所有可观察到的标本上都明显。C_3 脊形，并与齿带状的唇侧下前边尖相连。有中脊，但不与下后尖一下原尖脊相连。后齿带很发育，呈横向延长的卵圆形。6 例具有两齿根，其中 4 例的前齿根变宽；一例 (V8861.30, YS4) 具有三齿根(两前齿根，一后齿根)。

讨论 *Micromys tedfordi* 较该属各已知种都大，其最小的个体也大于 Sète (MN15) 的上新世种 *M. praeminutus* (J.Michaux, 1969) 的最大标本。但其它牙齿性状都是 *Micromys* 特有的，因此我们将该种仍归入 *Micromys* 属。它具有一些 *Micromys* 的进步性状：M^1 有 5 齿根，已有个别 M_2 具有三齿根；M^1 的 t_9 小，t_4 与 t_7 分离；M_1 和 M_2 的唇侧附尖弱或呈齿带状。它在下列形态上与 Sète 的 *M. praeminutus* 相似：五齿根的 M^1 和三齿根的 M_2，M_1，M_2 的中脊弱，其唇侧附尖为齿带状。但它所有的 M_1 都具有小而明显的前中尖，且都只有两个齿根；而 *M. praeminutus* 的无前中尖，具三齿根 (Michaux,

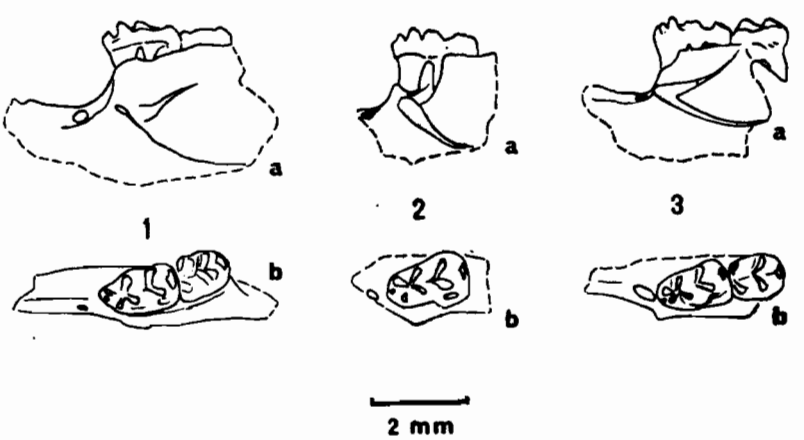


图 4　戴氏巢鼠 (*Micromys tedfordi* sp. nov.) 及近戴氏巢鼠 (*M. aff. tedfordi*) 的下颌，示颏孔位置的变化

Fig. 4　Comparison of *Micromys tedfordi* sp. nov. with *M. aff. tedfordi*, showing the positional change of mental foramena on the lower jaw

1. *M. tedfordi* 左下颌 (left lower jaw) V8859.1, YS50, paratype.
   a. 唇面视 labial view; b. 背面视 dorsal view
2. *M. tedfordi* 左下颌 (left lower jaw) V8861.21, YS4.
   a. 唇面视 labial view; b. 背面视 dorsal view
3. *M. aff. tedfordi* 左下颌 (left lower jaw) V8865, YS6.
   a. 唇面视 labial view; b. 背面视 dorsal view

1969, p.17)。

该种在榆社盆地中不同层位的标本在形态上的差异反映了 *Micromys* 的进化趋势：M_1 的中央小根由中央移向唇侧；齿骨上的颏孔由侧方渐移向齿槽背面（图 4）。榆社盆地的 *Micromys* 共有四个种，关于其它三个种及有关讨论将在专刊中介绍。

姬鼠 *Apodemus* Kaup, 1829

邱氏姬鼠（新种） *Apodemus qiui* sp. nov.

（图 5；图版 II, 1—7）

正型标本 一支带有 M_1-M_2 的左下颌支（V8883.15, M_1 2.00 × 1.15; M_2 1.41 × 1.23）。

副型标本 $5M^1$（2 破残），$1M^2$，$6M_1$（4 破残），$2M_2$（1 破残），V8883.1-14。

模式地点 山西榆社，YS50。

层位与时代 高庄组，南庄沟段；早上新世。

种名由来 对邱占祥教授在中国新第三纪古脊椎动物学和生物地层学方面所作的贡献表示敬意。

种征 中等大小的 *Apodemus*，M^1 三齿根，M^2 四根，颏孔位于咬肌脊前端前下方。

归入标本 YS4：$7M^1$，$1M^2$，$1M^3$，$6M_1$ 及 $2M_2$（V8886.1-17）；YS97：$2M^1$，$1M_2$（V8885.1-3）；YS48：一支带 M_1 的不完整右下颌支（V8884）。

归入标本的层位与时代 高庄组，南庄沟段和醋柳沟段；早上新世。

测 量 数 据

	长度 (Length)					宽度 (Width)			
	范围 Range	均值 X	标准差 S	变异系数 C.V.	标本数 N	范围 Range	均值 X	标准差 S	变异系数 C.V.
M^1	1.84—2.23	2.08	0.143	7	8/14	1.16—1.33	1.29	0.074	6
M^2	1.37—1.41	1.39	0.028	2	2/2	1.24—1.35	1.30	0.078	6
M^3		0.90			1/1		0.98		
M_1	1.76—2.00	1.87	0.077	4	7/8	1.01—1.23	1.11	0.081	7
M_2	1.21—1.41	1.34	0.069	5	6/6	1.14—1.26	1.21	0.043	3.5

描述 正型标本为一带 M_1-M_2 的不完整左下颌支。其水平支深约 3.4mm。颏孔位于咬肌脊前端略靠下（图 5a）。M_1 及 M_2 与归入标本相同，M_1 的 C_1 为卵圆形，C_2 及 C_3 融成齿带状脊。M_2 的 C_1 弱，C_2 与 C_3 与 M_1 的相同。

M^1：t_1 较 t_3 后位，通常具有一与 t_5 相连的、发育程度中等的后刺（两枚牙齿无该刺）。t_3 较 t_2 稍靠后，一般也具有发育程度中等的后刺（但在 V8886.1 上弱，在 V8886.3 很发育）。t_4 与 t_7 在未经及稍经磨蚀的齿上分离，但在磨蚀较深的标本上相连。t_6 与 t_9 紧挨。t_{12} 在所有可观察标本上明显，但不如 t_7 发育。所有 M^1 具三齿根及一细小的中央根。

M^2：t_1 大。t_3 圆，很小。t_4 与 t_7 分离，仅在基部相连。t_{12} 很发育。仅 YS4 的一枚 M^2 具

有齿根，且为四齿根。

M^3：t_1 卵圆形，横向长。t_3 仅保留痕迹。t_4，t_5 和 t_6 组成弯度很大的向前凸的脊。无 t_7，t_9 和 t_{12}。t_8 很大，卵圆形，横向延长。三齿根。

M_1：前中尖很发育，大小不等。经磨蚀后，与舌侧下前边尖，或与舌、唇侧下前边尖的联合部相连，或仍保持孤立。舌侧和唇侧下前边尖大小近乎相等，舌侧下前边尖稍靠前。这对下前边尖总是与下后尖一下原尖脊相连接。中脊偏于舌侧，但从来不与下后尖一下原尖脊相连。C_1 总存在，是最大的唇侧附尖。在 13 例中 C_2 仅在 2 例中的“唇侧齿带”上明显可见，C_3 则在 12 例的 3 例中明显。经磨蚀后 C_1 与下次尖相连。后齿带横向延长并位于偏舌方。两齿根，无明显的中央小齿根。

M_2：唇侧下前边尖总存在；无舌侧下前边尖。中脊有或无，不发育。C_1 明显或仅留有痕迹。C_2 及 C_3 不明显。后齿带卵圆形，两齿根。

张洼沟姬鼠(新种) *Apodemus zhangwagouensis* sp. nov.

(图 5b；图版 II，8，9)

正型标本　带 M_1-M_3 的不完整左下颌支（V8887.5，$M_1$1.89×1.13；$M_2$1.39 × 1.23；M_3 1.13 × 1.07）。

副型标本　$1M^1$，$1M^2$，$1M^3$，$1M_1$（V8887.1-4）；M^1 2.17 × 1.29；M^2 及 M^3 磨蚀深。M_1 1.97 × 1.06。

模式地点　山西榆社，YS87。

层位与时代　麻则沟组；中上新世。

种名由来　“Zhangwagou”，张洼沟之汉语拼音，模式地点 YS87 所在山丘东侧的山沟名。

种征　中等大小。M^1 具三齿根，M^2 四齿根。颏孔位于咬肌脊前端。

归入标本　YS135：带有 M_1-M_2 的一不完整右下颌支（V8882；M_1 1.94 × 1.19；M_2 1.36 × 1.25）。

归入标本的层位与时代　麻则沟组；中上新世。

描述　正型标本的水平下颌支深 3.7mm。颏孔位于咬肌脊前端（图 5b）。牙齿磨蚀深。M_1 的前中尖圆、大，与舌、唇侧下前边尖的联合部连接。这对下前边尖又与下后尖一下原尖脊相连，组成“X”图案。中脊短、位于偏舌侧。C_1 卵圆形，前后向延长；C_2，C_3 融合成齿带状脊。后齿带卵圆形，位于偏舌侧。M_2 的唇侧下前边尖发育，无舌侧下前边尖，唇侧附尖呈齿带状。中脊及后齿带与 M_1 的相同。M_3 的唇侧下前边尖很小、且低；无舌侧下前边尖；下后尖一下原尖脊很发育。后齿脊（posterior chevron）为单叶状，具有一明显的、位于偏舌侧的中脊。

其余归入该种的 M_1 及 M_2（YS87）和右下颌支（YS135，V8882）与正型标本相似，但 M_1（V8887.1）具有明显的 C_2，下颌支上的 M_1（V8882）的前端较宽。

唯一的 M^1 为很发育的皇冠型齿。t_1 与 t_3 相连，t_3 具有很发育的与 t_6 相连的后刺。t_7 很发育，与 t_4 分离。有 t_{12}。M^2 磨蚀深，有 4 齿根。M^3 磨蚀深，且破损；其 t_1 相当大，侧向延伸；t_4，t_5，t_6，t_9，t_8 可能还有 t_7 组成一马蹄形齿脊，与 t_1 相连，具三齿根。

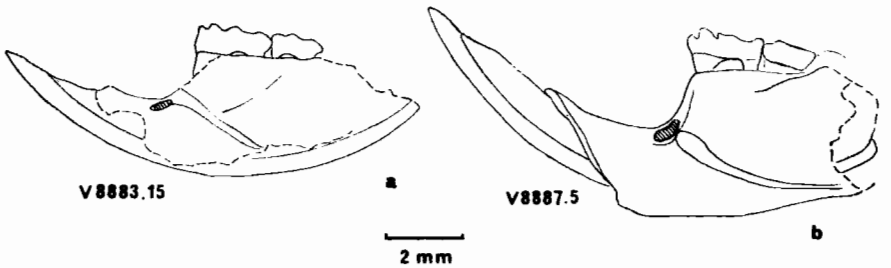


图 5 邱氏姬鼠 (*Apodemus qiui* sp. nov.) 与张洼沟姬鼠 (*A. zhangwagouensis* sp. nov.) 下颌形态比较,示咬肌脊形态及与颏孔的相对位置

Fig. 5 Morphological comparison of lower jaw between *Apodemus qiui* sp. nov. and *A. zhangwagouensis* sp. nov., showing masseteric crest and the position of the mental foramen

a. *A. qiui*, 左下颌 (left lower jaw), V8883.15, YS50; 正型标本 (holotype);
b. *A. zhangwagouensis*, 左下颌 (left lower jaw), V8887.5, YS87; 正型标本 (holotype)

讨论 *Apodemus qiui* 和 *A. zhangwagouensis* 在大小和形态上与产自希腊 Tourkobounia-1 的 *A. dominance* Kretzoi (de Bruijn and Van der Meulen, 1975)一致,但以具有三齿根的 M^1 和四齿根的 M^2 为特征。 *A. dominance* 的 M^1 和 M^2 都是三齿根的。本文前一作者观察了保存在哈佛大学比较动物学博物馆 (MCZ) 内的所有欧亚的 *Apodemus* 的现生种标本 (属于 12 个种的 19 个亚种)。榆社盆地的 *A. qiui* 和 *A. zhangwagouensis* 与产自中国浙江宁波的 *A. agrarius ningpoensis* (MCZ no. 24280),秦岭太白山麓及万县的 *A. a. pallidior* (MCZ no. 23491-23496), 河北东陵的 *A. a.* (near) *mantschuricus* (MCZ no.23487) 最相似。它们与 *A. agrarius* 共有的特征是: 下臼齿的唇侧附尖弱,M^2 具四齿根, M^1 及 M_1 的齿冠较长。但 *A. agrarius* 具有更发育的皇冠型齿: M^1 的 t_1 和 t_3 具有发育的后刺; M_1-M_2 具发育的中脊; M^1 为四根齿; M^3 及 M_3 缩小。

A. zhangwagouensis 与 *A. qiui* 的区别仅在于颏孔位置的差异, 前者的颏孔紧挨咬肌脊前端(图 5)。这一性状与 *A. agrarius* 相同。可能 *A. zhangwagouensis* 和 *A. qiui* 是与 *A. agrarius* 亲缘关系较近,但较为原始的种,而 *A. qiui* 又较 *A. zhangwagouensis* 原始。这两个种与周口店第一地点的 *A. "sylvaticus"* (Young, 1934) 也很不同, 后者的 M^1 很长,几乎为 M^2 和 M^3 的长度之和。

李传夔、郑绍华、邱铸鼎和 L. Jacobs 给我们的研究工作提出过宝贵意见。Guy Musser (美国自然历史博物馆) 和 Maria Rutzmoser (哈佛大学动物学比较博物馆) 为我们提供了珍贵的对比标本。纽约自然历史博物馆 Peling Fong 拍摄电镜照片。 中国科学院古脊椎动物与古人类研究所陈瑄帮助完成了部分插图。作者在此一并表示感谢。最后要特别感谢我们的朋友 William R. Downs, 由于他辛勤的野外和室内工作, 使我们小哺乳动物组的工作得以顺利进行。

(1991 年 1 月 21 日收稿)

参　考　文　献

Bruijn, H. de and A. J. Van de Meulen, 1975: The early Pleistocene rodents from Tourkobounia (Athens, Greece). *I. Kon. ned. Akad. Wetensch. Proc.*, Ser. B, **78**(4): 314—327.

Jacobs, L. L. and Li, Chuankuei, 1982: A new genus (*Chardinomys*) of murid rodent (Mammalia, Rodentia) from the Neogene of China, and comments on its biogeography. *Geobios*, **15**(2), 255—259.

Kretzoi, M., 1959: Insectivoren, Nagetiere und Lagomorphen der jüngstpliozänen Fauna von Csárnota im Villanyer Gebirge (Südungarn). *Vert. Hungarica*, **1**(2), 237—246.

Michaux, J., 1964: Muridae (Rodentia) du Pliocéne supérieur d'Espagne et du Midi de la France. *Palaeovertebrata*, 3, 1—25.

Storch, G., 1987: The Neogene mammalian faunas of Ertemte and Harr Obo in Inner Mongolia (Nei Mongol), China.——7. Muridae (Rodentia). *Senckenbergiana lethaea*, **68**(5/6), 401—431.

Tedford, R. H., Qiu, Z. X. and L. J. Flynn, 1988: Second year progress report.——Collaborative research: Neogene rocks and faunas, Yushe, Shanxi Province, People's Republic of China. 1—20.

Young, C. C., 1934: On the Insectivora, Chiroptera, Rodentia and Primates other than *Sinanthropus* from Locality 1 at Choukoutien. *Palaeontologia Sinica*, Ser. C, **8**(3), 1—160.

NEW MURID RODENTS FROM THE LATE CENOZOIC OF YUSHE BASIN, SHANXI

Wu Wenyu

(Institute of Vertebrate Paleontology and Paleoanthropology, Academia Sinica)

Lawrence J. Flynn

(Research Associate, American Museum of Natural History, NY, and Peabody Museum, Harvard University)

Key words Yushe Basin; Late cenozoic; murids; new taxa

Summary

As scientific collaborators of the Chinese-American joint project "Neogene Rocks and Faunas, Yushe Basin, Shanxi, PRC", the present authors, with William R. Downs, Northern Arizona University, sampled the Yushe microfauna in the fall of 1987 and 1988. The fossil remains were retrieved by surface collection and by wet-sieving bulk quantities of sediment.

As one set of results from this project, following is a description of new taxa (one genus and five species) of murid rodents, including 164 specimens, of which most are isolated teeth. A more comprehensive report including all material collected will be published later. There has been little previous work on Yushe Muridae, with the notable exception of a paper on the murid *Chardinomys yusheensis* (Jacobs and Li, 1982) that bad been collected by an IVPP reconnaissance team in 1955 (our site YS57). This is the first time that substantial samples from many sites in Yushe Basin have been recovered from the Late Miocene to Pleistocene sequence of deposits.

Herein we follow Storch (1987) on murid dental terminology. Specimens were measured (in mm) on a Wild M7A Stereomicroscope and photomicrographs were prepared with a Zeiss Digital Scanning Microscope 950 at 5KV under low magnification. The micromammal sites

and murid biostratigraphy concerned are shown in fig. 1.

Systematics

Family Muridae Gray 1821

Huaxiamys gen. nov.

Type species *Huaxiamys downsi* sp. nov.

Included species *Huaxiamys downsi* sp. nov., *Huaxiamys primitivus* sp. nov.

Stratigraphic and geographic range Localities YS32,YS3, Mahui Formation; YS60, YS50, YS97 and YS4, Gaozhuang Formation.

Age Late Miocene through early Pliocene.

Derivatio nominis "Huaxia", Chinese Pinyin, an ancient name for China.

Diagnosis Small murid with developed stephanodonty. All cusps strongly inclined. t\2 of M\1 projecting far forward. t/3 shifted backward, making wide valley between t/2 and t/3. t/2 connected with t/1, forming an anterolabial-posterolingually directed ridge. t/7 absent. t/ma of M/1 reduced or absent, connected to lingual anteroconid with wear, when present. Lingual anteroconid more or less anterolabial-posterolingually swollen and more forward protruding than labial anteroconid. Paired anteroconid connected with paired metaconid-protoconid, forming an asymmetrical "x" pattern. Medial ridge present but not fully developed. Labial accessory cuspids reduced. Three roots present on M\1, four roots on M/2 and two or three roots on M/1 and M/2.

Huaxiamys downsi sp. nov.

(Pl. I, 8—15; fig. 3)

Holotype M\1 sin (V8855.7); 1.88×1.00.

Paratypes 20M\1,3M\2,2M\3,14M\1,7M\2,4M\3, 5 fragmentary lower jaws with M\1 or M\1-2 (V8855.1—6, V8855.8—57).

Type locality YS4, Yushe County.

Stratum typicum Gaozhuang Formation, Culiugou Member.

Age Early Pliocene.

Derivatio nominis In honor of Mr. William R. Downs who made great contributions to the Sino-American joint project.

Diagnosis *Huaxiamys* with advanced characters: t/2 of M\1 narrows sharply anteriorly. t/3, t/6 more backward shifted than in *H. primitivus,* increasing stephanodonty. t/12 absent. t/ma of M/1, labial accessory cuspids and CP on M/1, M/2 reduced to a cingulum-like ridge. Two or three roots on M/1 and M/2.

Referred material 2M\1, 1M/1 (B8854.1—3) from YS97; M\1 (partly broken),3M/2 (1 partly broken), 5M/1 (4 partly broken), 2M/2(V8853.1—11) from YS50.

Age and horizons of refersed material Early Pliocene. Gaozhuang Formation, Nanzhuanggou and Culiugou Members.

Measurements see Chinese text.

Description M\1 strongly stephanodont in tooth pattern, all cusps strongly inclined. The t/2 projects far forward, narrowing sharplp. The t/2 and t/1 are anterolabial-posterolingually elongated and connected with each other, forming an anterolabial-posterolingual ly directed crest. In some specimens, this crest extends beyond t/2 on to the labial cingulum. The t/3 is posterolabial to t/2 and connected to the latter by a very thin ridge, and between

them is a wide and deep valley except one tooth(V8855.15), in which the labial cusps: t/3, t/6, t/9 are not much backward shifted. The valley itself is dammed by a more or less leveloped labial cingulum. The t/4, t/5, t/6, t/9, t/8 connect to one another, forming a ring. The t/3 is in alignment with t/4 and t/5 but separated from them. The latter form a crest parallel to the t/1-t/2 crest. The t/3, t/6 and t/9 are about equal in size, being situatel on the labial margin and slightly smaller than the other cusps. The t/9 is connected to the lingual end of t/8 with a ridge. The t/7 and t/12 are absent. Three main roots, the front one protruding anteriorly, and a small central rootlet are present.

M\2 Rounded square in shape. The t/1 is large, anteroposteriorly extended, then turning labially to connect with t/5 on its anterolingual side. The t/3 is very small. The t/4, t/5, t/6, t/9, t/8 are connected with one another, forming a ring. The t/9 is reduced. The t/4 is subequal to or somewhat bigger than t/1. The t/7 and t/12 are absent. Four-rooted, occasionally with an extra tiny central rootlet.

M\3 Rounded triangle in shape. The t/1 is big, round and isolated. The t/3 is absent. The t/5 is labially situated. The t/9 is tiny or absent. The t/8 is round, posteromedially situated. One posterior root and two anterior roots that split distally.

M/1 The t/ma is tiny or absent (on most specimens), usually situated far below the occlusal surface. The lingual anteroconid is more or less anterolabial-posterolingually swollen and more forward protruding than the labial one which is anterolabially extended. The t/ma is connected to the lingual anteroconid with wear. The paired anteroconids connect with paired metaconid-protoconid chevron, forming an asymmetrical "x" pattern. The medial ridge is always present, but incomplete. The CP is transversely elongated and nearly ridge-like, as long as about half of the tooth width. On one M/1 from YS50, the CP is obviously oval. The labial accessory cuspids are reduced to a cingulum-like ridge, but on 4 specimens a trace of C/1 or C/3 is still visible. Two-rooted (11 cases) or 3-rooted (6 cases) for the YS4 assemblage. Two of the 11 2-rooted teeth possess a wide and grooved posterior root. Both of the observed teeth from YS50 are 2-rooted, one of them with a broad and grooved posterior root.

M/2 Rounded rectangle in shape. The labial anteroconid is a cingulum-like ridge. The medial ridge is present but not fully developed. The labial accessory cuspids are submerged into a cingulum-like ridge, which connects anteriorly with the cingulum-like labial anteroconid and extends posteriorly to the base of hypoconid (anterior or labial). The transverse CP is elongated (3 cases) or ridge-like (4 cases). Both M/2 from YS50 possess distinct oval-shaped CP. Two-rooted (4 specimens, one with broadened posterior root and one with grooved posterior root) or 3-rooted (6 specimens).

M/3 The labial anteroconid is absent or strongly reduced. The metaconid and protoconid are distinguishable. The hypoconid is absent or reduced. Two-rooted.

Huaxiamys primitivus sp. nov.

(figs. 2,3; Pl. I, 16—19)

Holotype M\1 dex (V8850.1); 1.72×1.00.
Paratype M/2 sin (V8850.5); 0.90×0.80.
Type locality YS32, Yushe County.
Stratum typicum Mahui Formation.
Age Late Miocene.
Derivatio nominis This is the most primitive known species of the genus.

Diagnosis Species with primitive features: less stephanodont, t/3 of M\1 less posteriorly situated, t/2 less narrow anteriorly, t/12 present on M\1; t/ma and accessory cuspids on M/1 and M/2 less reduced than in *H. downsi* sp. nov. CP on lower molars oval-shaped. M/1 and M/2 2-rooted.

Referred material one right lower jaw with M/1-M/2(V8852) from YS60; 3M/1 (one broken), 1M/2 (V8851.1—4) from YS3; one M\1 (broken), 1M\2 (broken), 1M/1 (V8850.2—4) from YS32.

Age and horizons of referred material Late Miocene; Mahui Formation and lower part of Taoyang Member, Gaozhuang Formation.

Measurements see Chinese text.

Description M\1 (holotype): The t/2 protrudes forward but does not narrow quickly. The t/3 is situated close to t/2. As a result the valley between t/2 and t/3 is narrower than that between t/3 and t/6. The posterior border of t/3 is situated at about the same level as the anterior border of t/5. The t/1 and t/2 are connected with each other and anterolabial-posterolingually extended, forming an anterolabial-posterolingually directed ridge parallel to the t/4-t/5 ridge. The t/12 is present.

M\2 The only M\2 is broken, but shows a well developed t/3. The posterior border of t/6 is at about the same level as (or slightly posterior to) the anterior border of t/8. 4-rooted.

M/1 The t/ma on the 4 observable teeth is small but distinct. The lingual anteroconid protrudes anterolingually but anterolabial-posterolingually swollen, while the labial anteroconid is anterolabially extended. The lingual anteroconid is more forwardly situated than the labial one. The t/ma becomes connected to the lingual anteroconid with wear. The paired anteroconids are connected to the paired metaconid-protoconid chevron, forming an asymmetrical "x" pattern. The medial ridge is present. The CP is oval-shaped. The labial accessory cuspids are more developed than in *H. downsi*, C/1 is always present as a small round cuspid, C/2 is present (3 out of 4 cases) or cingulum-like (one case). C/3 is tiny or a cingulum-like ridge. Both observable teeth are 2-rooted.

M/2 The labial anteroconid protrudes anterolabially as a cusp. The medial ridge is present. The oval CP is labial-lingually elongated, but less than in *H. downsi*. The labial accessory C/1 and C/3 are reduced but still distinct in 2 out of 3 cases, reduced to a cingulum-like ridge in the other. Both observed teeth are 2-rooted.

Comparisons *Huaxiamys* is obviously a derived genus, though it shares some characters with *Mus*: small size, anteriorly protruding front wall of t/2 on M\1, well developed and forward positioned lingual anteroconid. Its main diagnostic features are as follows: Low-crowned stephanodont molars with cusps strongly posteriorly tilted. The t/3 of M\1 is positioned well posteriorly relative to t/2 and t/1,forming a wide valley between t/2 and t/3. Most M/1 possess t/ma; labially, all M/1 and M/2 possess accessory cuspids or a cingulum-like ridge. In contrast, *Mus* possesses high-crowned, non-stephanodont molars with steep cusps. The t/3 is very close to t/2 on M\1 and the valley between them is very narrow. On all M/1 the t/ma is absent and the lingual anteroconid is heavily developed, protruding far forward. No accessory labial cuspids or cingulum-like ridge are present on lower molars .

Huaxiamys appears from late Miocene through early Pliocene in Yushe Basin. During this period (5.5 to 4.0Ma) two successive species show apparent evolutionary trends and can be easily distinguished from each other (see fig.2 and pl. I, 8—19).

Trends in upper molars: (i) the t/2 of M\1 protrudes forward, and narrows anteriorly;

(ii) the valley between t/2 and t/3 becomes wider with the labial cusps (t/3, t/6 and t/9) shifted backward and reduced in size; (iii) the t/12 of M\1 disappears; (iv) stephanodonty increases.

Trends in lower molars: (i) the t/ma of M/1 gets smaller or disappears; (ii) the labial accessory cuspids shrink and submerge into a cingulum-like ridge; (iii) the oval-shaped CP becomes transversely elongated or even a cingulum-like ridge; (iv) the number of roots increases.

The differential diagnosis for these two species:

Huaxiamys primitivus	*Huaxiamys downsi*
Upper molars	
(i) t/2 on M\1 not obviously narrow	tapers strongly forward
(ii) narrow t/2-t/3 valley; t/3, t/6, t/9 less shifted	wide valley; labial cusps shifted posteriorly
(iii) t/12 present (in the only tooth)	absent
(iv) less stephanodont	more stephanodont
Lower molars	
(i) t/ma of M/1 small	t/ma reduced or absent
(ii) labial accessory cuspids distinct	reduced to cingulum-like ridge
(iii) CP oval-shaped	usually reduced to cingulum-like ridge
(iv) M/1-M/2 2-rooted	2 or 3-rooted

Of course, only with a large sample is the species identification reliable because of the great variation within a population and the mosaic combination of primitive and progressive features in individuals. *H. primitivus* is based on a small sample, but its validity is supported by reference to the good sample of *H. downsi*.

Biostratigraphy *Hauxiamys primitivus* occurs in localities YS32, YS3 and YS60 in the Mahui Formation and lower Gaozhuang Formation (Taoyang Member); late Miocene in age. *H. downsi* occurs in localities YS50, YS97 and YS4 in middle and upper Gaozhuang Formation (Nanzhuanggou Member and Culiugou Member); early Pliocene in age. There exists a gap of approximately 1 m.y. between the last record of *H. primitivus* and first record of *H. downsi*. The mode of transformation for these species might be recorded in the sediments between YS60 and YS50.

Micromys Dehne 1841

Micromys tedfordi sp. nov.

(Pl. I, 1—7)

Holotype A left lower jaw with M/1-M/2 (V8859.3; M/1 1.56×0.96; M/2 1.14×1.00).

Paratypes M\1 sin (V8859.1, 1.67×1.09); M/2dex (V8859.2, 1.09×0.94).

Type locality YS50, Yushe County.

Stratum typicum Middle Gaozhuang Formation, Nanzhuanggou Member.

Age Early Pliocene.

Derivatio nominis In honor of Dr. R. H. Tedford for his leadership in the study of late Cenozoic vertebrate evolution and in particular for his work on the stratigraphy and vertebrate paleontology of Yushe Basin.

Diagnosis *Micromys* of large size with slightly weak stephanodonty and with the mental foramen located laterally on the dentary, below the dorsal crest of the diastema.M\1 always with t/7 and t/12, and 5-rooted; M/1 with small but distinct t/ma, undeveloped labial accessory cuspids, 2-rooted; M/2 occasionally 3-rooted.

Referred material A fragmentary lower jaw with M/1-M/2(V8859.4) from YS50; 9M\1,5M\2,1M\3,8M/1, 6M/2, and 2 fragmentary lower jaws with M/1 (V8861.1—31) from YS4;2M\1,1M\1 (V8858.1—3) from YS57b; 2M/1 (V8860.1—2) from YS97; 1 M\1 (broken, V8862) from YS90.

Age and horizons of referred material Early to middle Pliocene, Gaozhuang and Mazegou Formations.

Measurements see Chinese text.

Description The holotype is the frontpart of a lower jaw with M/1-M/2. The mental foramen is situatel on the external side of the jaw and anterior to the end of the masseteric crest. The M/1 is long and narrow anteriorly. The t/ma is small but distinct, and connected to the lingual anteroconid with wear. The lingual and labial anteroconids are extended anterolingually and anterolabially respectively, but the former protrudes a bit more forwards and is slightly larger than the latter. The paired anteroconids connect to the paired metaconid-protoconid, forming an "x"-shaped pattern. The medial ridge is present but not connected to the metaconid-protoconid chevron The well-developed CP is laterally elongated and lingually situated. The C/1 is well-developed and anteroposteriorly extended; C/2 and C/3 are very small but distinct. The M/1 has 2 main roots and a small central root on the labial side. The M/2 of the holotype possesses a moderate sized labial anteroconid and a small and low lingual anteroconid (which is usually absent on most M/2). The medial ridge is present but less developed than on M/1. The C/1 and CP are as developed as on M/1. The C/2 and C/3 are fused into the labial cingulum.

On the two fragmentary lower jaws from YS4 the mental foramen is somewhat more dorsally situated than in those from YS50 (fig. 4—2a,b).

M\1 The sample shows variation in posterior placement of t/1 with respect to t/2, and variation in development of a posterior spur from t/1. The t/3 is set close to and somewhat posterior to t/2. It is the smallest cusp of the three. The posterior spur on t/3 is absent (2 of 13 cases), weak (5), moderate (3) or strong (3). The t/4 is at about the same level as t/6 or posterior to the latter, always larger than t/7 and well separated from the latter except in one specimen (V8858.2 from YS57) whose t/7 is connected to and is almost as big as t/4. The t/9 is obviously smaller than t/6 and confluent with the latter with wear. The t/12 is always present. The valley between t/3 and t/6 is shallow and wide. Few teeth possess a minute t/0 or a prestyle. 5-rooted.

M\2 All specimens come from YS4. The tooth is longer than wide. The t/1 is twinned and large, the t/3 is smaller and laterally elongated, and both join t/5. The t/4 is at about the same level as t/6 or a bit posterior to t/6. The t/6 is distinctly longer than t/9 and connected to the latter with wear. The t/7 is smaller than t/4 and separated from the latter, it is ridge-like in 2 cases. The t/12 is well developed. Two of 3 observable teeth possess 5 roots (3 labial, 2 lingual), another tooth has 6 roots (the posterolabial root being split).

M\3 The only specimen is well-worn and demonstrates a large and laterally elongated t/1 connected anteriorly to the t/5. The t/3 is absent. The t/4, t/5, t/6, and t/9 form an anteriorly convex ridge. The t/8 is round and posteromedially situated. The t/7 and t/12 are absent.

There are 3 roots (two anterior and one posterior).

M/1 The t/ma is small but always distinct. With wear it joins either the labial or lingual anteroconid, or their junction. The paired anteroconids always connect paired metaconid-protoconid, forming an "x"-shaped pattern. The medial ridge is present, but not connected with the metaconid-protoconid chevron. The CP is well-developed, laterally elongated and lingually situated. The C/1 is anteroposteriorly extended on 11 out of 13 observable teeth and ridge-like on the remainder. The C/2 fuses into the labial cingulum (9 cases) or remains a distinct but small cuspid on the cingulum (5 cases). The C/3 is usually ridge-like and continuous with the labial cingulum, or a distinct but very small cusp on few specimens. One tooth from the oldest site (YS57b) possesses two strong roots with a tiny central rootlet. This rootlet is more labial on the specimen from YS50 and younger localities.

M/2 The labial anteroconid is large, cingulum-like, and projects anteriorly. The lingual anteroconid is usually absent. It is present only on one tooth (on the lower jaw from YS50, V8859.3), where it is situated very low. The C/1 is distinct on all observable teeth. The C/3 is ridge-like and continues the cingulum-like labial anteroconid. The medial ridge is present but not connected to the metaconid-protoconid chevron. The CP is well-developed and laterally elongated. Six out of 7 teeth are 2-rooted, including 4 teeth with their anterior root enlarged, one tooth is 3-rooted (2 anterior roots, V8861.30 from YS4).

Discussion we assign this form to *Micromys* without hesitation although it is large in size. It possesses the dental features characteristic for *Micromys* (see diagnosis). However our form shows several advanced features for *Micromys*: M\1 is 5-rooted, occurrence of 3- rooted M/2; smaller t/9 and well separated t/4 and t/7 on M\1; reduced or cingulum-like labial accessory cuspids on M/1-M/2.

Micromys tedfordi is larger than all other species of the genus. Even the smallest individual is larger than the biggest specimen of Pliocene *Micromys praeminutus* Kretzoi from Sète (J. Michaux, 1969). Morphologically it is similar to *M. praeminutus* in having 5-rooted M\1, 3-rooted M/2 and in having a weak medi l ridge and cingulum-like labial accessory cuspids on M/1-M/2, while different from it in having small but obvious t/ma and 2 roots on M/1 (*M. praeminutus* from Séte possesses no t/ma and 3 roots on M/1).

Some morphological differences among specimens of this species from various horizons in Yushe Basin may indicate evolutionary trends within *Micromys*: Central rootlet on M/1 shifts progressively from central to labial; the mental foramen on lower jaw moves from labial side on to dorsal surface of diastema (see fig.4).

Apodemus Kaup 1829

Apodemus qiui sp. nov.

(fig. 5; Pl. II, 1—7)

Holotype A left lower jaw with M/1-M/2 (V8883.15, M/1 2.00×1.15, M/2 1.41×1.23).

Paratypes 5M\1(2 broken), M\2, 6 M/1 (4 broken), 2 M/2 (1 broken) (V8883.1—14).

Type locality YS50, Yushe County.

Stratum typicum Nanzhuanggou Member, middle Gaozhuang Formation.

Age Early Pliocene.

Derivatio nominis In honor of Dr. Qiu Zhanxiang for his great contributions to the Neogene biostratigraphy and vertebrate paleontology of China, and for bringing the Yushe project to fruition.

Diagnosis Medium-sized *Apodemus* with 3-rooted M\1, 4-rooted M\2, mental foramen situated anterior to and below the front end of masseteric crest.

Referred material 7M\1, 1M\2, 1M\3, 6M/1 and 2M/2 (V8886.1—17) from YS4; 2M\1 1M/2 (V8885.1—3) from YS97; a fragmentary right lower jaw with M/1 (V8884) from YS48.

Age and horizons of referred material Early Pliocene: Nanzhuanggou and Culiugou Members, Gaozhuang Formation.

Measurements see Chinese text.

Description The holotype of *Apodemus qiui* is a fragmentary left lower jaw with M/1 and M/2. The horizontal ramus is shallower (about 3.4mm) than that of *A. zhangwagouensis*. The mental foramen is situated just anterior to and a little below the front end of the masseteric crest. The M/1 and M/2 resemble the referred specimens. An oval C/1 is present on M/1 and C/2 and C/3 are submerged into a cingulum ridge. On M/2 C/1 is reduced, C/2 and C/3 are as on M/1.

M\1 The t/1 is situated posterior to the t/3, usually with a moderately developed posterior spur connected to t/5 (absent in 2 teeth). The t/3 is slightly posterior to t/2, usually also with a moderately developed posterior spur (weak in V8886.1, well developed in V8886.3). The t/4 and t/7 are separated in unworn or moderately worn teeth but connected in well-worn teeth. The t/6 and t/9 are closely situated. The t/12 is distinct in all observable teeth, but not as developed as t/7. All M\1 are 3-rooted with a minute central rootlet.

M\2 The t/1 is large. The t/3 is round but very small. The t/4 and t/7 are well separated but connected at their base. The t/12 is well developed. One tooth from YS4 shows 4 roots.

M\3 The oval t/1 is large and laterally extended. The t/3 is vestigial. The t/4, t/5 and t/6 form a strong anteriorly convex ridge. The t/7, t/9 and t/12 are absent. The oval t/8 is very large and laterally extended. 3-rooted.

M/1 The strong t/ma is small to large, isolated or with wear joining either the lingual anteroconid or the junction between anteroconids. The lingual and labial anteroconids are nearly the same size, the lingual one a bit more anteriorly situated. The paired anteroconids are always connected to the paired metaconid-protoconid. The medial ridge is present, lingually positioned and never reaches the metaconid-protoconid chevron. The C/1 is present in all observable specimens and is the largest labial accessory cuspid. On the labial cingulum the C/2 is distinct in 2 out of 13 cases; C/3 is distinct in 3 of 12. The C/1 joins the hypoconid with wear. The CP is laterally elongated and lingually situated. 2-rooted with no distinct central rootlet.

M/2 The labial anteroconid is always present; the lingual one is absent. The medial ridge is present or absent but never developed. The C/1 is distinct or vestigial; the C/2 and C/3 are indistinct. As in the M/1, CP is an elongated oval. 2-rooted.

Apodemus zhangwagouensis sp. nov.

(fig. 5b; Pl. II, 8,9)

Holotype A fragmentary left lower jaw with M/1-M/3 (V8887.5. M/1 1.89×1.13; M/2 1.39×1.23; M/3 1.13×1.07).

Paratypes 1M\1, 1M\2, 1M\3, 1M/1 (V8887.1—4). M\1 2.17×1.29, M\2 and M\3 very worn, M/1 1.97×1.06.

Type locality YS87, Yushe County.

Stratum typicum Mazegou Formation.

Age Middle Pliocene.

Derivatio nominis After the name of the valley to the east of the hill where the type locality YS87 is situated.

Diagnosis Medium-sized *Apodemus* with 3-rooted M\1 and 4-rooted M\2, and mental foramen close to front end of masseteric crest.

Referred material A fragmentary right lower jaw with M/1-M/2 (V8882 M/1 1.94×1.19; M/2 1.36×1.25) from YS135.

Age and horizon of referred materal Middle Pliocene, Mazegou Formation

Description The holotype is a fragmentary left lower jaw, with horizontal ramus 3.7mm in depth, slightly deeper than in *A. qiui;* the mental foramen is situated just anterior to the front end of the masseteric crest. The teeth are well-worn. M/1: the t/ma is round and developed, connected with the junction of the paired anteroconids which is in turn connected with the paired metaconid-protoconid chevron, forming an "x" pattern. The medial ridge is short, lingually situated. The oval C/1 is elongated anteroposteriorly; C/2 and C/3 are submerged in a labial cingulum-like ridge. The oval CP is lingually located. The labial anteroconid is developed, the lingual one absent, and labial cuspids are cingulum-like on M/2. The medial ridge and CP are as on M/1. The M/3 labial anteroconid is very small and low, the lingual one is absent. The metaconid-protoconid chevron is well developed. The posterior chevron is single-lobed with a distinct, lingually situated medial ridge.

The other specimens of M/1 and M/2 show similar features to the holotype, but one M/1 (V8887.1) possesses a cuspate C/2 and the M/1 on the lower jaw from YS135 (V8882) is wide anteriorly.

The single M\1 is strongly stephanodont. The t/1 is connected to t/5, the t/3 possesses a well-developed posterior spur connected with t/6. The t/7 is well-developed and separated from t/4. The t/12 is present. The M\2 is well worn and 4-rooted. The M\3 is well-worn and broken; its t/1 is quite large, laterally extended. t/4, t/5, t/6, t/9, t/8 and possibly a t/7 make a horseshoe connected with t/1. 3-rooted.

Discussion Both *A. qiui* from the upper part of Gaozhuang Formation and *A. zhangwagouensis* from the Mazegou Formation are identical to *A. dominance* Kretzoi from Tourkobounia-1 (Greece; de Bruijn and Van de Meulen, 1975) in size, but are characterized by their 3-rooted M\1 and 4-rooted M\2. So far as we know *A. dominance* possesses 3 roots on both M\1 and M\2. The senior author observed all specimens of Eurasian *Apodemus* stored in the Museum of comparative Zoology, Harvard University (12 species, 19 subspecies). *A. qiui* and *A. zhangwagouensis* are most similar to living Chinese *A. agrarius ningpoensis* (MCZ no. (24280) from Ningpo, *A. agrarius pallidior* (MCZ no. 23491—23496) from base of Taibai Shan, Qinling Mts, and Wan Xian, and *A. agrarius* (near) *mantschuricus* (MCZ no. 23487) from "Chili, East Tombs". The features they share with *A. agrarius* are weakly developed accessory labial cuspids on lower teeth, the 4-rooted M\2 and the long crowned M\1 and M/1. However *A. agrarius* is apparently derived in greater stephanodonty with a stronger posterior spur on t/1 and t/3 of M\1, well developed medial ridge on M/1-M/2, 4-rooted M\1 and more reduced M\3 and M/3.

Apodemus zhangwagouensis differs from *A. qiui* in having the mental foramen close to the front end of the masseteric crest (fig. 5), which are features shared with *A. agrarius* (the slightly deeper lower jaw maybe related to individual age). It is suggested that *A. qiui* and *A.*

zhangwagouensis are closely related to *A. agrarius*, and that *A. qiui* is more primitive than *A. zhangwagouensis*.

Our new species are also quite different from *Apodemus sylvaticus* from Choukoutien (Young, 1934). The latter is characterized by a very long M\1, approximately equal in length to M\2+M\3.

Acknowledgements We express our g atitude to the Academia Sinica and National Science Foundation without whose support our project could not have been accomplished. The encouragement and guidance of Qiu Zhanxiang and Richard H. Tedford were the underlying forces that brought success to our work. Neil Opdyke kindly permitted use of unpublished magnetic work. Of course, Will Downs brought the micromammal effort to fruition. Li Chuankui, Qiu Zhuding, Zheng Shaohua, and Louis Jacobs provided valuable counsel and information. We thank all members of the Yushe field parties, and the people of Yushe. Guy Musser (AMNH) and Maria Rutzmoser (MCZ) kindly made mammalian comparative material available. Peling Fong of the American Museum of Natural History skillfully prepared the photomicrographs. Chen Yan of the Institute of Vertebrate Paleontology and Paleoanthropology helped prepare part of figures.

图 版 I 说 明

(all about × 18)

戴氏巢鼠(新种) *Micromys tedfordi* sp. nov.

1.左下颌带 M_1-M_2 (left lower jaw with M_1-M_2) V8859.3, YS50 正型标本 holotype; 2.左 M^1(M^1sin) V8861.8, YS4; 3.右 M^1(M^1 dex) V8861.7, YS4; 4.左 M^1(M^1 sin) V8858.1, YS57b; 5.右 M^2(M^2 dex) V8861.11, YS4; 6.左 M_1(M_1sin) V8858.3, YS57b; 7.右 M_1 (M_1dex) V8861.23, YS4

唐氏华夏鼠(新属新种) *Huaxiamys downsi* gen. et sp. nov.

8.左 M^1 (M^1 sin) V8855.7, YS4 正型标本 holotype; 9.右 M^1 (M^1 dex) V8855.13, YS4 副型标本 paratype; 10.左 M^2 (M^2 sin) V8855.22, YS4 副型标本 paratype; 11.右 M^3 (M^3 dex) V8825.25, YS4 副型标本 paratype; 12.左 M_1 (M_1 sin) V8855.28, YS4 副型标本 paratype; 13.右 M_1(M_1dex) V8855.35, YS4 副型标本 paratype; 14.右 M_1 (M_1 dex) V8855.36, YS4 副型标本 paratype; 15.左 M_2(M_2 sin) V8855.47, YS4 副型标本 paratype

原始华夏鼠(新属新种) *Huaxiamys primitivus* gen. et sp. nov.

16.右 M^1(M^1 dex) V8850.1, YS32 正型标本 holotype; 17.左 M_1(M_1sin) V8851.1, YS3; 18.左 M_1(M_1sin) V8851.2, YS3; 19.左 M_2(M_2sin) V8850.5, YS32 副型标本 paratype

图 版 II 说 明

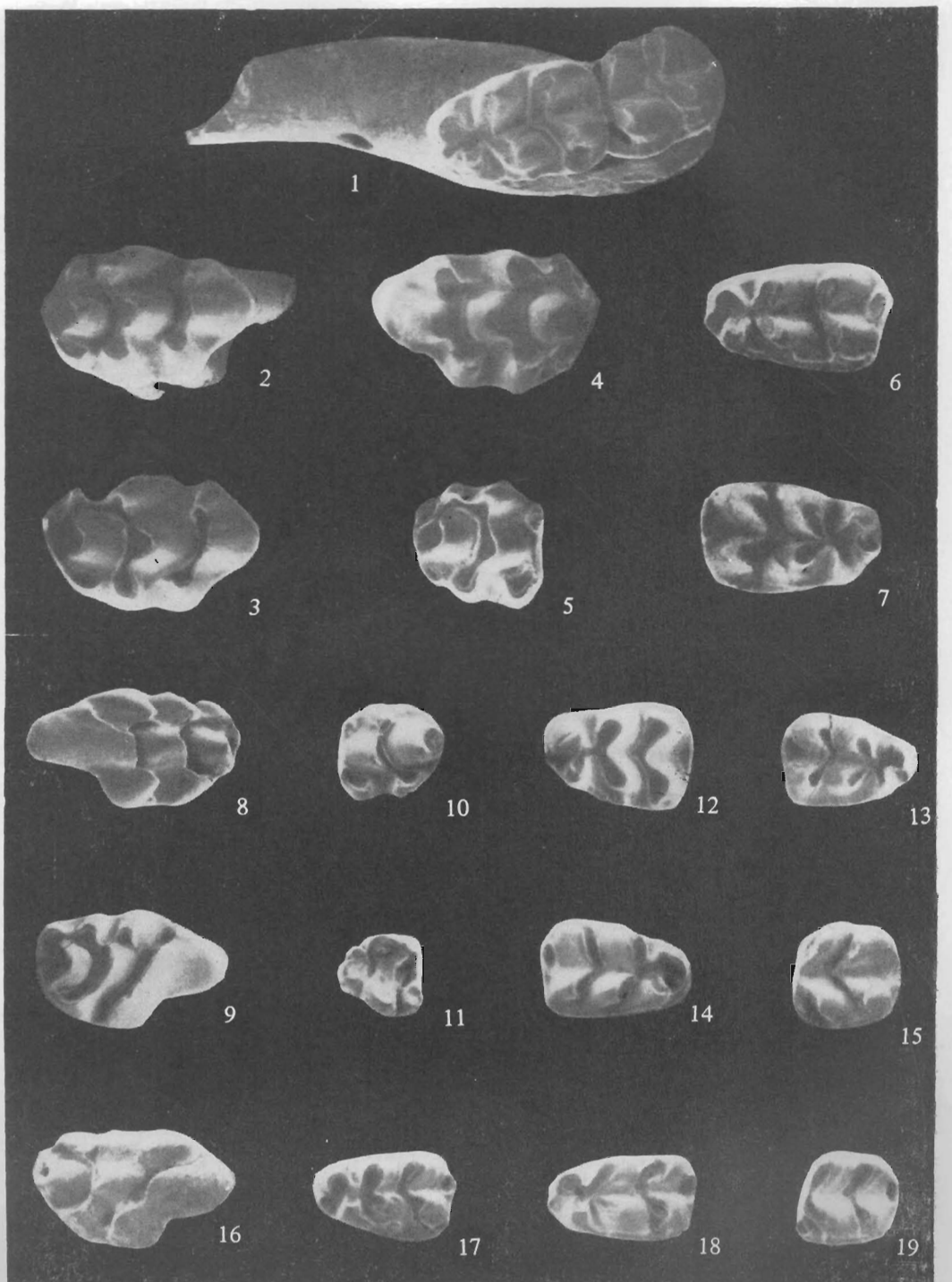
(除注明者外,均约×18)

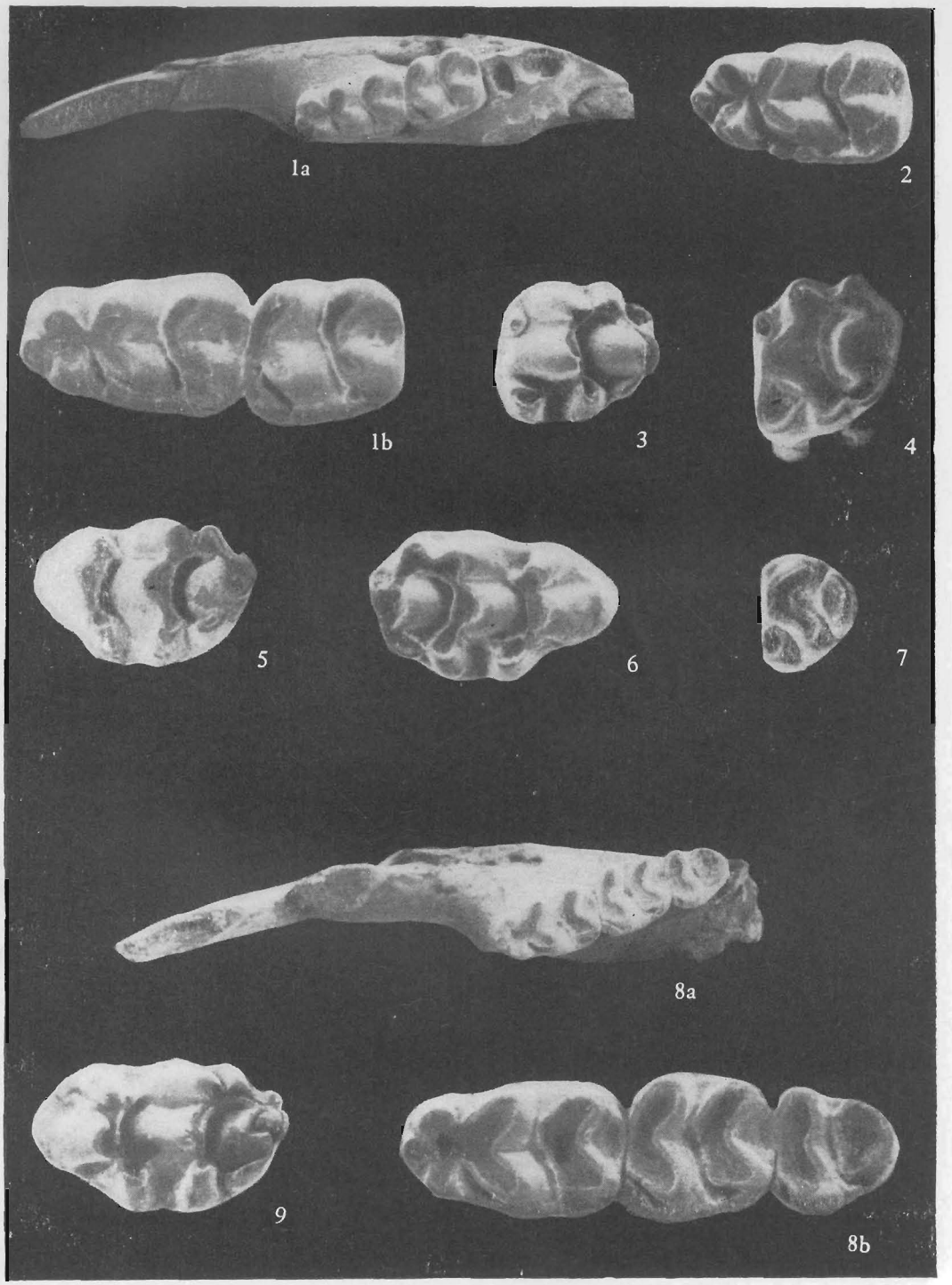
邱氏姬鼠(新种) *Apodemus qiui* sp. nov.

1.左下颌带 M_1-M_2 (left lower jaw with M_1-M_2) V8883. 15, YS50 正型标本 holotype, 1a. ×9; 2.左 M_1(M_1 sin) V8886. 10, YS4; 3.左 M^2 (M^2sin) V8883. 6, YS50 副型标本 paratype; 4.左 M^2(M^2sin) V8886. 8, YS4; 5.左 M^1(M^1sin) V8886. 1, YS4; 6.右 M^1 (M^1 dex) V8883.4, YS50 副型标本 paratype; 7.左 M^3(M^3sin) V8886.9, YS4

张洼沟姬鼠(新种) *Apodemus zhangwagouensis* sp. nov.

8.左下颌带 M_1-M_3 (left lower jaw with M_1-M_3) V8887. 5, YS87 正型标本 holotype, 8a.×9; 9.左 M^1(M^1sin) V8887.1, YS87 副型标本 paratype


1
2
4
6
3
5
7
8
10
12
13
9
11
14
15
16
17
18
19


1a
2
1b
3
4
5
6
7
8a
9
8b