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内蒙古二连浩特呼尔井组的大哺乳动物化石[1)]

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摘要:记述了近年来采自二连浩特附近呼尔井组中的大哺乳动物化石:*Hyaenodon* sp., *Metatitan* sp., *Aprotodon lanzhouensis*, *Symphysorrhachis*? sp., *Cadurcodon houldjinensis* sp. nov. 和 *Entelodon gobiensis*。新种 *Cadurcodon houldjinensis* 的主要特征是:个体大,齿冠高,上前臼齿外壁无明显的肋;上臼齿前附尖和前尖肋窄而紧靠;下臼齿外中沟弱;内齿带高,封闭内谷;具外齿带;m1 下三角座稍短于下跟座。Matthew 和 Granger (1923) 所记述之 *Cadurcotherium* sp. 和 *Cadurcotherium*? sp. 标本被分别归入 *Cadurcodon houldjinensis* 和 *C. ardynensis*。对呼尔井组迄今所发现的哺乳动物化石的分析表明,该组的时代应为晚始新世。

关键词:内蒙古,晚始新世,哺乳动物

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呼尔井[2)]陡坎(Houldjin escarpment)位于我国内蒙古锡林郭勒盟北部二连盐池[3)]西南约3 km、二连浩特市北约5 km处(图1)。它是我国最早发现古近纪地层及哺乳动物化石的地点之一(Berkey and Morris, 1927)。最初,美国纽约自然历史博物馆中亚考察团于1922年在呼尔井陡坎的黄色粗砂和砾岩中发现了少量哺乳动物化石,将该岩层称为呼尔井组(Houldjin Formation)[或呼尔井砾岩(Houldjin Gravel)、呼尔井层(Houldjin beds)],时代被认为是中新世或更晚(Granger and Berkey, 1922;Berkey and Granger, 1923)。由于化石很少,保存又不好,人们对呼尔井组的时代岐意颇多:曾先后被归入渐新世(Osborn, 1923; Matthew and Granger, 1923; Berkey and Morris, 1927; Russell and Zhai, 1987)、中渐新世(Romer, 1966)、中-晚渐新世(Li and Ting, 1983)、早渐新世(Wang, 1992)或晚始新世等(王伴月,1997)。

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1)中国科学院知识创新工程重要方向项目(编号:KZCX2-YW-120)和国家自然科学基金重点项目(编号:40730210)资助。

2)"Houldjin"源于蒙语"胡吉尔(Hu-ji-er)",意为盐碱。因"Houldjin"及其汉译名"呼尔井"现已通用,本文沿用之。

3)"二连盐池"在我国1971年出版的1:10万的地形图上被称为"达布散诺尔"(意即"盐池"),Berkey 和 Morris (1927)在其图版XXIII中称为"Eren Nor"。在后者图中的Iren Dabasu Telegraph Station位于Iren Nor的西侧,相当于现二连盐厂北约1 km处。

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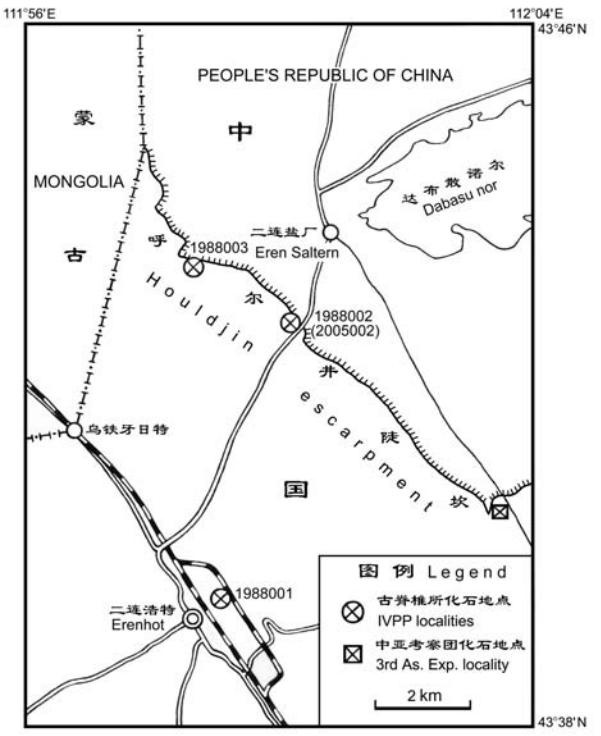

图 1 二连浩特附近化石地点

Fig. 1 Fossil localities around Erenhot

IVPP Loc. 1988001(=I-87RT),二连浩特火车站东 east of Erenhot Railway Station (43°39′50.9″N, 111°58′54.2″E);IVPP Loc. 1988002(=II-87RP, EL 2005002),呼尔井陡坎 Houldjin escarpment (43°42′34.5″N, 112°00′18.3″E);IVPP Loc. 1988003,呼尔井陡坎西端 west end of Houldjin escarpment

从 1985 年开始,二连恐龙博物馆(原二连浩特市文化馆)在该市附近的呼尔井组中陆续发现了一些化石。随后,该馆与中国科学院古脊椎动物与古人类研究所一野外队联合组队进行了多次考察(1988,1990,1991,1992,2005 年),又在该层中发现了一些化石。这些化石对呼尔井组时代的确定提供了新的佐证。其中的小哺乳动物和巨犀化石已被陆续报道(王伴月,2001, 2007a,b, 2008a,b,c; 邱占祥、王伴月,2007)。本文是对除巨犀外的大哺乳动物化石的报道,并根据整个哺乳动物群的性质对呼尔井组的时代进行讨论。

文中缩写:AMNH,美国纽约自然历史博物馆化石编号;EL,中国科学院古脊椎动物与古人类研究所二连地区野外地点编号;EMM,二连恐龙博物馆哺乳动物化石编号;Field. No,美国纽约自然历史博物馆中亚考察团化石野外编号;IVPP Loc.,中国科学院古脊椎动物与古人类研究所野外地点编号;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;RT 和 RP 为二连恐龙博物馆野外地点编号。犀类颊齿各部位术语依邱占祥、王伴月(2007)。

1 系统记述

肉齿目 Creodonta Cope, 1875

鬣齿兽科 Hyaenodontidae Leidy, 1869

鬣齿兽 *Hyaenodon* Laizer & Parieu, 1838

鬣齿兽(未定种) *Hyaenodon* sp.

(图 2)

标本 一段左下颌具 m2-3(EMM 0148),2 枚下犬齿(EMM 0125, 0131)。

地点 二连浩特市附近,详细地点不明:EMM 0148;IVPP Loc. 1988001 东南约

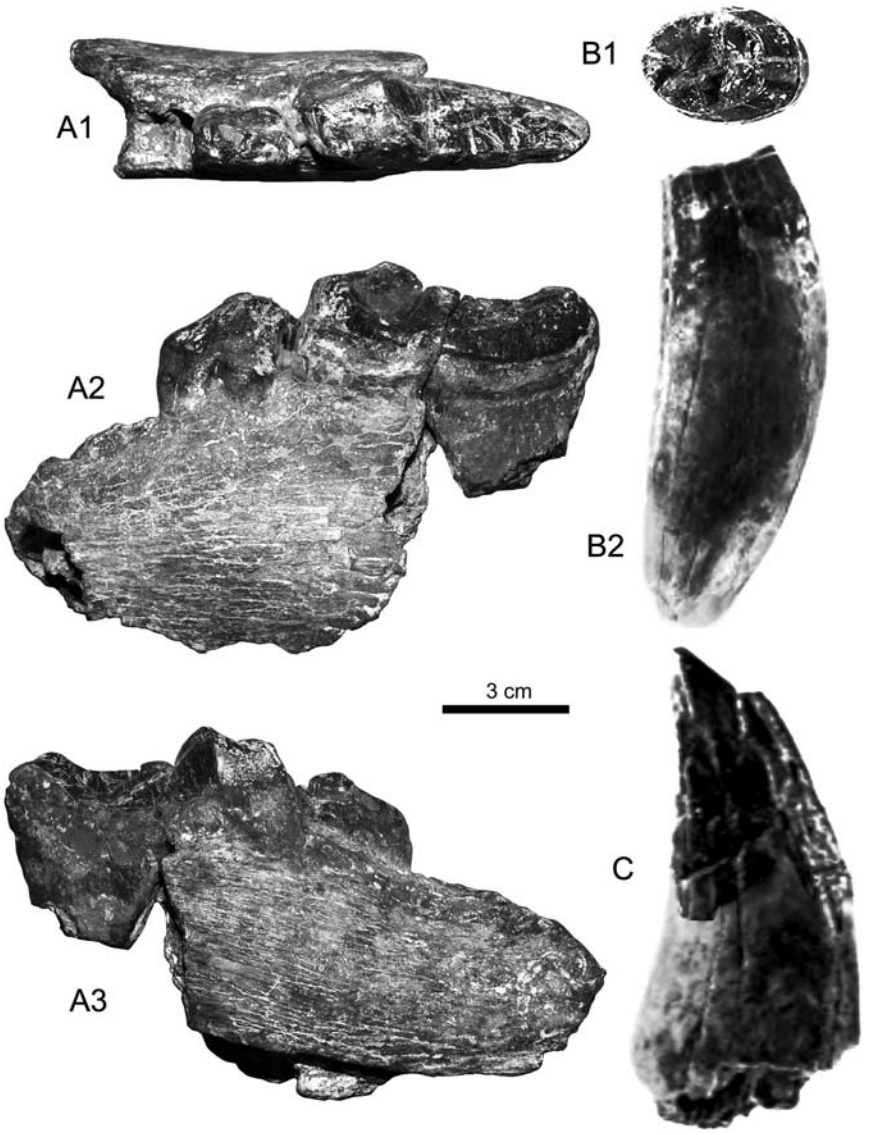

图 2　鬣齿兽(未定种)

Fig. 2　*Hyaenodon* sp.

A. 左下颌骨残段 left mandibular fragment with m2–m3, M 0148, A1. 冠面 occlusal view, A2. 颊面 buccal view, A3. 舌面 lingual view; B. 左 left c1, M 0131, B1. 冠面 occlusal view, B2. 侧面 lateral view; C. 左 left c1, M 0125, 侧面 lateral view

10 ~ 20 m:EMM 0125, 0131。

记述　EMM 0125 为一左下犬齿(图 2C)。齿冠破损,齿根仅保留接近齿冠的一小段。牙齿非常粗大,齿根粗大于齿冠。齿冠表面看不出棱及嵴的构造,但后面上半部外侧有与上犬齿的磨耗面。齿冠基部断面卵圆形,前后长 45 mm, 横宽 35 mm。EMM 0131(图

2B)可能为一左下犬齿,根部保存完整,弯曲弱。尺寸比上一犬齿小而断面较短宽:长径 40.6 mm,横径 34.3 mm。

下颌残段(图 2A) m2 前有 2 个齿槽,说明 m1 具双齿根,齿槽总长约 16.5 mm,宽约 15 mm,前齿槽稍小于后齿槽。m2 和 m3 均无下后尖痕迹。m2 具双齿根,整个牙齿后倾,其裂叶前半部已磨光,后半部顶端也深度磨耗。跟座丘形,与裂叶以深沟相隔。跟座长 3.5 mm,宽 8.2 mm。内齿带连续分布,呈弱 W 形,前半部形成较深的凹。外齿带不清楚。裂叶的后半部有切割磨面。m3 非常长大,下前尖前内壁破损,前外侧有凸棱,裂凹很深。整个裂叶外壁形成弱弧,上半部为切割磨面;前裂叶磨面高,几乎达到齿冠基部;后裂叶磨面为长条形,长 40 mm。牙齿内面有条纹状的沟和棱。齿冠两侧面的下缘为弧形。外侧者后端上升明显。跟座可能已完全退化。齿冠基部之下有突起的棱带状的结构,可能为齿带的残迹;舌侧的带状隆起不如颊侧者明显。m3 后齿根薄而长,横切面为扁圆形。

测量 (长×前宽×后宽,单位:mm) m2: 27×10.8×16.9; m3: 68.8×24×19.8。

比较 EMM 0148 在下臼齿无下后尖和 m3 的前裂叶明显短于后裂叶等特征上与 *Hyaenodon* 属的一致。*Hyaenodon* 是一个非常庞大的属,现知包括 40 多个种。其中绝大多数种都是小至中等大小的动物。在晚始新世至早中新世的 *Hyaenodon* 中,只有 3 个种在尺寸上接近 EMM 0148 者,即晚始新世至渐新世的 *H. gigas* Dashzeveg, 1985 和 *H. mongoliensis* (Dashzeveg, 1964)及早中新世的 *H. weilini* Wang et al., 2005。其中以 *H. gigas* 的个体最大。遗憾的是,上述 3 个种的材料都很少而破碎,很难和 EMM 0148 进行直接比较。*Hyaenodon gigas* 的 M2 的长为 54 mm。根据一般的规律,*Hyaenodon* 的 m3 大体和 M2 等长,而 EMM 0148 的 m3 的长达 68.8 mm,应比 *H. gigas* 者(应为 54 mm 左右)长很多。EMM 0148 的 m2 的长为 27 mm,这一长度也明显大于 *H. mongoliensis* 者(21 ~ 23.7 mm,见 Lange-Barde and Dashzeveg, 1989, table 6)。根据 Wang et al. (2005)的记述,*H. weilini* 的 M2 的长为 45.7 ~ 50.3 mm,亦即小于 *H. gigas* 者。因此,总体说来,EMM 0148 或者应该归入 *H. gigas*,或者是比 *H. gigas* 还大的一个新种。

我们把上述两个犬齿与下颌残段归在一起的主要理由是其硕大的尺寸。同时代生存的两栖犀和猾类(entelodonts)虽然也有很大的犬齿,但其形态差别较大。

奇蹄目 Perissodactyla Owen, 1848

雷兽科 Brontotheriidae Marsh, 1873

晚雷兽 *Metatitan* Granger & Gregory, 1943

晚雷兽(未定种) *Metatitan* sp.

(图 3)

Brontotheriidae indet. Wang, 1992, p. 540

标本 部分右上颌骨具 P1–3(IVPP V 15714),上臼齿外脊的前部(EMM 0155),左 p4(EMM 0132),左 m2(EMM 0156)和左 m3(EMM 0127)。

地点 IVPP Loc. 1988002:IVPP V 15714;IVPP Loc. 1988001 东南约 10 ~ 20 m 处:EMM 0127,EMM 0132;二连浩特附近其他未知地点:EMM 0155,EMM 0156。

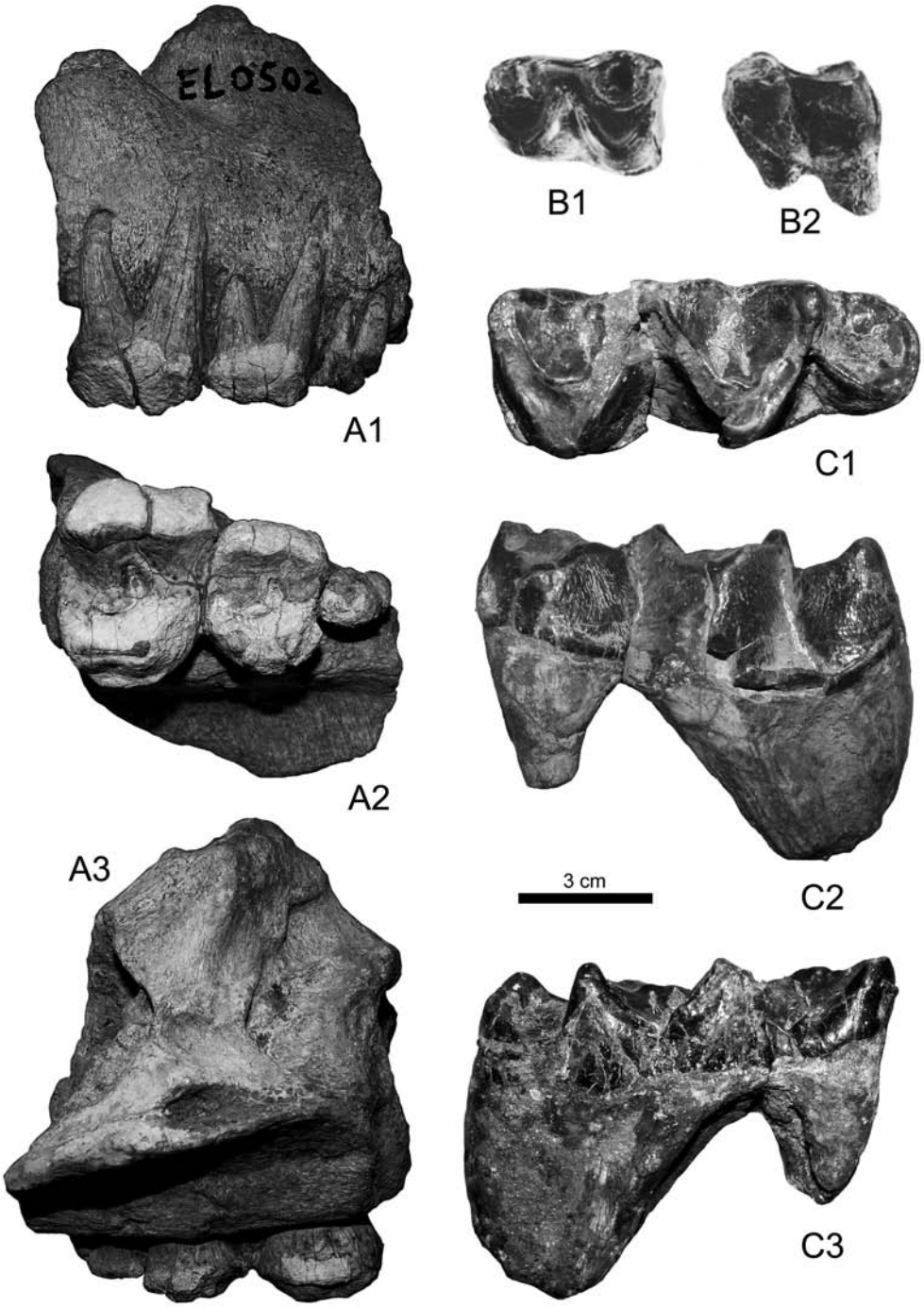

图 3　晚雷兽(未定种)颊齿

Fig. 3　Cheek teeth of *Metatitan* sp.

A. 右上颌骨 right maxilla with P1–3, V 15714, A1. 颊面 buccal view, A2. 冠面 occlusal view, A3. 舌面 lingual view; B. 左 left p4, M 0132, B1. 冠面 occlusal view, B2. 颊面 buccal view; C. 左 left m3, M 0127, C1. 冠面 occlusal view, C2. 颊面 buccal view, C3. 舌面 lingual view

记述 IVPP V 15714(图 3A)眶下孔位于 P3 上方,腭面横向凹入。P1–P3 紧密排列,均具 3 齿根。P1 前 5 mm 处有一大而深的齿槽后壁,表明有较大的上犬齿,C–P1 齿隙短。P1 齿冠大部分破损并深度磨耗,从保存部分看,冠面约为长卵圆形,舌侧短于颊侧,中心为一新月形的凹坑。P2 和 P3 均近横宽的长方形。外脊磨耗较深,其外壁稍向舌侧倾,前后向稍凸;前、后尖肋弱,仅在近冠面处显现。外脊内侧的前、后肋都很发育;后尖肋明显大于前尖肋,两肋间为卵圆形深凹。前附尖较小,稍破损。原尖和次尖舌端相连成纵脊,但在该纵脊的内、外侧仍有分隔沟。齿带在舌缘和前缘内部很发育,在后缘和外缘不明显。上臼齿(EMM 0155)只保留了 W 形外脊的一半,长 40.7 mm,其上未见外肋。

左 p4(图 3B)为双根齿。冠面 W 形,下三角座较下跟座高而窄,下前脊较下后脊细,下三角凹向舌侧开口;下后附尖后嵴很发达,几乎封闭下跟凹。前、后、外侧均具明显齿带。左 m2 已深度磨耗到齿冠基部。冠面较平,齿质的分布仍呈 W 形。其前、后有与 m1 和 m3 的接触面。左 m3(图 3C)下次脊外壁破损。下三角座和下跟座大小相近,冠面均为 V 形。下三角凹向内开口。下后附尖后嵴和下内尖的前嵴均存在,但彼此不相连,不封闭下跟凹。第三叶大,形成近圆的环形脊。在齿的前缘和外缘有明显的齿带。

测量 (单位: mm) P1–P3 长,70.9; 颊齿(长×宽):P1,18.5×13;P2,24.5×31;P3,31.2×42.6;p4,41×29;m3,96.2×38.8。

Wang (1992:540)曾将上述标本鉴定为 Brontotheriidae indet.。由上面的描述可以看出,在尺寸大小,C–P1 齿隙短,P1–P3 排列紧密,P1 小,但齿冠完整,P2–P3 具 4 个主尖和发达的内齿带等特点上,上述标本均与 *Metatitan* 相近。现将其归入 *Metatitan* 属,但因材料太少,暂未定种。

犀科 Rhinocerotidae Gray, 1821

巨獐犀 *Aprotodon* Forster-Cooper, 1915

兰州巨獐犀 *Aprotodon lanzhouensis* Qiu & Xie, 1997

(图 4; 表 1)

标本 一段右下颌,具 p3–4(EMM 0079),同一个体的右 m1(EMM 0080)和右 m2(EMM 0081),一件完整的左 i2(EMM 0082)和 3 段下门齿(EMM 0066, 0083, 0084)。

地点 IVPP Loc. 1988001。

记述 i2(图 4A)长大,弧形弯曲(弦长 295 mm,内弧长 305 mm,外弧长 355 mm)。齿冠基部釉质层很薄。齿冠在前面向下延伸最远,弦长 155 mm,弧长约 170 mm;齿冠在外后缘最短,直线长 114.5 mm。齿冠断面近三角形,三边分别代表舌、前外和后外面。舌面(图 4A2)仅基部有釉质层痕迹,无釉质层的磨面部分长(约 145 mm)而平;其下部另有一长 80 mm 宽 22 mm 的舌形平面(磨耗面?);舌面与前外和后外面都以锐嵴分开。前外面和后外面(图 4A1)间的棱圆滑,向基部变缓,并逐渐消失。前外面近内侧有一明显而较开阔的纵沟;后外面平,上有弱的纵沟、棱。齿根与齿冠同样弯曲,断面为卵圆形,其长轴方向与齿冠者不同,即由齿冠的前内向扭转为齿根的横向。齿根在前面的弧长 185 mm,弦长 175 mm;齿根内后面弧长也为 185 mm,弦长 180 mm。齿根内后面的远中侧有浅的纵向凹槽,其他面上有弱的棱和沟。

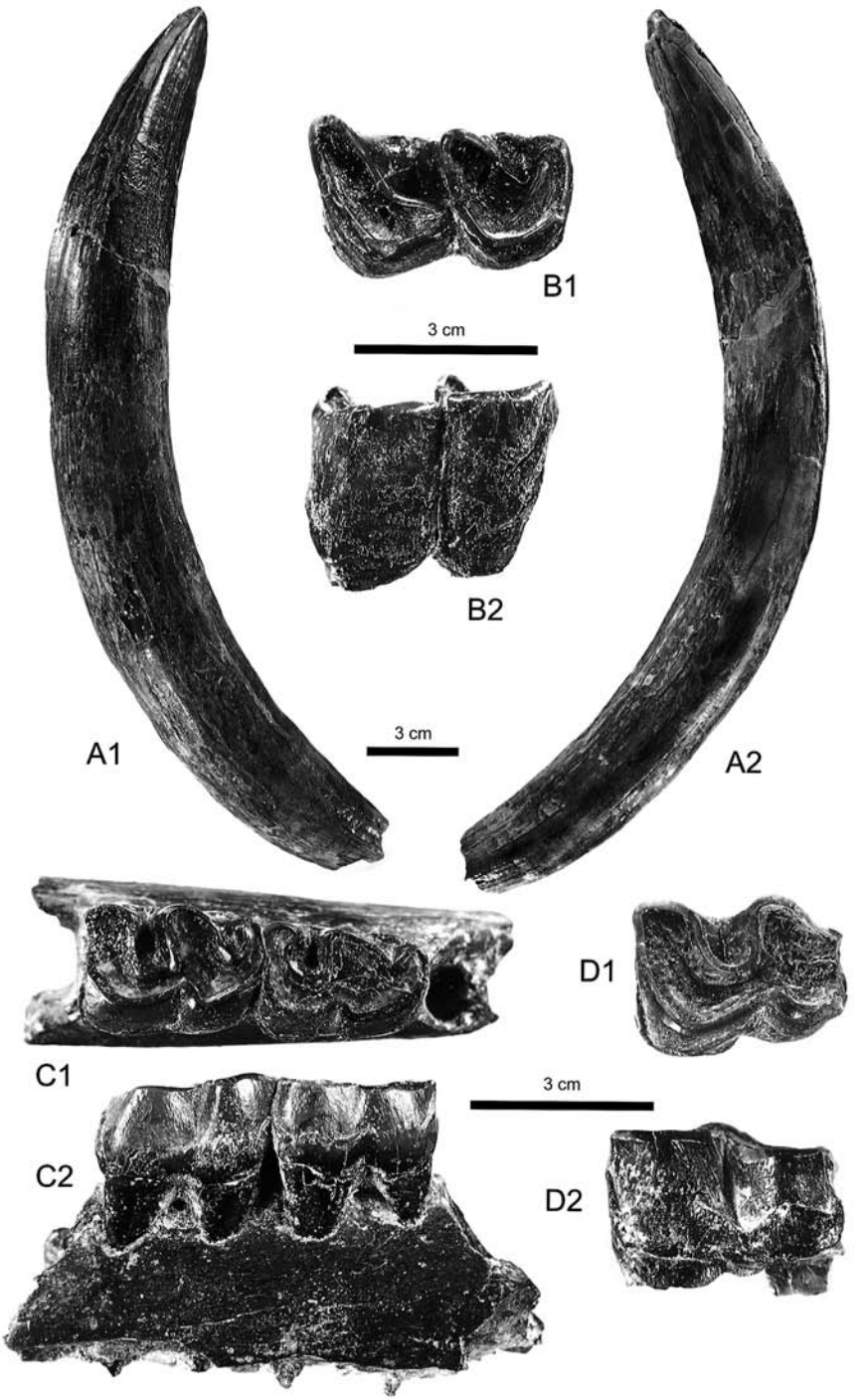

图 4　兰州巨獐犀下牙

Fig. 4　Lower teeth of *Aprotodon lanzhouensis*

A. 左 left i2, M 0082, A1. 唇面 labial view, A2. 舌面 lingual view; B. 右 right m2, M 0081, B1. 冠面 occlusal view, B2. 颊面 buccal view; C. 右 right p3–4, M 0079, C1. 冠面 occlusal view, C2. 颊面 buccal view; D. 右 right m1, M 0080, D1. 冠面 occlusal view, D2. 颊面 buccal view

颊齿齿冠高。下颌骨(图4C)在p3前有2个齿槽,说明p2较发达,并具双根;是否有p1不清楚。P3三角座较跟座窄长,下前脊很短,下原脊斜向前舌侧伸,和下后脊的长度相近,彼此近于直角相交。下三角凹V形,浅。下次脊伸达下后脊外1/3处。下内脊横向,完全。下跟凹深。外齿带弱,但在外中沟处明显,其前、后端几近陡直地斜向上方延伸。内齿带在下三角座内侧发育,在下跟座内侧无。p4与p3相似,只是下三角座相对较短宽,下三角凹和下跟凹均较深。外齿带更弱,在下跟凹内侧有齿带存在。m1(图4D)前端破损。下原脊和下后脊相交处较圆缓,下外中谷较深。下次脊前端约达下后脊中部。下跟座及外齿带与p4者相似,但在下跟座内侧无齿带。m2(图4B)的下前脊与下原脊长度相近,均短于下后脊。下原脊与下后脊约成直角相交,但外壁圆缓。齿带和下跟座均与m1的相似,因磨耗较浅,下次脊短于下内脊,下三角凹和下跟凹均较深。外齿带更弱。

上述下门齿(i2)在形态、大小和细长程度上都和*Aprotodon*属者一致。这也是该属区别于所有已知犀类最鲜明的特征。在该属已知的4种(*A. lanzhouensis*, *A. sminth-woodwardi*, *A. fatehjangensis* 和 *A. aralensis*)中,EMM 0082和*A. lanzhouensis*者最为接近,它们在大小、弯曲程度和断面形态上都非常接近(见表1),而和其他3种差别较大。*A. aralensis*者较短(最大弦长只有237 mm),弯曲度也明显较小(见Beliajeva, 1954a, fig. 4)。*A. sminth-woodwardi*的下门齿,根据Beliajeva (1954a)的记述,断面特别扁宽(宽52~60 mm,前后径长仅24 mm)。*A. fatehjangensis*没有下门齿的记录,但这是该属中相当特化的一个种,个体较大,估计不会和呼尔井的材料为同种。*Aprotodon*属的下颊齿的鉴别特征不很明显。但呼尔井的材料在形态和大小上都与*A. lanzhouensis*者基本一致(见表1)。上述比较使我们相信,呼尔井的材料应该归入*A. lanzhouensis*种。

表1 兰州巨獐犀下牙测量和比较

Table 1 Measurements and comparison of lower teeth of *Aprotodon lanzhouensis* (mm)

	Erenhot	Lanzhou Basin	Yagou
	this paper	Qiu & Xie, 1997	Qiu et al., 2004
p3 L	26.5	23.6~29.3	28
p3 W	19.8	19~21	20
p4 L	30.4	26.2	32.3
p4 W	21.8	21.8	23
m1 L	35.5	31.3~35.4	31
m1 W	23.4	24.1~24.2	24.3
m2 L	42.3	26.2~42.8	40.7
m2 W	25.3	22.5~24.2	25
i2 Lc	40.3; 43.6	41.1~43	
i2 Wc	29.5; 32.7	23~34	
i2 Lr	42.5; 47.7; 51.4	43	25.8
i2 Wr	32.9; 43; 41.7	34	15.3

缩写 Abbreviations: L. length 长; Lc. major diameter of cross section of crown 齿冠横切面长径; Lr. major diameter of cross section of root 齿根横切面长径; W. width 宽; Wc. minor diameter of cross section of crown 齿冠横切面短径; Wr. minor diameter of cross section of root 齿根横切面短径。

Aprotodon 是亚洲特有的一种犀类,主要分布于我国的甘肃、巴基斯坦的俾路支斯坦和哈萨克斯坦的 Agyspe 等地点,时代分布为晚渐新世–早中新世。*Aprotodon lanzhouensis* 仅在我国的甘肃省兰州盆地和临夏盆地发现过,时代也为晚渐新世–早中新世。

嵴颌犀 *Symphysorrhachis* Beliajeva, 1954b

嵴颌犀?(未定种) *Symphysorrhachis*? sp.

(图 5)

Caenopus or *Praeaceratherium* sp. Matthew & Granger, 1923, p. 4, fig. 5

标本　一段右下颌骨具 m2–3(EMM 0123)和左 M1/2(EMM 0078)。

地点　IVPP Loc. 1988001。

记述　m2 下三角座颊侧破损,m3 保存完整(图 5A)。m2 和 m3 的形态相同,只是 m3 稍长,下跟座稍窄于 m2 者。两者的齿冠低,下三角座稍长于下跟座。下原脊的外壁向前内方斜伸,与牙齿纵轴呈锐角相交,与下后脊约呈直角相交。下后脊较下前脊和下次脊粗。下次脊前端伸达下后脊颊侧 1/3 处。下外中谷明显。下三角凹较下跟凹浅而稍窄。齿带在齿的前、后发达;内齿带仅在下三角凹和下跟座凹的入口处发育;m2 的外齿带较 m3 者发育较好,在 m3 的下原尖和下次尖基部中断。臼齿测量(长×前宽×后宽, 单位:mm):m2,54.1e×38e×39.9; m3, 61×38.9×36.8。

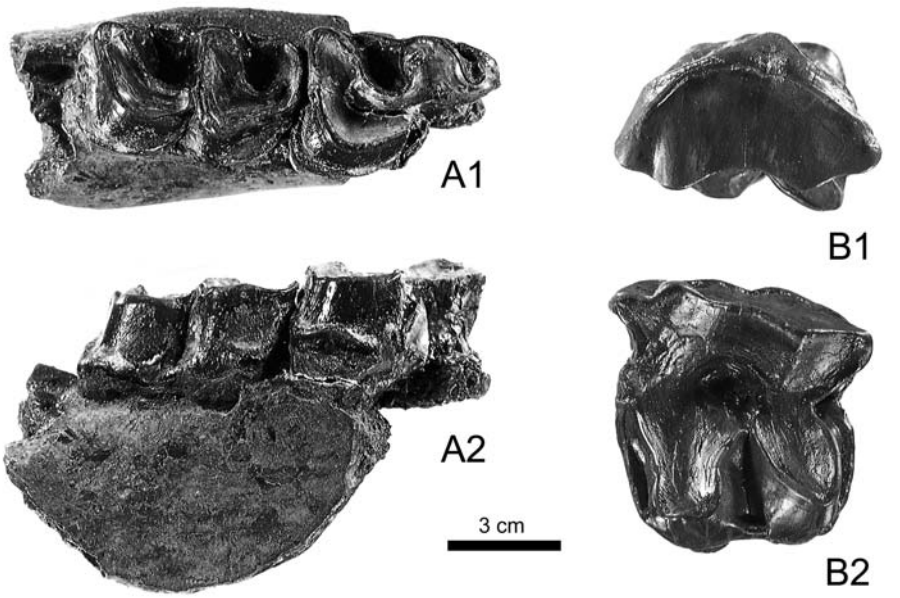

图 5　嵴颌犀?(未定种)颊齿

Fig. 5　Cheek teeth of *Symphysorrhachis*? sp.

A. 右 right m2–3, M 0123, A1. 冠面 occlusal view, A2. 颊面 buccal view; B. 左 left M1/2, M 0078, B1. 颊面 buccal view, B2. 冠面 occlusal view

上述下臼齿在形态上和 *Aprotodon* 及 *Symphysorrhachis* 者没有什么区别,但在尺寸大小上则只和始-渐新世真犀中最大的 *Symphysorrhachis* 者接近。呼尔井标本比该属惟一已知种(*S. brevirostris*)还要稍大些(后者的 m2 长 43 mm, 宽 29 mm; m3 者为 45 mm 和30 mm, 依 Beliajeva, 1954b:197)。呼尔井的标本太少,特别是没有特征明显的下颌联合部,因此暂时存疑地将其归入该属,不定种。

与上述下臼齿同时发现的还有一枚上臼齿(EMM 0078, M1 或 M2; 图 5B)。该牙齿冠低,外壁具明显的前附尖和前尖肋;后尖外壁较平,无后尖肋。两横脊彼此近于平行,较少向后内斜。原尖具很弱的前、后收缩沟。次尖无收缩沟。反前刺发达,因磨耗较深,几乎伸达后脊,将中谷封闭。无前刺。后谷窄长而深。前、后齿带均很发达;外齿带明显而连续;内齿带仅在中谷入口处存在。M1/2 长 69 mm,前宽 75 mm。

Symphysorrhachis 目前仅知下颌及下颊齿,上颊齿的情况不知。考虑到该 M1/2 的尺寸与上述的下臼齿较近,暂时将它也归入 *Symphysorrhachis*? sp. 中。

Matthew 和 Granger (1923)曾将一枚右 M3(该文 fig. 5)归入 *Caenopus* 或 *Praeaceratherium* sp. 。该牙冠面约为三角形,外脊和后脊相连形成连续的外后脊,无后附尖的痕迹。其原脊和前齿带很发达的特点与上述 M1/2(EMM 0078)的相似,可能也应归入 *Symphysorrhachis* 属。

Symphysorrhachis 过去仅在蒙古东部额尔吉林卓地点[Ergilin Dzo, 原称 Ardyn Obo (阿尔丁鄂博)]发现过(Beliajeva, 1954b; Dashzeveg, 1991)。该地点属 Ergilin Dzo 组的 Ergilin 段(Dashzeveg, 1991),时代现被认为是晚始新世(Meng and McKenna, 1998)。

两栖犀科 Amynodontidae Scott & Osborn, 1883

两栖犀亚科 Amynodontinae Scott & Osborn, 1883

卡地犀 *Cadurcodon* Kretzoi, 1942

呼尔井卡地犀(新种) *Cadurcodon houldjinensis* sp. nov.

(图 6、7; 表 2、3)

Cadurcotherium sp. Matthew and Granger, 1923, p. 4, fig. 2

正型标本 一枚右 m2(EMM 0126)。

归入标本 一段右下颌骨具 m1-2(EMM 0086),左 P3(EMM 0072)和左 P4(EMM 0073)的外脊各一件,左 M2(EMM 0124),右 M2 部分外脊(EMM 0149),右 M3(IVPP V 15713),右 M3 外脊前部(EMM 0150),2 枚左 m1(EMM 0129, 0151)和一左下颌骨残段具 m3(EMM 0152)。

地点 IVPP Loc. 1988001:EMM 0072-0073;IVPP Loc. 1988002:EMM 0086,IVPP V 15713;IVPP Loc. 1988001 东南约 10~20 m 处:EMM 0124, 0126 和 0129;二连浩特附近其他地点:EMM 0149-0152。

特征 大个体的 *Cadurcodon*。颊齿齿冠高。上前臼齿外壁无明显的肋和褶;上臼齿前附尖和前尖肋细窄,互相紧靠。下臼齿下外中谷在基部不显;内齿带高,封闭内谷;外齿带清晰。m1 下三角座稍短于下跟座,m3 在比例上较宽。

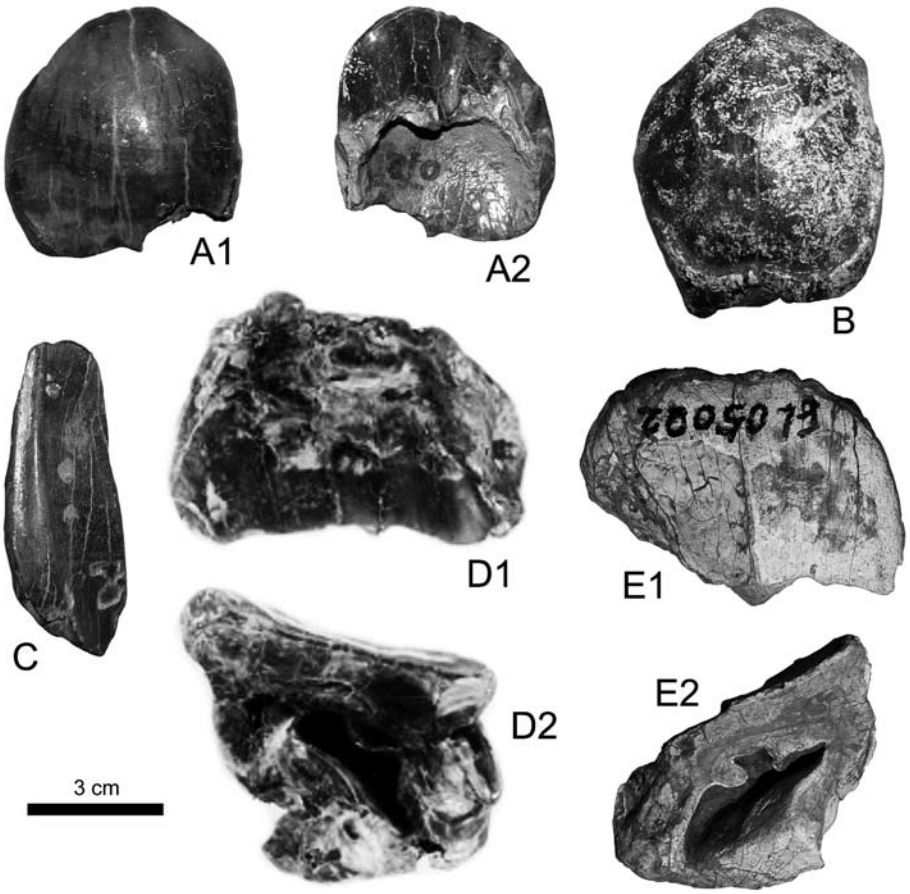

图 6　呼尔井卡地犀(新种)上颊齿

Fig. 6　Upper cheek teeth of *Cadurcodon houldjinensis* sp. nov.

A. 左 left P3, M 0072, A1. 颊面 buccal view, A2. 舌面 lingual view; B. 左 left P4, M 0073, 颊面 buccal view; C. 右 right M3, M 0150, 外脊前部 anterior part of ectoloph; D. 左 left M2, M 0124, D1. 颊面 buccal view, D2. 冠面 occlusal view; E. 右 right M3, V 15713, E1. 颊面 buccal view, E2. 冠面 occlusal view

名称来源　根据化石产地 Houldjin 命名。

描述　下颌骨水平支较低而薄,在正型标本(图 7C2)上,其高约与 m2 的长相近。

颊齿齿冠很高,有弱的白垩质覆盖。上前臼齿外壁平滑,在垂向和横向上均圆凸,前、后尖肋仅微弱可见;外齿带发育,前、后端向齿冠方向急剧上升。在未磨耗的牙齿上,外脊顶端呈圆弧形,最高点处位于前 1/3 处(图 6A,B)。P3 外脊舌侧有与横脊连接的痕迹,位于外脊高度之半。P4(图 6B)仅保留外脊外壁,其顶端已稍磨耗;外齿带比 P3 者更为发育。上、下颊齿测量见表 2、3。

M2 外壁平,后尖外壁稍向外凸,该凸向齿冠基部方向逐渐消失。磨耗深的 M2(图 6D)的外壁在前后方向上稍凹。前尖和前附尖非常靠近,前附尖褶不明显。外脊与原脊的夹角约 40°,与后脊的夹角为 50°;外脊与后脊交界处有圆隆的小刺。后齿带明显。M3

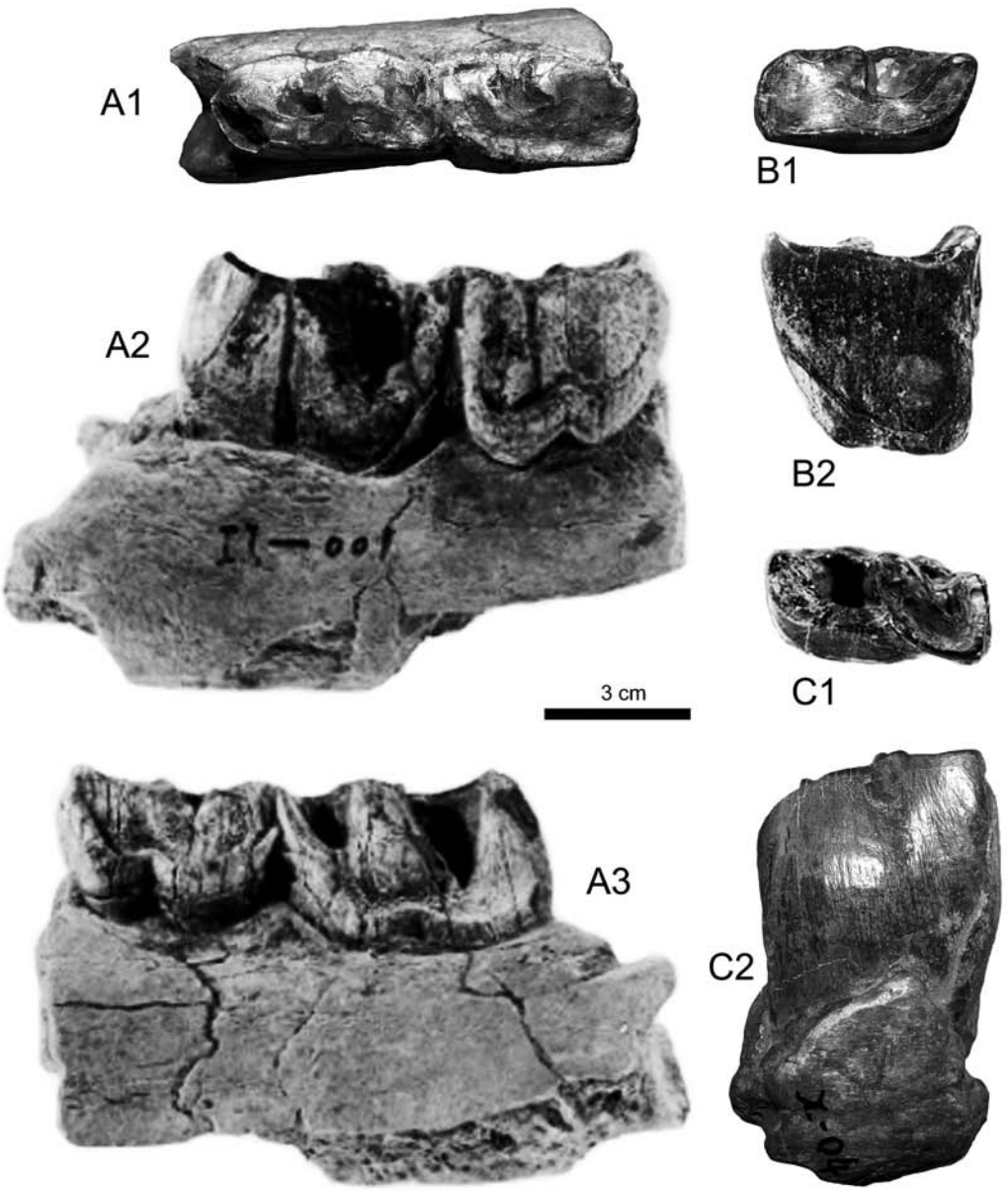

图 7 呼尔井卡地犀(新种)下颊齿

Fig. 7 Lower cheek teeth of *Cadurcodon houldjinensis* sp. nov.

A. 右下颌残段 right mandibular fragment with m1–2, M 0086, A1. 冠面 occlusal view, A2. 颊面 buccal view, A3. 舌面 lingual view; B. 左 left m1, M 0129, B1. 冠面 occlusal view, B2. 颊面 buccal view; C. 右 right m2 正型 holotype, M 0126, C1. 冠面 occlusal view, C2. 颊面 buccal view

(图 6E)的原脊前部和后脊后部破损。其外脊与 M2 的相似,前后向稍凹。前尖和前附尖同样非常靠近,前附尖褶非常窄,仅在齿冠上部较明显。原脊比 M2 者更斜,其与外脊的

表 2　卡地犀上颊齿测量和比较

Table 2　Measurements and comparison of upper cheek teeth of *Cadurcodon*　(mm)

		Erenhot, Nei Mongol, China		Ardyn Obo, Mongolia	
		C. houldjinensis sp. nov.	*C. ardynensis*		
		this paper	Matthew & Granger 1923 *	Osborn 1924	Gromova 1954
	长 L	54			19.5 ~ 22
P3	外脊高 H ectol.	>51.8			
	外脊高/外脊长 H/L(%)	95.9e			
	长 L	55.6	26.5		20 ~ 26
P4	宽 W		40.3		37 ~ 40.5
	外脊高 H ectol.	65.6			
	外脊高/外脊长 H/L(%)	118			
	齿轴长 L axial		45	32	35 ~ 52
	外脊最大长 Max. L ectol.		46.2		40 ~ 54
	前宽 W ant.		41.3	46	38.5 ~ 45
	后宽 W post.		35.5		36.5 ~ 43
M1	外脊高 H ectol.				65e
	前宽/外脊最大长 W ant./max. L ectol.(%)		92		83.7 ~ 112.5
	后宽/前宽 W post/W ant.(%)		86		93.3 ~ 97.7
	原脊与外脊的夹角 Ectol-protol. angle		50°		45° ~ 50°
	外脊高/外脊最大长 H/max. L(%)				129e
	齿轴长 L axial	72		46	49 ~ 58
	外脊最大长 Max. L ectol.	76.2; >72.5			51.5 ~ 61
	前宽 W ant.	72.5		56	40 ~ 52
	后宽 W post.	58			36 ~ 46
M2	外脊高 H ectol.	48#; 61.4#			65 ~ 68
	前宽/外脊最大长 W ant./max. L ectol.(%)	95.1			70.8 ~ 86.7
	后宽/前宽 W post/W ant.(%)	80			82.7 ~ 92
	原脊与外脊的夹角 Ectol-protol. angle	40°			35° ~ 40°
	外脊高/外脊最大长 H/max. L(%)	63#; 84.7#			117.2; 126.5
	齿轴长 L axial	65		56	47 ~ 54
	外脊最大长 Max. L ectol.	72.1			47 ~ 54
	前宽 W ant.	48.9		56	35 ~ 45
	后宽 W post.	34			30 ~ 32
M3	外脊高 H ectol.	52#; 71.2		59	58e
	前宽/外脊最大长 W ant./max. L ectol.(%)	67.8			74.5 ~ 83.3
	后宽/前宽 W post/W ant.(%)	69.5			66.7 ~ 80
	原脊与外脊的夹角 Ectol-protol. angle	30°			30°
	外脊高/外脊最大长 H/max. L(%)	72.1#			112.6

注:e. 大约 estimated; # 磨耗较深 heavily worn; * measured based on Matthew and Granger, 1923, figs. 3, 4.

夹角约为 30°。原脊舌侧无明显的原尖收缩。中谷窄而深,舌侧入口处收缩。小刺和前刺都很发育。齿带在颊侧发育,在舌侧较弱。

m1 和 m2 齿冠高而窄,轻度磨耗的 m2(EMM 0126)的冠高为 56 mm,估计其未磨高度可达 60 mm 或更高些。横脊中等倾斜。下外脊(下原脊+下次脊)外壁很平,下外中谷仅在较年幼的、磨耗较少的 m2(EMM 0086 和 EMM 0126)的近顶端处明显,但往齿冠基部很快消失,而在其他的臼齿上均不明显。下三角凹小而浅,在磨耗较深的 m1(EMM 0086)下三角座冠面成为平面,下三角凹完全消失,而 EMM 0129 仍保留有弱的凹。下跟凹大而深,呈漏斗状。齿带围绕牙齿四周;内、外齿带均明显,内齿带比外齿带高很多,封闭下三角凹和下跟凹。EMM 0151(m1)的磨耗程度最深,其冠面已成较光滑的、稍凹的面,其结构已不清楚,只是在近舌侧中部有一微弱的隆起,可能为下跟凹的痕迹。珐琅质层仅在颊侧保留,在舌侧已无珐琅质层。齿的颊侧未见下外中谷,但可见明显的外齿带沿齿的基部连续分布。具双齿根,前齿根小于后齿根。EMM 0152 只保留了 m3 的齿质部分。未见珐琅质层,冠面结构不清楚。

表 3 卡地犀下牙齿测量和比较

Table 3 Measurements and comparison of lower cheek teeth of *Cadurcodon* (mm)

		Nei Mongol		Mongolia		Kazakhstan	
		Erenhot		Ardyn Obo	Solonkeur	Turgay area	Zaisan Basin
		C. houldjinensis sp. nov.		*C. ardynensis*		*C. kazakademius*	*C. zaisanensis*
		this paper	AMNH 19138 *	Gromova		Birjukov	Beliajeva
				1954	1958	1961b	1962
	长 L	45.3; 46.4; 48.2		30 ~ 38 (33.9)	32; 34	46	38; 39
	宽 W	31.4; 23.1; 28.9		22.5 ~ 25 (23.5)	22; 23	30	24; 25
m1	宽/长 W/L(%)	69.3; 49.8; 60		(69) **	64.7; 71.9	65.2	63.1; 64.1
	下后脊与下外脊夹角	70°					
	metaloph. -protoloph. angle						
	长 L	57.3; 48.7	53e	43 ~ 48.5 (45)	42.5; 45e	60	48; 47
	宽 W	29.9e; 23.5	29.6	23 ~ 26.5 (24.7)	25; 28	37	29; 26
	外脊高 H ectol.	>56	50#				
m2	宽/长 W/L(%)	52.2; 48.3	56	49.5 ~ 58.9 (54.3)	58.9; 62.2e	61.6	60.4; 55.3
	下后脊与下外脊夹角	50°; 40°	50°	35° ~ 55°		52° ~ 56°	
	metaloph. -protoloph. angle						
	外脊高/外脊长 H/L ectol. (%)	115	94.3#			64.3	
	长 L	70.5e		47.5 ~ 52.5	48; 50	70	65
m3	宽 W	39.9e		22 ~ 25	28	34	
	宽/长 W/L(%)	56.6		44.6 ~ 51	56	48.6 ***	

注:e. 大约 estimated; # 磨耗较深 heavily worn; 括号内为均数 means in brackets.

* 依 Matthew 和 Granger (1923)插图 2 测量 measured based on Matthew and Granger, 1923, fig. 2; ** 依 Gromova (1954)测量的平均数计算 calculated based on means in Gromova, 1954; *** Birjukov(1961b)原误为 48.8 Birjukov's original 48.8 is in error.

比较与讨论　上述二连浩特的上臼齿,在前附尖和前尖肋窄且紧靠这一特点上与 *Hypsamynodon* 者很接近。但后者在齿冠的绝对高度和牙齿的高/长比上却比二连浩特者大得多。在这一方面,二连浩特标本与 *Cadurcodon* 者相近(见表 2、3)。此外,在二连浩特标本中,后面的臼齿不特别伸长,前臼齿不怎么缩短;下臼齿较宽,横脊中度倾斜,外壁较平,下外中谷弱等特征,都与 *Cadurcodon* 相似。因此,本文将二连浩特的标本归入 *Cadurcodon* 属。

Cadurcodon 属目前已知 3 种:蒙古南戈壁的 *C. ardynensis*,哈萨克斯坦斋桑盆地的 *C. zaisanensis* 和土尔盖地区的 *C. kazakademius* (Osborn, 1924; Gromova, 1954; Birjukov, 1961b; Beliajeva, 1962)。Lucas 和 Emry (1996b)认为 *C. zaisanensis* 是 *C. ardynensis* 的后出同物异名。我们认为 *C. zaisanensis* 可能仍应为一有效种。其臼齿内齿带很低,无外齿带,且无外中沟。在这些特点上它与 *C. ardynensis* 是有区别的。二连浩特的标本与上述 3 个种都不同。与 *C. kazakademius* 相比,虽然两者在尺寸上比较接近,都较大(见表 2、3),但两者在形态上有许多区别:如二连浩特者齿冠高得多,下臼齿的下外中谷微弱,在近基部处消失,m1 下三角座短于下跟座,m3 在比例上较宽等(在 *C. kazakademius* 的下臼齿中,下外中谷清晰可见,其 m1 下三角座明显长于下跟座)。与 *C. zaisanensis* 的区别为:臼齿尺寸大,下外中谷仅在齿冠下部消失,内齿带位置高,封闭内谷,具外齿带等(在 *C. zaisanensis* 中,无下外中谷,内齿带位置低于内谷的开口处,m2–m3 无外齿带)。与 *C. ardynensis* 的区别,除颊齿尺寸明显较大外,其上前臼齿外壁无肋和褶,上臼齿前附尖和前尖肋变窄、非常靠近的特点也与后者明显不同。上述区别使我们相信,二连浩特的标本应为 *Cadurcodon* 属的一个新种,这里定名为呼尔井卡地犀(*Cadurcodon houldjinensis* sp. nov.)。

Matthew 和 Granger (1923)曾报道过 3 枚产自呼尔井组的两栖犀牙齿。一枚下臼齿[AMNH 19138 (Field no. 36, fig. 2)]被鉴定为 *Cadurcotherium* sp., 另外 2 枚上颊齿被定为 *Cadurcotherium*? sp.。Gromova (1954:182)已经把它们归入到 *Cadurcodon* 中。这 3 枚颊齿均无明显的白垩质覆盖,下臼齿比例上较宽,横脊不很倾斜等特点都表明 Gromova 是对的。其中的 AMNH 19138 可能为 m2。它的齿冠高大,比例上较宽,横脊中等倾斜和下部无明显的下外中谷等特点均与 *Cadurcodon houldjinensis* 的一致,而且其尺寸也在该种的变异范围内(见表 3),似应归入新种。

其余的两件标本分别为右 P4(Matthew and Granger, 1923, fig. 4)和右上臼齿(M1/2, Matthew and Granger, 1923, fig. 3)。P4 外壁上仍可见明显的前尖肋和后尖肋,2 横脊在舌端相连,具小刺和发达的齿带。这些特点与 *C. ardynensis* 者一致。M1/2 的外壁前后向微凹;前尖肋很高,高出前附尖,前尖肋+前附尖宽(前后方向)约 10 mm,原脊与外脊的夹角为 50°。这些特征也与 *C. ardynensis* 一致。而且它们的尺寸都在 *C. ardynensis* 的变异范围内(见表 2)。因此,上述 P4 和 M1/2 似应归入 *C. ardynensis* 种。

偶蹄目 Artiodactyla Owen, 1848

猯科 Entelodontidae Lydekker, 1883

猯属 *Entelodon* Aymard, 1846

戈壁猯 *Entelodon gobiensis* (Trofimov, 1952)

(图 8)

标本 左 P4 一枚(EMM 0128)。

地点 IVPP Loc. 1988001 东南约 10 ~ 20 m 处。

记述 P4 保存较好,只是磨耗较深。牙齿冠面为近浑圆的三角形,舌侧较短,宽大于长。前尖和原尖彼此靠近,前尖稍大于原尖,磨耗后彼此相连。齿带沿齿冠周围发育。P4 的上述特点都与 *Entelodon gobiensis* 的一致,而且其尺寸大小(长×宽;29 mm×35 mm)也在该种的变异范围内[*E. gobiensis* 的 P4 的长×宽为 31 mm×35 mm (正型标本,依 Trofimov, 1952);25.5 mm×29.6 mm (依 Lucas and Emry, 1996a)],故被归入 *E. gobiensis* 种。

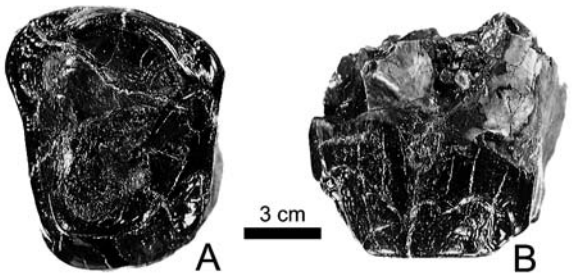

图 8 戈壁猪左 P4 (M 0128)

Fig. 8 Left P4 of *Entelodon gobiensis* (M 0128)

A. 冠面 occlusal view; B. 颊侧 buccal view

Entelodon gobiensis 的正型标本产于蒙古南戈壁的阿尔丁鄂博(Trofimov, 1952),时代为晚始新世(原为早 - 中渐新世)。Lucas 和 Emry (1996a)认为杨钟健和周明镇(1956)描述的 *Archaeotherium ordosius*, Birjukov (1961a)描述的 *E. major* 和 Dashzeveg (1965)描述的 *E. orientalis* 均是 *E. gobiensis* 的后出同物异名,这样,亚洲 *Entelodon* 的小型种只有一个,即 *E. gobiensis*。与此同时,他们还将产于脑木根敖包和额尔登敖包"巴润绍组"(现被称为上脑岗代组,见王伴月,2003)和马捷茨营地"呼尔井组"的猪类化石也归入 *E. gobiensis* 种。这样 *E. gobiensis* 的时代分布应为晚始新世–早渐新世。

2 呼尔井哺乳动物群时代讨论

关于呼尔井组的时代,意见分歧很大。最早被认为是中新世或更晚(Granger and Berkey, 1922),后多被认为是渐新世(Osborn, 1923; Matthew and Granger, 1923; Berkey and Morris, 1927; Russell and Zhai, 1987),包括中渐新世(Romer, 1966)、中–晚渐新世(Li and Ting, 1983)和早渐新世(Wang, 1992)。近年来则多被归入晚始新世(王伴月,1997, 2001, 2007a,b, 2008a,b,c; 邱占祥、王伴月,2007)。

综合前人的研究(Matthew and Granger, 1923; Lucas and Emry, 1996a; 王伴月,2001, 2007a,b, 2008a,b,c; 邱占祥、王伴月,2007),二连浩特市附近的呼尔井组中所产哺乳动物化石共计 8 目 18 科 24 属 30 种(包括 4 个相似种,9 个未定种):

灵长目 Primates Linnaeus, 1758

曙猿科 Eosimiidae Beard et al., 1994

曙猿(未定种 A) *Eosimias* sp. A

始镜猴科 Omomyidae Trouessart, 1879

二连假懒猴 *Pseudoloris erenensis* Wang, 2008

翼手目 Chiroptera Blumenbach, 1799

小蝙蝠亚目(属、种未定) Microchiroptera gen. et sp. indet.
刺猬目 Erinaceomorpha Gregory, 1910
刺猬科 Erinaceidae Fischer de Waldheim, 1817
内蒙东方猬 *Anatolechinos neimongolensis* Wang, 2008
莱氏鼬鼩 *Ictopidium lechei* Zdansky, 1930
兔形目 Lagomorpha Brandt, 1855
短耳兔科 Ochotonidae Thomas, 1897
年迈链兔 *Desmatolagus vetustus* Burke, 1941
兔科 Leporidae Fischer de Waldheim, 1817
托氏戈壁兔 *Gobiolagus tolmachovi* Burke, 1941
兔科(属、种未定) Leporidae gen. et sp. indet.
啮齿目 Rodentia Bowdich, 1821
戈壁鼠科 Gobiomyidae Wang, 2001
内蒙古戈壁鼠 *Gobiomys neimongolensis* (Meng et al., 1999)
小戈壁鼠 *G. exiguus* Wang, 2001
小戈壁鼠(相似种) *G.* cf. *G. exiguus* Wang, 2001
戈壁鼠?(未定种) *Gobiomys*? spp.
镶鼠科 Chapattimyidae Hussain, de Bruijn & Leinders, 1978
布林陌生鼠(相似种) *Advenimus* cf. *A. bohlini* Dawson, 1964
贝克陌生鼠(相似种) *A.* cf. *A. burkei* Dawson, 1964
豫鼠(未定种) *Yuomys* sp.
梳趾鼠科 Ctenodactylidae Gervais, 1853
原塔塔鼠(未定种) *Protataromys* sp.
仓鼠科 Cricetidae Rochebrune, 1883
祖仓鼠?(未定种) *Pappocricetodon*? sp.
北方始仓鼠 *Eocricetodon borealis* Wang, 2007
二连锐齿仓鼠 *Oxynocricetodon erenensis* Wang, 2007
跳鼠科 Dipodidae Fischer de Waldheim, 1817
双连异蹶鼠(相似种) *Allosminthus* cf. *A. diconjugatus* (Tong, 1997)
大异蹶鼠 *Allosminthus majusculus* Wang, 1985
蕾异蹶鼠 *Allosminthus ernos* Wang, 1985
山河狸科 Aplodontidae Brandt, 1855
原始原松鼠 *Prosciurus pristinus* Wang, 2008
松鼠科 Sciuridae Fischer de Waldheim, 1917
旱獭族(属、种未定) Marmotini gen. et sp. indet.
肉齿目 Creodonta Cope, 1875
鬣齿兽科 Hyaenodontidae Leidy, 1869
鬣齿兽(未定种) *Hyaenodon* sp.
奇蹄目 Perissodactyla Owen, 1848
雷兽科 Brontotheriidae Marsh, 1873
晚雷兽(未定种) *Metatitan* sp.
犀科 Rhinocerotidae Gray, 1821

兰州巨獠犀 *Aprotodon lanzhouensis* Qiu & Xie, 1997

嵴颌犀?(未定种) *Symphysorrhachis*? sp.

巨犀科 Paraceratheriidae Osborn, 1923

咸海巨犀(未定种) *Aralotherium* sp.

两栖犀科 Amynodontidae Scott & Osborn, 1883

阿尔丁卡地犀 *Cadurcodon ardynensis* (Osborn, 1923)

呼尔井卡地犀(新种) *Cadurcodon houldjinensis* sp. nov.

偶蹄目 Artiodactyla Owen, 1848

豨科 Entelodontidae Lydekker, 1883

恐豨 *Entelodon dirus* Matthew & Granger, 1923

戈壁豨 *E. gobiensis* (Trofimov, 1952)

上述哺乳动物中的 25 类在其他地区已知时代分布如表 4 所示。

表 4 呼尔井哺乳动物群成员的地史分布

Table 4 Stratigraphic distribution of the mammals of Houldjin Fauna

	Middle Eocene			Late	Early	Late
	middle	late	latest	Eocene	Oligocene	Oligocene
Eosimias		×	×			
Pseudoloris			×	×	×	
Anatolechinos neimongolensis				×		
Ictopidium lechei			×			
Desmatolagus vetustus				×		
Gobiolagus tolmachovi		×		×		
Gobiomys neimongolensis				×		
G. exiguus				×		
Gobiomys sp.				×		
Advenimus	×					
Yuomys		×				
Protataromys		×	×			
Pappocricetodon		×	×	×		
Eocricetodon				×		
Oxynocricetodon				×		
Allosminthus		×	×	×		
Prosciurus				×	×	
Aprotodon lanzhouensis						×
Symphysorrhachis				×		
Aralotherium				×	×	×
Cadurcodon ardynensis				×		
Metatitan				×		
Hyaenodon	×	×	×	×	×	×
Entelodon dirus				×		
E. gobiensis				×	×	

根据过去已知的地史分布资料,除翼手类(属种未定)外,上述哺乳动物可以分为

5 组:

1) 仅产于中始新世者有 6 种:*Ictopidium lechei*, *Advenimus* (*A.* cf. *A. bohlini*, *A.* cf. *A. burkei*), *Yuomys* (*Yuomys* sp.), *Protataromys* (*Protataromys* sp.)和 *Allosminthus diconjugatus* (*A.* cf. *A. diconjugatus*)(括号内为在二连浩特附近呼尔井组中所发现的种,下同);

2) 时代分布为中始新世晚期–晚始新世者 3 种: *Eosimias* (*Eosimias* sp.), *Gobiolagus tolmachovi* 和 *Pappocricetodon* (*Pappocricetodon*? sp.);

3) 仅限于晚始新世者 14 种:*Anatolechinos neimongolensis*, *Desmatolagus vetustus*, *Gobiomys neimongolensis*, *G. exiguus*, *G.* cf. *G. exiguus*, *Gobiomys* sp., *Eocricetodon* (*E. borealis*), *Oxynocricetodon* (*O. erensis*), *Allosminthus* (*A. majusculus*, *A. ernos*), *Symphysorrhachis* (*Symphysorrhachis*? sp.), *Cadurcodon ardynensis*, *Metatitan* (*Metatitan.* sp.)和 *Entelodon dirus* (Granger and Gregory, 1943; Beliajeva, 1954b; 王伴月,2007a,b, 2008a,c);

4) 分布于始新世–渐新世期间者 4 种:中始新世–渐新世的 *Hyaenodon* (*Hyanodon* sp.)和 *Pseudoloris* (*P. erenensis*);晚始新世–渐新世期间的 *Prosciurus* (*P. pristinus*)和 *Entelodon gobiensis*;

5) 从晚渐新世开始出现者 2 种: *Aralotherium* (*Aralotherium* sp.)和 *Aprotodon lanzhouensis* (邱占祥、谢骏义,1997;邱占祥等,2004)。

上述分析表明,呼尔井动物群的绝大多数种类都在晚始新世地层中发现过(2–4 组),共 22 种,约占总数的 3/4。

如果将呼尔井动物群的时代定为晚始新世,尚需对 1 和 5 组的成员作进一步分析。在 1 组的 6 种中有 2 个未定种和 3 个相似种。其中的 *Allosminthus* cf. *A. diconjugatus*,王伴月(2008a)曾认为该相似种形态上更进步些,其时代也可能晚些。其余的相似种和未定种的标本都比较零星,王伴月(2001)早就指出过,*Advenimus* 等较早期的梳趾鼠化石在呼尔井组的发现"有两种可能性:1) 表明这些种类的分布时代比原来认为的要长些,可延续到晚始新世;2) 它们有可能是从较老的地层中冲刷出来后再沉积的。"从其标本多较零星看,后一种可能性似乎更大。

Aralotherium 过去仅在晚渐新世发现过(邱占祥、王伴月,2007)。*Aprotodon lanzhouensis*过去仅在我国甘肃兰州和临夏盆地以及巴基斯坦和哈萨克斯坦等地的晚渐新世–早中新世地层中发现过。在呼尔井组中发现的 *Aralotherium* 的材料较多。*Aprotodon lanzhouensis*的材料很少,但有一颗非常特征的大门齿,标本上未见搬运的痕迹,表明不是经搬运后再沉积的。对于这两类动物在呼尔井组的发现,目前只能有一种解释,即该种出现得比过去想象的更早,亦即在晚始新世时即已出现。

与蒙古高原其他 3 个晚始新世哺乳动物群[我国的乌兰戈楚动物群、查干布拉格动物群和蒙古的额尔吉林卓动物群(Ergilin-Dzo Fauna, 即原阿尔丁鄂博 Ardyn Obo 动物群)]相比(见表 5),呼尔井动物群的小哺乳动物与乌兰戈楚动物群和查干布拉格动物群相同的种属较多,而大哺乳动物则主要与额尔吉林卓动物群的相近。不过,这可能与在额尔吉林卓动物群产出地采集小哺乳动物化石不够有关。

表 5 呼尔井动物群与蒙古高原其他晚始新世哺乳动物群的对比

Table 5 Taxa commonly shared by Houldjin and other Late Eocene faunas in Mongolian Plateau

	Houldjin	Ulan Gochu	Qagan Bulag	Ergilin Dzo
Anatolechinos neimongolensis	×	×	×	
Ictopidium	×			×
Desmatolagus vetustus	×	×		
Gobiolagus tolmachovi	×	×	×	
Gobiomys neimongolensis	×		×	
G. exiguus	×	×		
Pappocricetodon	×	×		
Symphysorrhachis	×			×
Cadurcodon ardynensis	×			×
Metatitan	×	×		×
Hyaenodon	×			×
Entelodon gobiensis	×			×

致谢 插图由沈文龙先生清绘,部分图片由杜治和邓涛先生摄制,诚致谢意!

LARGE MAMMALS FOUND FROM HOULDJIN FORMATION NEAR ERENHOT, NEI MONGOL, CHINA

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Summary

The Houldjin Formation was discovered and named by the Third Asiatic Expedition in 1922. Its geological age was first considered as Miocene or later, then varied from Oligocene to Late Eocene because of scarcity of mammalian fossils found in that formation. Since 1985, some additional mammalian fossils have been found. These discoveries have throw more light on its age determination. The micromammalian fossils have already been reported. The large mammalian fossils, except paraceratherines, are described here.

1 Systematics

Creodonta Cope, 1875

Hyaenodontidae Leidy, 1869

***Hyaenodon* Laizer & Parieu, 1838**

***Hyaenodon* sp.**

(Fig. 2)

Specimens Left mandibular fragment with m2–3 (EMM 0148), 2 c's (EMM 0125, 0131).

Locality Unspecified locality near Erenhot: EMM 0148; 10 ~ 20 m southeast of IVPP Loc. 1988001: EMM 0125, 0131.

Remarks Both c's have worn facets (with C's) on their posterior side of the crown. EMM 0125 (Fig. 2C) preserves only a small portion of its root below crown, which is almost

complete, although damaged on surface. The cross section is oval, longer than wide, 45 mm × 35 mm measured at the base of the crown. EMM 131 (Fig. 2B) has the top of its crown broken, but its root is almost complete, which may be about twice as long as the crown. It is smaller than the above specimen. Cross sections of both crown and root are oval in shape, 40.6 mm ×34.3 mm measured at the base of the crown.

Both m2 and m3 lack metaconids. The heavy worn m2 has a cone-shaped talonid and a weak W-shaped lingual cingulum. The m3 is very long, with its paraconid blade higher, but much shorter than the protoconid one. Measurements (L×AW×PW, in mm): m2: 27×10.8×16.9; m3: 68.8×24×19.8.

The lack of any metaconids on m2 and m3 and the relative lengths of the paraconid and protoconid blades on m3 tend to show that the above specimen is to be referred to the genus *Hyaenodon*, which is currently known to include more than 40 species. Majority of the species of the genus are small to medium sized animals. There are only three large-sized species, which are of the size more or less comparable with the above described material: *H. gigas*, *H. mongoliensis* and *H. weilini*. Of them *H. gigas* is the largest one. The m3 of EMM 0148 is 68.8 mm long. *Hyaenodon gigas* is so far represented only by upper molars, M2 of which is 54 mm long. As the m3 is usually about equally long as the M2 in hyaenodonts, we came to the conclusion that the Houldjin specimen is larger than those of *H. gigas*. EMM 0148 may either be attributed to *H. gigas*, or represent a new species.

Perissodactyla Owen, 1848
Brontotheriidae Marsh, 1873
***Metatitan* Granger & Gregory, 1943**
***Metatitan* sp.**
(Fig. 3)

Brontotheriidae indet. Wang, 1992, p. 540

Specimens Fragment of right maxilla with P1–3 (IVPP V 15714), a piece of a broken upper molar (EMM 0155), left p4 (EMM 0132), left m2 (EMM 0156) and left m3 (EMM 0127).

Localities IVPP Loc. 1988002: IVPP V 15714; 10 ~ 20 m southeast of IVPP Loc. 1988001: EMM 0127, M 0132; and unspecified localities near Erenhot: EMM 0155, EMM 0156.

Remarks The infraorbital foramen is located above P3. The C–P1 diastem is short, about 5 mm. P1–P3 are crowded in maxilla. P1 is small and oval, while P2–P3 subquadrate in occlusal view. The protocone connects with the hypocone to form a lingual band, which is particularly long and clearly shown in the P4. The lingual cingulum is well developed. The p4 is W-shaped, with its trigonid narrower and higher than talonid. The m3 is very long, with a large 3rd lobe, which forms a quasi-circle.

The specimens mentioned above were first identified as Brontotheriidae indet. by Wang (1992:540). A closer observation tends to show that they are rather close to those of *Metatitan* in both morphology and size.

Rhinocerotidae Gray, 1821
***Aprotodon* Forster Cooper, 1915**
***Aprotodon lanzhouensis* Qiu & Xie, 1997**
(Fig. 4; Table 1)

Specimens A right mandibular fragment with p3–4 (EMM 0079), a right m1 (EMM 0080) and right m2 (EMM 0081) belonging to one and the same individual, a left i2 (EMM

0082) and 3 pieces of lower incisors (EMM 0066, 0083, 0084).

Locality IVPP Loc. 1988001.

Description and remarks The i2 (Fig. 4A) is particularly long (chord length 295 mm, external arc length 355 mm) and rather strongly curved. Its crown is about as long as its root, and triangular in cross section. The lingual surface of the crown is devoid of enamel except at its very base, where very fine enamel layer can be observed. The anterobuccal and posterobuccal surfaces are confluent and covered with enamel layer. Both edges formed by the above mentioned surfaces with the lingual one are sharp. The root of the i2 is similarly curved as the crown, with an oval cross section, major axis of which stretches in transverse direction. The p2 is large and apparently 2-rooted, as evidenced by the 2 alveoli before the p3 (Fig. 4C1). The trigonid of p3 is longer but narrower than the talonid, with a shallower basin. The paralophid is short, and the protolophid extends anterolingually. The entolophid is complete and transverse. The talonid basin is deep. The p4 is similar to the p3, but has a shorter and wider trigonid. On the m1 the corner formed by the protolophid and metalophid is round and the ectoflexid is deep. On the m2 the subequal paralophid and protolophid are shorter than the metalophid. The metalophid meets the protolophid at right angle. The external cingula of the cheek teeth are week.

There is no doubt that the EMM 0082 tusk (i2) should be attributed to *Aprotodon*, one of the most diagnostic features of which is its extremely long and curved lower tusks. The EMM 0082 is almost identical with those of *A. lanzhouensis* in size and morphology. It differs from those of *A. aralensis* in being longer and more curved. In *A. sminth-woodwardi* the cross section of the i2 is much more flattened. In general morphology the above described lower teeth resemble those of *Aprotodon* closely and their sizes fall within the ranges of *A. lanzhouensis* (see Table 1).

Symphysorrhachis Beliajeva, 1954b
Symphysorrhachis? sp.

(Fig. 5)

Caenopus or *Praeaceratherium* sp. Matthew & Granger, 1923, p. 4, fig. 5

Specimens A right mandibular fragment with m2–3 (EMM 0123) and a left M1/2 (EMM 0078).

Locality IVPP Loc. 1988001.

Description and remarks The m2 and m3 are similar in morphology. The trigonid is slightly longer than talonid. The protolophid extends anterolingually and forms a right angle with the metalophid. The trigonid basin is shorter and narrower than the talonid one. The cingula are well developed on the anterior and posterior sides. The m2 and m3 differ hardly from those of *Aprotodon* and *Symphysorrachis* in morphology, but in size they are close to those of *Symphysorrachis*, which is the largest among the Eocene-Oligocene rhinocerotids. They are even slightly larger than those of *S. brevirostris* (the only species of the genus) in size. There is an M1 or M2 (EMM 0078) of compatible size found together with the lower teeth (Fig. 5B). Both specimens are referred to *Symphysorrachis*? sp.

Matthew and Granger (1923, fig. 5) had once referred an M3 from Houldjin gravels to *Caenopus* or *Praeaceratherium* sp. It is similar to the above M1/2 in morphology, but slightly smaller in size. It may also belong to *Symphysorrhachis*.

Amynodontidae Scott & Osborn, 1883
Amynodontinae Scott & Osborn, 1883
Cadurcodon Kretzoi, 1942
Cadurcodon houldjinensis sp. nov.

(Figs. 6–7; Tables 2–3)

Cadurcotherium sp. Matthew and Granger, 1923, p. 4, fig. 2

Holotype　A right m2(EMM 0126).

Referred specimens　A mandibular fragment with m1-2(EMM 0086), a left P3(EMM 0072), left P4(EMM 0073), left M2(EMM 0124), ectoloph part of a right M2(EMM 0149), a right M3(IVPP V 15713), an anterior part of ectoloph of right M3(EMM 0150), 2 left m1's (EMM 0129, 0151), and a mandibular fragment with m3(EMM 0152).

Localities　IVPP Loc. 1988001: EMM 0072-0073; IVPP Loc. 1988002: EMM 0086, IVPP V 15713; 10 ~ 20 m southeast of IVPP Loc. 1988001: EMM 0124, 0126 and 0129; and unspecified localities near Erenhot: EMM 0149-0152.

Diagnosis　Large-sized *Cadurcodon*. Cheek teeth hypsodont. Upper premolars with hardly discernible ribs on ectolophs. Parastyles and paracone ribs in upper molars very narrow and closely appressed. Lower molars with very weak ectoflexids disappearing basally; high lingual cingula closing trigonid and talonid basins. Trigonid shorter than talonid in m1, and m3 wider in proportion.

Etymology　Houldjinensis = Houldjin + ensis, Houldjin, the locality where the fossils were collected.

Description　The mandibular ramus is slender and low, with the height of the part under the m2 no more than the m2's length.

All cheek teeth are hypsodont, with thin layer of cement. The buccal walls of the upper premolars are smooth and convex in both directions, with hardly discernible paracone and metacone ribs. Both ends of the buccal cingula turn sharply toward the crown tops. P3 has low transverse lophs. The buccal cingulum on P4 is better developed than on P3. The parastyles and the paracone ribs of the upper molars are very narrow and closely appressed. On M2 the transverse lophs are moderately oblique, the crista and posterior cingulum are distinct. The angles formed by the ectoloph with protoloph and metaloph are about 40° and 50° respectively. On M3 the protoloph is more oblique than on M2, the angle between it and the ectoloph is only about 30°. The lingual end of the protoloph is flattened, without protocone constrictions.

On m1 and m2 the transverse lophids are moderately oblique and the buccal walls are almost flat, with the ectoflexids only present on the top parts of little worn molars. Talonid basins are large and deep. Trigonid and talonid basins are blocked by the well-developed lingual cingula.

Comparison and discussion　The above described Erenhot specimens closely resemble those of *Hypsamynodon* in having very narrow and appressed parastyles and paracone ribs in upper molars. However, *Hypsamynodon* is characterized by having particularly hypsodont cheek teeth, which is not the case in the Erenhot specimens. As a whole, the Erenhot specimens share much more common features with those of *Cadurcodon*. These are the similar degree of hypsodonty, the longer premolars relative to molars, broader lower molars with moderately oblique transverse lophids, flat buccal walls, highly reduced ectoflexids, etc. This led the authors to attribute the above described specimens to the genus *Cadurcodon*.

Cadurcodon is known to include three species: *C. ardynensis*, *C. zaisanensis* and *C. kazakademius*. As the Table 3 shows, the Erenhot specimens are larger than *C. ardynensis* and *C. zaisanensis*, but close to *C. kazakademius* in size. However, they differ from *C. kazakademius* in having more hypsodont cheek teeth, more reduced ectoflexids on lower molars, trigonid shorter than talonid in m1, and proportionally wider m3. In addition to size differences, the Erenhot specimens can be distinguished from those of *C. zaisanensis* in retaining partly discernible ectoflexids, having buccal cingula, and higher lingual cingula closing the trigonid and talonid basins in lower molars; from *C. ardynensis* in having nearly smooth buccal walls without clearly shown paracone and metacone ribs in upper premolars, and the very narrow parastyle-paracone rib complex in upper molars. A new species is thus erected for these Erenhot specimens, named as *C. houldjinensis*.

Matthew and Granger (1923) reported three teeth from the Houldjin Formation, referred a lower molar [AMNH 19138(Field no. 36, fig. 2)] to *Cadurcotherium* sp. and the other two to *Cadurcotherium*? sp. Gromova (1954:182) already transferred them to the genus *Cadurcodon*, an opinion we can only concur with, based on further examination of these teeth. The m2 (AMNH 19138) is similar to *C. houldjinensis* in general morphology and falls within the range of variation of the latter (see Table 3), and therefore can be referred to *C. houldjinensis*. The other two teeth, a right P4(Matthew and Granger, 1923, fig. 4) and a right upper molar (M1/2, Matthew and Granger, 1923, fig. 3), are more similar to those of *C. ardynensis* in morphology. In addition, they fall within the range of variation of the latter (see Table 2). Both can be referred to *C. ardynensis*.

Artiodactyla Owen, 1848
Entelodontidae Lydekker, 1883
***Entelodon* Aymard, 1846**
***Entelodon gobiensis* (Trofimov, 1952)**
(Fig. 8)

Specimen Left P4(EMM 0128).

Locality 10 ~ 20 m southeast of IVPP Loc. 1988001.

Remarks The P4 is roughly triangular in occlusal view. The paracone and protocone are close situated. Its paracone is slightly larger than the protocone and confluent with the latter on worn. The cingulum is developed around the tooth. The P4 is almost identical with that of *Entelodon gobiensis* in morphology. In size (29 mm×35 mm) it falls also within the range of variation of the latter species, to whom EMM 0128 is referred.

2 Geological age of the Houldjin Fauna

Opinions as to the geological age of the Houldjin fauna differed widely, varying from Miocene (or later) to Late Eocene (Granger and Berkey, 1922; Osborn, 1923; Matthew and Granger, 1923; Berkey and Morris, 1927; Romer, 1966; Li and Ting, 1983; Russell and Zhai, 1987; Wang, 1992, 1997). As is currently known (Lucas and Emry, 1996a; Wang, 2001, 2007a,b, 2008a,b,c; Qiu and Wang, 2007), the Houldjin fauna is composed of 30 species of 24 genera belonging to 18 families of 8 orders. As far as their stratigraphic distribution is concerned, these taxa can roughly be divided into 5 groups:

1) 6 taxa occurred in Middle Eocene: *Ictopidium lechei*, *Advenimus* (*A.* cf. *A. bohlini*, *A.* cf. *A. burkei*), *Yuomys* (*Yuomys* sp.), *Protataromys* (*Protataromys* sp.) and *Allosminthus diconjugatus* (*A.* cf. *A. diconjugatus*);

2) 3 taxa ranging from late Middle Eocene through Late Eocene: *Eosimias* (*Eosimias* sp.), *Gobiolagus tolmachovi* and *Pappocricetodon* (*Pappocricetodon*? sp.);

3) 14 taxa occurred in Late Eocene: *Anatolechinos neimongolensis*, *Desmatolagus vetustus*, *Gobiomys neimongolensis*, *G. exiguus*, *G.* cf. *G. exiguus*, *Gobiomys* sp., *Eocricetodon* (*E. borealis*), *Oxynocricetodon* (*O. erensis*), *Allosminthus* (*A. majusculus*, *A. ernos*), *Symphysorrhachis* (*Symphysorrhachis*? sp.), *Cadurcodon ardynensis*, *Metatitan* (*Metatitan* sp.) and *Entelodon* dirus;

4) 4 taxa ranging from Eocene through Oligocene: *Hyaenodon* (*Hyaenodon* sp.), *Pseudoloris* (*P. erenensis*), *Prosciurus* (*P. pristinus*) and *Entelodon gobiensis*;

5) 2 taxa occurred in Late Oligocene and later: *Aralotherium* (sp.) and *Aprotodon lanzhouensis*.

It is evident from the above listing that 22 taxa (76%) existed in Late Eocene, which is most probably the geologic age of the Houldjin fauna. A few words are needed to interpret the

unusual occurrence of the taxa so far found from deposits older or younger than Late Eocene in the Houldjing fauna. The Houldjin specimens referred to *Allosminthus* cf. *A. diconjugatus* was considered by Wang (2008a) as more advanced than the typical Middle Eocene *A. diconjugatus*. Wang (2001) also proposed that some of these taxa, for example, *Advenimus* cf. *A. bohlini*, *A.* cf. *A. burkei*, "may be transported from some underlying deposits." However, the tusk of *Aprotodon lanzhouensis* is so well preserved that it could not be transported from underlying deposits. The alternative explanation of its occurrence in the Houldjin fauna should thus be its earlier appearance in Late Eocene.

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