第27卷 第4期　　古脊椎动物学报　　pp. 284—300
1989年10月　　VERTEBRATA PALASIATICA　　figs. 1—8, Pl. I-II

记同心铲齿象一幼年头骨化石

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关键词　宁夏同心　中中新世　同心铲齿象　头骨

内　容　提　要

本文记述了一个采自宁夏同心丁家二沟的同心铲齿象幼年头骨。通过与 *Pl. danovi*、*Pl. grangeri* 比较，进一步证明了 *Pl. tongxinensis* 的进化水平介于二者之间，并与后者的关系更为密切。笔者选择 *Phiomia* 和现生 *Elephas maximus* 为参照分析了同心头骨的进化特征。尽管三者不属于同一枝系，但表现在它们身上的性状变化仍可大体反映出长鼻类的进化趋向。

1986年叶捷、贾航曾报道了宁夏同心地区发现的铲齿象化石。通过与 *Platybelodon grangeri*、*Pl. danovi* 等的比较，他们将那些化石确立为欧亚大陆上 *Platybelodon* 的第三个种——*Pl. tongxinensis* (Chen)。当时所依据的材料仅是一些孤立的牙齿和残破的齿列。此后，中国科学院古脊椎动物与古人类研究所和宁夏地矿局先后三次派人去同心地区工作，收集了更为丰富的材料。其中 V8503 号标本是保存较完整、上下颌咬合在一起的幼年头骨。这使我们有可能了解同心铲齿象的一些头骨特征，并对 *Pl. tongxinensis* 的分类位置等问题做更进一步的探讨。

本文所研究的化石由曹强修理，侯晋封绘图、张杰照相，在此深表谢意。

一、化石记述

Proboscidea Illiger, 1811
Amebelodontidae Barbour, 1927
***Platybelodon Borissiak*, 1928**
***Platybelodon tongxinensis* (Chen), 1978**

（图版I、II；图1—4）

标本　同一幼年个体的头骨和下颌，具 DP2—DP3（其中左 DP2 缺失）；中国科学院古脊椎动物与古人类研究所标本编号 V8503。

地点及地质时代　宁夏同心县，马二嘴子沟。中中新世通古尔早期（可能相当于欧洲的 MN6）。

1. 头骨

背面(图 1)；葫芦形，面部窄长，颅后部较宽。

前颌骨 (Os premaxillare) 自鼻孔两侧向前水平伸出，形成明显突出的吻部。其上表面圆隆，但在左右前颌骨体相接部位如现生象者形成一明显的凹区。因前部破损长度不清。

鼻骨 (Os nasale) 前端已退缩至眶前缘之后，为一块小的三角形骨骼，构成略向前伸的前鼻孔顶壁。前鼻孔 (anterior narial aperture) 已成横宽形。

额骨 (Os frontale) 相对较短，向后逐渐上升，形成略向前倾的斜面，主要构成眶上顶壁。其前侧方向外突伸，形成明显的眶上突。从眶上突尖向后下方伸出一锐嵴，嵴之末端与翼蝶骨相接。

顶骨 (Os parietale) 大，是颅顶和侧壁的主要构成部分。前面较水平，向后略抬升，在中部形成颅顶最高点，然后较迅速降低，使颅顶呈拱形。虽受挤压变形，仍可看出顶嵴存在，它向前与眶上突相接。

腹面 (图 2)；前颌骨和基枕骨部分均未保存。犁骨已破坏，右耳泡及鳞骨表面亦受损坏。

腭骨 (Os palatinum) 长三角形。前端尖锐伸达 DP^4 之前缘位置。硬腭后缘为∩形。前部可见一腭孔位于 DP^4 第一齿脊后内侧、腭骨一上颌骨交界处，在 DP^4 跟座内侧还可以辨认出两个腭孔。

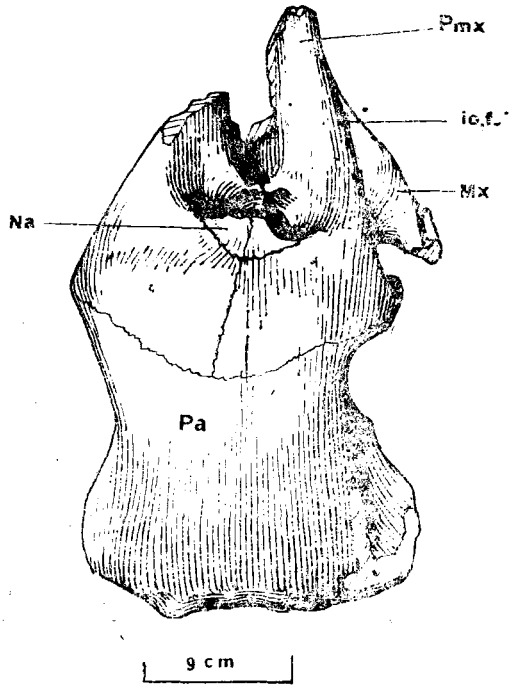

图 1　同心铲齿象 (*Platybelodon tongxinensis*) 头骨 (V 8503)，背面视

Fig.1　Dorsal view of skull of *Platybelodon tongxinensis*

翼蝶骨 (Os alisphenoidale) 位于腭骨之后，与内侧翼骨 (Os pterygoidale) 愈合，共同包裹了上颌骨后部的上颌突 (tuber maxillae) 的下、内侧。翼蝶骨前部向下突伸，形成粗壮的三角形翼钩 ("pterygoid" hamulus)。后部翼上穿孔形成大而圆的翼蝶管 (alisphenoid canal)，为外颈动脉 (external carotid artery) 之通路。前蝶骨 (Os presphenoidale) 和基蝶骨 (Os basisphenoidale) 中部向下突隆，二者界线不清。

卵圆孔 (foramen ovale) 大，与中破裂孔 (foramen lacerum medium) 共同开口在翼蝶骨之后，听泡之前，形成向内前方斜伸的长椭圆形大孔。

听泡 (Bulla ossea) 大，但与现生象相比略显低平而小。近中部位置较高，缓慢地向远中方下倾，在远中侧中部位置最低，由此向前内方突伸一嵴与翼蝶骨腹向突棱相接。欧氏管 (eustachian canal) 开口于此嵴上方。内颈动脉孔 (foramen internal common ca-

rotid) 大而圆，位于听泡前内方，开口在鼓骨上。

鳞骨 (Os squamosum) 相对较大，在头骨后部顶骨之下，明显的向侧方膨起使头骨在后部加宽。其下表面前半部成一向前上方升起的平面，中部位置最低形成一向下突起的关节 (glenoid)，因侧方破坏而不能窥其全貌，但可见外耳道 (meatus acusticus externus) 位于其后上方。从保存部分判断在外耳道下部不形成明显的关节后窝，在这方面与现生象者不同。右侧鳞骨下表面已破损，呈现出若干凹坑，表明鳞骨部已发育气窦 (sinus)。

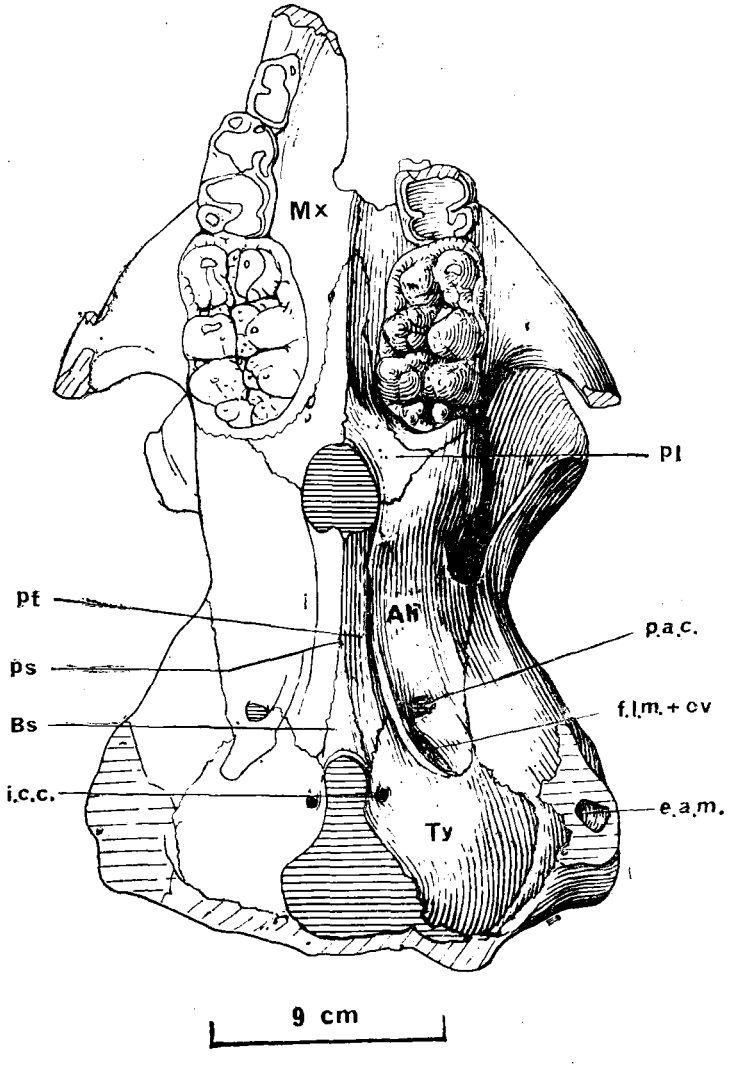

图 2 同心铲齿象 (*Platybelodon tongxinensis*) 头骨 (V8503)，腹面视

Fig.2 Ventral view of skull of *Platybelodon tongxinensis*

后面 (图 3)；因标本尚属幼年期，可能外枕骨与相接骨骼愈合较差，已脱落。仅可见到上枕骨 (Os supra-occipitale)。该骨板微向前倾，形似梯形。中央有一圆形凹陷，其底

面粗糙，凹陷中有一纵向中隔板，为项韧带（ligamentum nuchae）附着处。骨板的上部和侧部不平整，纵纹依稀可见，应为项部肌群之附着面。

侧面（图 4）；面部较低，颅部较高，顶缘大致成一前缓后陡的拱形，最高点位于顶骨中部。与现生象的最大不同处是头骨长而低平。

上颌骨（Os maxillare）低长。颧突如现生象者，大而向后斜伸，构成眼眶底缘。眶下孔（foramen infraorbitale）位于 DP^3 上方，由上下两孔组成，上孔小，虽已破损，光滑的槽状底壁清晰可见，与大的下孔相通。

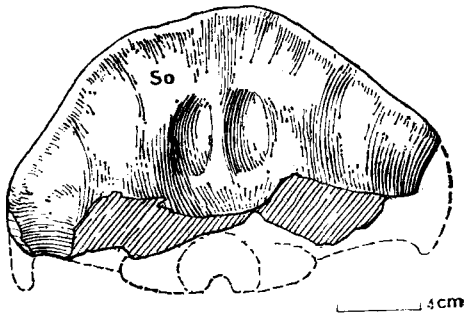

图 3　同心铲齿象（*Platybelodon tongxinensis*）头骨（V 8503），后面视

Fig.3　Occipital view of skull of *Platybelodon tongxinensis*

泪骨（Os lachrymale）小，斜嵌于额骨和上颌骨间，构成眼眶前缘。一大而圆的泪孔（foramen lacrimalis）位于中部。因前部破损未见泪骨小突。

眶蝶骨（Os orbito-sphenoidale）小，背侧与额骨相接。其上可见大而圆的视神经孔（foramen opticum），位置相对较低的前破裂孔（foramen lacerum anterius）以及后部位于该骨和翼蝶骨间的一个较大的圆孔（foramen rotundum）。经修理证明和现代象一样，翼蝶管的前部开口也位于圆孔之中。因标本变形各孔间准确位置无法确定。

在眶上突之正下方额骨腹缘与眶蝶骨相接处有一大的筛孔（foramen ethmoidale）为第Ⅴ神经眼支的筛神经小支和筛动脉的入口。紧接眼眶之后可见一宽阔的扇形颞窝，由顶骨、额骨和鳞骨部分组成。

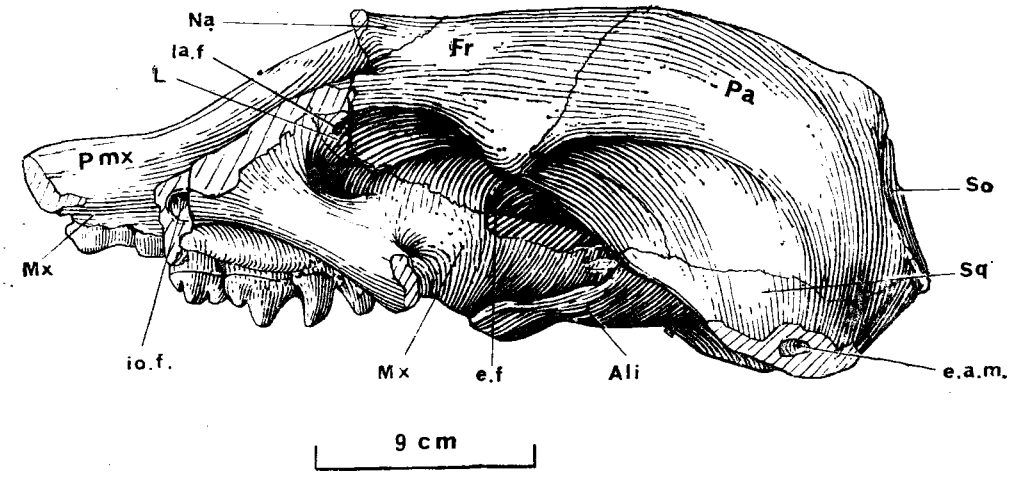

图 4　同心铲齿象（*Platybelodon tongxinensis*）头骨（V 8503），侧面视

Fig. 4　Lateral view of skull of *Platybelodon tongxinen is*

2. 下颌骨

下颌骨最显著的特征是长，与上颌咬合时其前部已远远超出了头骨。

联合部 (symphysis mandibulae) 前部破碎折成三段，上下叠覆。若将其恢复，保存部分可长达 195mm，约相当非联合体长的 57%。上表面成槽形，向前逐渐变平变宽构成一对容纳宽板形门齿的齿槽。

水平枝 (ramus horizontalis) 纵向略上弯，内侧壁平，外侧壁竖直方向外凸。在颊齿区和联合部之间其高度略大于宽，在颊齿区下方则高远大于宽，因而显得较薄。在与上升枝结合部位宽大于高。左右枝上均可见到颏孔，位于颊齿列前约 12mm 处下方。

上升枝 (ramus ascendens) 从 dP_4 后部外侧向后缓缓升起。其顶部均已残破，但仍不难判断冠状突 (processus coronideus) 略高于下颌髁 (condylus mandibulae)，二者间距离较长，整个上升枝相对较低。下颌髁位于下颌体最后端，已脱落，在上升枝后方顶端留下一块向外前方倾斜的长椭圆形粗糙面。该面近中缘之中部有一突隆伸向下前方。下颌角 (angulus mandibulae) 圆钝且薄，向后上方逐渐加厚，在髁颈的下方达到最大厚度，形成明显的内侧隆起。

3. 牙齿

上牙 上门齿均未保存，但从右前颌骨上齿槽判断 dI^2 基部断面近圆形。二乳颊齿齿列中部向外弯凸，前后端方向均有相聚趋势。

dP^2 冠视为前端变尖的长方形。磨蚀较深，可见到颊侧有两个不封闭的珐琅质环，舌侧有一个位置靠后的齿环。前、后及内侧齿带发育。

dP^3 冠视为前部稍窄的长方形。磨蚀深，但仍可看出由二脊和一发育的跟座组成。

dP^4 由三个齿脊和一发育的跟座组成。主齿柱前后斜嵴发育，第一、二副齿柱亦可见到微弱的后斜嵴。跟座已和第三脊分离，主、副齿锥初步形成，已构成第四脊的雏形。齿带发育，齿谷内可见到零星残存的白垩质。

下牙 下乳颊齿列相对较直，二齿列向前方成聚合趋势。

dI_2 板形，外端厚 11mm，内端厚 12mm，宽 60.1mm，横断面显露出不明显的柱状结构。

dP_2[1] 由一个高大的前部主锥和一个小的后部锥构成，主锥顶部有一微弱纵向沟，后壁已被磨蚀形成向后倾斜的磨蚀面。后部锥较低，与齿带相接恰似齿带膨大而成。该齿与 dP_3 相比小很多，出露位置低，磨蚀程度弱，可见是一颗功能退化的颊齿。

dP_3 冠视三角形，磨蚀很深，但仍可看出由三个齿脊及前后跟座构成。

dP_4 冠视前部略窄的长方形。由三个齿脊和一跟座组成。附锥发育，在主齿锥前后构成斜嵴，在第一、二副齿柱后形成弱的后嵴。第一脊主齿部磨蚀较深形成三叶形。第二脊仅可见到前部斜切擦痕。第三脊尚未磨蚀。跟座开始分化出两个大锥，初步与第三脊分离形成较弱的第四脊。齿谷内可见残存的白垩质。

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1) 1986 年发表的“宁夏同心中新世铲齿象化石”一文曾记述了 3 枚孤立的 DP_2（见叶捷等 1986，P142，图版 I,5)。根据本文记述的材料看它们是 dP^2，特此更正。

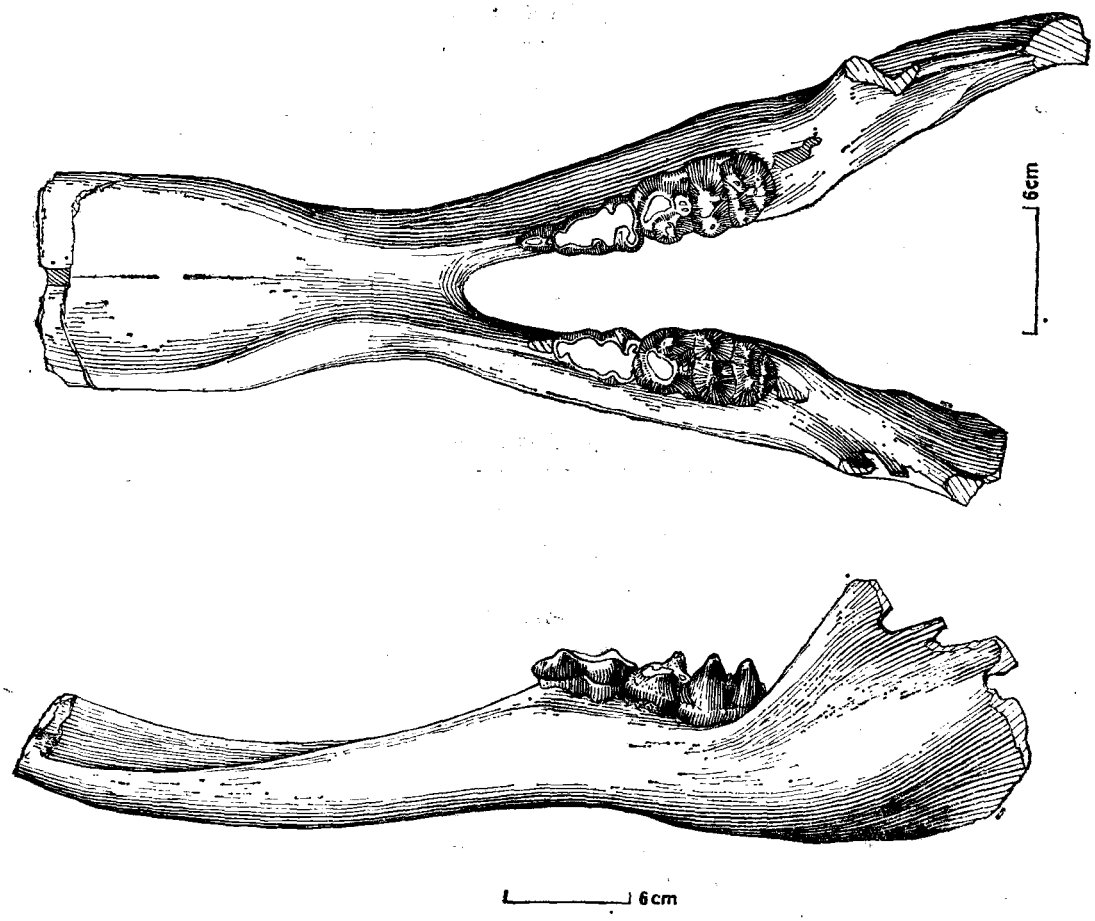

图 5　同心铲齿象 (*Platybelodon tongxinensis*) 下颌骨 (V8503)

Fig.5　Mandible of *Platybelodon tongxinensis*

上 (above): 嚼面视 (occlusal view); 下 (below): 唇面视 (lateral view)

二、比较与讨论

1. 关于 V8503 的分类位置

V8503 是采自宁夏同心马二嘴子沟地点的许多象化石中保存最为完整的一具带下颌的幼年个体头骨。该头骨低长，吻部纤细；下颌联合部长，向前逐渐加宽，具发达的柱形结构板状门齿等性状表明其应属 *Platybelodon*。其上所带的上下乳颊齿中等高冠，附锥发育构成斜嵴，尤其是 dP4 趋于 4 脊形的程度与在同一地区丁家二沟、沙台沟等地点采集到的 *Pl. tongxinensis* 者相同。与 V8503 一起收集到的其它成年个体也明显具有同心种的特征。因此将 V8503 归为 *Pl. tongxinensis* 应无疑问。

(1) 与 *Pl. danovi* 比较　*Pl. danovi* 的幼年个体化石仅发现在苏联北高加索的 Belomecheskaya。唯一的一个残破头骨 (ПИН, No 1311—1) (Belyaeva & Gabunia, 1960)仅保存了鼻骨之前的部分，但带有上门齿和 dP^3—M^1 的颊齿列。显然比同心标本

表 1 头骨测量对比表 单位：mm

	Platybelodon	
	tongxinensis (V 8503)	*grangeri* (A.M. 26464)[1]
DP^2—上枕骨后缘	350	ca. 334.4
鼻骨前端—上枕骨上缘	230	--------
眶上突间宽度	190	--------
鳞骨间最大宽度	217	228.7
头骨最大高度	160	--------

1) 根据 Osborn (1936) Fig. 435 测量

表 2 下颌测量对比表 单位：mm

	Platybelodon			
	tongxinensis (V8503)	*grangeri* A.M. 26464[1]	A.M. 26460[2]	*danovi*[3]
1.联合部长	195	177.6	522	634.2
2.联合部最窄处宽度	85.4	80.5	144	120.4
3.联合部前端宽度	120	132.7	367	228.2
4.联合部最窄处—前端距离	160	120.9	415.7	558.6
5.下颌总长度	536	498	-----	1187.2
6.联合部平均扩展梯度$\frac{3-2}{4}\times100\%$	21%	43%	54%	19%
7.联合部长度指数$\frac{1}{5}\times100\%$	>36.4%	35.7%	-----	53%

1) 根据 Osborn(1936) Fig. 435, 2) Fig. 437, 3) Fig. 426 测量

表 3 乳颊齿测量对比表 单位：mm

	Platybelodon				
	tongxinensis (V8503)	*grangeri*[1] A.M. 26465	26464	*danovi* ПИН,[2] No. 1311-1	ИП,[3] No. 5/23
DP^2L/W	28.5/16.4	25/16	23/17	—	—
DP^3L/W	48.0/30.5	47/30	46/34.5	36—38/30—31	—
DP^4L/W	70.7—72.1/42.3—43.1	—	75/41	62—63/38—39	—
DP_2L/W	17/10.5	10/6.5	—	—	15/9
DP_3L/W	44.9—45.2/27.4—27.5	48/32	46/32	—	44/20
DP_4L/W	74.3—75.9/38.5—39.0	—	80/39	—	57/—
DP^2-DP^4	140	—	138.6	—	—
DP_2-DP_4	132.5	—	—	—	—

1) 根据 Osborn(1936); 2) 根据 Belyaeva & Gabunia(1960); 3) 根据 Gabunia(1973)

表 4　V8503 下颌水平枝测量表

测量位置	高度(左/右枝)	宽度(左/右枝)
联合部后端	47.7/48.7	43.0/45.5
DP^3 前端	62.1/61.5	34.1/37.9
上升枝开始处	47.0/50.0	63.4/63.3

年龄稍长。此外有三段残破的下牙床和三枚孤立的幼年下门齿 (Belyaeva & Gabunia, 1960; Gabunia, 1973)，其中 ПИНNo23 保存较多，带有未磨蚀的 dI_2 和 dP_2—dP_4 齿列，其中 dP_4 未全部萌发，可能是胎儿或刚刚出生不久的幼年个体。由于 *Pl. danovi* 标本过于残破，同心头骨前部受压顶部下陷变形，二者在这部分所表现出的形态差异很难做为特征相比。但二者上乳颊齿间的差别十分明显，具体表现在 *Pl. tongxinensis* 的上乳颊齿轮廓更窄长；齿冠相对更高，小附锥更发育，在 dP^4 主齿部已形成前后斜嵴；dP^4 已趋于四脊形。二者下乳颊齿的主要区别是，在 *Pl. danovi* 中 A. dP_2 前部相对更宽后部更窄，生长在 dP_3 的前外方，斜向前内方[1]。B. dP_{3-4} 齿锥相对粗壮、齿冠相对较低。C. dI_2 相对较厚，横断面内外侧厚度相差较大。虽然 *Pl. tongxinensis* 与 *Pl. danovi* 出现的地质时代大致相同，但上述差异表明后者的性质相对较为原始。

(2) 与 *Pl. grangeri* 比较　1936 年 Osborn 报道了两个残破的 *Pl. grangeri* 的幼年个体头骨和下颌。其中 A. M. 26465 为胎儿头骨 (Osborn, 1936, Figs. 433, 434)；A.M. 26464 头骨具 dP^2—dP^4，M^1 已形成即将萌出，下颌上带 dP_3—dP_4 齿列，M_1 已形成未萌出 (Osborn, 1936, Fig.435)。A. M. 26464 应与 V8503 年龄相当，是最理想的比较材料。经测量对比(见表 1,2)发现如下重要差别：A. *Pl. grangeri* 头骨相对短宽；B. 下颌联合部亦短宽，而 *Pl. tongxinensis* 下颌联合部较窄长，向前加宽梯度小；C. *Pl. grangeri* 的 dP_2 更为退化，主要表现为个体变小仅长 10mm，在齿列中位于 dP_3 前内侧角中，在与 V8503 相当年龄时 dP_2 在齿列中已不存在，甚至无齿槽的痕迹。以上三点区别更进一步支持了叶捷、贾航 1986 年首次报道同心铲齿象时根据臼齿特征所推出的 *Pl. tongxinensis* 性质相对原始，*Pl. grangeri* 性质相对进步的论断。这表明在同心种出现约二百万年后的通古尔晚期出现的葛氏铲齿象的 dP_2 显著退化，下颌联合部下门齿更为特化，形成了更利于取食的宽短的铲形联合部。

综上所述并结合有关成年个体的比较，我们将 *Pl. tongxinensis*, *Pl. grangeri*, *Pl. danovi* 间的关系以图 6 表示。

2. V8503 的特征分析

为了判明 V8503 标本的某些特征的进化水平，我们选择了构造原始的埃及 Fayûm 渐新世的 *Phiomia* 属和古脊椎动物与古人类研究所保存的一个年龄仅 1.5 岁的雄性现生亚洲象 *Elephas maximus* 头骨与 V8503 进行对比。尽管 *Phiomia*、*Platybelodon* 和 *Elephas* 属于不同枝系，但表现在它们身上的性状变化仍可大体反映出长鼻类的进化趋向。我们把与 *Phiomia* 属相近而和现代象不同的特征称之为原始性状，而把接近现代

1) 该 DP_2 的生长位置不同于葛氏种和同心种很可能是个体变异。

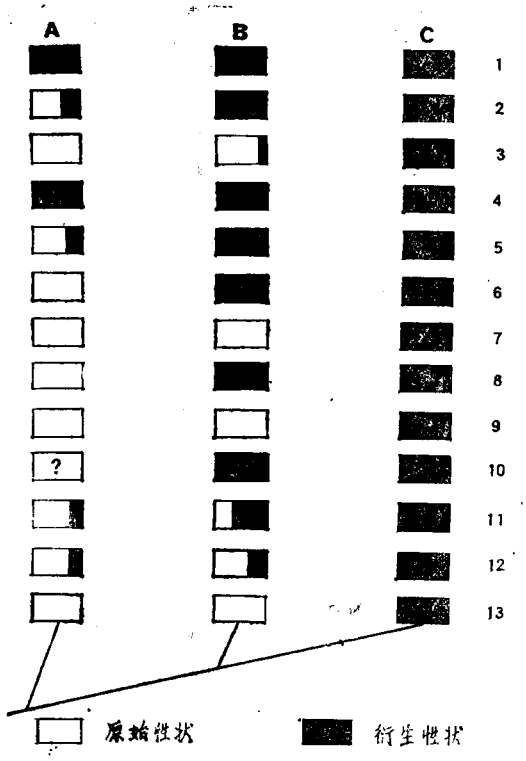

图 6 A: *Pl. danovi*, B: *Pl. tongxinensis*, C: *Pl. grangeri* 间相互关系的解释

Fig. 6 Proposed relationship of *Pl. tongxinensis*, *Pl. grangeri*, *Pl. danovi*

1. dI_2 柱形结构，2. dI_2 成宽板形，3. 联合部加宽相对变短，4.铲齿象型乳颊齿，5. dP^{3-4} 附锥发育构成斜嵴，6. dP^4 趋于 4 脊形，7. dP_2 明显退化，8. dP_4 趋于 4 脊形，9. M^2 趋于 4 脊形，10. M_2 趋于 4 脊形，11. M3 窄长、脊多、冠高，12. 臼齿上白垩质发育，13. M^3 主齿柱发育前部斜嵴。黑色面积表示衍生性状发育程度。以上性状的确定是以 *Phiomia* 为参照

象及另一些特化性状称之为衍生性状。

在 V8503 中残存的原始性状为：(1) 头骨长而低平，最高点位于顶骨中后部。(2) 前颌骨前部下伸幅度小，基本上向前平伸。(3) 上颌骨低长。(4) 有两个眶下孔，上孔小下孔大。(5) 颞窝较宽浅，位置相对靠后。(6) 顶嵴较发育。(7) 腭部相对位置高，颅基部相对较长。(8) 翼蝶管后部开口位于关节窝之前内方。(9) 听泡相对较小、较平、位置较靠后。(10) 下颌联合部较窄长，向前扩展梯度小。(11) 下颌上升枝相对较低、顶缘相对较平，髁位于颌体最后端。

V8503 显示出的衍生性状有：(1) 上颌骨颊齿列后有较长的供齿胚发育的上颌突，其下、内侧被翼骨一翼蝶骨包裹。(2) 眶前缘已移至 DP^3 中后部位置。(3) 鼻骨小，后缘位于眶上突水平，前端不伸出眶前缘。(4) 卵圆孔后退与中破裂孔共同开口形成向前内方斜伸的长椭圆形大孔。(5) 内颈动脉孔开口在鼓骨上，但位置靠前内侧。(6)[1] 圆孔大，位置靠后，开口在眶蝶骨与翼蝶骨间与翼蝶管前口相通。(7) 乳颊齿远比 *Phiomia*

1) 在 *Phiomia* 中圆孔情况不清楚。

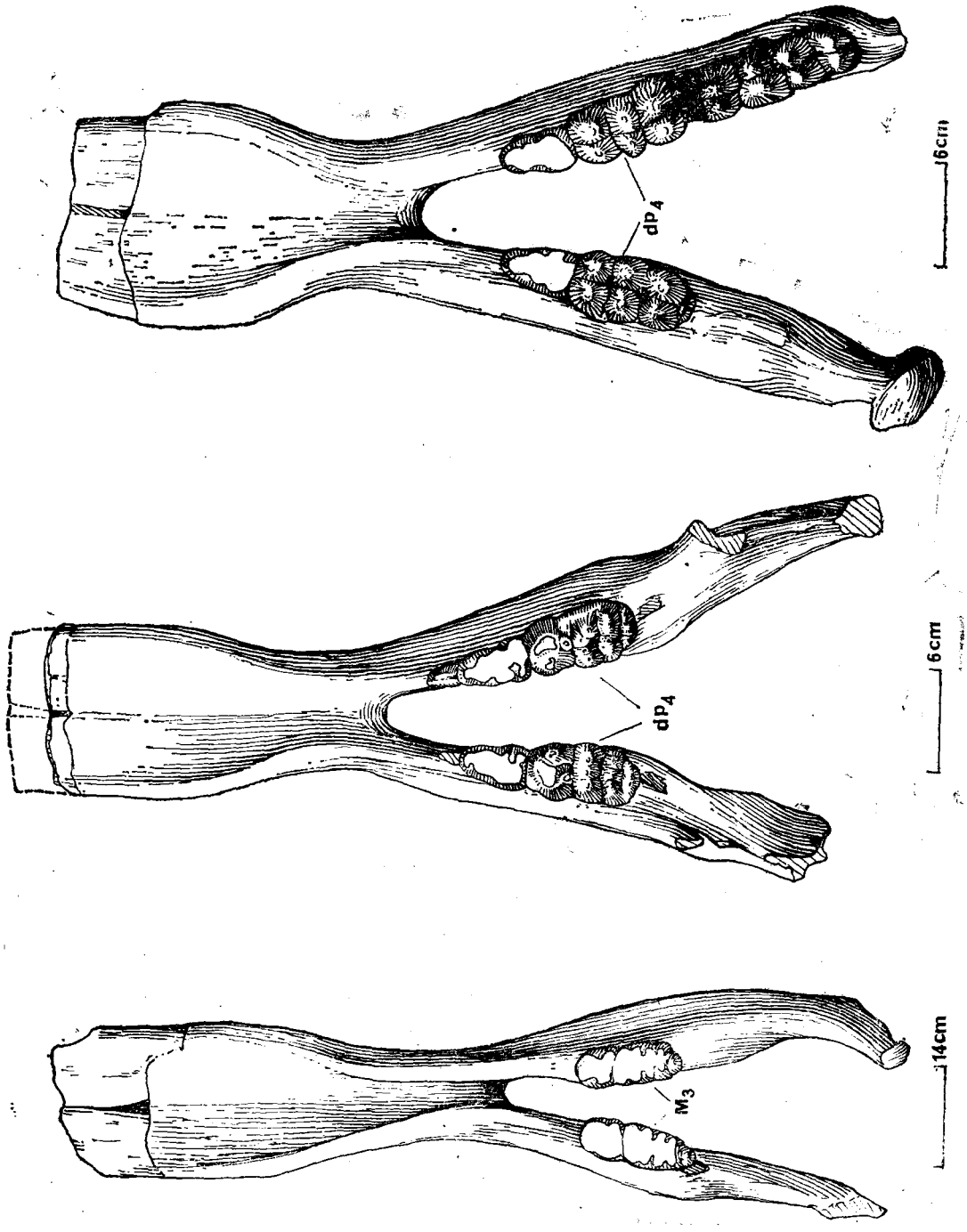

图7　*Pl. danovi* (adult) (A), *Pl. tongxinensis* (B), *Pl. grangeri* (C), 下颌形态比较,明显可见联合部所占下颌体长度比依次减小,联合部宽度增加梯度依次增大

Fig.7　Mandibules of *Pl. danovi* (adult) (A), *Pl. tongxinensis* (B), *Pl. grangeri* (C), showing the difference in morphology (ref. to table 2)

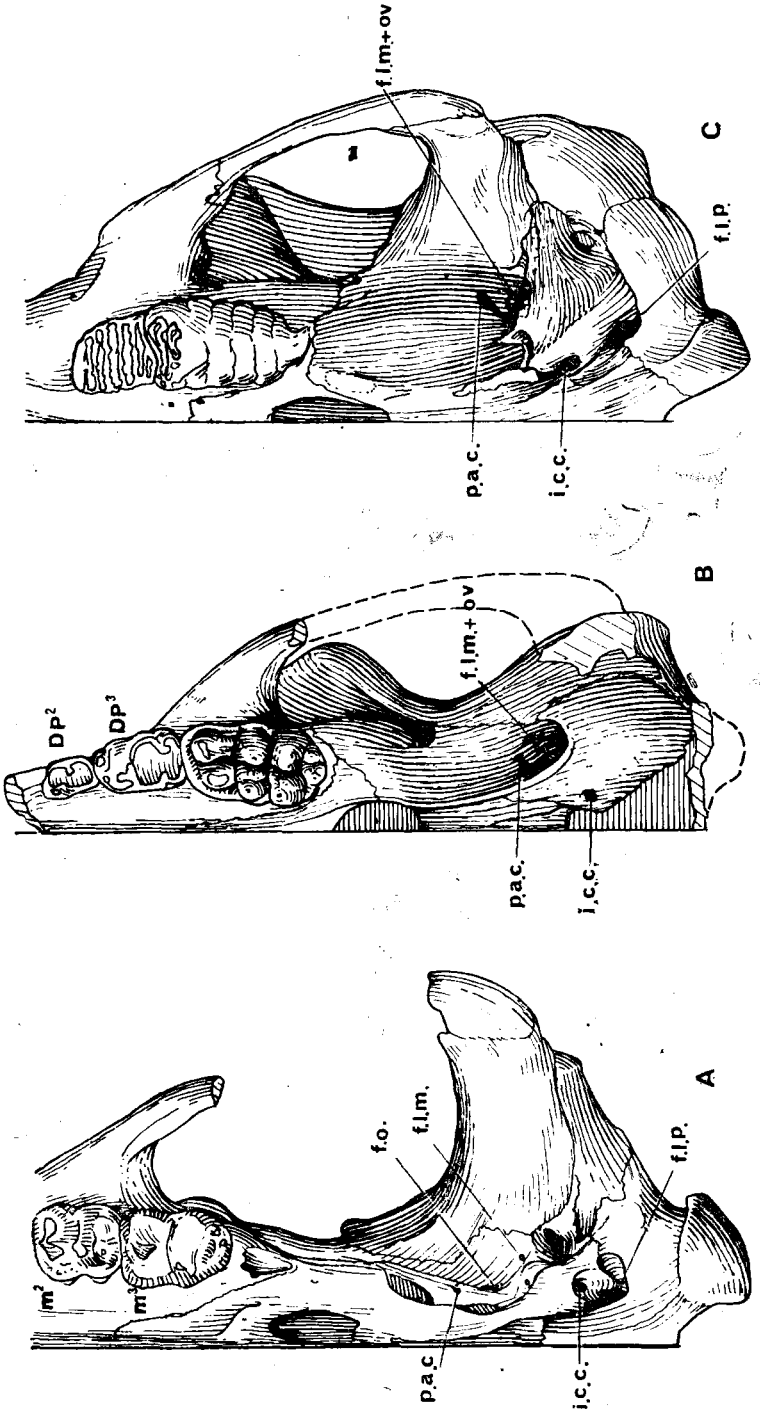

图 8 *Phiomia*, *Platybelodon*, *Elephas* 头骨腹面比较

Fig.8 The base of the skull and part of the palate of: A. *Phiomia*(= *Palaeomastodon* Andrews) (after C. W. Andrews, 1906, Text-fig. 49); B. *Platybelodon* (V 8503); C. *Elephas*

者大，冠更高，附锥发育排列成斜嵴，dP4 已趋于四脊形。(8) dI_2 薄板状、柱形结构。

上述特征的比较表明，V8503 标本在总体进化水平上代表了长鼻类原始型和现生类型间的中间阶段。衍生特征中的(1)、(2)、(5)、(7)项是典型的 *Phiomia* 和 *Elephas* 之间的过渡性状（图 7）。在这三个属中依次看到，从上颌骨后部微膨大到上颌突的出现，直至变化到位置近于竖直。在 *Elephas* 中由于腭部下降，上颌骨下延，上颌突底缘被向前下方牵引形成深而近于竖直的上颌突。翼骨—翼蝶骨构成上颌突的后壁，翼钩转变为竖直状，翼蝶骨变短，引起鼓泡前移等……。这些变化是随着颊齿不断增大齿冠逐渐增高而发生的。如同大多数有蹄类，*Phiomia* 为全齿列和自下而上的出齿方式。在铲齿象阶段，象的臼齿依次推出的出齿方式已基本形成，但前臼齿和乳齿的替换仍保留自下而上的出齿方式，直到上颌突变深、位置近于竖直状时才真正实现了高冠颊齿斜向推出的出齿方式。

衍生特征 (5) 表明很可能在鼓泡前移之前内颈动脉孔已从以 *Phiomia* 为代表的原始类型中的在鼓骨近中央偏后的位置逐渐向前内方向移动，成为如在 V 8503 中的鼓泡前半部内侧边的封闭圆孔。而在现生象中该孔已成为鼓骨前半部近中缘上一个不封闭的大缺口。

衍生特征 (4) 表明早在腭部位置尚未明显下降阶段前卵圆孔已后退并与中破裂孔合并，且形态已和现生象者相同。但 V 8503 中的孔比现代象的相对更大，这很可能与同心铲齿象是具有发达下门齿的长颌象有关，下颌不仅参加咀嚼运动，也担负取食功能。故此从该孔发出了相对更为发达的第 V 神经第 3 支，以支配下颌肌群运动。

在此值得一提的是 N. B. Eales 1926 年发表的关于非洲象胎儿头骨解剖一书，书中图 27 显示了头骨右侧的上小下大的两个眶下孔。表明现生象中的单眶下孔确实是由原始的双孔型进化而成。

同心铲齿象的筛孔大，鼻骨小、位置靠后，圆孔大。显然应有一条发达的长鼻，但和现生象相比，眶下孔小，鼻肌群的附着位置——眶前缘与眶下孔相邻部、鼻孔周缘（确切而言应是鼻孔上未保存的鼻软骨部分）等均不如现生象者发育，因而铲齿象的长鼻尚不如现生象者发达，应似 Borissiak (1929) 复原的那样，是一条向前伸展、覆盖在很长的下颌联合部之上的上唇鼻。

（1988 年 12 月 26 日收稿）

插图简字说明

(Abbreviation for figures)

Ali	Os alisphenoidale	翼蝶骨
Ba	Os basisphenoidale	基蝶骨
e.a.m.	external auditory meatus	外耳道
e.f.	foramen ethmoidale	筛孔
f.l.m.	foramen lacerum medium	中破裂孔
f.l.m. + ov	foramen lacerum medium + foramen ovale	中破裂孔＋卵圆孔

f.o.	foramen ovale	卵圆孔
f.l.p.	foramen lacerum posterius	后破裂孔
Fr	Os frontale	额骨
i.c.c.	internal carotid artery canal	内颈动脉孔
i.o.f.	foramen infraorbitalis	眶下孔
L	Os lachrymale	泪骨
la.f.	foramen lacrimalis	泪孔
Mx	Os maxillare	上颌骨
Na	Os nasale	鼻骨
Os	Os orbitosphenoidale	眶蝶骨
Pa	Os parietale	顶骨
p.a.c.	alisphenoid canal	翼蝶管(后口)
Pl	Os palatinum	腭骨
Pmx	Os premaxillare	前颌骨
Ps	Os presphenoidale	前蝶骨
Pt	Os pterygoidale	翼骨
So	Os supra-occipitale	上枕骨
Sq	Os squamosum	鳞骨
Ty	Os tympanum	鼓骨

参 考 文 献

周明镇、张玉萍,1974: 中国的象化石。科学出版社。

叶捷、贾航,1986: 宁夏同心中新世铲齿象化石。古脊椎动物学报, 24(2),139—151。

Andrews, C. W., 1906: A descriptive Catalogue of the Tertiary Vertebrata of the Fayum, Egypt. London.

Belyaeva, E. I. and L. K. Gabunia, 1960: New finds concerning Platy/belodontinae from the Caucasus. *Trudy Inst. Paleobiol. Akad. Nuak Gruz. SSR.*, V, 63—105.

Eales, N. B., 1926: The Anatomy of the Head of a Faetal African Elephant, *Elephas africanus* (*Loxodonta africana*). *Trans. Roy. Soc. Edinburgh.*, Vol. LIV, Part III, 491—551.

Gabunia, L. K., 1973: The Belomechetskaya fauna of fossil vertebrates. Metsniyereba, Tbilisi.

Gregory, W. K., 1903: Adaptive Significance of the shortening of Elephant's Skull. *Bull. Amer. Mus. Nat. Hist.*, 19, 387—394.

Osborn, H. F., 1936: Proboscidea I.

Tobien, H., 1973: On the evolution of Mastodon (Proboscidea, Mammalia). Part I. The bunodont trilophodont groups. *Notizbl. hess. L. -Amt Bodenforsch.*, 101, 202—276.

COMPARATIVE STUDY OF A JUVENILE SKULL OF *PLATYBELODON TONGXINENSIS*

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Key words　Tongxin, Ningxia; Middle Miocene; *Platybelodon;* Skull

Summary

Ye Jie and Jia Hang reported the occurrence of the genus *Platybelodon* in the Tongxin area in 1986. The species name was taken from Chen, who erected a new species of *Gomphotherium, G. tongxinensis,* from the same region. The materials Ye and Jia described then were, unfortunately, mainly isolated teeth and, in a better case, incomplete tooth rows. Since then more specimens have been collected, among which there is a juvenile skull in assosiation with its lower jaw, V 8503. This enables the authors of the present paper to ascertain some skull features of that special kind of proboscidean and to discuss its phylogenetic position based on skull morphology.

Brief Description

I. Skull

Dorsal View: The premaxillas stretch forward horizontally, bordering the nostril laterally. Their upper rims are blunt and rather wide, forming a central fossa on the dorsal surface of the plate formed by the two premaxillar bones anteriorly. The nasals are very small and triangular in shape. They are retracted back to the anterior border of the orbit, thus overlap little the nostril, which is high in position and rather widened laterally. The frontals are also short, forming a flat upper surface, ascending posteriorly. The supraorbital processes are well developed. The parietals are large. Their middle part forms the apex of the skull. Posterior to the apex the parietals slope down markedly. Though compressed, the parietal ridges are still recognizable, leading to the supraorbital processes.

The ventral side of the skull is rather damaged. The palate is long-triangular in shape, with their anterior tip reaching the level of anterior border of the DP^4. Their posterior border is U-shaped. One foramen is seen on the suture line between the palate and the maxilla on each side, while another pair of foramina is present in the posterior part of the palates. Together with the pterygoid, the alisphenoid embraces the maxillar tuber postero-internally The anterior part of the alisphenoid stretches downward, forming a robust pterygoid hamulus. The alisphenoid canal is of considerable size. The suture line between the pre- and basi-sphenoid is not clearly seen. Both stretch downward markedly. The foramen ovale has a common openning with the foramen lacerum medium. It is situated between the pterygoid and the bul-

la. The latter is small and flat in comparison with that in recent elephants. The internal carotid foramen is large and rounded, situated in the medioanterior part of the bulla, perforating the tympanic bone. The squamosal is comparatively large, bulges laterally, so that the posterior part of the skull broadens considerably. The external auditory meatus lies above and posterior to the glenoid fovea. Probably, there is not a well marked post-glenoid fovea below the meatus, as in the recent elephants. The squamosal is likely pneumatic as shown by its broken parts.

On the occipital side only supraoccipital is seen, which is trapezoid in shape, slanting slightly anteriorly toward its upper part. A deep depression is present in the centre of the bone. The bottom of the depression is rough, provided with a vertical medial ridge, where the ligamentum nuchae attaches.

Lateral view: The facial part is low, while the cranial part is rather high. The profile of the skull forms a curve which is flat anteriorly, but slanting posteriorly. The most remarkable feature of the skull by which V. 8503 differs from those of the recent elephants is its elongation and flatness. The maxillas are low and long, forming the lower border of the orbit. The infraorbital foramen lies above the DP^3 and consists of two openings: a small upper one and a large lower one, which are connected posteriorly. The lacrymal is wedged between the frontal and the maxilla bones. It is perforated by a large foramen which lies in the centre. The relative position of the foramina on the orbito-sphenoid bone: for. opticum, for. lacerum anterium and for. rotundum, is like that in the recent elephants.

II. Lower jaw

The most remarkable character of the lower jaw is its elongation. It is much longer than the skull, which is better seen when they are set in occlusion. The restored length of the symphysis measures 195 mm, about 36.4% of the total length of the jaw. The dorsal side of the symphysis is grooved posteriorly, but becomes more and more flat and widened anteriorly, so that it can accommondate the plateform incisors. The horizontal ramus is weakly convex upward, with its inner side rather flat, but its labial one convex. The height of the part between the symphysis and the cheek teeth exceeds the breadth of this part of the jaw. However, at the junction of the horizontal and ascending rami the opposite is the case: breadth exceeds height. Mental foramina are visible on both rami, 12 mm anterior to the tooth rows. The ascending ramus rises at the level of the second ridge of the DP_4.

III. Teeth

No upper incisors are preserved. Judging by its alveolus, DI^2 seems to have a rounded cross-section. The two cheek tooth rows slightly converge at their extremities. The DP^2 is roughly quadrate in shape, but its anterior part is narrower than its posterior border. It is heavily worn. Two incompletely closed enamel rings are formed on the labial half of the crown, while on the lingual half there is only one, which is situated posterior to the above mentioned ones. Cingula are developed on the anterior, posterior and lingual sides. DP^3 likes DP^2 in shape, but much larger, also much worn, composed of 2 ridges and a talon. DP^4 is composed of 3 ridges and a talon. Both anterior and posterior oblique crests are developed on the pretrites. On the first and the second posttrites faint oblique crests are also visible. The talon, already separate from the third ridge, is composed of two main cones, forming an emb-

ryonic ridge. Cingulum is developed, and the tooth is sparsely covered by thin cement in its valleys.

DI_2 is plate-like, 11 mm thick at its lateral edge, 12 mm at its mesial edge. Breadth of the plate is 60 mm. Dentinal Rod-cones structure can be seen on its cross-section, though not very clearly. The two tooth rows converge only anteriorly. The DP_2 is composed of a large and high anterior cone and a small posterior one. The anterior cone is cut by a faint sagittal groove. The posterior side of the cone is flat because of wearing. The posterior cone is connected with the posterior cingulum. The DP_2 is much smaller and situated much lower than DP_3. It is evidently a degenerated tooth as evidenced by its less degree of wearing. DP_3 is much heavily worn, composed of 2 ridges, one anterior and one posterior talons. DP_4 is roughly quadrate, slightly narrower anteriorly. There are 3 ridges and a talon. Its morphology very much resembles its upper counterpart.

Comparison and discussion

I. Character analysis of the specimen V 8503

For comparison we have chosen 2 skulls of comparable ages: one of *Phiomia* from the Oligocene of Fayûm, Egypt, and the other of a recent *Elephas maximus* of 1.5 years old, kept in IVPP.

The primitive characters found in V 8503 are: 1. The skull is low and long, with its apex situated on the posterior part of the parietals. 2. The premaxillas stretch anteriorly almost horizontally. 3. The maxillas are low and long. 4. There are two infraorbital foramina: a small upper one and a large lower one. 5. The temporal fossa is broad and shallow more posteriorly positioned. 6. The parietal ridges are comparatively well developed. 7. The palate is not considerably lowered down relative to the basisphenoidal part, and the basicranium is comparatively long. 8. The posterior openning of the alisphenoid canal is situated anterior to the glenoid. 9. The bulla is small, not specially inflated, and situated rather posteriorly. 10. The symphysis is long, broadens slowly. 11. The ascending ramus is comparatively low, its upper edge is rather flat, the condyle forms the posteriormost part of the jaw.

The derived characters found in V 8503 are: 1. A large maxillar tuber is present, providing more rooms for the enlarged teeth. The lower and inner sides of the maxillar tuber are embraced by the pterygoid and alisphenoid bones. 2. The anterior border of the orbit is shifted to the level of the middle of the DP^3. 3. The nasals are reduced. Their posterior border is retracted to the level of the supraorbital processes and their tips are not beyond the orbit. 4. The foramen ovale is retracted and shares a common openning of considerable size with the foramen lacerum medium. 5. The tympanic bone is perforated by the internal carotid foramen, which is situated on its mesioanterior part. The foramen rotundum is situated posteriorly and connected with the anterior openning of the alisphenoid canal. 7. In comparison with *Phiomia,* the milk cheek teeth of V 8503 are longer, more high-crowned, with stronger developed accessary conules forming oblique crests. The DP^4 is tending to be four-ridged. 8. DI_2 is plate-like, formed primarily by Dentinal Rod-cones as is seen in cross-section.

Fig. 7 shows the character distribution in *Phiomia, Platybelodon* and *Elephas*. Although these three genera are almost certainly remotely related phyolgenetically, the characters they possess would reflect the general evolutionary trend of the proboscideans. This is clearly demonstrated in the transformation of the complex of the characters directly related to the gra-

dual increase of the crown height of the teeth and the change of the way of the tooth replacement. The above mentioned changes in teeth caused the enlargement and displacement of the maxillar tuber, the shortening of the alisphenoid bone etc. The derived character 5 demonstrates that the internal carotid foramen changed its position in the tympanic bone from a posterior one (in *Phiomia*) to an anterior one (in V 8503), and finally it changed into an openning only partly enclosed by the tympanic bone. The derived character 4 shows that the sharing of a common openning by the foramen ovale and the foramen lacerum medium occurred earlier than the apparent lowering of the palatine took place. It is remarkable that the openning is larger in V 8503 than in the recent elephants. It may imply the intensified function of the lower jaw in taking and chewing the food in *Platybelodon*.

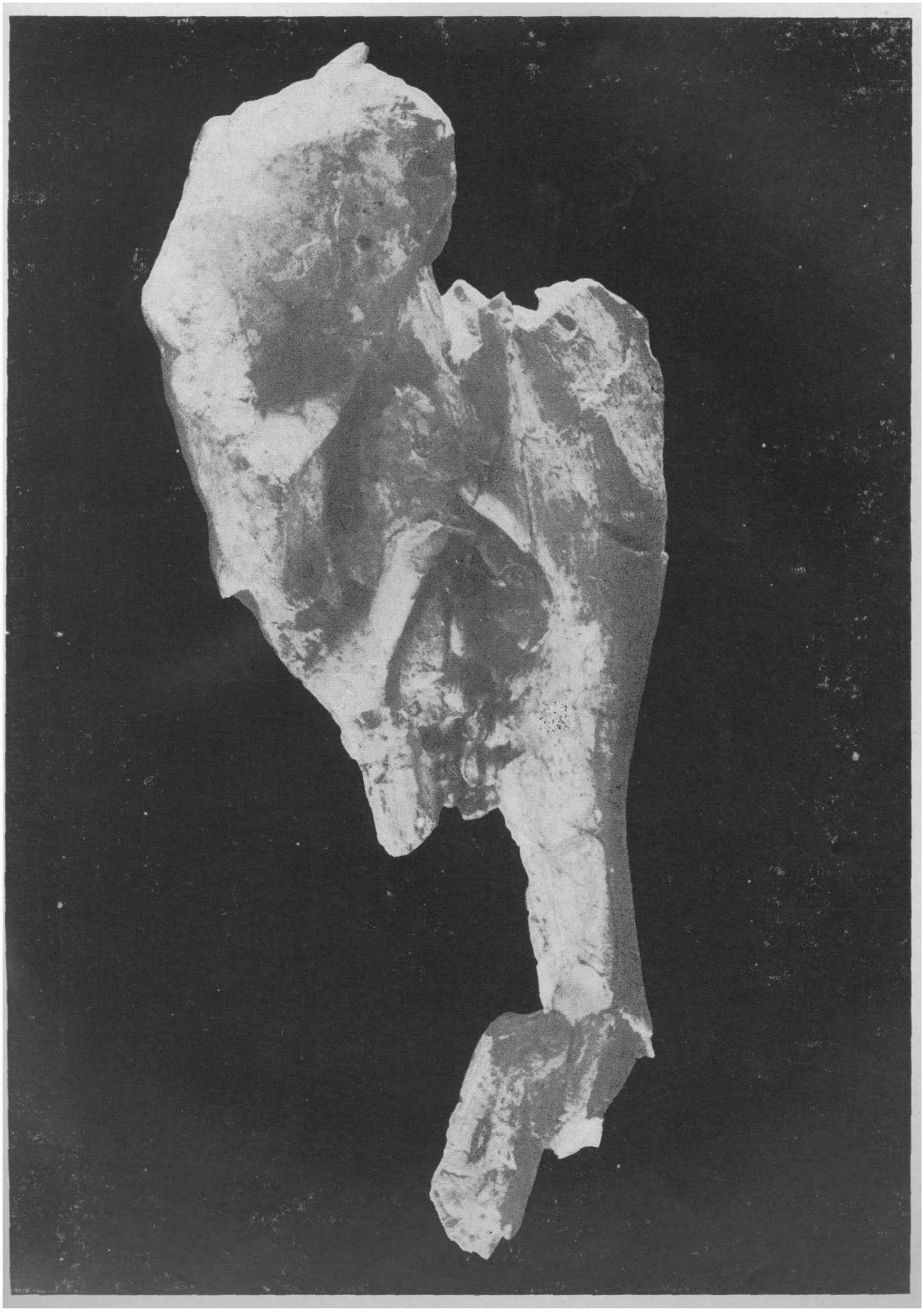
It is worthy to be mentioned here that Eales illustrated two infraorbital foramina on embryonic skull of an African elephant (fig. 27) in 1926. This seems to show that the single infraorbital foramen in recent elephants may originate from a double one.

Judging by its large ethmoid foramen, small and retracted nasal bones, *Platybelodon* had apparently a rather developed and long proboscis. However, the small infraorbital foramen and the limited space for attachment of the muscles controlling the proboscis tend to indicate that *Platybelodon* had a proboscis smaller than that in recent elephant.

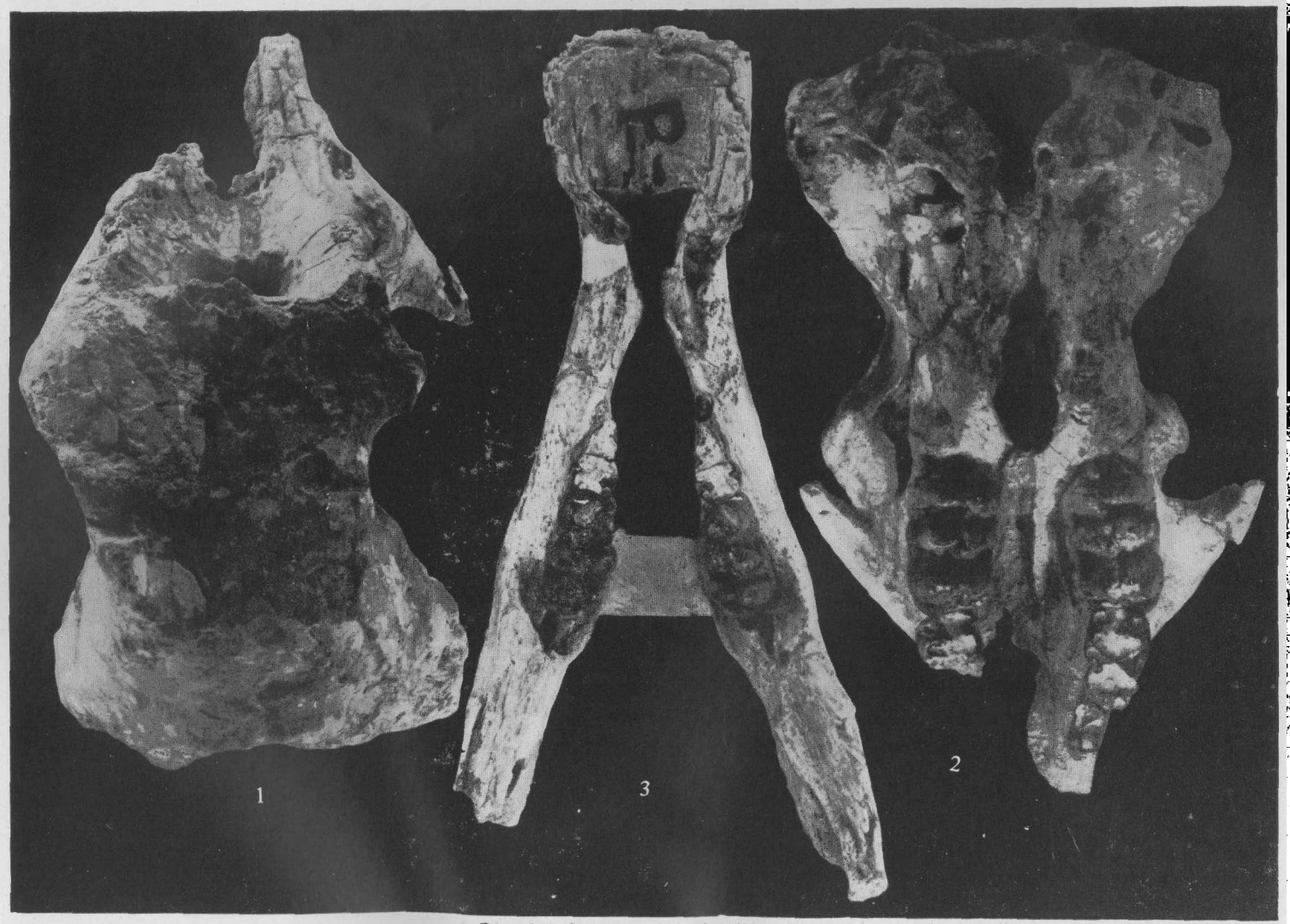
II. Systematic position of *Platybelodon* based on V 8503

There is no doubt that V 8503 belongs to *P. tongxinensis*. The juvenile skull material of *P. danovi* is too poor to be compared with V 8503. However, the milk teeth of these two species are comparable and could be well distinguished. Taken as a whole, the upper milk teeth of *P. tongxinensis* are longer, more high-crowned, with more developed accessary conulets than in *P. danovi*. The DP^4 is tending to be fourridged. The differences between the two species are: 1. The DP_2 is wider anteriorly, but narrower posteriorly in *P. danovi*. 2. The counles on DP_{3-4} are comparatively robust, but the DP_{3-4} are less high-crowned in *P. danovi*. 3. The DI_2 is thicker and the difference in thickness at mesial and lateral edges is larger in *P. danovi*. In general, *P. danovi* seems to be more primitive than *P. tongxinensis*.

There are two fragmentary juvenile skulls of *P. grangeri* among the specimens reported by Osborn in 1936. The differences between them and V 8503 are: 1. The skulls of *P. grangeri* are generally broader and shorter in proportion. 2. *P. grangeri* has a short and broad, spade-like symphysis, while what of *P. tongxinensis* is longer and narrower. 3. The DP_2 of *P. grangeri* is more reduced, smaller in size and situated mesially to the anterior tip of the DP_3. The DP_2 seems to drop off at the age comparable with that of V 8503. It seems that *P. grangeri* is more advanced than *P. tongxinensis*, as proposed by Yie and Jia in 1986.



Platybelodon tongxinensis



Platybelodon tongxinensis (V 8503)

头骨：1.顶面；2.咬面。×3/10；　下颌：3.咬面。×2/7