第 27 卷 第 4 期　　古 脊 椎 动 物 学 报　　pp. 248—267
1989 年 10 月　　VERTEBRATA PALASIATICA　　figs. 1—7, pl. I-II

陕西府谷前棱蜥类一新属及有关问题的讨论

李 锦 玲
（中国科学院古脊椎动物与古人类研究所）

关键词 陕西府谷　下三叠统和尚沟组　前棱蜥科

内 容 提 要

本文详细记述了陕西府谷下三叠统和尚沟组中发现的一前棱蜥类骨架。依据头骨及头后骨骼特征订立一新属种：河套五角蜥（*Pentaedrusaurus ordosianus* gen. et sp. nov.）。讨论中，对原归入前棱蜥科的袁氏三台龙（*Santaisaurus yuani*）的系统分类位置提出了修正意见，同时建议取消黄河保德蜥（*Paoteodon huanghoensis*）这一名称。

一、化 石 描 述

前棱蜥是一类小型的原始爬行动物，也是除龟鳖类外唯一生存到晚三叠世的无孔类。长期以来它被归入无孔亚纲杯龙目（Anapsida, Cotylosauria）。近年来由于杯龙目中同时包括了两栖类和爬行类，也由于杯龙目命名的基础阔齿龙科（Diadectidae）的系统位置未定，对杯龙目有众多的讨论。Heaton（1980）提出杯龙目应仅包括蜥蜴型亚目和阔齿龙型亚目（Seymouriamorpha and Diadectomorpha）。Carroll（1987）提出以无孔亚纲大鼻龙目（Anapsida, Captorhinida）来包括大鼻龙型亚目，前棱蜥亚目和钜齿龙亚目等最原始的羊膜类。

1986 年野外工作期间，在陕西府谷麻镇和尚沟组上部褐红色砂质泥岩中发现一具不完整的前棱蜥骨架，依据其头骨及头后骨骼特征建立了前棱蜥类的一新属种，河套五角蜥（*Pentaedrusaurus ordosianus*）。这一发现丰富了我们对中国前棱蜥类的认识，同时为这一门类的世界性对比提供了新材料。

前棱蜥科 Procolophonidae Seely 1888

五角蜥属 *Pentaedrusaurus* gen. nov.

属名由来 由两个拉丁化希腊文（pentaedru 及 saurus）组成，意为具五边形头骨的前棱蜥。

特征 见属型种。

河套五角蜥 *Pentaedrusaurus ordosianus* gen. et sp. nov.

种名由来　以化石所产地区命名。

正模　一不完整骨架，包括近于完整的头骨，大部分背椎，部分肩带，腰带，前肢和后肢。中国科学院古脊椎动物与古人类研究所标本登记号 V8735。

产地　陕西府谷县麻镇。

时代及层位　早三叠世，和尚沟组上部。

特征　头骨大，扁平，顶视为五边形。眶颞孔大，外形不规则，其长度超过头骨长度的二分之一。顶孔弹头形，位于眶颞孔后缘之前。方颧骨发育，在眶颞孔中点连线的位置上形成指向头骨两侧的尖突。翼骨横翼为大的三角形，强烈向腹面延伸。下颌短而粗壮，腹缘强烈弯曲，喙状突发育。牙齿数目少，分化明显，齿列极短，上颌 9 齿，下颌 7 齿。身体较高而窄，具远端扩张的特殊颈肋。

标本记述　头骨前部及右后侧保存完好，左侧眼眶下缘自颧骨至鳞骨断失，眼眶前缘两泪骨破损，枕面及脑颅部未保存。头骨大而低平，全长 78 毫米。顶视为一以中线为对称的不等边五边形。枕边最长，为舒缓的波状曲线。两后侧边自上颞骨的后外角延至方颧骨侧突，为一内凹的弧线，显示次生耳凹 (secondary otic notch, Kemp 1974) 的存在。两前侧边较长，在前端以大约 70° 的角相交，形成削尖的吻部。头骨的最大宽度通过方颧骨侧突一线，58 毫米，为头骨长度的 74.5%。头骨大的尺寸及部分头骨骨片间的愈合表明化石代表一成年个体。

眶颞孔大，外形不规则，长 38 毫米，接近头骨长度的二分之一。大的顶孔呈弹头形，位置靠前，孔的后缘较眶颞孔后缘大大超前，孔的前缘抵方颧骨外突一线。Ivachnenko (1979) 在记述俄罗斯地台的前棱蜥类时认为眶颞孔的加大可归为两种类型：一种以 *Tichvinskia* (苏联，T_1) 为代表，封闭眼孔后缘的眶后骨强烈退化，变为很薄的骨片，贴于颧骨之上；另一种以 *Hypsognathus* (北美，T_3) 为代表，它虽具同样发育的眶颞孔，但未见眶后骨退化的迹象。这一标本类似于前者，眶后骨显著退化。

前颌骨结构清晰，其上支纤细，左右会合为一尖突状夹于两鼻骨之间。侧视可见前颌骨主部向下，向内收缩，与产自同一地区的 *Eumetabolodon* 十分相似。

一对下颌支与头骨紧紧地咬合在一起，前颌骨腹板的部分结构被它所掩盖。从暴露的部分看，前颌骨腹板较为粗壮，构成了内鼻孔的前缘。左、右前颌骨沿中线结合紧密。在中线两侧，相对于第一对齿骨齿，有一对大而清晰的孔。与此不同，*Tichvinskia* 的前颌骨腹板，沿中央骨缝有一纵向窄沟自前端齿列向前颌骨与锄骨相连部位延伸。Ivachnenko 推测这是“相当于颌间腺构造” (гомология межчелюстной железы)。Carroll 和 Lindsay (1985) 记述了 *Procolophon trigoniceps* 位于前颌骨和锄骨骨缝上的一个小孔，将其和 *Captorhinus* 的相同结构对比称之为前腭孔 (prepalatal foramen) 认为它通过供给锄鼻器 (jacobson's organ) 下鼻动脉的末端分支 (terminal branch of the inferior nasal artery)，连接侧腭窦 (lateral palatine sinus) 和横腭窦 (transverse palatine sinus) 间短的静脉，中筛神经中间分支的腹侧小支 (ventral twig of the median branch of the median ethmoid nerve) 和中腭神经 (median palatine nerve)。而 *Contritosaurus simus*

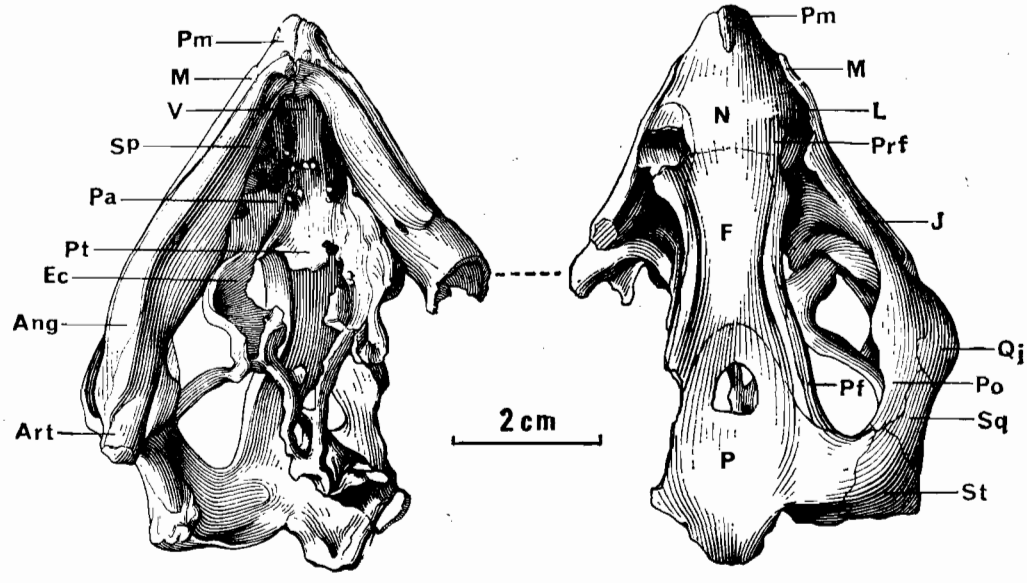


图 1 河套五角蜥(新属、新种)头骨

Fig. 1 The skull of *Pentaedrusaurus ordosianus* (gen. et sp. nov.), 简字说明 Abbreviation: Ang. Angular 隅骨, Art. Articular 关节骨, Ec. Ectopterygoid 外翼骨, F. Frontal 额骨, J. Jugal 颧骨, L. Lacrimal 泪骨, M. Maxilla 上颌骨, N. Nasal 鼻骨, P. Parietal 顶骨, Pa. Palatine 腭骨, Pf. Postfrontal 后额骨, Pm. Premaxilla 前颌骨, Po. Postorbital 眶后骨, Prf. Prefrontal 前额骨, Pt. Pterygoid 翼骨, Qj. Quadratojugal 方颧骨, Sp. Splenial 夹板骨, Sq. Squamosal 鳞骨, St. Supratemporal, 上颞骨, V. Vomer 锄骨

和 *Tichvinskia vjatkensis* (Ivachnenko 1979, 图 8, 图 9)前颌骨的腹面前端靠近前颌齿的部位有一对小孔被称为中筛神经孔 (foramen nervi ethmoidalis medialis)。在前颌骨与锄骨骨缝上的一对孔被称为腭动脉孔 (foramen arteriae palatina)。

与上述几种情况不同,五角蜥的一对孔相当大,且纵向伸长,它不在前颌骨与锄骨相交的骨缝上,而位于内鼻孔前缘一线之前的前颌骨腹板上。孔直接穿透腹板进入鼻腔。腹板顶面情况与腹面相似,骨片两侧隆起成纵嵴,大的孔位于两嵴之间。此孔之前可能不存在单独的中筛神经孔。由于下颌的覆压,此点在前颌骨腹板的腹面尚无法证实,但其背面鼻腔之内似乎未见单独的中筛神经孔存在。五角蜥上一对大孔的形态和位置表明它应该是腭前孔,或称之为前颌孔 (premaxillary foramen)。前颌孔的功能一般认为是鼻腭管 (nasopalatine canal) 的腹侧开口。该管的发生与锄鼻器有关,成体中该孔为软组织所闭塞,不通过任何神经血管。丛林玉等对现生爬行动物扬子鳄的解剖证实了这点 (尚未发表,个人意见交换)。

笔者(1982)记述的 *Eumetabolodon bathycephalus* V 6067 标本上同样可以清楚地见到这一结构 (图 2),大的前颌孔占据前颌骨半圆形腹板的中央,腹板四周凸出,中央凹入,其中心部位为大的蚕豆状的前颌孔。孔之前未见单独的中筛神经孔。这一部位结构的相似性表明在五角蜥与 *Eumetabolodon* (可能还包括 *Neoprocolophon*) 之间——较之与前棱蜥的其它属有更密切的亲缘关系。

上颌骨的背板宽大，近于直立。在一贯穿前后的直棱之下，上颌骨的下部向内收缩，形成一窄长的小面，上颌齿列位于这一小面内侧的上颌骨腹缘上。Carroll 和 Lindsay (1985) 记述了 *Procolophon* 在上颌骨向内收缩处的一纵嵴，认为象鸟臀类的恐龙一样有软组织的颊 (cheek) 生于这一部位。其功能是当动物"咀嚼"时，使食物保持在口中。在五角蜥的头骨上，上颌的向内收缩恰好与齿骨的向内收缩相对应。当上下齿交错咬合在一起时，齿列与头骨的外表面之间形成一窄长的小空间。虽然在两骨片的转折处未见明显的嵴和特殊的软组织着生的痕迹，但一个 cheek 的存在似乎是可信的。

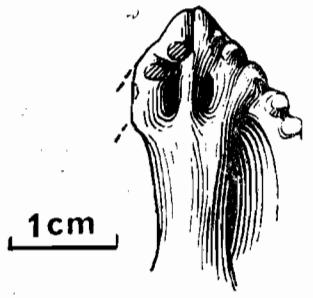


图 2　深头置换齿蜥 (V6067) 头骨前端腹面图，图示前颌孔的形态及位置

Fig. 2　The shape and position of the premaxillary foramen in the ventral view of *Eumetabolodon bathycephalus* (V 6067)

象大多数的前棱蜥一样，五角蜥的上颌骨与颧骨之间也不是锯齿状缝合，而是前者贴接在后者外侧，使头骨在这一部位具一定的活动性。五角蜥左上颌骨后端略有破损，除了与颧骨的贴靠关系之外，它似乎也叠于前颌骨、鼻骨和泪骨之上，成为眼眶前最外侧的一骨片。右上颌骨的上缘突出于泪骨和鼻骨之上，可能是由骨片在连接面上发生活动所造成的。

上颌骨的前部表面紧接外鼻孔之后有一明显的凹坑，两侧均存在，但形状略有不同。Ivachnenko (1979) 将它称为"侧鼻腺凹" (ямка латеральной носовой железы)，而 Carroll 和 Lindsay (1985) 则称其为"上颌骨凹" (maxillary depression)，将它解释为生于大的外鼻孔后缘，口盖状肌肉的固着处。

右上颌骨的前缘稍有破损，未见隔颌骨的踪迹。左上颌骨之前一浅的凹沟标志着隔颌骨与上颌骨的分界。但与 *Procolophon trigoniceps* 不同，在二者之间未见前颌骨细小的上突。

五角蜥的吻部短小，为三角形，与 *Procolophon trigoniceps* 的吻部外形十分相似。鼻骨的前部呈尖突状，从左右两侧包围前颌骨的长而尖的背突，构成外鼻孔的上缘。鼻骨的后部与泪骨，前额骨，额骨的界线不甚清晰，图 1 所示为推测界线，它们并不是确定无疑的。外鼻孔大，为不规则的椭圆形。特征是位置十分靠前，其前端大大超出第一前颌齿的水平。

左右泪骨的顶面部分均已破损。前额骨与鼻骨的界线不清，其后部为一窄长的尖突状贴于眼眶的内侧缘，后端几达眼眶长径的二分之一处。

额骨为一形态不规则的骨片。它的后端以较明晰的波状曲线与顶骨相接。受顶骨的阻隔额骨并未直接伸达顶孔的前缘。象两鼻骨一样，两额骨间的中央骨缝已愈合。额骨虽然占据了顶孔之前眶间部的绝大部分面积，但它几乎被前额骨和后额骨从眼眶内缘排除出去，额骨在二者之间只以一毫米左右的宽度伸达眼眶。

顶孔为一长 7 毫米，宽 6 毫米，后缘及两侧平直，前缘弯曲的子弹形大孔。其位置靠前，孔的后缘位于眶颞孔后缘之前，孔的前缘达方颧骨侧突一线。此孔的位置较 *Procolophon* 的顶孔要大为靠前，而类似于三叠纪中晚期较为特化的属，如 *Leptopleuron*, *Hy-*

psognathus 和 *Neoprocolophon*。孔的形态和大小也与 *Neoprocolophon* 的顶孔十分相似。

后额骨的前部为一尖突，位于眶颞孔内缘的后部，额骨的侧后突覆压于其上。但其后部与顶骨完全愈合，无界线可寻。腹面眶颞孔内缘上一纵向的浅沟，自前下方向后上方扬起，其延伸的趋向似乎显示后额骨在额骨之后很快结束。依据这一推断，后额骨只是一块位于眶颞孔内缘的细长的小骨片，其后端并未伸达眶颞孔的最后端。

顶骨宽大，中线部分向后延伸大大超出了两侧角的上颞骨。这一标本的眶颞孔虽然也很大，但其后端与头骨后缘之间的距离大于其它具有大的眶颞孔属的相同部位，如 *Leptopleuron*, *Hypsognathus* 等。

位于头骨后外侧角的骨片，依 Ivachnenko(1979), Carroll and Lindsay(1985) 的意见称为上颞骨，而不称棒骨。Carroll and Lindsay 提供了这一作法的依据——在更原始的羊膜类，包括盘龙类中，是棒骨而不是上颞骨支持耳囊的侧部；而在大鼻龙类和早期的乌龟中棒骨缺失了，仅仅上颞骨保存下来，但它并不支持脑颅，而是伸向鳞骨或与鳞骨直接接触。晚二叠世的 millerosaurs 则保存了颞区所有的原始成分，它的上颞骨占据着前棱蜥中那单一骨块的位置。这一确认与其它的晚古生代和早中生代羊膜类头骨的模式是一致的。五角蜥中上颞骨大，骨片的顶面向后侧方倾斜，其后缘折向枕面。一般前棱蜥类中，其下延的部分与向侧上方伸出的副枕突相连。五角蜥正模的脑颅部缺失，但上颞骨的向下延伸是可以清楚地观察到的。

颧骨和眶后骨组成了眶颞孔的外缘，二者之间界线不清。

鳞骨在顶视面，上颞骨，眶后骨和方颧骨间只有很小的暴露。后视面，鳞骨自上颞骨之下向前下方延伸，形成面向侧后方的弯曲的凹面，其腹端遮盖方骨。鳞骨的顶面与后面之间有一明晰的棱，它与上颞骨的侧缘一道标示着次生耳凹 (secondary otic notch) 的存在。Carroll and Lindsay (1985) 不同意 Kemp (1979) 提出的在前棱蜥类中存在方骨后鼓膜的观点，他们依据前棱蜥与蜥蜴颊部局部解剖的相似性，认为这类动物的鼓膜是由次生耳凹支持的。鳞骨与方颧骨下端盖于方骨上端的后表面，它们共同环围着大的方骨孔。

方颧骨大，表面近似三角形，虽然没有刺棒着生于其上，但表面粗糙。它与颧骨、鳞骨、眶后骨之间锯齿状缝合清晰。鳞骨和方骨前倾，使其位置前移。在 *Procolophon trigoniceps* 中方颧骨对应于眶颞孔的后半部，而五角蜥中方颧骨则对应于眶颞孔中部区域。一般说来，方颧骨的前移出现在前棱蜥的晚期类型中，为进步特征。

右方骨保存完好，左方骨上部断失，仅方骨骨髁保存下来。方骨末端横宽，中部微微向内，向上收缩，形成内外两个关节髁，关节面平凸状，内外相对。方骨内髁之上，一薄片状分支向中央部伸出，与翼骨的方骨支相会。方骨位置的前移在这一标本中清楚地显示出来，自吻端至下颌关节投影到头骨中线上的位置为 53 毫米，是头骨全长 (78 毫米) 的 68%。

头骨腹面在基关节之前，除翼骨间孔外的各部构造基本保存完整，基关节之后则缺损严重。腹面可辨认的结构特征有下列几点。

一对内鼻孔大，细长，其长轴几乎互相平行。锄骨齿和翼骨齿发育，在锄骨上它们排

列成半圆形，在翼骨上它们围绕翼骨间孔的边缘分布。位于腭骨、外翼骨和上颌骨骨缝相交处的眶下孔（suborbital foramen）或称腭孔（palatinum foramen）大，狭长。

翼骨横翼（transverse flange of pterygoid）发育，强烈地向下延伸，其末端几达下颌的腹缘。外翼骨存在，它们共同组成一前缘浑厚，后缘菲薄，外面凸出，而内面微凹的三角形下突。这也是河套五角蜥头骨进步性的标志之一，它与 *Tichvinskia*, *Hypsognathus* 的这一部位结构相似。翼骨末端为一对面向后侧方的发育完好的关节窝，它表明基关节的存在和脑颅及腭部间的活动性。

与方骨的前移相适应，五角蜥的下颌短，其长度 58 毫米，是头骨全长的 3/4 左右。下颌异常粗壮，整体来看，下颌的腹缘强烈弯曲，呈起伏的波浪状。齿列极短，23 毫米，仅为下颌总长的 40%。这些特征使它明显地区别于任何已知的前棱蜥。

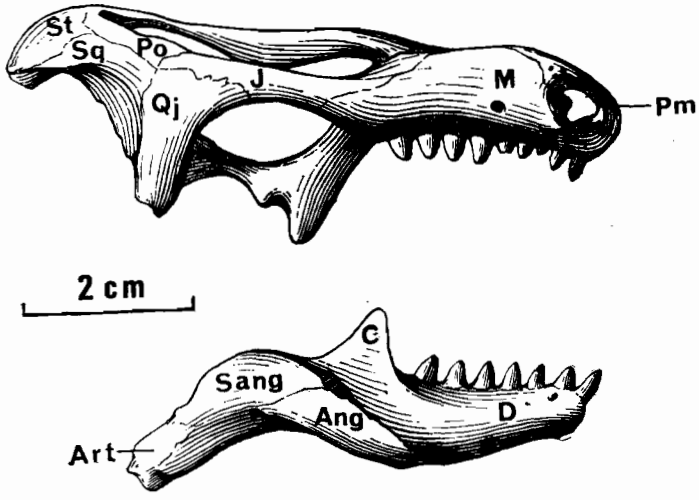


图 3　河套五角蜥(新属、新种)头骨及下颌右侧视

Fig. 3　Skull and lower jaw of *Pentaedrusaurus ordosianus* (gen. et sp.nov.) in lateral view. 简字说明 Abbreviation: Ang. Angular 隅骨, Art. Articular 关节骨 C. Coronoid 喙状骨, D. Dental 齿骨, J. Jugal 颧骨, Po. Postorbital 眶后骨, Sang. Surangular 上隅骨, Sq Squamosal 鳞骨, St. Supratemporal 上颞骨

齿骨宽大，自前向后骨片逐渐加深，可达最大高度 10 毫米，这是最大齿骨齿高度（4 毫米）的 2.5 倍。下颌喙状突发育，与 *Phaanthosaurus*, *Burtensia*, *Procolophon* 等不同，喙状骨为一高耸的三角形，在顶端未见圆形结节的存在。在这一部位下颌达到它的最大高度20毫米。在隅骨、上隅骨部位，下颌的上下两缘开始向中间收缩，然后整体向后下方倾斜，使下颌关节的位置大大低于齿列的高度。舌面，夹板骨盖于麦克尔氏沟上，前端并未伸达下颌的缝合部，其后缘的一大孔为麦克尔氏凹（infra-Meckelian fossa）。

前关节骨界线不清，这是一强烈向内弯曲的骨片。关节骨形态异常复杂，正如 Carroll and Lindsay (1985) 在记述 *Procolophon* 关节骨时所划分的，前部为一三角形的部分，主体部顶面为一近似圆形的凹陷区，凹内有次一级的起伏。其前部，靠近内侧为凹陷，外侧局部隆起。后外侧亦为隆起。在这两个隆起之间的凹入区容纳方骨的外髁。内髁则吻

合在凹的中心部位。方骨和关节骨表面的形状说明下颌与上颌之间只有简单的张开-闭合运动。在关节面内侧的后方可见清楚的鼓索孔 (foramen chordae tympani)。关节凹内侧缘后部加厚,可能为下颌降肌 (depressor mandibulae) 的固着处。反关节突部短小和粗壮,最末端为一圆形的平截面。

在前棱蜥类中,从原始类型到进步类型的发展,往往伴随有牙齿的分化和齿数的缩减。五角蜥上颌 9 齿,包括3个前上颌齿和 6 个上颌齿,下颌 7 齿。数目少于 *Procolophon*; 多于更特化的类型 *Leptopleuron* 和 *Hypsognathus*; 而与 *Sclerosaurus* 的牙齿数相当。

牙齿为端生齿或称原槽生齿 (protothecodont)。齿列分化明显。3 个前颌齿,前两个上颌骨齿和前 3 个齿骨齿为简单的锥状齿,它们都较小,但较粗壮。前颌齿自前向后减小。后 4 个上颌骨齿和齿骨齿为横宽、双尖的牙齿,自前向后逐渐加大,但最后一个牙齿小于倒数第二齿。最后一个牙齿虽然已经使用,但它似乎代表一正在生长中的新生齿。

象所有牙齿发生分化的前棱蜥类一样,前上颌齿包在前部齿骨齿之外,而后部横宽的上颌齿与齿骨齿犬牙交错,大致看来它们为一对一的交插关系。每一个上颌齿冠的后面与相对应的齿骨齿冠的前面互相作用,切断食物。如果把下颌摘开,齿冠上可见到清楚的磨蚀面。但不规则生长的例子也是存在的,左侧的第 2 和第 3 上颌齿同时夹于第 4 和第 5 齿骨齿之间。标本上未见牙齿置换现象。

表 1 河套五角蜥(新属新种)头骨及下颌测量 (单位: 毫米)

Table 1 *Pentaedrusaurus ordosianus* (gen. et sp. nov.) skull and lower jaw measurement (in mm)

	长 度 length	宽 度 width
头 骨 skull	78	58
眶 颞 孔 orbitotemporal	38	15
顶 孔 parietal opening	7	6
眶 前 部 from the anterior end of snout to the anterior margin of orbit	24	—
眶 后 部 from the posterior margin of orbitotemporal opening to the posterior end of skull table	11	—
下 颌 lower jaw	58	20 (hight at the level of coronoid process)
下颌齿列 the dentition of lower jaw	73	—

头后骨骼 共有 13 节脊椎保存下来,最前面的一节位于肩带附近,可能为一前部背椎。相隔一段距离有一串 12 节连续保存的脊椎,其最后一节压在腰带的耻骨之上,且形态有别于前 12 节,推测它为第一荐椎。完整骨架的脊椎总数不清。与其它前棱蜥类相

似，脊椎为双凹型，神经弓宽大，神经棘短，两侧的前后关节突相距甚远，关节面几近水平。椎体腹面有一中棱，棱的两侧有极深的凹。与 *Nyctiphruretus* 和 *Procolophon* 一样，在相连的各背椎之间均有间椎体存在。

左侧有 15 根完整或不完整的肋骨保存，依位置可分为三组。最前面的一组 4 根，其中第 3 根与那单独保存的背椎相连，自前向后肋骨加长。第二组 4 根，肋骨头及相应的脊椎未保存。最后一组 7 根，分别属于那一串脊椎的前 7 个。这 7 根肋骨以等间距的自然状态分布，自前向后逐渐变短。这样荐前椎的最后 4 节没有肋骨——据 Colbert (1946), *Nyctiphruretus* 的最后 5 节，*Procolophon* 的最后 3 节荐前椎不具肋骨，河套五角蜥的情况恰恰介于这两属之间。肋骨单头，其关节面细长。近端部分相当弯曲，这表明该动物可能具有较窄而高的体躯。

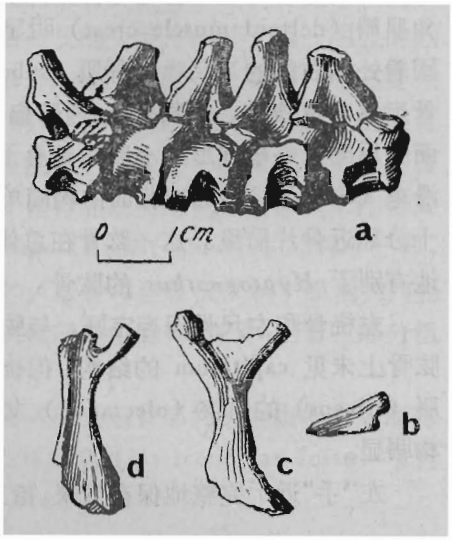


图 4　a. b. 河套五角蜥（新属、新种）脊椎侧视和颈肋远端；c. d. 深头置换齿蜥颈肋
Fig. 4　a. b. *Pentaedrusaurus ordosianus* (gen. et sp. nov.) vertebrae in lateral view and brocken distal end of cervical rib c. d. *Eumetabolodon bathycephalus* (V 6087) cervical ribs

在肩带附近发现了一近三角形的小骨片，两角完整，第 3 个角为一断面。从其大小和宽度推断它是肋骨的一部分。两完整角之间的边缘保存完好，与背肋的近端有些相似，但不具关节面，排除了这一可能。在笔者的手头，有以前发现的两个特殊形态的前棱蜥颈肋 (V6087，未研究标本，与其它的头后骨骼一道发现，可能属于 *Eumetabolodon*，如图 4)。它们短而宽，双头，肋骨中部收缩远端扩张，扩张部的边缘非薄。此次发现的小三角形骨片可能相当于颈肋远端的加宽部分。据 Romer (1956) 称，颈肋扩张的现象见于蜥蜴型类 (Seymouriamorpha)，阔齿龙类 (Diadecteds) 和大鼻龙型类 (Captorhinomorpha)，它是锯肌和肩胛提肌的起点 (origin of serratus and levator scapulae muscles)。但 Romer 认为这一现象未出现于前棱蜥类中，它们的颈肋应是纤细而削尖的。V 6087 和 V 8735 中的颈肋均产自三叠系，它们与前棱蜥类的骨架埋藏在一起，无疑是前棱蜥类的一部分。事实上在此之前，Ivachnenko (1979) 在记述 *Tichvinskia* 的骨架时曾提到：环椎上具短的双头肋骨，远端扩张。第 5 节脊椎的肋骨具远端分叉的特殊形态。

肩带中保存了间锁骨，一对锁骨和不完整的右肩胛骨。肩胛骨上部缺失，保存部分与 Watson(1914) 所记述的 *Procolophon trigoniceps* 的十分相似。它的构造简单，没有肩峰 (acromion)，下部外表面有一向外突出的中嵴。大的臼上孔 (supraglenoid foramen) 仍原始地位于臼上凸壁区 (supraglenoid buttress)。

丁字形的间锁骨十分粗壮，它的横向部分顶视中央向前凸出，两侧向后延伸，侧视为一前凹后凸的弧形面。纵向骨柄部上表面光滑，下表面具一中嵴。一对大的镰刀状的锁骨下部扁平宽阔，为一稍向前凸的弧面，它贴接在间锁骨横梁两端的前面。这明显不同于 Romer (1956) 的断言，他说："前棱蜥类间锁骨的横梁平行于锁骨纤细的下端，二者失去

重叠”。锁骨向上收缩变细，末端形成尖突。

左肱骨保存完整，形态较原始，具扩大的近端和远端。与其它早期四足类肱骨的区别是两端面间的夹角减小，只有 60 度左右；同时在扩大的两端之间有一明显的骨干部。肱骨近端为一背面凸起，腹面凹入的三角形曲面，近端关节面为弯曲的带状。背面前缘的三角肌嵴 (deltoid muscle crest) 明显。腹面前缘的上乌喙肌 (supracoracoideus muscle) 固着处和后缘的下乌喙肩胛肌 (subcoracoscapularis muscle) 固着处也有小的突起。肱骨远端背腹较平。外髁粗壮，内髁扁平。腹面在内外两髁之间形成一浅的三角形凹面。凹面的后部有一半圆形的小凹面重叠于其上，从所处位置推测，它可能相当于与尺骨相接的滑车 (trochlea)。远端背面结构简单。内髁孔 (entepicondylar foramen)大，细长，位置十分靠近骨片后缘。这一肱骨在总体结构上与 *Procolophon trigoniceps* 的相似，明显地有别于 *Hypsognathus* 的肱骨。

左桡骨和左尺骨保存完好，与肱骨比较起来这是一对短小且相当纤细的骨片。虽然肱骨上未见 capitelum 的结构，但桡骨顶端同样为一椭圆形的凹面。尺骨近端附着三头肌 (triceps) 的肘突 (olecranon) 发育。肘突内侧与肱骨滑车相连的 sigmoid notch 结构明显。

左“手”近于完整地保存下来，指式为 2.3.4.5.3。掌骨及指骨细长，与南极 Fremouw

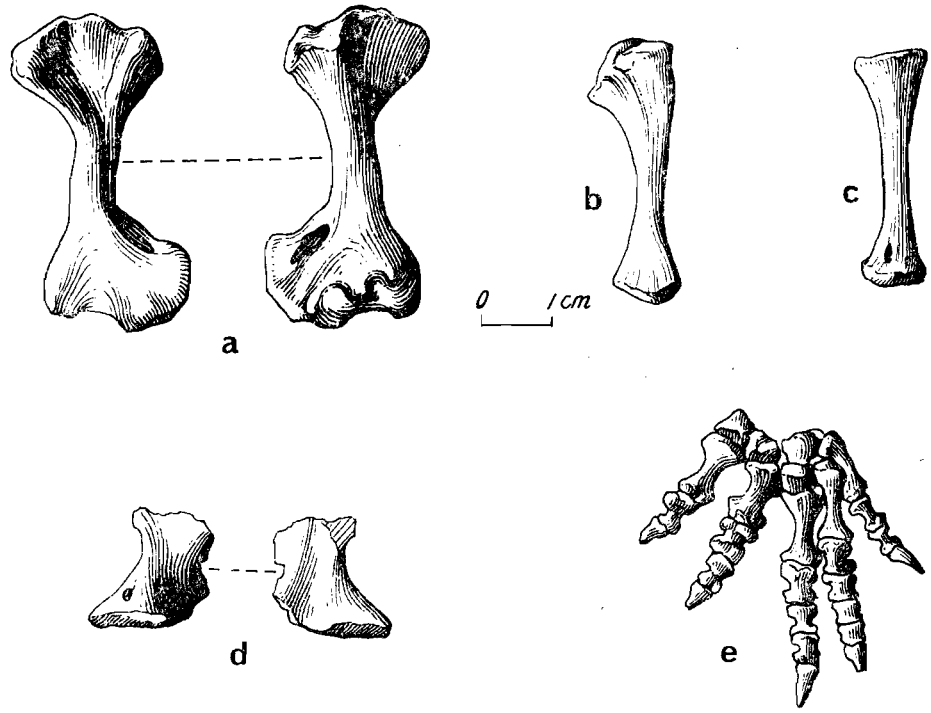


图 5 河套五角蜥(新属、新种) a. 肱骨后视及前视；b. 尺骨；c. 桡骨；d. 肩胛骨远端外侧视及内侧视；e. 左“手”

Fig. 5 *Pentaedrusaurus ordosianus* (gen. et sp. nov.) a. humerus in posterior and anterior view; b. ulna; c. radius; d. the distal end of scupular in external and internal view; e. manus

组的 *Procolophon trigoniceps* (Colbert and Kitching 1975, 图 22B)的形态非常相似。腕部除图 5e. 所示的 4 块远端腕骨外，尚保存有三块小骨片。两块较大，且形态复杂，目前缺少对比标本，仅凭前人文章中的插图，很难对这小骨片作出正确的鉴定。

腰带中保存了不完整的右肠骨和一对在中线相连的耻骨。肠骨下部保存完好，内表面平凸，为扇面状，具放射状细纹。外面形成浅的前后拉长的关节凹。其上为一明显的凸壁结构 (supra-acetabular buttress)。肠骨上部 (iliac blade) 断失。耻骨为一形态复杂的宽板状。它的前后缘都较薄，背面中央一横向弯曲的嵴将其分成前后两部分，大的耻骨孔即位于这横嵴的外端。耻骨的内侧缘和外侧缘明显加厚。外缘为一弧形面。耻骨的腹面(外侧面)较平，仅在耻骨孔的周围有稍隆起的嵴。坐骨的缺失给恢复腰带的工作带来困难，但肠骨和耻骨的形状似乎表明，象 *Nyctiphruretus* (Romer 1956, 图 150D) 一样，在河套五角蜥中髋臼 (acetabulum) 是由肠骨组成的，耻骨和坐骨仅仅从下部封闭它。而 *Procolophon trigoniceps* (Watson 1914 图 4) 的髋臼是由肠骨、耻骨、坐骨三部分组成的。

股骨较长而粗壮，总体观之骨干平直，仅从后视面可见近端背部和远端腹部有局部弯曲现象。近端关节部粗大，远端前后髁发育，其间的髁间凹 (intercondylar fossa) 窄长

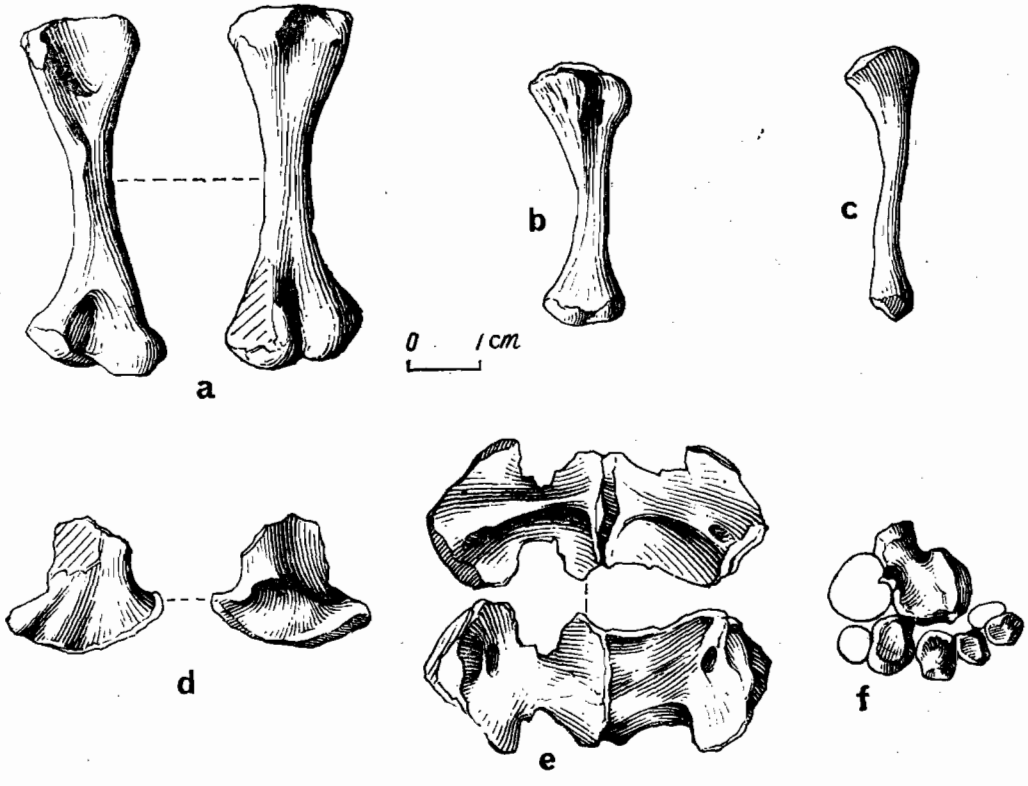


图 6　河套五角蜥(新属、新种)　a. 股骨腹视与背视；b. 胫骨；c. 腓骨；d. 肠骨内侧视与外侧视；e. 耻骨背视与腹视；f. 跗部距骨与远端跗骨

Fig. 6　*Pentaedrusaurus ordosianus* (gen. et sp. nov.) a. femur in ventral and dorsal view; b. tibia; c. fibula; d. ilium in interior and external view; f. tarsus

而深。股骨近端腹面中央的间转节凹（intertrochanter fossa）窄而深，远端中央的腘肌凹（popliteal space）则相对较宽阔。第四转节明晰可见。保存的胫骨、腓骨较为短小而纤细。

跗部保存了5块骨片——距骨和4块远端跗骨。跟骨，中间跗骨及第5远端跗骨未保存。距骨近端较小，远端膨大，二者之间为一收缩的细颈。其外侧一清晰的凹缺标志着动脉从跟骨与距骨间穿过。距骨近端与腓骨的关节面及内侧与胫骨的关节面清晰。

表2 河套五角蜥（新属、新种）肩带、腰带各骨测量（单位：毫米）

Table 2 *Pentaedrusaurus ordosianus* (gen. et sp. nov.) pectorial and pelvic girdles measurement (in mm)

	长 length	宽 width
间锁骨 interclavicle	40	32
锁骨 clavicle	35	—
肩胛骨 scapular	—	17 the distal end
肠骨 ilium	—	22 the distal end
耻骨 pubis	21 antero-posterior direction	23 transvers direction

表3 河套五角蜥（新属、新种）肢骨测量（单位：毫米）

Table 3 *Pentaedrusaurus ordosianus* (gen. et sp. nov.) limb bones measurement (in mm)

	长 length	宽 width	
		the proximal end	the distal end
肱骨 humerus	44	22	24
桡骨 radius	32	10	8
尺骨 ulna	37	14	10
股骨 femur	71	15	22
胫骨 tibia	36	19	12
腓骨 fibular	37	8	10

二、比较与讨论

新属的确立 对于河套五角蜥属于前棱蜥类无需作更多的说明，它头骨的各项特征

清楚地证明这点。前棱蜥类开始出现于晚二叠世，在早、中三叠世异常繁盛，晚三叠世时趋于绝灭。它的化石发现于苏联及非洲的上二叠统，和几乎各大陆的三叠系。

发现于陕西府谷早三叠世和尚沟组的 *Pentaedrusaurus* 明显地不同于早期的具为数众多同形齿的属，如 *Nyctiphruretus*, *Owenetta* 等。从头骨的各项特征来看它属于较为进步，但尚未特化的前棱蜥类，与早、中三叠世的一些属不无相似之处。就其进步特征来看，大的眶颞孔，前置的顶孔，短小的吻部，短的下颌支，它确与晚期特化的属 *Hypsognathus* 和 *Leptopleuron* 相似。但它的上颌齿列牙齿数为 9 (Pm 3 M6)，稍多于后两属的上颌齿数 7 (Pm2 M5)；它的方颧骨发育，但与 *Hypsognathus*, *Leptopleuron* 及 *Sclerosaurus* 不同并未有棘突着生于其上。

Pentaedrusaurus 与产自同一盆地，同一层位，但不同地点的 *Eumetabolodon* 不同，后者的形态更接近于 *Procolophon*，方颧骨向侧后方延伸，与此相关联的方骨前移和下颌缩短的程度都比不上河套五角蜥。*Eumetabolodon* 和 *Procolophon* 上颌齿列数为 10—11，稍多于五角蜥的齿数。

河套五角蜥头骨顶面形态与产自山西榆社二马营组上部的 *Neoprocolophon* 最为接近，后者也有大的眶颞孔，前置的，大的，子弹形的顶孔，短小的吻部和前移了的，指向头骨两侧的方颧骨。但由于保存于坚硬的钙质结核中，且头骨的石化程度极深，*Neoprocolophon* 的牙齿形态和数目仍无法最终确定。但这两属头骨的腹面结构有较大差异。

事实上，五角蜥的独特之处在于它的异常短而粗壮的下颌，仅占下颌总长 40% 的短的齿列，及强烈弯曲，呈波浪起伏状的下颌腹缘。依据头骨的综合特征及下颌的特殊形态，这一属可以区别于任何已知前棱蜥的属。

三、关于中国前棱蜥类各属的讨论

到目前为止，已报道的中国前棱蜥类共五属六种(如表 4 所示)。下面仅就亚洲新前棱蜥及有疑问的袁氏三台龙和黄河保德蜥进行重点讨论。

发现于新疆韭菜园组(水龙兽带)的袁氏三台龙是一小型的不完整骨架，头骨自吻部至眼眶后缘保存较好，后部骨片错位或缺失；头后骨骼包括部分脊椎，肩带，前肢和股骨等。该化石的研究者戈定邦 (Koh 1940) 在讨论三台龙的归属时，将其与 *Prolacerta*, *Broomia*, Eosuchia 等进行了对比，认为"……把它归入爬行类中的任何一大类可能都是不稳妥的，因为一些关键性的特征，如颞颥孔数目，脑颅结构都尚不明了。……推测这一属一方面接近 Lacertilia 和 Rhynchocephalia，另一方面可能接近 Thecodontia，如 *Youngina*, *Prolacerta* 和 *Broomia*"。Romer (1956) 将这一属归入始鳄目，杨氏鳄亚目，Paliguanidae。在其后的许多文章中 (Romer 1967, Kuhn 1969, 中国脊椎动物化石手册 1979, Carroll 1987) 三台龙被从双孔类移到无孔类归入前棱蜥科。

袁氏三台龙在具大的眼孔，短小的吻部，丁字形的间锁骨和双凹型的脊椎等方面确与前棱蜥类相似。但它的牙齿为亚侧生型，明显地有别于前棱蜥类的端生或原槽生齿。它的肢骨也较前棱蜥类的更为进步，骨干长而纤细，暗示着这小的爬行动物运动时更为轻巧和活跃。与两端扩张的前棱蜥类的肱骨不同，三台龙的肱骨两端只稍粗于骨干部，远端关

表 4
(Table 4)

	产 地 Locality	层 位 及 时 代 Geological age and Horizon
袁氏三台龙 *Santaisaurus yuani* Koh 1940	新疆阜康—吉木萨尔一带 The area of Fukang-Jimusar, Xinjiang	韭菜园组,早三叠世 Jiucaiyuan Fm. Early Triassic
亚洲新前棱蜥 *Neoprocolophon asiaticus* Young 1957	山西榆社 Yushe, Shanxi	二马营组中上部，中三叠世 Middle-Upper Ermaying Fm. Middle Triassic
黄河保德蜥 *Paoteodon huanghoensis* Chow et Sun 1960	山西 保德 Baode, Shanxi	二马营组下部,早三叠世 Lower Ermaying Fm. Early Triassic
深头置换齿蜥 *Eumetabolodon bathycephalus* Li 1983	内蒙准格尔旗及陕西府谷 Jungar, Nei Mongol and Fugu, Shaanxi	二马营组下部及和尚沟组，早三叠世 Lower Ermaying Fm. Upper Heshanggou Fm. Early Triassic
东胜置换齿蜥 *Eumetabolodon dongshengensis* Li 1983	内蒙准格尔旗东胜 Dongsheng, Jungar, Nei Mongol	(?)石千峰群 (?) Shiqianfeng group
河套五角蜥 *Pentaedrusaurus ordosianus* (gen. et sp. nov.)	陕西府谷麻镇 Mazhen, Fugu, Shaanxi	和尚沟组,早三叠世 Upper Heshanggou Fm. Early Triassic

节面不具与尺骨相连的转节，在外髁孔的位置上有一道特殊的深沟。脊椎椎体虽为双凹型,且具间椎体,但神经弓不如前棱蜥类的扩张,前后关节面距中线较近,从顶面看神经弓的长度大于宽度。这些特征明显地有悖于把三台龙看作是前棱蜥类一员的观点。

三台龙产自水龙兽带,正模的具体地点不详，但古脊椎所野外队 1964 年在新疆阜康县黄山街附近采到了一批可归入三台龙的化石材料，包括颌骨、牙齿、脊椎及肢骨等。含化石层为一厚层粗砂岩，位于韭菜园组最底部，如果与南非地层对比，该层恰恰在 *Daptocephalus* 带与水龙兽带的界线上。据 Carroll (1975) 称，*Palaeagama* 和 *Paliguana* 的原产出层位同样不清，据产地分布地层推测，前者产自水龙兽带，后者产自 *Daptocephalus* 带或水龙兽带。这样三台龙与南非的 *Paliguana* 和 *Palaeagama* 时代相同或相近。化石材料表明它们之间在结构上有极大的相似性。它们都为小型个体，头骨的大小相近,头骨的各部比例也一致,具短吻,大的眼眶和短的颞区;它们的牙齿从侧面看都为小的钉状 (peg-like tooth)，亚侧生型;脊椎都为双凹型,有间椎体存在,神经弓不如前棱蜥类扩张;肢骨细长,肱骨远端保持了原始的内髁孔。

从目前了解的三台龙的特征看,没有什么关键的问题妨碍将它放入 Paliguanidae 科。值得一提的是这一科原属始鳄目，杨氏鳄亚目 (Eosuchia, Younginiformes) (Romer 1956)。最近 Carroll (1975) 依据头骨的大小,比例和功能上的特征，认为 *Paliguana*, *Palaeagama* 与晚三叠世的蜥蜴 *Kuehneosaurus* 及 *Icarosaurus* 非常相似，它们的头后骨骼具原始特征及蜥蜴类特征的混合,因此将 Paliguanidae 移入有鳞目,蜥蜴亚目,始蜥下目 (Squamata, Lacertilia, Eolacertilia)。这样三台龙就属于蜥蜴类，而且是中国目前所发现的最早的蜥蜴化石。

新前棱蜥是这类动物在中国产出层位最高的一属,它仅以一近于完整的头骨为代表。

从杨钟健 1957 年文章的插图可以看到头骨上的一些关键性特征是含混的，如它的牙齿形态和数目，脑颅部及枕部的结构等。为了进一步了解前棱蜥类中这一有趣的属，也为了便于属之间的对比，笔者试探性地对化石进行了再加工。由于骨片过于菲薄，而岩石致密坚硬，致使修理工作很难进行，效果不甚显著。仅有下述几点可作为对原始描述的补充。

脑颅部的骨片依然存在，但不完整。如两侧的外枕骨，形态不规则，很难记述，唯有它们向侧上方延伸，与上颞骨相连是准确无误的。经过修理头骨上显示了两个令人费解的特征。一是头骨腹面中部，翼骨横缘三角状下突外侧暴露出一水平的骨板，它自齿列之后，围绕翼骨横缘外侧向后延，与翼骨的方骨支相连。它可能也是翼骨的一部分，但目前很难对其功能作出令人满意的解释。二是锄骨前部骨片向下弯曲，呈一垂直的屏壁，末端悬挂着四个小的锄骨齿。壁的前面与前颌骨的腹板相接，该腹板与锄骨的主体部不在同一平面内，前者大大地低于后者。这一特征未见于任何其它前棱蜥的属。

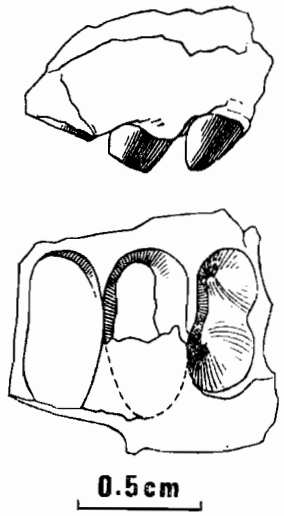


图 7　黄河保德蜥右上颌内侧视与嚼面视

Fig. 7 *Paoteodon huanghoensis* right upper jaw in lingual and occlusal view

保德蜥正模是一段颌骨带有 3 个保存不全的牙齿(IVPP V971 图 7)。原作者认为“这是一块前棱蜥类右上颌骨的中段，上面的牙齿可能是代表第二到第四上颌齿”。“就牙齿的形态构造来说，这一标本与北美晚三叠世的 *Hypsognathus* 很相似，但在咀嚼方式上则有显著的不同”。

保德蜥的鉴订在新前棱蜥之后，二者的牙齿很难对比。近年来随着野外工作的开展，在鄂尔多斯盆地的几个地点发现了大量的前棱蜥类化石，少数头骨完整，大多数只保存了部分颌骨、牙齿和头后骨骼。新材料的发现丰富了我们对这类动物的认识。在此基础上对保德蜥作进一步的观察和对比，发现 V971 标本很可能不是“右上颌骨中段”，而代表右上颌齿列的后端，原来确认的第二、第三、第四齿可能前后顺序颠倒，分别为倒数第一、倒数第二和倒数第三齿。下列各点可以作为证明。

1. 前棱蜥类的颌骨在咬合面上是自前向后加宽的。保德蜥正模 V 971 中保存完好的双尖牙齿(原鉴订者认为是第二右上颌骨齿)部位的颌骨最宽(图 7)，因此它应比另外两个牙齿靠后。

2. 在前棱蜥类中，随着颌骨的加宽，牙齿自前向后加大，但在不少标本中最后一个或两个牙齿是新生齿，其齿冠高度和宽度都小于前面的牙齿，一般尚未使用或磨损程度较轻。这种情况见之于 *Procolophon trigoniceps* (Carroll and Lindsay 1982, 图 1)，*Eumetabolodon bathycephalus* (Li 1983, 图 27,28)，*Tichvinskia vjatkensis* (Ivachonenko 1979, 图 3) 等。V971 保存完好的双尖牙齿解释为最后一个牙齿与上述情况恰好符合。侧视面可见两个大牙的磨蚀面在同一平面内，保存完好具双尖的牙齿位置明显高于前面两个牙齿，它的齿尖尚未达到磨蚀面，显然为一新生的，尚未投入使用的牙齿。

3. 笔者(1983)在讨论 *Eumetabolodon* 的牙齿使用情况时发现，一般来说动物随年龄

的增长，个体加大，牙齿磨蚀程度加深。在"老"年个体，如 IVPP V6070 齿列前部的牙齿完全磨光，以颌骨代为行使咀嚼的功能，而齿列后部的新生齿仍在继续生长。保德蜥的正模倒数第三齿最大宽度 3 毫米，说明这是一个较大个体，同时这一牙齿磨蚀程度极深，齿冠几乎完全消失，磨蚀面几达颌骨的部位。这从另一个角度证明了它的前方不可能有完好的未经使用的牙齿。Colbert 记述的 *Hypsognathus*（1946，图 15，16 等）虽有较大的头骨，但齿冠较高，牙齿的咀嚼面是倾斜的，前面的牙齿由于齿冠低，磨蚀程度较后部浅，表明它处于牙齿使用的较早期阶段。原鉴订者将磨蚀程度极深的保德蜥与 *Hypsognathus* 对比，其结论是不那么令人信服的。

保德蜥的命名虽然较早，但它是建立在资料不够完整，也不够准确的基础上的。与其它前棱蜥类对比时发现，具有这种形态牙齿的前棱蜥类分布于世界各地，如南非的 ***Procolophon trigoniceps*** Owen 1876，苏联的 ***Tichvinskia vjatkensis*** Tchudinov et Vjuchkov 1956，北美的 ***Hypsognathus fenneri*** Gilmore 1928 等。就中国材料而言，它既相似于 ***Eumetabolodon***，也与五角蜥的牙齿一致。因此保德蜥这一属没有确定的特征，而目前又没有理由将它归入任何一已知的属。建议停止使用这一名称，在今后的化石名单上最好使用前棱蜥类（procolophonid）来标明这一类动物在山西保德地区的存在。

野外工作期间，郑钟及彭江华参加了化石的采集工作。室内，承沈文龙绘图，张杰照相，笔者在此致以衷心的感谢。

（1989 年 1 月 4 日收稿）

参 考 文 献

Broom R., 1936: The South African Procolophonia. *Ann. Transvaal Mus.*, 18(4), 387—391.

Carroll, R. L., 1975: Permo-Triassic "Lizards" from the Karroo. ***Palaeont. afr.*, 18, 71—87.**

———— 1987: Vertebrate Paleontology and Evolution. W. H. Freeman. and Company. 1—698.

———— and W. Lindsay, 1985: Cranial Anatony of the Primitive Reptile *Procolophon*. *Canadian J. Eart. Sci.*, **22**(11), 1571—1587.

Chow, M. and A. Sun, 1960: A New Procolophonid from North-Western Shansi. *Vert. PalAsiat.*, **4**(1), 11—13.

Colbert, E. H., 1946: *Hypsognathus*, a Triassic Reptile from New Jersey. *Bull. Am. Mus. Nat. His.*, 86, 225—274.

———— and J. W. Kitching, 1975: The Triassic Reptile *Procolophon* in Antarctica. *Amer. Mus. Novitates*, 2566, 1—23.

Heaton, M. J., 1980: The Cotylosauria: A Reconsideration of a Group of Archaic Tetrapods. In "The Terrestrial Environment and the Origin of Land Vertebrates" Edited by A. L. Panchen. Academic Press, New York, 497—552.

Ivachnenko, M. F., 1979: The Permian and Triassic Procolophonoids of the Russian Platform. Akademiya Nauk. SSSR, 164, 1—80.

Kemp, T. S., 1974: The Braincase and Associated Structures of the Cotylosaur Reptile *Procolophon trigoniceps* Owen. *Ann. S. Afr. Mus.*, 64, 11—26.

Koh, T. P., 1940: *Santaisaurus yuani gen.* et. sp. nov. ein neues Reptil aus dem unteren Trias von China. *Bull. Geol. Soc. China*, 20, 73—92.

Kuhn, O., 1969: Handbuch der Palaeoherpetology, Part 6. Gustav Fischer Verlag. Stuttgart.

Li, J., 1983: Tooth Replacement in a New Genus of Procolophonid from Early Triassic of *China*. *Palaeontology*, 26(3), 567—583.

Romer, A. S., 1956: Osteology of the Reptiles. University of Chicago Press, Chicago, IL, 772p.

———— 1966: Vertebrate Paleontology. University of Chicago Press, Chicago, IL, 468p.

Watson, D. M. S., 1914: *Procolophon trigoniceps*, a Cotylosaurian Reptile from South Africa. *Proc. zool. Soc. Lond.*, 735—747.

Young, C. C., 1957: *Neoprocolophon asiticus*, a New Cotylosaurian Reptile in China. *Vert. PalAsiat.*, 1(1), 1—7.

A NEW GENUS OF PROCOLOPHONIDAE FROM LOWER TRIASSIC OF SHAANXI, CHINA

Li Jinling

(Institute of Vertebrate Paleontology and Paleoanthropology, Academia Sinica)

Key words Fugu, shaanxi; Heshanggou Formation, Procolophonidae

Summary

In the present paper a new procolophonid, *Pentaedrusaurus ordosianus* gen. et sp. nov. is erected on the basis of an incomplete skeleton. *Pentaedrusaurus*, following the *Neoprocolophon* and *Eumetabolodon*, is the third genus of procolophonid found in China, since *Santaisaurus yuani* is here considered as an early lizard and *Paoteodon huanghoensis* as *nomen dubium*. The material described was collected from Lower Triassic, the upper part of Heshanggou Formation of Fugu County, Shaanxi, the same horizon and region as that of *Eumetabolodon bathycephalus*.

Besides chelonians, small sized procolophonids are the only representives of Anapsida survived in Late Triassic. For a long time, Procolophonidae was assigned to Anapsida Cotylosauria. Since Cotylosauria has been used to include both amphibians and reptiles, and the phylogenetic position of Diadectidae, based on which Cotylosauria was erected, is still uncertain, there is much discussion on the meaning of this order. Heaton (1980) indicated that Cotylosauria was a member of the amphibian subclass Batrachosauria, and including Seymoriamorpha and Diadectomorpha only. Carroll (1987) brought up a new proposal that Anapsida Captorhinida, instead of Anapsida Cotylosauria, contains the suborder Captorhinia, Procolophonia and Pareiasauria——the most primitive amniontes.

Procolophonidae Seely 1888

Pentaedrusaurus ordosianus gen. et sp. nov.

Type specimen An incomplete skeleton including slightly damaged skull and lower jaw, most dorsal vertebrae, incomplete pectoral and pelvic girdles, fore and hind limbs.

Type locality and horizon Mazhen, Fugu County, Shaanxi Province. Heshanggou Formation; Lower Triassic.

Diagnosis Body large sized, slightly high and narrow; skull flat, pentagonal in dorsal view; orbitotemporal opening large with irregular configuration and longer than half of skull; parietal foramen large, bullet-like, located anterior to the posterior border of orbitotemporal opening; quadratojugal developed, forming no spikes but a process directed laterally; transverse flange of pterygoid extending ventrally strongly; quadratojugal and quadrate extending

obliquely forward; lower jaw short and robust with ventral margin curved obviously, coronoid process developed; dentition short and differentiated; 9 teeth on upper jaw, 7 on lower; cervical ribs with especially expanded distal end.

Description The skull is preserved well except for the damage of lacrimals and the loss of the occipital plate, braincase and the left posterior part of skull. The skull being pentagonal in dorsal view is large, low and flat. Its total length is 78 mm. The large size of the skull and the fusion of bones on the dorsal surface indicate that the animal is a mature individul.

The premaxilla, septomaxilla and nasal surround the large, elliptical external naris. Although the ventral plate of premaxilla is covered partly by the anterior portion of lower jaw which interlockes with skull tightly, it can be seen that the left and right premaxilla join closely along the mid-line and there is a large fenestra on the centrum of ventral plate of each premaxilla. Destinguished from *Pentaedrusaurus* a longitudinal narow groove on the ventral suture of two premaxillae was described in *Tichvinskia* by Ivachnenko (1979) which was explained as a fenestra "homology of intermaxillary gland". There are two pairs of small fenestrae shown on the Fig. 8 & 9 (Ivachnenko 1979) in *Contritosaurus simus* and *Tichvinskia viatkensis*. The first, called "foramen nervi ethmoidalis medialis", is very close to the premaxillary teeth on the ventral plate of premaxilla. The second, called "foramen arteriae palatina", is on the suture of premaxilla and vomer. A small foramen extending through the premaxilla dorsally and running posteriorly to exit along the suture line between this bone and the vomer in *Procolophon trigoniceps* (Carroll and Lindsau 1985) is visible. This fenestra, termed "prepalatal foramen" seems to be an analogue of "foramen arteriae palatina" of *Contritosaurus* and *Tichvinskia*. It was suggested that the opening transmitted the terminal branch of the inferior nasal artery that supplied Jacobson's organ, a short venous connection between the lateral palatine sinus and the transverse palatine sinus, a ventral twig of the median branch of the median ethmoid nerve, and the median palatine nerve. On the contrary, in *Pentaedrusaurus* there is neither a "foramen nervi ethmiodalis medialis" on the anterior portion of premaxilla, nor a foramen "homology of intermaxillary gland" along the mid-suture of premaxillae, but a large elliptical opening perforating the premaxilla into nasal cavity. The shape and position of the foramen indicate that the opening should be prepalatal foramen or so-called premaxillary foramen being presumbly as the ventral exit of nasopalatine canal. In an adult of living reptiles the fenestra is usually closed by soft tissues and transmites no nerve or blood vessel. This was prooved definitly by the anatomy of *Alligator*, made by Cong Linyu and his collegues (personal communication).

It is interesting to note that a premaxillary foramen, almost in the same shape, size and structure, appers in *Eumetabolodon* as well (Fig. 2). The similarity on this portion of skulls may indicate *Pentaedrusaurus* and *Eumetabolodon* are closely related.

The large maxilla extends almost vertically. As in most procolophonid, the connecting pattern between maxilla and jugal overlapping rather than suturing in serrated line, implies the presence of mobility in this region. In fact a little slide can be observed on the left—the upper rim of maxilla stands out lacrimal and nasal—that means the maxilla presumbly overlapes not only the jugal but also the premaxilla, nasal and lacrimal. The left septomaxilla is a small bone on the posterior margin of the external naris. It is different from that of *Procolophon trigoniceps* in the direct contact with maxilla without an upper process of premaxilla intruding between them. The snout is small and short. The large nasals surround the long

and pointed dorsal processes of premaxillae from left and right sides. But its posterior margin connecting with lacrimal, prefrontal and frontal can not be distinguished in confidence for the fussion and serious damage of two lacrimals.

The large frontals occupy most areas of the inter-orbitotemporal region, but they are almost excluded from the edge of orbitotemporal opening by the prefrontals and postfrontals. The posterior ends of frontals reach the level of the posterior border of parietal foramen, but the frontals fail to enter its margin for being obstructed by the parietals. The parietal foramen is large bullet-like, moved forward as in some Middle or Late Triassic genera, such as *Leptopleuron, Hypsognathus* and *Neoprocolophon.* The parietals are broad and large. Along the midline they extend more posteriorly than the supratemporal does. The dorsal surface of supratemporal is declined slightly and forms a small post-lateral point. The posterior margin of the supratemporal turns over to the occipital plate.

The squamosal embraced by the supratemporal, postorbital and quadratojugal has a small exposure on the dorsal view, then it extends an antero-lateral direction. The line distincting the dorsal surface of squamosal from the posterior surface indicates the presence of a secondary otic notch, and may serve as the attached margin of the tympanum. The quadratojugal lies anteriorly and projects laterally, making the skull shape of *Pentaedrusaurus* more similar to that of *Neoprocolophon* than other genera. It forms neither a posterior process as in *Procolophon* and *Eumetabolodon,* nor some spikes as in *Hypsognathus* and *Leptopleuron,* but its lateral surface is somewhat rugose. The right quadrate is preserved well. Its distal end is transversely broad, antero-posteroly narrow and contracted at the midline—forming two condyles, madial and external with flat and convex surface. The position of quadrate has moved foward obviously. It is 53 mm from the anterior end of snout to the projective point of quadrate on the midline, and that is 68 percent of the total length of the skull.

It is difficult to describe the ventral structure of the skull, since the portion behind the basipterygoid articulation is lost. The characteristics of the palatal are as follows: The internal nares are long and narrow with the longitudinal axis of the left internal naris paralleling to the right. The teeth on the palatal surface are developed. The transverse flange of pterygoid, extending inferiorly strongly, forms a triangular process convex in external and concave in internal. It almost reaches the ventral level of the lower jaw.

The lower jaws including well preserved right ramus and incomplete left one are interlocked with the skull tightly. Adapting to the forward migration of the quadrate, the lower jaws have become very short and robust. It is 58 mm in length, that is about three fourth of the skull length.

The dentary is quite strong and deepening backwards. As the case in other procolophonids, the splenial covers the Meckelian canal and does not enter the symphysis. The coronoid process without a round tubercle on its top, is triangular. At this level the lower jaw reaches the largest hight, 20mm. Behind the coronoid process the upper and lower margins of the lower jaw concentrate first, then parallelly decline post-inferiorly, that makes the lower jaw articulation in a line much lower than the lower dentition. The boundarys of the prearticular can not be trace for certain. With the very complicated structure the dorsal surface of the articular can be divided into three parts, an anterior triangular portion, a nearly round articulation surface and a very short, straight posterior process. The uneveness articulation surface receives the medial condyle of the quadrate in its main depression, the lateral condyle of the quadrate on its external margin. The presence of convex on the antero-lateral portion of the

articulation surface indicates that the propalinal movement of the lower jaws can not occur.

Along with the evolution of procolophonids, the number of their teeth is decreased. The detition of *Pentaedrusaurus,* 9 on the upper jaw including 3 premaxillary and 6 maxillary teeth, 7 on the lower jaw, is similar to that of *Sclerosaurus* and slightly more advanced than that of *Procolophon.* The differentiation of the dentition is quite obvious. The teeth on the anterior portion of the jaws, including 3 premaxillary teeth, the first 2 maxillary and the first 3 dentary teeth are small, conical but rather robust. The other teeth with two cusps are transversely widened and increased in size gradually, except the last one, which is smaller than the one ahead. The small size of the last tooth indicates that it is a growthing new one although it has been used. The anterior dentary teeth are enveloped by the premaxillary teeth, just as is the case in the other procolophonids with differentiated dentition, but the broadened maxillary and dentary teeth interdigitate each other almost one by one. The only exception is that the second and the third maxillary tooth on the left are squeezed into the space between the fourth and the fifth dentary tooth. If the lower jaws were taken off, it could be seen the presence of the wearing facets on the posterior sloping surface of the upper teeth and the anterior sloping surface of the lower teeth.

Discussion It seems to be not necessary to interpret that *Pentaedrusaurus* is of a member of the primitive reptiles, Procolophonidae, since all the characteristics of the skull and postcranial skeleton prove it definitely. The procolophonids had a short but very successful history, made their first appearance in Late Permian, flourished in Early and Middle Triassic, declined and extincted in Late Triassic. The procolophon fossils were discovered in the Upper Permian of Russia and Africa, and almost every continent of Triassic.

Pentaedrusaurus with differentiated dentition is easily distinguished from the primitive genera with numerous homodont teeth such as *Nyctiphruretus* and *Owenetta.* In some respects, the large orbitotemporal fenestra, anteriorly located parietal opening, small snout and short lower jaw, *Pentaedrusaurus* is similar to some specialized genera, such as *Hypsognathus* and *Leptopleuron.* But the former with larger tooth formular (3 premaxillary teeth and 6 maxillary teeth) and the anteriorly located quadratojugal formed a laterally pointed process without spikes is no doubt less advanced than the latter two genera with smaller tooth formular (2 premaxillary teeth and 5 maxillary teeth) and the quadratojugal modified to form several spikes. Judging from the synthetic characters *Pentaedrusaurus* stands at the same developing level with most of Early and Middle Triassic genera of procolophonids. It is interesting that *Eumetabolodon* found in the same stratigraphic level and the same basin with *Pentaedrusaurus,* is more similar to *Procolophon* than to *Pentaedrusaurus* in having a long quadratojugal pointing postolaterally and a jaw articulation near the posterior border of the skull. The tooth number of upper jaw, 10—11 in *Eumetabolodon* and *Procolophon* is also larger than that in *Pentaedrusaurus.* As far as the characters of skull, *Pentaedrusaurus* is most similar to *Neoprocolophon* found in a higher stratigraphic level. Unfortunately, the tooth shape and number of *Neoprocolophon* are still not known for certain.

In fact, the *Pentaedrusaurus* is characterized by its short and robust lower jaw with undulated ventral margin and short dentition being 40 percent of lower jaw length. If the features in all respects are considered, the *Pentaedrusaurus* must represent a new genus differentiated from all known procolophonids.

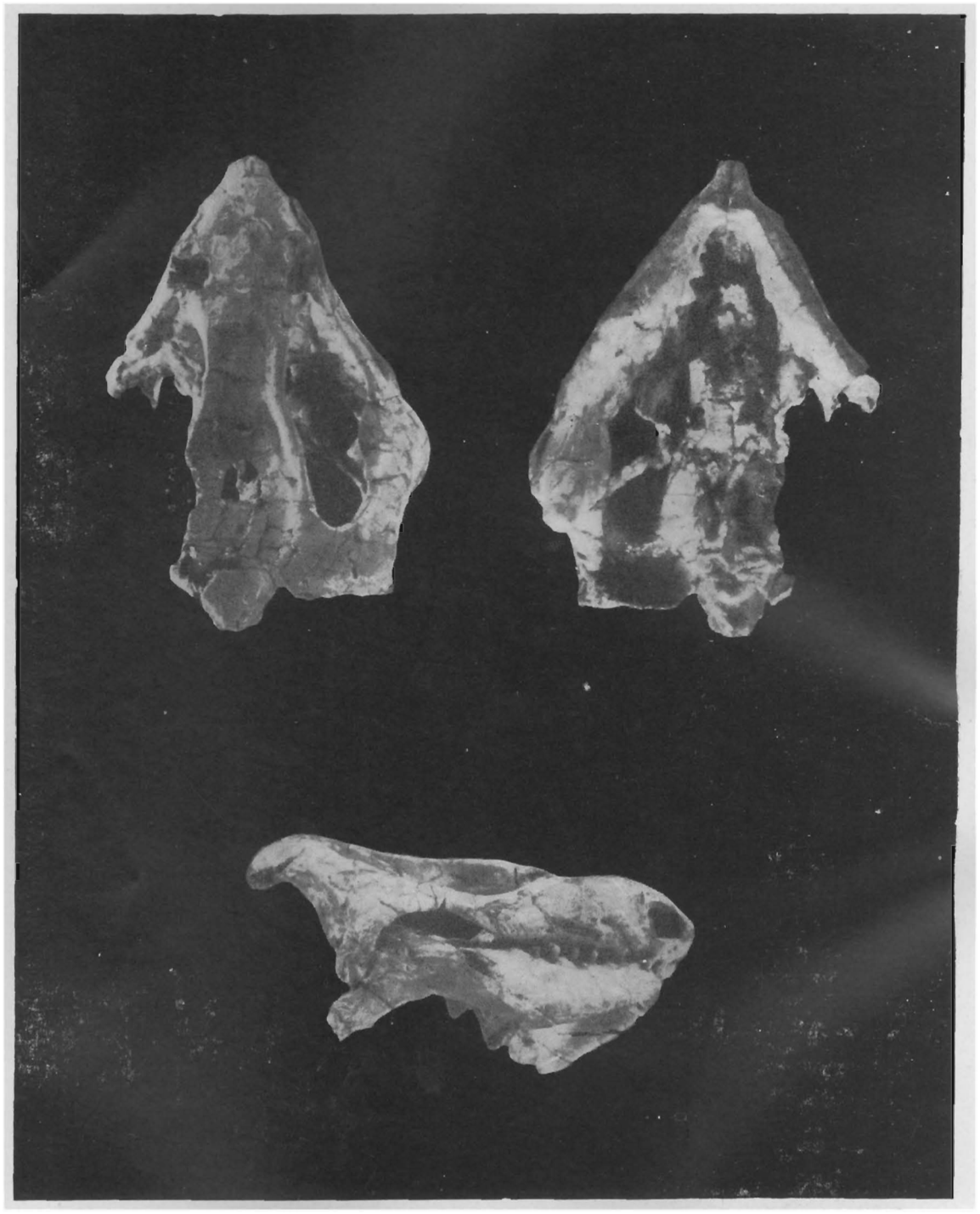
About Chinese procolophonids 5 genera 6 species procolophonids (see Table 4) have been reported from China so far. Among them, especially the assignment of *Santaisaurus yuani*

Koh 1940 and the identification of *Paoteodon huanghoensis* Chow et Sun 1960, will be discussed.

The type specimen of *Santaisaurus* is an incomplete skeleton, including skull, vertebrae, shoulder girdle, fore and aft limbs. It was collected from Santai Junggar Basin, but the exact locality is not clear. In 1964, additional material of *Santaisaurus* was found in a thick layer of coarse sandstone at the bottom of Jiucaiyuan Formation. For the damage of the posterior portion of skull, the attribution of the genus is still questionable. It was first assigned to Eosuchia, Paliquanidae (Romer 1956), then transfered to Anapsida, Procolophonidae (Romer 1966, Kuhn 1969, Chinese Fossil Vertebrate Handbook 1979, Carroll 1988). In having a large orbit, short snout, T-shaped interclavicle, and amphicoelous vertebra, *Santaisaurus* is similar to procolophonids, but it differs most significantly from procolophonids in having small subpleurodont teeth rather than acrodont or so called prototheco dont teeth, and in having slender limbs, which implies that this small animal was more agile than procolophonids. Although the distroyed skull of type specimen does not prove the presence of temporal opening in *Santaisaurus*, all other features show close affinity of the genus with Paliguanidae. The Paliguanidae used to be a family of Eosuchia Younginiforms, but it has been recently removed into Lacertilia, Eolacertilia by Carroll (1988). In that case *Santaisaurus* represents the earliest lizard found in China so far.

The *Paoteodon huanghoensis* was erected on the basis of a fragmentary piece of maxilla with three teeth. It was considered by the original authors, Chow and Sun, as a piece of right maxilla from the middle part of the bone and the teeth preserved were supposed to be the second, third and fourth maxillary tooth. They concluded: "··· it seems that our specimen can be more closely compared with *Hypsognathus* of the North American Upper Triassic. But in the latter genus the cutting surface of the teeth is not in one plane in contrast to that in ours which is in one plane". In 1970's, aboundant procolophonid fossils including a few skulls, many jaws with teeth and postcranial bones, were recovered from North China, which enriched greatly our knowladge of this group. The reexamination and recomparison indicate that the identification of *Paoteodon* is questionable. Because on the occlusal view the maxilla is widened backward, the tooth with two perfectly preserved cusps in the type specimen of *Paoteodon* is opposed to the wider part of the maxilla, and must be posterior to, rather than anterior to, the other two teeth. It is likely that the tooth being unworned and smaller than the one before is the last one on the tooth row and a growing, unused new tooth. The same phenomenon has been reported from the *Procolophon trigoniceps* (Carroll and Lindsay 1982 Fig. 1) and *Eumetabolodon bathycephalus* (Li 1983 Fig. 27, 28). In that case the material of *Paoteodon* is a piece of posterior portion, instead of middle part, of the right maxilla and these teeth are probably the last three. Since the type specimen of *Paoteodon* was interpreted incorrectly and can not be distinguished from that of *Procolophon trigoniceps, Tichvinskia vjatkensis, Hypsognathus fenneri, Eumetabolodon bathycephalus* and so on, it is better to use "procolophonid" in the fossil list of Baode region and eliminate the genus of *Paoteodon*.

河套五角蜥(新属、新种)骨架(×2/3) The skeleton of *Pentaedrusaurus ordosianus* (gen. et sp. nov.)



河套五角蜥(新属、新种)头骨，下颌顶视、腹视及侧视 (×1) The skull and lower jaw of *Pentaedrusaurus ordosianus* (gen. et sp. nov.) in dorsal, ventral and lateral view