第36卷 第2期
1998年 4 月

古 脊 椎 动 物 学 报
VERTEBRATA PALASIATICA

pp.147—158
fig.1, pl.I

辽西义县组鹦鹉嘴龙(鸟臀目,角龙亚目)新材料及其地层学意义[1)]

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摘要 根据采自辽宁省北票市四合屯义县组下部的一鸟臀类恐龙新材料的形态学特征,鉴定其为一鹦鹉嘴龙未定种,这是迄今为止产出层位最低的鹦鹉嘴龙材料。鹦鹉嘴龙材料在义县组的发现,对于确定义县组的时代具有一定的意义。

关键词 辽宁四合屯,早白垩世,鹦鹉嘴龙

中图法分类号 Q915.864

七十年代,赵喜进和程政武在辽宁朝阳地区梅勒营子的九佛堂组发现了鹦鹉嘴龙材料, Sereno等(1988)记述鉴定为*Psittacosaurus mongoliensis*和*P. sittacosaurus meileyingensis*。最近,在*P. meileyingensis*化石材料发现的邻近地区——朝阳地区北票市的四合屯村,又有鹦鹉嘴龙新材料的发现。新材料的产出层位为义县组下部的页岩层,低于*P. meileyingensis*化石材料产出的九佛堂组。这是迄今为止产出层位最低的鹦鹉嘴龙材料。在同一化石产地发现了大量鱼类、两栖类、爬行类、早期鸟类、哺乳类、早期被子植物、昆虫及大量的其他各门类的无脊椎动物化石(侯连海等,1995;金帆, 1996; 侯连海, 1996; 季强、姬书安,1996,1997; 姬书安、季强,1997; 曹正尧等, 1997; Hu等, 1997;个人观察),这些门类形成了一个极其丰富的中生代晚期生物群落。鹦鹉嘴龙在义县组中的发现,对于长期以来一直存在争议的义县组时代问题(任东等, 1997; 李佩贤等, 1994; 金帆等, 个人交流)的解决具有一定的意义。

新材料是由当地农民采自辽宁省北票市上园镇四合屯村,产出层位为义县组下部的页岩层,现由梁世宽先生收藏。中国科学院古脊椎动物与古人类研究所辽西野外队于1997年10月对该地区进行了野外调查和化石采集,在义县组第三段第一旋回上部的黑色湖相页岩层(汪筱林等, 1998)采集到了部分鹦鹉嘴龙材料,通过化石材料的形态对比和产出层位的岩性对比,我们确认了本文所记述的标本也出自同一层位。

L系梁世宽个人收藏标本编号。

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1) 中国科学院资源与生态环境研究重大项目(KZ951-B1-410)资助。

收稿日期: 1997-12-20

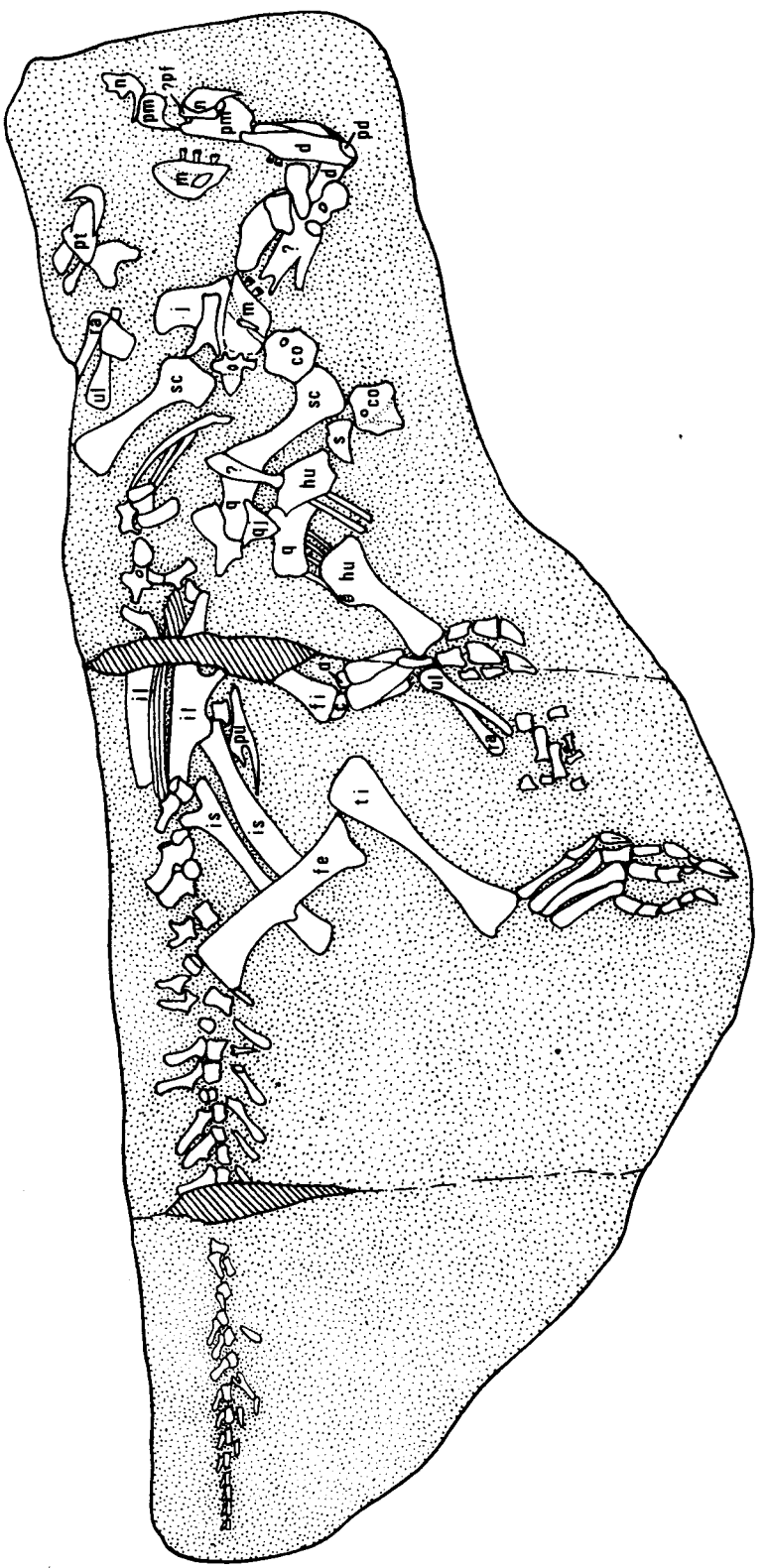

图 1 新材料(L0001)骨架侧视

Fig.1 Lateral view of the new psittacosaur material (L0001)

a, 距骨 astragalus; c, 跟骨 calcaneum; co, 乌喙骨 coracoid; d, 齿骨 dentary; fe, 股骨 femur; fi, 腓骨 fibula; hu, 肱骨 humerus; il, 肠骨 ilium; is, 坐骨 ischium; j, 颧骨 jugal; m, 上颌骨 maxilla; n, 鼻骨 nasal; pd, 前齿骨 predentary; pf, 前额骨 prefrontal; pm, 前上颌骨 premaxilla; pt, 翼骨 pterygoid; pu, 耻骨 pubis; q, 方骨 quadrate; qj, 方颧骨 quadratojugal; ra, 桡骨 radius; sc, 肩胛骨 scapula; s, 胸骨 sternal; ti, 胫骨 tibia; ul, 尺骨 ulna

1　化石描述

Family Psittacosauridae Osborn, 1923

Genus *Psittacosaurus* Osborn, 1923

***Psittacosaurus* sp.**

(Pl. I; Fig.1)

标本收藏于梁世宽先生处，标本编号 L0001：一个基本完整的骨架，但由于受到挤压，骨骼各部分散布于一页岩板上，尤其头骨各骨片变形较严重。

化石采自辽宁省北票市上园镇四合屯村义县组下部的黑色页岩层。该层位的时代目前尚有争议，一般认为是晚侏罗世到早白垩世。

标本描述　标本 L0001 (图版 I；图 1)左右前上颌骨都有保存，左前上颌骨较完整，为一很大的片状骨，侧后突很发育。未见前上颌齿。由前上颌骨和鼻骨围成的外鼻孔很小，位于前上颌骨的背部。上颌骨为一近三角形骨片。未见眶前孔发育。眶前窝位于上颌骨的背部，为一很浅的凹槽。眶前窝腹缘相对较高、较窄，紧接腹缘下部发育有三个较大的滋养孔，最后方的一个滋养孔孔径最大。上颌骨后部发育一突起，其长轴的方向为前上方。左鼻骨独立保存，右鼻骨后背部与一小骨片愈合在一起。鼻骨吻支可能没有其他鹦鹉嘴龙种长。与右鼻骨愈合在一起的小骨片可能为前额骨。右颧骨保存，构成眼眶的腹缘，在眼眶下的部分很宽，在眼眶的后腹方发育一较微弱的突起，可能为颧骨突。在方骨的表面上有一骨片，发育一较纤细的背支和较宽的前支，应为方颧骨。方骨几乎完整保存下来，但被前后向压扁，方骨腹端横向扩展，形成一宽阔的关节头。方骨主干的后缘微弱凹陷，这一特征常见于原始的鸟臀类恐龙。一个破碎的宽带状骨片被认为是部分翼骨。前齿骨似乎发育一较短的腹支。左齿骨被挤压为两片，其形态与其他鹦鹉嘴龙没有区别。在齿列的侧面，发育几个滋养孔。齿骨后的骨片虽然有保存，但是很难描述其特征。

尽管上颌骨和齿骨都保存下来，但大多数牙齿缺失，因此，无法了解颊齿的排列和替换方式。釉质几乎均匀地分布于颊齿的两面。上颌齿的舌面和下颌齿的唇面具有宽阔的磨蚀面，多数磨蚀面接近于齿冠基部。上颌齿齿冠轮廓为近卵圆形，唇面较平，舌面凸起。新材料的上颌齿主脊非常微弱。唇面的二级脊非常发育，几乎延伸至齿冠基部；舌面的二级脊也较发育，但不如唇面。下颌齿齿冠相对较宽，其轮廓近圆形。在下颌齿齿冠的舌面，强烈发育一主脊，主脊基部呈泡状，这是鹦鹉嘴龙的一个鉴定特征(Sereno, 1990a)。在主脊的两侧，发育有二级脊。在下颌齿的唇面，也发育有二级脊，但远无舌面发育。

由于脊柱受到强烈挤压，所以颈椎数目不明，可以确认的颈椎有 4 个，另有 3 个可能也是颈椎。颈椎椎体侧腹面凹陷，腹中嵴较发育。这一特征常见于原始鸟臀类。椎体高大于宽。前后关节面近三角形。侧视，椎体腹缘与背缘长度相等。椎弓横突位置靠后，几乎接近于后关节面。椎弓横突更接近于带状，不同于其他鸟臀类恐龙中的近棒状。神经脊较高，神经脊下方发育一较小的卵圆形的椎管。背椎、荐椎和尾椎的数目不明，其形态与鹦鹉嘴龙其他种没有区别。背椎形态上近似于后部的颈椎，主要的区别在于背椎的椎体横突位于椎体和椎弓连接处以上，而颈椎的椎体横突则位于椎体上。背椎的腹面逐渐变平

缓，腹中嵴逐渐消失。荐椎的数目不明，个体似乎大于邻近的背椎和尾椎。共有 28 个尾椎保存。尾椎椎体的长度和高度逐渐变小，由于高度的变化快于长度的变化，所以，后部的尾椎呈长棱柱状。愈合的尾肋长度逐渐变短，到尾的中部就基本消失，而神经脊和关节突的变化没有尾肋快，一直到保存的最后一个尾椎，都发育有神经脊和关节突。脉弧和对应的神经脊的长度几乎相等。

肋骨形态类似于鹦鹉嘴龙其他种。由于保存原因，肋骨近端形态大多不明，但似乎有单头肋骨存在。胸骨外缘厚，内缘薄，成近半圆形。骨化肌腱发育于椎弓横突与神经脊之间。它具体的长度不明，但似乎仅仅延伸至第一尾椎处。骨化肌腱相互平行排列。

肩带保存较好。肩胛骨长于肱骨，肩峰为垂片状，远端扩展，肩胛骨柄较厚实。厚实的乌喙骨形态与鹦鹉嘴龙其他种近似。乌喙孔从与肩胛骨缝合处附近的乌喙骨侧面穿出。在乌喙骨侧面，发育一脊，分割乌喙骨侧面为前面和后面。由于挤压，两面之间的夹角不明。关节窝前方的腹缘和缓弯曲。

总的来说，鹦鹉嘴龙所有种的前肢形态非常相近。肱骨的三角胸脊强烈扩展，以至于肱骨近端呈长方形；远端的外髁比内髁延伸得远，并且大于后者。右肱骨与右股骨的长度比率为 0.86。尺骨的近端强烈扩展，肘突较为发育，与其他种近似，也较短圆；尺骨远端形态较为奇特，几乎没有扩展（右尺骨侧后视，左尺骨内前视），因此，近端远宽于远端（超过 2 倍）。相对而言，桡骨的远端扩张程度远大于其他种。腕骨没有保存。4 个不关连的掌骨和 6 个指骨节保存下来。相对而言，第一掌骨明显宽于鹦鹉嘴龙其他种。

腰带完整保存。肠骨带状髋臼前突和较宽的髋臼后突长度几乎相等；球根状的坐骨突远宽于耻骨突，也远短于后者。坐骨突侧向突出，这一特征常见于 Cerapoda (Sereno, 1986)；在坐骨突和耻骨突之间是完全开放的髋臼。相对于肠骨和坐骨，耻骨较小。耻骨后突较长。坐骨相对而言非常长，远端扩张。坐骨的耻骨突和肠骨突宽度相等。

所有鹦鹉嘴龙属种的后肢和后足骨骼形态几乎没有区别。与其他种相似，新材料在股骨骨干一半处发育一垂片状的第四转子；胫骨近端和远端都非常扁平；左腓骨下部保存，远端扩张；距骨和跟骨没有愈合于胫骨；后足骨骼除了第五跖骨，全部保存。第一趾远短于第二、第三和第四趾；趾式与其他鹦鹉嘴龙相同，为：2-3-4-5-0；第一和第三跖骨的长度比为0.67。

2 比较与讨论

Psittacosauridae 由 Osborn 于 1923 年建立。迄今为止，共描述了 2 个属、13 个种，其中，除了 *P. mongoliensis*, *P. sinensis*, *P. meileyingensis*, *P. xinjiangensis*, *P. ordosensis*, *P. neimongoliensis*, *P. mazongshanensis* (Osborn, 1923; 杨钟健，1958; Sereno 等，1988; Sereno and Chao, 1988; Russell and Zhao, 1996; Xu, 1997)等 7 个种外，其余属种没有较明确的鉴定特征（Sereno, 1990b; 徐星，1995，硕士论文），因此，有效属种只有 1 属 7 种。新材料与其他种具有以下共同特征：外鼻孔小，位置较高；在与颧骨连接的口缘凸起处，上颌骨发育一突起；眶前孔缺失；发育颧骨突；下颌齿齿冠发育一球状主脊，掌骨第五指缺失等。这些特征也是 *Psittacosaurus* 的鉴定特征（Sereno, 1990a），因此，把新材

料(L0001)归于 *Psittacosaurus* 是没有疑问的。

新材料的颈椎椎弓片状横突非常靠后，尺骨远端不扩张，近端宽度为远端的两倍以上，桡骨远端强烈扩张，第一掌骨相对宽阔。这些特征未见于鹦鹉嘴龙其他属种，可能代表新材料的自近裔性状，但由于标本受到较严重的挤压，因此，不能排除这些特征是由于变形造成的。

上颌骨口缘处发育一向前背方延伸的脊，颊齿两面的釉质厚度近似相等，近半圆形胸骨等三个特征未见于其他鹦鹉嘴龙属种，应该代表新材料的有效特征。其中，上颌骨口缘处发育一向前背方延伸的脊和颊齿两面的釉质厚度近似相等这两个特征类似于朝阳龙(V11527)。在其他鹦鹉嘴龙中，上颌骨在与颧骨缝合处附近也发育一突起，但相对较宽，长轴方向为腹背向；颊齿齿冠两面的釉质分布明显不对称(Sereno, 1990a)。新材料近半圆形的胸骨明显不同于其他鹦鹉嘴龙属种的新月形胸骨(Sereno, 1990a)。除了以上特征与鹦鹉嘴龙其他属种在形态上有一定区别外，新材料分别与其他种还具有以下不同点：

新材料的眶前窝较浅，不同于 *P. mongoliensis* 独特的三角形的较深的眶前窝；新材料的坐骨远远长于股骨，而 *P. mongoliensis* 的坐骨长度短于或等于股骨长度；新材料骨化肌腱相互平行排列，不同于 *P. mongoliensis* 的肌腱相互绞织在一起；新材料脉弧和对应的神经脊的长度几乎相等，而 *P. mongoliensis* 的脉弧总是长于对应的神经脊。

新材料的颧骨突远没有 *P. sinensis* 发育；*P. sinensis* 的眶前窝完全消失，而新材料则保留有一较浅的眶前窝；新材料坐骨的耻骨突和肠骨突宽度相等，而 *P. sinensis* 的前者远远窄于后者；新材料在背椎和荐椎处发育有骨化肌腱，这一特征未见于中国种。

新材料与 *P. xinjiangensis* 的主要区别也在于颧骨突；另外，新材料显然没有发育 *P. xinjiangensis* 的鉴定特征，即上颌齿锯齿缘向内、向后延伸，肠骨的髋臼后突相对而言很大，骨化肌腱一直延伸到尾中部。

新材料的方颧骨上未见类似于 *P. meileyingensis* 的突起；方骨柄后缘微弱凹陷，不同于 *P. meileyingensis* 方骨柄后缘明显凹陷；眶前窝腹缘相对较高、较窄，不同于 *P. meileyingensis* 较宽矮的腹缘。

新材料与 *P. neimongoliensis* 的区别有：新材料的坐骨远端扩张，而 *P. neimongoliensis* 坐骨远端没有扩张；新材料的肱骨与股骨长度比为 0.86，远大于 *P. neimongoliensis* 的(0.80)；新材料的第一掌骨相对而言明显宽于 *P. neimongoliensis* 的；新材料第一和第三跖骨的长度比 0.67，小于 *P. neimongoliensis* 的(0.70)。这里需要指出的是，新材料的坐骨非常长，这一特征也见于 *P. neimongoliensis*。

与 *P. ordosensis* 的区别也在于颧骨突的形态和发育程度。此外，*P. ordosensis* 的眶前窝明显深于新材料，上颌齿主脊与齿冠前缘之间发育一沟槽，而新材料则为一平面。

与 *P. mazongshanensis* 的区别：新材料的上颌骨突起的形态明显不同于 *P. mazongshanensis;* 眶前窝也没有 *P. mazongshanensis* 的深；*P. mazongshanensis* 上颌齿齿冠呈一明显的三叶状，主脊发育，而新材料的主脊非常微弱。

尽管新材料与鹦鹉嘴龙已知属种在形态上有较大的差别，但是，由于材料保存较差，明确的自近裔性状较少，因此，这里暂时把新材料归入鹦鹉嘴龙属未定种。义县组中的鹦鹉嘴龙材料的确切分类位置有待更好材料的发现。

3 新材料的地层学意义

鹦鹉嘴龙广泛分布于亚洲早白垩世地层中，其头骨形态十分进步(Sereno, 1990a)，尤其是前上颌齿缺失这一特征，迄今为止只见于白垩纪的鸟臀类恐龙；另外，独特的前足结构(第四指只有一个简单的指节；第五指缺失)，眶前孔缺失等特征表明鹦鹉嘴龙是一类较进步的小型鸟臀类恐龙。现在一般认为，鹦鹉嘴龙多生存于早白垩世晚期(Sereno, 1987; Buffetaut and Suteethorn, 1992; Dong, 1993; Russell and Dong, 1993; Russell and Zhao, 1996)。基于鹦鹉嘴龙新材料在义县组的发现，以及孢粉方面的证据，鸟类化石显示的分异度和进步性，以及最近同位素年龄的证据，我们倾向于义县组的地质时代为早白垩世这一观点。但是，正如上文所说，相对于鹦鹉嘴龙其他种，新材料显示了一些比较原始的特征，表明四合屯这一鹦鹉嘴龙化石点的时代应该早于 Aptian-Albian, 可能为早白垩世最早期。需要指出的是，由于新材料保存较差，许多特征无法鉴定，所以，新材料的进化程度需要更深入的研究。义县组的时代问题可能需要通过对包括鹦鹉嘴龙材料在内生物群的系统研究才能最终得以解决。

致谢 本文在成文过程中得到赵喜进、董枝明的指导，地层方面的问题得到金帆和北票地矿局郝兆林的宝贵意见，野外工作得到中国科学院古脊椎动物与古人类研究所辽西野外队诸位同仁的帮助，插图由李荣山绘制，图版由崔贵海制作，化石由丁金昭和王海军修理，Christina Kelly 帮助修改英文，在此一并致谢。

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NEW PSITTACOSAUR (ORNITHISCHIA, CERATOPSIA) OCCURRENCE FROM THE YIXIAN FORMATION OF LIAONING, CHINA AND ITS STRATIGRAPHICAL SIGNIFICANCE

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Key words　Sihetun, Liaoning, Early Cretaceous, *Psittacosaurus*

Summary

In 1970s, Zhao Xijin and Cheng Zhengwu collected some psittacosaur materials from Early Cretaceous Jiufotang Formation of Meileyingzi, Chaoyang, Liaoning, China(Sereno *et al.*, 1988). Recently, some new psittacosaur materials were discovered from a neighboring area, Sihetun, Beipiao, Liaoning, but from an older lithostratigraphic unit: Yixian Formation. The new material was collected by the local farmer from the black shale of the lower part of Yixian Formation where a diverse fauna, including the famous "feathered" theropod *Sinosauropteryx prima* (Ji and Ji, 1996), pterosaur *Eosipterus yangi* (Ji and Ji, 1997), bird *Protarchaeopteryx robusta* (Ji and Ji, 1997), *Confuciusornis sanctus* (Hou *et al.*, 1995) and *Liaoningornis longiditris*

(Hou, 1996), and Anura (personal observation), was discovered. The fossil remain is housed in Mr. Liang Shikuan's collections. L is the prefix to the studied fossils of Mr. Liang.

Family Psittacosauridae Osborn, 1923

Genus *Psittacosaurus* Osborn, 1923

Psittacosaurus sp.

(Pl. I; Fig. 1)

Specimen a nearly complete but dadly crushed skeleton, L0001, housed in Liang's collections.

Locality and horizon Sihetun, Beipiao City, Liaoning Province, China: Yixian Formation.

Description The elements of the skeleton (L0001) are individually distributed throughout the shale–slab (Fig. 1; pl. I). The premaxilla is a big sheet–like bone, with an expansive caudolateral process. The small external naris, which is bordered by the premaxilla and the nasal, is located in the very dorsal part of the premaxilla. The maxilla is, as in other psittacosaurs, sub–triangular in shape. There is no trace of the antorbital fenestra. The antorbital fossa is retained as a shallow depression confined to the dorsal portion of the maxilla. The ventral margin of the antorbital fossa is relatively high and narrow. Right below the ventral margin present three relatively large foramina, with the caudally located one the biggest. An eminence, located in the same position in all psittacosaurs, is retained as a dorsoanteriorly directed crest. The nasal is the same in general morphology as in other psittacosaurs, but, possibly the slender rostral process is not as long as in other species. The jugal is preserved but partially hidden by other elements on the slab. The infraorbital ramus of the jugal is very broad dorsoventrally. A jugal horn is present. There is a small sub–triangular bone present on surface of the quadrate, which is identified as the quadratojugal, with a slender dorsal process and relatively broad anterior process. The quadrate is anterocaudally flattened, with the ventral end expanding transversely to form a broad condylar surface. The caudal margin of the quadrate shaft is slightly excavated. A fragmentary strap–like bone was identified as the part of the pterygoid. The predentary is easily recognized as it caps the anterior end of the dentary. It seems to have a short ventral process. The left dentary was crushed into two pieces. It is generally similar to that of other psittacosaurs in morphology. Lateral to the tooth row, there are a few foramina. The post–dentary elements preserve little detail except that it seems the coronoid process is of moderate size.

Although both maxilla and dentary are preserved, most teeth are lost. The enamel is distributed almost equally on the opposing crown surfaces of the cheek tooth. As in

other psittacosaurs, the broad wear facets are present in the medial surface of the maxillary crown and lateral surface of the dentary crown, respectively. The wear facets are almost truncated near the base of the crown. The maxillary crowns are ovoid in outline. As in other psittacosaurs, the buccal surface is very flat while the lingular surface strongly convex. The new specimen has a primary ridge on the lateral surface of the maxillary crown, which is extremely weakly developed. The secondary ridges are, however, well developed in that they reach almost to the base of the crown. The secondary ridges are not as developed on the medial surface as on the lateral surface. The dentary crowns are proportionately broader than the maxillary crowns, sub-circular in outline. A primary ridge with a bulbous base is developed on the medial surface of the dentary crown, which is a diagnostic feature for psittacosaurids (Sereno, 1990a). A few secondary ridges are flanked to the primary ridge. Same as found in the maxillary crown, on the opposing side, i.e. the lateral surface, are a few much more weakly developed secondary ridges.

Due to the crushment of the vertebral column, the exact number of the cervicals is not known. The centrum of the cervical is excavated ventrolaterally for muscle attachment, producing a narrow median ventral keel. The centrum is higher than wide, with the ends of the centrum subtriangular in outline. In lateral view, the ventral margin is the same as the dorsal in length. Unusually the diapophysys is located so caudally that it is almost at edge of the posterior end, and, also uniquely, the diapophysys is more strap-like than rod-like as in other ornithischians. The neural spine is represented by a relatively high strap-like median ridge, while in other psittacosaurs, it is very low. Below the neural spine is a small ovoid neural canal. The description of dorsal, sacral and caudal vertebrae of other psittacosaurs can be almost entirely applied to that of the new material.

The ribs are preserved and similar to those of other psittacosaurs. The sternum is similar to that of other species in the thickened lateral margin and very thin medial margin, but different from all other psittacosaurs in semicircular rather than crescentic outlines. Ossified tendons are present between the transverse processes and neural spines. Its length along the vertebral column is not know precisely, but it seems that the ossified tendons extend from the caudal dorsals to before the anteriormost caudal vertebrae.

The pectoral girdle is very well preserved. The scapula is longer than the humerus, the acromion tab-shaped, the distal end expanded, and the blade relatively thick. The heavily built coracoid is similar to that of other psittacosaurs. As in other psittacosaur species, a coracoid foramen pierces the coracoid laterally, near the coracoid suture medially. A crest divides the lateral surface of the coracoid into anterior and posterior portions. Due to the crushment, the angle between two portions

of the coracoid is not known. The ventral edge anterior to the glenoid is broadly arched. The forelimb is similar in general morphology to that of other psittacosaurs. The deltopectoral crest of the humerus is broadly expanded such that the proximal end of the humerus is rectangular in shape. The farther distally extended medial condyle of the distal end is larger than the lateral one. The humerus–to–femur length ratio is 0.86. The proximal end of the ulna is broadly expanded with the short and rounded olecranon process of the ulna; the distal end of the ulna remains unchanged in width from the shaft of ulna, such that the proximal end is more than twice as wide as the distal end; distal end of the radius is expanded more strongly than that of other psittacosaurs. No carpals have been identified. The manus in the specimen is known from four disarticulated metacarpals and six phalanxes. The metacarpal I is proportionately wider than that of other psittacosaurs.

The pelvic girdle is completely preserved. The ilium has a strap–like preacetabular and a proportionately deeper postacetabular processes and the two are approximately equal in length; the bulbous ischiac peduncle of the ilium is not only much wider than the pubic peduncle, but also much shorter than the latter. As in other cerapoda (Sereno, 1986), the ischiac peduncle is protruding laterally. The pubis is a small element relative to the ilium and ischium, with a relatively long postpubic process. The ischium is proportionately very long. It is moderately expanded distally. The pubic peduncle and the iliac peduncle are of the same width. The bones of the hind limb and pes lack unique features. As in other psittacosaurs, just above midshaft, a pendent fourth trochanter is present; both the proximal and distal ends of the tibia are strongly compressed; only part of left fibula is preserved and the distal end is moderately expanded; the astragalus and calcaneum are not fused with the tibia; except for the fifth metatarsal, the pes is almost completely preserved; the first digit is much shorter than the second, third and fourth digits; the phalangeal formula is, as in other psittacosaurs, 2–3–4–5–0. The ratio between the lengths of metatarsals I and III is 0.67.

Comparison and discussion The new material is referred to *Psittacosaurus* in the highly situated small external naris, the eminence on the rim of the buccal emargination of the very caudal maxilla, the developed jugal horn, the bulbous primary ridge on the dentary crown, manual digit V absent, etc. The following characteristics, strap–like diapophysys extremely caudally positioned, unexpanded distal end of the ulna and the proximal end more than twice as wide as the former, distal end of radius strongly expanded, and metacarpal I relatively broad, are not present in other species. Since this specimen is badly crushed, these differences are possibly due to the distortion.

However, the dorsoanteriorly directed crest on the rim of the buccal emargination of the maxilla and the enamel distributed almost equally on the opposing sides of the

cheek teeth (L0001) are not present in any other ceratopsians except chaoyangosaurid (V11527). Also the semicircular sternum is different from the crescentic sternum of other psittacosaurs (Sereno, 1990a). So the new fossil remains show some differences from other psittacosaurs. Also, there are a few differences between the new material and other psittacosaur species as follows:

The new material has a relatively shallow antorbital fossa whereas *P. mongoliensis* possesses deep triangular antorbital fossa; in the new material the ischium is proportionately much longer than in *P. mongoliensis*; the chevron is almost as long as the corresponding neural spine in the new material whereas the former is always longer than the latter in *P. mongoliensis*.

The new material differs from *P. sinensis* in possessing a shallow antorbital fossa; a weakly developed jugal horn (that of *P. sinensis* is very strong); the pubis peduncle of the ischium is as wide as the iliac peduncle (the former is much narrower than the latter in *P. sinensis*); having ossified epaxial tendons.

The new material differs from *P. xinjiangensis* in lacking a developed jugal horn; less denticles on the edge of the tooth crowns; maxillary crowns with denticulate margin not curving posteromedially onto the side near the crown base; having a much shorter ossified epaxial tendons.

The gently excavated posterior margin of the quadrate in the new material is different from the deeply excavated quadrate of *P. meileyingensis*; the new material lacks the quadratojugal boss as in *P. meileyingensis*; the relatively high and narrow ventral margin of antorbital fossa in the new material differs from the relatively short and broad one in *P. meileyingensis*.

The differences between the new material and *P. neimongoliensis* are listed as following: the new material has a expanded distal end of the ischium whereas the distal end of the ischium remains unexpanded in *P. neimongoliensis*; the humurus-to-femur length ratio (0.86) is much larger than that of *P. neimongoliensis* (0.80).

The new material differs from *P. ordosensis* in possessing a relatively shallow antorbital fossa; having a flat surface between primary ridge and anterior margin of tooth rather than a shallow sulcus in *P. ordosensis*.

P. mazongshanensis is different from the new material in possessing a much deeper antorbital fossa; having an obviously developed central lobe of the maxillary crown.

Although the new material is different from the other psittacosaur species in morphology, few autopomorphies can be observed on the fossil remain mainly due to the bad preservation. So, the authors tentatively classified this new material as *Psittacosaurus* sp. Work on the exact taxonomic status of psittacosaur from Yixian Formation will be done when well preserved material is available.

Stratigraphical significance There is general agreement as to the Early Cretaceous age of the *Psittacosaurus* localities in Mongolia, China, Siberia, Japan and Thailand, and most of these localities were considered to be the late Early Cretaceous in age (Sereno, 1987; Buffetaut and Suteethorn, 1992; Russell and Dong, 1993; Russell and Zhao, 1996). The discovery of psittacosaur material from Sihetun, Liaoning suggests that it originates no earlier than the Early Cretaceous age of Yixian Formation, though, according to some primitive characteristics found in the new specimen, it is earlier than Aptian–Albian age of other *Psittacosaurus* localities.

图版 I 说明(Explanations of Plate I)

Psittacosaurus sp. 完整个体(A skeleton), L0001

1. 骨架前部(anterior portion of the skeleton), × 3 / 10
2. 骨架中部(middle portion of the skeleton), × 1 / 5
3. 尾椎部分(posterior portion of the skeleton), × 2 / 5


1


2


3