

山西榆社上新世的貉(食肉目,犬科) 化石兼论中国的貉化石

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关键词 山西榆社 上新世 貉

中国貉化石的记录始于舒罗塞 1903 年定为 *Vulpes sinensis* 的那批材料。1924 年师丹斯基把采自河南滎池的一件带有次角叶的下颌也归入了这个种。1930 年德日进和皮韦陀根据泥河湾的丰富材料才把这个种改归貉属。到 1941 年归入这个种的还有周口店第一和第十三地点的材料。德日进和斐文中(1941, p. 13—14)也提到榆社有这个种的化石。本文所记述的貉化石都是从榆社盆地的云簇次盆地内采集的。它们的层位都可以根据邱占祥等(1987)所创的岩石地层单位予以确定。丁氏貉(新种)和中华貉都发现于高庄组上部至麻则沟组上部这段沉积中。根据 N. Opdyke 所提供的古地磁资料,这一段地层相当于吉伯特期上部至高斯期上部,其绝对年龄为 4.4 至 2.8 Ma。

文中 F:AM 代表美国自然历史博物馆弗里克标本; THP 代表天津自然博物馆标本; V 代表中国科学院古脊椎动物与古人类研究所藏品。

丁氏貉(新种) *Nyctereutes tingi* sp. n.

正型 F:AM 97030 (图 1 F—G), 较完整左下颌, 缺冠状突; 刘家沟, 麻则沟组顶部。

其它材料

正型地点: F:AM 97029 (图 1, D—E), 右下颌; F:AM 97032, 右下颌, M_2 以后部分断失; F:AM 97033, 左下颌水平枝; F:AM 96799, 左下颌水平枝;

南庄沟(高庄组上部): F:AM 96757 (图 2, A—C), 不完整头骨;

申村(麻则沟组下部): THP 10274, 右下颌, 冠状突顶端缺失; THP 10299, 几近完整的头骨; V9544, 左下颌前段;

麻则沟(高庄组顶部或麻则沟组底部): THP 22727—22730, 两个下牙床;

拐沟(高庄组上部): V9545 (图 1, H—I), 下颌骨;

井家沟(高庄组上部): 榆社县博物馆标本, 左下颌。

特征 下颌有次角叶, 但小, 角突也不特别扩展。与 *N. donnezani* 的区别是尺寸较

大, M_1 跟座具连接下次尖和下内尖的横脊, 上臼齿前尖大于后尖, 原小尖小于后小尖。与中华貉的不同是眶后突小而尖, 额窦向后伸延至矢状嵴分岔处, 副矢状嵴(额嵴)不十分明显, 矢状嵴弱, 无中纵沟, 耳泡长, 向前达关节后突。丁氏貉的牙齿在大小上虽然落入中华貉变异范围内, 但都偏大。

比较与讨论 丁氏貉的头骨和已知的貉属各种一样, 上颌骨额支在眼眶之前有一浅凹, 矢状嵴和副矢状嵴相对较强, 顶骨表面粗糙, 鼻骨向后延伸超过上颌—额骨缝, 眶后突强壮, 额窦伸入其基部, 但其末端仍为实心。与中华貉相同而不同于现生种 *Nyctereutes procyonoides* 的首先是尺寸较大, 硬腭后缘位于 M^2 而不是在 M^2 之后, 颧骨的眶支和额骨相接, 使泪骨完全退入眶内。丁氏貉的额窦向后延伸至额—顶骨缝处。在中华貉中额窦向后伸延不那么远, 但后部也隆凸, 使眶后收缩显得较宽。现生种的眶后收缩由于额窦后部不扩展而很显著。丁氏貉的矢状嵴不像在中华貉和现生貉中那么高耸, 那么宽, 也无中纵沟。丁氏貉的顶缘自侧面看不像一般貉中那样弯曲, 听泡的近中部分较隆胀, 其前端也比中华貉的更尖, 向前超过关节后突的水平。

丁氏貉的下颌比中华貉的大而粗壮, 其水平枝虽然向前也变低, 却并不那么显著; 下颌联合突强壮, 破坏了下颌下缘的平直; 次角叶和角突都较弱, 但比 *Canis* 和 *Vulpes* 的都大; 角突内侧面下方附着内翼肌下支的凹痕不如在貉的其它种中那样扩展。

丁氏貉的牙齿和貉属其它各种一样, 犬齿低冠而弯曲, 前臼齿简单, 裂齿粗壮, 臼齿大而趋于方形, 但形态上显得更原始些: 上臼齿的前尖大于后尖而原小尖很小; 下牙中 M_1 的跟座有连接下次尖和下内尖的横脊, 把跟座分成前大后小的两部分。在现生貉中由于下次小尖扩大而使跟座的后半部变大。丁氏貉的 M_2 的跟座构造简单, 没有其它种中常见的多瘤构造。

从形态上讲, 丁氏种是一个相当原始的种。它大体和欧洲路西尼期的 *Nyctereutes donnezani* 相当。但是后者似乎比丁氏貉稍进步些。这表现在上臼齿的前尖和后尖差不多大小, 而小尖变大; M_1 和 M_2 的跟座呈多瘤状。但是另一方面, 丁氏貉 M_1 跟座上的横脊则是进步性状。Deperet 对正型的下颌没有详细记述, 只是提到有次角叶。西班牙大体同时代的 Layna 的材料则表明这个种在次角叶的发育程度和翼肌附着区形态上都和丁氏貉相似。

中华貉 *Nyctereutes sinensis* (Schlosser), 1903

保存在天津、北京和纽约的榆社材料中有许多可以归入本种的头骨和下颌。这里不打算对这些材料作全面研究。本文的目的只是对这个种现存的问题作一些探讨。

舒罗塞据以建种的材料和师丹斯基后来归入该种的材料都很少。貉属第一批较好的化石是泥河湾那批材料。舒氏和师氏的标本在形态和大小上都没有超出泥河湾材料的变异范围。因此, 虽然舒氏的标本不够典型, 为了名称的相对稳定, 我们建议保留这一种名, 指定舒罗塞记述的“下颌 A”作为选型, 并将泥河湾这批标本作为携带该种名的生物实体看待。

云簇次盆地的材料(图 1, A—C; 图 2, D—F)在大小和形态上都与泥河湾的相符。图 3 是关于 M^2 长宽比例的图解。它表明泥河湾和榆社的标本和 St. Vallier 的

Nyctereutes megamastoides 及周口店中更新世的“*Nyctereutes sinensis*”的变异情况不同,虽然它们都比现生貉大。

中华貉的化石在云簇次盆地中从高庄组上部至麻则沟组上部都有,但至今未在海眼组中发现。但海眼组的哺乳动物群无疑和泥河湾者相当,所以中华貉化石的缺失只是采集上的问题。在欧洲早上新世的代表是 *Nyctereutes donnezani*, 可能还有更早的晚中新世的代表 (Morales, J. and E. Aguirre, 1976)。至晚上新世则有 *Nyctereutes megamastoides*。

德日进和皮韦陀(1930)认为中华貉与欧洲的 *Nyctereutes megamastoides* 不同,后者次角叶更大,副枕突也宽大,上臼齿更近方形,四尖型式更清楚,珐琅质细褶更强。这些都显得比中华貉更进步些。但两者在大小和形态的变异上有重叠。Soria 和 Aguirre (1976) 把 St. Vallier 的居群看作是 *Nyctereutes megamastoides* 的一个新亚种: *N. m. vulpinus*, 依据是其前臼齿和裂齿相对较长,而 M_2 更小。

裴文中(1934)把周口店第一地点的貉化石都归入了中华貉,并且指出,它和 *N. megamastoides* “很难”区别。如果我们把它们和泥河湾或榆社的中华貉以及欧洲的 *N. megamastoides* 比较一下的话,可以看出周口店第一和第十三地点的貉在形态上确有些不同。它的眶后突较小,眶后收缩较强(亦即额窦后部较小),次角叶的后面还有一小尖突,使次角叶的后缘呈V形凹入。这些性状都和现生貉接近。因此,虽然周口店中更新世的貉化石都比现生种大,但它们显然和现生种关系更近。Soria 和 Aguirre (1976) 也得出相近的结论。他们并没有指出具体的性状,但判定周口店中更新世的材料具有介于 *N. megamastoides* 和现生貉之间的过渡性质。

综上所述,从中国现有的化石资料看,貉属在早上新世突然出现形态上原始和进步的两个姐妹种。原始种在晚上新世已灭绝,而进步种或也灭绝或逐渐进化为中更新世的 *Nyctereutes* sp., 而后者已和现生的 *Nyctereutes procyonoides* 很接近,并可能就是现生貉的祖先。

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PLIOCENE *NYCTEREUTES* (CARNIVORA: CANIDAE) FROM YUSHE, SHANXI, WITH COMMENTS ON CHINESE FOSSIL RACCOON-DOGS

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Key words Yushe, Shanxi; Pliocene; racoon-dogs

The first Chinese fossil record of the racoon-dog, *Nyctereutes* Temminck 1838-9, was described by Schlosser in 1903 as *Vulpes sinensis* based on three ramal fragments obtained from pharmacies in Tianjin and Henan. Schlosser's "Kiefer A" is a right ramal fragment containing alveoli for incisors, canine and P/1, broken P/2-3 and complete P/4; "Kiefer B" contains the right P/3-4, the anterior alveolus of M/1, and the third ramal fragment contains only the talonid of the left M/1. The inferior border of the ramus that might have indicated the presence or absence of a subangular lobe is broken away. The illustration prepared by Schlosser (plate 1, fig. 6) was a composite of all three specimens. Zdansky (1924) referred a left ramal fragment to this taxon from Mianchi County, Henan, that shows the subangular lobe. In 1930 Teilhard de Chardin and Piveteau, on the basis of skulls and rami from the late Pliocene of Nihewan, Hebei, were able to show that *V. sinensis* should be referred to the genus *Nyctereutes*.

By 1941 materials referred to this taxon had also been obtained from medial Pleistocene sites at Zhoukoudian (Localities 1 and 13, Pei 1934, and Teilhard de Chardin and Pei, 1941, respectively). Material from the Pliocene of the Yushe Basin was mentioned by Teilhard de Chardin and Pei (1941, p. 13-14). Abundant material from the latter area includes two taxa that serve as the subject of this contribution.

New studies of the stratigraphy of the Yuncu Subbasin within the larger Yushe Basin by Qiu *et al.* (1987) and additional work jointly undertaken by us and colleagues has clarified the biostratigraphy of many of the taxa in the historical collections. The samples of *Nyctereutes* species dealt with in this work were all obtained from this subbasin where their stratigraphic range can be described using the lithostratigraphic terminology developed by Qiu *et al.* (1987). *Nyctereutes tingi* n. sp. is demonstrably the earliest occurring Yushe canid being found *in situ* in the upper half of the Gaozhuang Formation. Its local range extends into the upper part of the overlying Mazegou Formation. Throughout this range it is a contemporary of *N. si-*

nensis. Magnetostratigraphic studies by Neil Opdyke (pers. comm., 1989) of the Yuncu subbasin indicates that this stratigraphic interval includes the late Gilbert through late Gauss chrons, approximately 4.4 to 2.8 Ma., in early to middle Pliocene time.

Family Canidae Gray 1821

Subfamily Caninae (Gray) 1821

Genus *Nyctereutes* Temminck 1838-9

Nyctereutes tingi n. sp.

Type F:AM 97030 (Fig. 1F-G), left ramus lacking coronoid process, with complete dentition from Liujiagou, upper Mazegou Formation, Yuncu Subbasin, Yushe Basin, Shanxi Province.

Referred specimens from Yuncu Subbasin From the type locality: F:AM 97029 (Fig. 1D-E), right ramus lacking coronoid process and incisors, canine broken, P/1-4 M/1, and alveoli for M/2-3; F:AM 97032, fragment of a right ramus broken behind M/2, C-P/1 alveoli, P/2-4 and M/1-2 present; F:AM 97033, fragment of left ramus lacking ascending process, C and P/1-2 alveoli, P/3-4 M/1-2 present; F:AM 96799, fragment of left ramus lacking ascending process, C, P/1-4, M/1-2 present, M/3 alveolus. From Nanzhuanggou, upper Gaozhuang Formation, F:AM 96757 (Fig. 2A-C), partial skull, palate and anterior part of cranium, right and left canines, P1-4/, M1-2/. From Shencun, lower Mazegou Formation: THP 10274, fragment of right ramus, tip coronoid missing, root canine P/1-2 broken, P/3-4, M/1-2, M/3 alveolus; THP 10299, nearly complete skull lacking left zygoma, right I1/root, I2-3/, C root, P1/, P2-4/broken, M1/, M2/broken, left I1-3/, C, P1/ alveolus, P2-4/, M1-2/ broken (not the same individual as THP 10274); IVPP V9544, fragment of a right ramus, incisor, canine and P/1 alveoli, P/2-4 and anterior alveolus of M/1. From Zhaozhuang, but collected to the south in the Mazegou, uppermost Gaozhuang or lowermost Mazegou formations: THP 22727, fragment of right ramus lacking ascending process, I/3, C broken, P/1-3 broken, P/4, M/1-2, M/3 alveolus; THP 22728 fragment of left ramus associated with 22727, C, P/1, P/2-3 broken, P/4, M/1-2; THP 22729, fragment of left ramus C, P/1 alveoli, P/2-4 M/1-2, M/3 alveolus; THP 22730, fragment of right ramus associated with 22729, P/2, P/3 broken, M/1, M/2 broken. From Guaigou, upper Gaozhuang Formation: IVPP V 9545 (Fig. 1H-I) fragmentary mandible in concretion, teeth only in left ramus, P/1, P/2 broken, P/3-4 M/1-3; Jingjiagou, upper Gaozhuang Formation: Yushe County Museum, fragment of left ramus C, P/1 alveolus, P/2, P/3 roots, P/4 and associated fragment of right ramus M/2-3.

Etymology Named for Ting V-K, able first director of Geological Survey of China, 1921-25, and promoter of paleontology.

Diagnosis Mandible distinguished from most *Nyctereutes* spp. by the plesiomorphic condition of the ascending ramus, particularly the vestigial subangular lobe (digastric process) and lack of expansion of the angular process. From *N. donnezani*, which also possesses a mandible of similar character, it is distinguished by larger size, M/1 talonid with consistent development of cristids uniting the hypoconid and

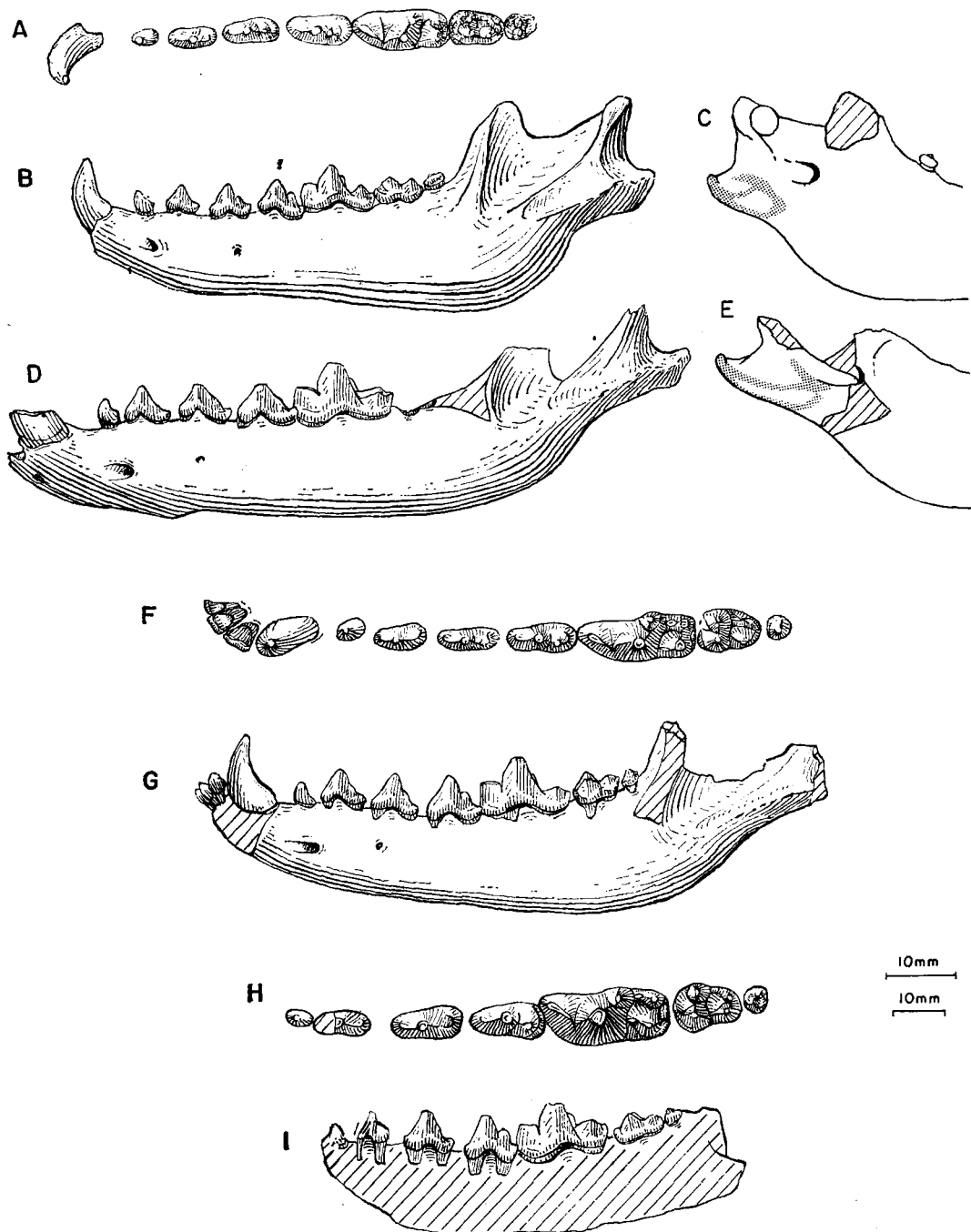


Fig. 1. *Nyctereutes sinensis*: F:AM 97007, Mazegou Formation, Liujiagou, Yuncu Subbasin, A. occlusal view of dentition, B. lateral view of ramus, C. medial view of base of ascending ramus showing pattern of pterygoid muscle insertions on angular process; *Nyctereutes tingi*: F:AM 97029, Mazegou Formation, Liujiagou, Yuncu Subbasin, D. lateral view of ramus, E. view as in C. Holotype F:AM 97030, Mazegou Formation, Liujiagou, Yuncu Subbasin, F. occlusal view of dentition, G. lateral view of ramus; IVPP V9545, Upper Gaozhuang Formation, Guaigou, Yuncu Subbasin, H. occlusal view of dentition, I. lateral view of ramus. Large scale for dentition, small scale for jaws

entoconid, upper molars with paracone larger than metacone and paraconule smaller than metaconule. The skull of *N. tingi* is similar in size to *N. sinensis* but distinguished by plesiomorphic features, particularly the smaller, pointed, postorbital processes, greater posterior inflation of the frontal sinus beneath the diverging limbs of the parasagittal crests, lack of strong emargination of those crests, weaker sagittal crest that lacks a sutural cleft, and longer auditory bulla that extends anterior to the postglenoid process. The dentition of *N. tingi* overlaps the upper part of the range of *N. sinensis*, but is mostly larger in size, particularly the widths of the premolars. The ramus is deeper anteriorly than in *N. spp.*

Description and comparison The *Nyctereutes tingi* sample is compared with materials of contemporary *N. sinensis* from the Yuncu subbasin. The skull of *N. tingi* is similar in size to that of *N. sinensis*. Like other *N. spp.* whose skulls are known, there is a shallow depression on the frontal process of the maxillary anterior to the orbit, strong sagittal and parasagittal crests, a rugose surface of the parietal, nasals that extend posterior to the frontal-maxillary suture, and strong postorbital processes whose bases are invaded by the frontal sinus, but the tips remain solid bone. Like *N. sinensis*, but contrary to living *N. procyonoides*, the palatal incision lies opposite M2/ rather than behind the tooth row; and the jugal has an orbital process which contacts the frontal restricting the lacrimal to the orbit. In *N. tingi* the postorbital process has a shallow vulpine groove on its dorsal surface that marks the limit of the invasion of the process by the frontal sinus. The bony part of this process is not extended laterally into a strong, blunt-tipped structure cupping the dorso-posterior part of the orbit as seen in *N. sinensis*. Parasagittal crests emanate from the posterior surface of the postorbital processes and join to form the sagittal crest just anterior to the frontoparietal suture as in other *N. spp.*, but they are not raised as in *N. sinensis* or *N. procyonoides*, nor is the sagittal crest so wide and cleft along the midline as in other *N. spp.* The frontal sinus is enlarged posteriorly in *N. tingi* extending above the braincase nearly to the parietal suture. In *N. sinensis* the frontal sinus is not as posteriorly extended but does inflate the postorbital region so that the post-orbital constriction is relatively wider than in *P. procyonoides*. The latter shows a distinct postorbital constriction resulting from lack of posterior expansion of the sinus. The dorsal cranial profile of *N. tingi* is not so arched as in other *Nyctereutes* whose skulls are known. The auditory bullae are more inflated medially and more pointed anteriorly than in *N. sinensis* and they extend forward beyond the level of the postglenoid process.

The mandible of *N. tingi* is larger and more robust than in *N. sinensis*, it tapers forward, but not so markedly as in other *N. spp.* There is a stronger symphyseal process that interrupts the ventral profile of the horizontal ramus. The enlargement of the digastric process beneath the ascending ramus, referred to as the "subangular lobe", is marked in *N. tingi*, but not as strongly developed in as *N. sinensis*, nor does it bear a low spinose process as in some examples of *N. procyonoides*. The angular process is enlarged over the condition seen in *Canis* or *Vulpes* but is more attenuate than in other *N. spp.* and has a well developed distal hook. On the medial side of this process the dorsal fossa for the superior ramus of the medial pterygoid

muscle is well marked as in *N. spp.*, but the ventral fossa for the inferior ramus is not expanded as fully as in other species of *Nyctereutes* in which this structure is known. Like other *N. spp.*, *N. tingi* has the condyle elevated above the level of the tooth row, and the masseteric fossa is deep and limited ventrally by strong crest from the condyle and angular process.

Like other *Nyctereutes*, the dentition of *N. tingi* includes short-crowned and re-curved canines, robust premolars of simple form, robust carnassials, and large molars tending to quadrate form. These teeth are larger than in other *Nyctereutes* species, but morphologically differ very little from them except for the primitive appearance of the upper molars which have paracones larger than metacones and small paraconules. In the lower dentition the premolars are wider relative to their length than in other species and the M/1 talonids usually show cristids linking the hypoconid and entoconid separating the talonid basin into a larger anterior moiety and smaller posterior one. The latter condition is universal in *N. sinensis* and carried further in *N. procyonoides* by extension of the hypoconulid shelf enlarging the posterior moiety of the talonid basin. The M/2 shows a variable presence of a paracoid as in *N. sinensis*, but the talonids do not show the multicuspidate condition that is an important variant in the latter and other *N. spp.* (Martin 1971).

Discussion Morphologically *N. tingi* is a primitive member of its genus. It corresponds, in most of the features that can be compared, with the smaller, and less completely known, European *N. donnezani* of Ruscinian age. *Nyctereutes donnezani* seems somewhat more derived in the direction of other *N. spp.*, particularly in the construction of its upper molars which have subequal paracones and metacones and

Table 1 Tooth Measurements of *Nyctereutes tingi* n. sp. (in mm)

	Canine	P1	P2	P3	P4	M1	M2
<i>Upr. Dentition</i>							
F:AM 96757	8.5×5.6	4.8×3.0	8.8×3.5	9.7×4.0	15.8×8.0×6.1	12.0×14.9	8.2×10.2
THP 10299	6.6×4.3	4.6×2.6	7.0×3.4	8.9×3.9	13.3×7.1×5.9	9.8×12.5	6.8×8.6
<i>Lwr. Dentition</i>							
F:AM 97029	9.6×6.0	3.8×2.9	9.2×4.1	10.6×4.3	12.1×5.6	19.3×7.7×7.9	—
F:AM 97030	8.7×5.7	4.5×3.1	8.2×3.8	9.6×3.9	11.4×5.2	17.8×7.2×7.6	9.6×7.2
F:AM 97032	—	—	8.5×3.6	9.6×4.1	11.6×5.2	17.6×6.7×6.9	9.2×6.7
F:AM 97033	9.3×5.6	—	—	10.5×4.5	11.9×5.9	18.2×7.4×8.3	9.0×7.5
F:AM 96799	8.0×5.6	5.2×3.8	8.5×3.6	9.4×3.8	10.5×4.9	17.6×6.8×7.3	9.1×6.6
THP 10274	—	4.6×2.8	—	9.0×4.2	10.2×5.1	17.5×7.0×7.6	9.2×6.0
THP 22728	8.3×6.0	4.2×3.0	—	—	10.4×5.0	18.0×6.7×7.4	9.1×6.8
THP 22729	8.7×5.3	—	8.3×3.9	9.5×4.2	10.8×5.2	18.8×7.3×8.2	10.0×6.3
IVPP YS 91	—	—	8.7×3.6	9.3×3.9	10.8×5.0	—	—
IVPP YS 131	—	3.9×2.8	ca8×3.9	10.5×4.3	12.0×5.5	19.2×7.9×7.5	9.7×7.2
Yushe Co. Mus.	—	—	9.4×4.0	—	11.5×5.0	—	8.8×6.5

Anteroposterior×transverse diameters except for P4/ in which the anteroposterior diameter is followed by width across protocone then width across metacone and M/1 in which the anteroposterior diameter is followed by width of trigonid then width of talonid.

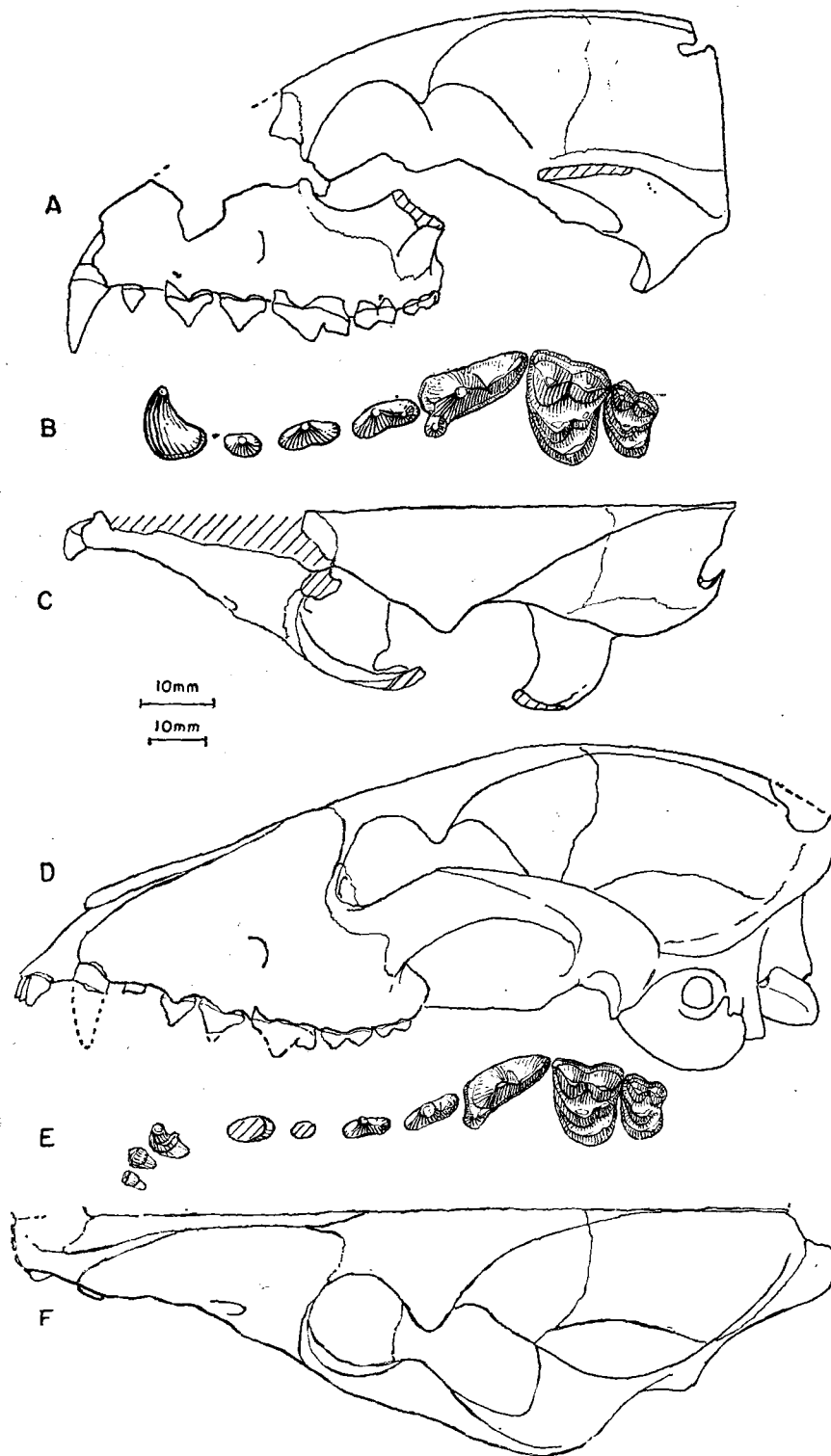


Fig. 2 *Nyctereutes tingi*: F:AM 96757, upper Gaozhuang Formation, Nanzhuanggou, Yuncu Subbasin, A. lateral view of skull, B. occlusal view of dentition, C. dorsal view of skull; *Nyctereutes sinensis*: F:AM 96759, Mazegou Formation Baihai, Yuncu Subbasin, D. lateral view of skull, E. occlusal view of dentition, F. dorsal view of skull. Large scale for dentition, small scale for skulls

enlarged conules and in the presence of multicuspidate M/1 and M/2 talonids. On the other hand, the more consistent development of cristids connecting the major talonid cusps on M/1 in *N. tingi* foreshadow more derived *N. spp.* Little is known of the skull of *N. donnezani*, but Deperet's (1890) brief description of topotypic material from Perpignan, France, indicates that the sagittal and parasagittal crests are of primitive form. Likewise the topotypic mandible has not been described beyond Deperet's recognition of the presence of a subangular lobe, but referred material from Layna, Spain (Soria and Aguirre, 1976), of comparable geologic age, shows that the development of the angular process and insertions of the medial internal pterygoid are similar to that in *N. tingi*.

It is conceivable that the Chinese and European forms, both of early Pliocene age, could biologically represent zoogeographic variation of a single taxon. The Chinese record shows that this taxon is contemporary with more derived *Nyctereutes sinensis*, whereas the record in Europe (Soria and Aguirre, 1976) places *N. donnezani* as successional to late Pliocene *N. megamastoides*, a species morphologically comparable to *N. sinensis* as discussed below.

***Nyctereutes sinensis* (Schlosser) 1903**

1903 *Vulpes sinensis* Schlosser.

1930 *Canis (Nyctereutes) sinensis* (Schlosser) Teilhard de Chardin and Piveteau.

1941 *Nyctereutes sinensis* (Schlosser) Teilhard de Chardin and Pei.

1976 *N. megamastoides sinensis* (Schlosser) Soria and Aguirre.

Discussion Teilhard de Chardin and Pei (1941) mentioned the presence of this taxon in the Yushe Basin during description of referred material from Zhoukoudian Locality 13. The Yushe collections in Tianjin, Beijing and New York include many skulls, partial skulls and jaws which will be more fully described elsewhere. The purpose of the following discussion is to record their local stratigraphic range, general characters as needed to typify *N. sinensis* and to offer some comments on taxonomic matters.

As detailed in the introduction to this paper, when Schlosser (1903) created *Vulpes sinensis* he had three lower jaw fragments whose dentitions partly overlapped and this composite was illustrated (his plate 1, fig. 6, 6a). As none of these fragments were designated the type of *V. sinensis* we select Schlosser's "Kiefer A" as the lectotype (BSP 1900XII 5). It is the most complete of the three fragments, and shows features diagnostic of the taxon except the ascending ramus is lacking so that its critical characters can not be observed.

The first reference of additional material to Schlosser's taxon was Zdansky's (1924) reference of a ramal fragment showing the subangular lobe from "Upper Pliocene" deposits in Mianchi County, Henan Province. In 1927 he referred another jaw fragment with subangular lobe and a provisionally allocated partial skull obtained from different site in the same county to *Vulpes sinensis*. These specimens served to indicate the general features of the taxon.

Secure knowledge of late Pliocene *Nyctereutes* in China came from the Nihewan material described by Teilhard de Chardin and Piveteau (1930) and this sample has

served historically to typify the taxon *N. sinensis*. Schlosser's cotypes agree in dental morphology and size with the Nihewan sample and the morphological features of the ramal fragments also fall within those observed in the Nihewan material as far as comparison will allow. Despite the doubts about the identity of this, and many of the other "drugstore" taxa Schlosser erected in 1903, we nevertheless recommend, in the interests of stabilizing the nomenclature, that the Nihewan sample of the *N. sinensis* hypodigm be used as the biological entity to which that name is attached for purposes of comparison.

The Yuncu subbasin sample (exemplified by F:AM 97007, Fig. 1A—C and F:AM 96759, Fig. 2D—F) conforms to that from Nihewan in dimensions and morphology including the presence of large individuals indicated by the mandibular fragment discussed by Teilhard de Chardin and Piveteau (1930, p.95, plate 18, Fig. 5, 5a). An example of the intergradation in size is given in Fig. 3 using data on the dimensions of M2/ from Martin (1971, fig. 7) for *N. megamastoides* and *N. procyonoides*. This plot shows that the Nihewan and Yushe samples define a different rate of covariation than either *N. megamastoides* from Saint-Vallier or *N. sp.* ("*N. sinensis*" of Pei 1934) from Zhoukoudian Locality 1, and that all fossil samples are larger than the living *N. procyonoides*.

As mentioned, a large sample conforming to our concept of *N. sinensis* occurs in the Yuncu subbasin in the upper Gaozhuang through Mazegou formations and from most of the sites that also yield *N. tingi*. Fragmentary materials also record its presence in the overlying Haiyan Formation in the Yuncu Subbasin that yields a fauna comparable to that of the Nihewan. The occurrence of this taxon in the Yushe area in early Pliocene deposits constitutes the oldest sample of this taxon known in China. The European record, summarized by Soria and Aguirre (1976), likewise indicates a sister taxon, *N. megamastoides*, in deposits of the medial Pliocene age. The genus, however, represented by the species *N. donnezani*, occurs in earlier Pliocene and possibly latest Miocene (Morales and Aguirre 1976) deposits in Spain, but, unlike the Chinese records, this primitive member of the *Nyctereutes* clade does not coexist with the more derived species in western Europe.

Schlosser (1903, p. 25) mentioned the resemblance of "*Vulpes*" *sinensis* to "*Canis*" *megamastoides* Pomel 1843 from Perrier, France. This resemblance was further explored by Teilhard de Chardin and Piveteau (1930) who regarded *N. sinensis* as distinct from the latter which was supposed to have a much larger subangular lobe, more expanded paroccipital process, upper molars that were more quadrangular in form and more quadrituberculate with more rugose enamel. All of these features are more derived conditions of the same characters in *N. sinensis* and subject to some overlap in the Yushe sample. Likewise the size of the dentition in *N. megamastoides* (sample used by Soria and Aguirre, 1976) overlaps that of the Yushe *N. sinensis*, but the proportional relationships (e. g. M2/ dimensions for *N. m. vulpinus* from Martin, 1971, fig. 7) may not strongly overlap (our Fig. 3).

Viret (1954), in describing the late Pliocene Saint-Vallier sample of *N. megamastoides*, examined all the features said by Teilhard de Chardin and Piveteau to separate *N. sinensis* from the former and concluded that these could all be subsumed

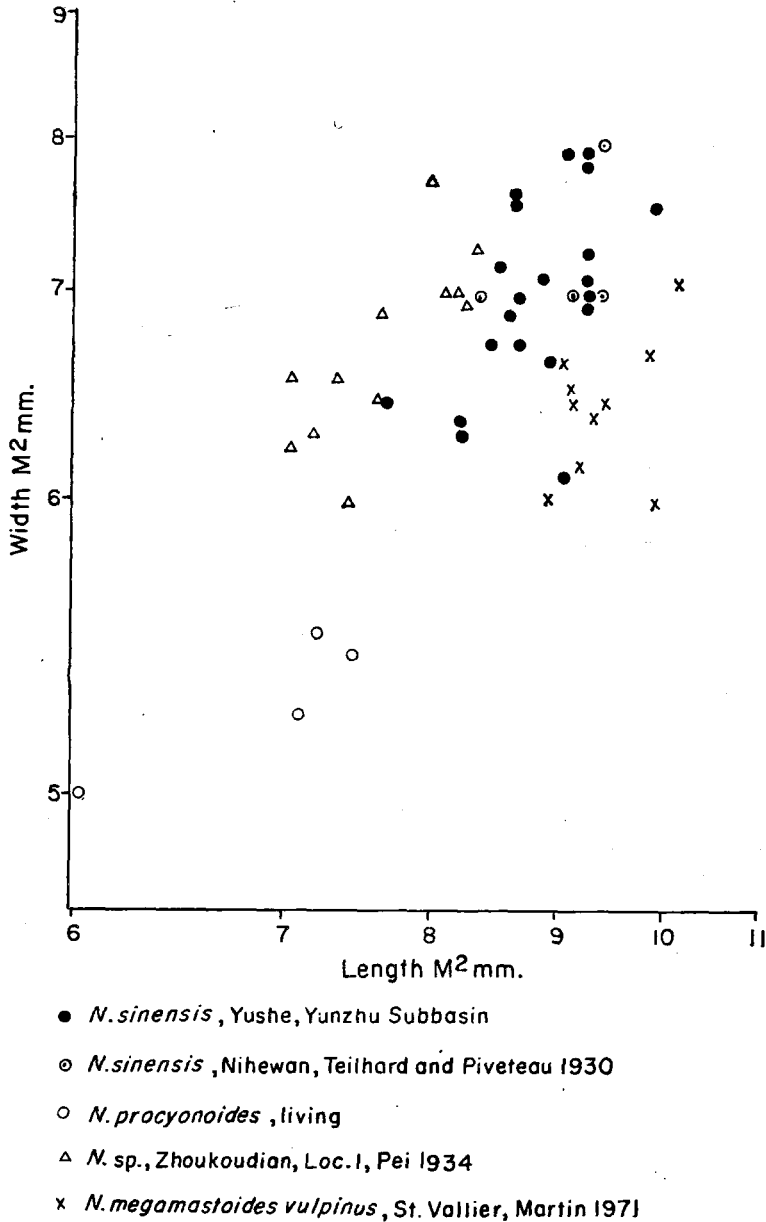


Fig. 3 Bivariate logarithmic plot of the dimensions of the upper second molar of five samples of *Nyctereutes* from China and Western Europe. Data derived from sources indicated, except *N. sinensis*, Yushe, this paper, and *N. procyonoides*, this paper and Martin, 1971

in the variation (or logical extension thereof) seen in the Saint-Vallier sample. Martin's (1971) review of the affinities of *N. megamastoides* did not further consider this question, but Soria and Aguirre (1976) placed *N. sinensis* as a subspecies of *N. megamastoides*. Furthermore, they separated the Saint-Vallier population from typical *N. megamastoides* as a new subspecies, *N. m. vulpinus*, based on the proportionally longer premolars and carnassials and the smaller M/2 as compared with *N. megamas-*

toides from the type locality and contemporary sites in Western Europe.

Pei (1934) attributed the *Nyctereutes* sample from Zhoukoudian Locality 1 to *N. sinensis* and remarked that it was "hardly distinguishable" from *N. megamastoides*. However there are a number of morphological differences that this sample and that from Locality 13 (Teilhard de Chardin and Pei 1941) show when compared with Yushe or Nihewan *N. sinensis* or with *N. megamastoides*, namely, more attenuated post-orbital process, greater postorbital constriction (i. e. smaller posterior limb of the frontal sinus), parasagittal crests joining at the frontal-parietal suture, large medially inflated bullae and presence of a low process on the posterior surface of the subangular lobe giving a sharply V-shaped outline to the subangular notch (Teilhard de Chardin and Pei, 1941, plate 3, fig. 4a, plate 4 fig. 3a), all of which are features of the living *N. procyonoides*. On this basis the Locality 1 and 13 taxon, although larger than the living form, seem more closely related to it than to *N. sinensis*. Soria and Aguirre (1976) reached a similar conclusion although no characters were cited beyond their appraisal of the transitional nature of the Zhoukoudian material between *N. megamastoides* and the living form.

Conclusions This paper presents a description of a new species of fossil racoon dog, *Nyctereutes tingi*, and discussion of the previously described taxon *N. sinensis* (Schlosser 1903) on the basis of material from the Yuncu subbasin of the Yushe Basin, southeastern Shanxi Province. These taxa are coeval through the upper Gaozhuang and Mazegou formations (Qiu, 1987) of early to medial Pliocene age (4.4—2.8 Ma) and represent the oldest occurrences of the genus *Nyctereutes* in China.

Nyctereutes tingi is a primitive member of the genus lacking the strongly developed subangular lobe of the mandible, the expanded angular process, tabular postorbital process and strongly marked parasagittal and sagittal crests seen in its contemporary *N. sinensis* or in the living *N. procyonoides* of eastern Asia. As such it is comparable to *N. donnezani* of the early Pliocene of western Europe, but differs in minor morphological features and in slightly larger size.

Nyctereutes sinensis was described by Schlosser (1903) from three unassociated specimens lacking provenience. We select one of these ("Kiefer A" BSP 1900 XII 5) as the lectotype. This taxon has been historically associated with the first adequate sample of fossil *Nyctereutes* from the late Pliocene Nihewan Formation of Hebei Province, described by Teilhard de Chardin and Piveteau (1930). We recommend continuation of this practical solution to the use of the taxon *N. sinensis*. Our preliminary work on the Yuncu sample finds intergradation with that of Nihewan sufficient for application of that taxon to the geological older Yushe material.

Evidence cited in the recent literature regarding the relationships of *N. sinensis* to western Eurasian *Nyctereutes* of late Pliocene age is reviewed and we agree with Viret (1954) and Soria and Aguirre (1976) that *N. sinensis* and *N. megamastoides* (*sensu* the Perrier type material and the Seneze and Villaroya samples) are closely allied morphologically and mensurally and could represent the extremes of the zoogeographic range of a single taxon. Further work is necessary to explore this suggestion.

We cite morphological evidence to support Soria and Aguirre's (1978) suggestion that the *Nyctereutes* sample from medial Pleistocene Zhoukoudian Locality 1 (Pei, 1934) and Locality 13 (Teilhard de Chardin and Pei, 1941) previously referred to *N. sinensis*, represent a taxon more closely allied to *N. procyonoides* that shows little, other than size, of the transitional morphology between these taxa predicted by Soria and Aguirre (1976).

The history of *Nyctereutes* in eastern Asia, as revealed by the Chinese record, shows the abrupt appearance of primitive (*N. tingi*) and derived (*N. sinensis*) sister taxa in the early Pliocene, the local extinction of the former by the late Pliocene and the loss of the latter either by extinction or evolution to *N. sp.* in the medial Pleistocene. The Zhoukoudian samples seem already like the living *N. procyonoides* morphologically and may have anagenetically yielded the living form in late Pleistocene and Recent time (Pei, 1934).

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