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陕西蓝田灞河组陕西转角羚一新种[1)]

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摘要 1997～2001 年,中科院古脊椎动物与古人类研究所与芬兰赫尔辛基大学合作,于灞河组地层中发现哺乳动物化石计 45 种。其中牛科化石种类与蓬蒂期典型三趾马动物群中的种类不同,至少存在分别归属于 *Shaanxispira*、*Protoryx*、*Dorcadoryx* 和 *Gazella* 的 4 个新的种类。本文仅记述其中陕西转角羚羊一新种:灞河陕西转角羚(*Shaanxispira baheensis* sp. nov.)。

该种主要鉴定特征:角心长而直,粗壮,横断面呈圆形,具一条发育的棱,起始于前内侧,右角上呈顺时针方向旋转一周至一周半(从角基部视),角心前视向两侧中等程度散开,侧视中等后倾,起始于眼眶之后,角柄短。鼻骨窄,向上隆起,其后缘延伸至眼眶前棱之后的位置;眶前窝较宽浅,面部长而窄;角前额顶宽、稍隆起,眶上孔成椭圆形,眶上窝发育,向前的沟槽可延伸至泪骨;额骨在角前轻微隆起;角后颅顶宽、短,颅轴与面轴交角约为 90°。枕面宽、平,面向后下方。牙齿齿冠中等高度。臼齿上底柱与肋皆不发育。p4 的下后尖位于下原尖之后,在老年个体上与下内尖连接,封闭后内谷。

与已知大型转角羚羊相比较,灞河组新发现的种类与周氏陕西转角羚最为接近。不同的是该新种角心只发育一条棱,而不是两条,角心横断面呈圆形;顶骨较短;臼齿列相对较短,下臼齿上的下前附尖、下中附尖及下后附尖相对较弱,下后尖与下内尖较圆凸。

根据角心的旋转方向(右角上顺时针方向,即内旋),角心在眼眶的后部,脑颅短、宽,鳞状骨在枕面上较宽大以及牙齿的形态特征等认为,陕西转角羚不同于 *Antilospira*、*Spirocerus* 等 Antilopini 羚羊,而可能与我国晚中新世三趾马动物群中的 *Urmiatherium*、*Plesiaddax* 以及 *Hezhengia* 等系统关系最为接近,有可能代表了一个新的分类单元(族或亚科)。另外,被认为与 *Protoryx* 关系最接近的 *Sinotragus* 也具有该类群的一些重要特征,有可能也归入该类群中。

关键词 陕西蓝田,晚中新世,灞河组,陕西转角羚
中图法分类号 Q915.876

A NEW SPECIES OF SHAANXISPIRA (BOVIDAE, ARTIODACTYLA, MAMMALIA) FROM THE BAHE FORMATION, LANTIAN, CHINA

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Abstract A new species of large bovid *Shaanxispira*, *S. baheensis* is briefly described. The materials were found from the middle part of the Bahe Formation, Lantian County, China. *S. baheensis* is characterized by having straight horn cores with a clockwise twisted keel on the right, positioned behind the orbit. The braincase is rather short in respect to the width, and the cranial axis is at about 90° with the facial axis.

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The occipital surface is wide and flat with a wide mastoid exposure. No basal pillars on the labial side of lower and on the lingual side of upper molars. The phylogenetic relationships of the *Shaanxispira* with some other large bovids are also tentatively discussed. There possibly existed a group of large bovid of tribal or subfamilial level that died out during the late Miocene, which includes the *Urmiatherium*, *Plesiaddax*, *Hezhengia*, *Shaanxispira*, and possibly *Sinotragus*.

Key words Lantian, Shaanxi, Late Miocene, Bahe Formation, *Shaanxispira*

During 1997～2001, the joint Sino～Finnish research project was carried out in the Lantian area of Shaanxi Province, focusing on the study of the Late Miocene mammals. This project produced a large collection of fossil bovids from the Bahe Formation, including some new taxa. The bovid assemblage from the Bahe Formation is evidently different from those of the typical Late Miocene *Hipparion* fauna in the Baode area. There are at least four new species belonging to *Shaanxispira*, *Protoryx*, *Dorcadoryx*, and *Gazella*, respectively (Zhang et al., 2002).

The earliest bovid genera from China, *Palaeohypsodontus* and *Hanhaicerus* were reported from Middle Oligocene of Ulantatal, Nei Mongol (Huang, 1985), which were only represented by lower jaws and teeth. The Early Miocene bovid is only represented by the *Sinopalaeoceros* (*Oioceros* (?) *xiejiaensis*) (Li and Qiu, 1980; Chen, 1988). From the Middle Miocene of China, there have been discovered three genera of Bovidae, *Turcocerus*, *Kubanotragus* and *Eotragus* (Pilgrim, 1934; Chen and Wu, 1976; Chen, 1988, 1990; Ye et al., 1999). During the Late Miocene, the Bovidae diversified to their greatest extent. In all, 17 genera have been recorded (Table 1), including the well-known *Urmiatherium*-*Plesiaddax* group and the *Protoryx*-*Sinotragus* group (Bohlin, 1935; Teilhard de Chardin and Young, 1931; Teilhard de Chardin and Trassaert, 1938). The study of the new forms from Lantian area will improve our understanding of the evolutionary history of fossil Bovidae in China.

Table 1　Fossil bovid genera from China

	Genera of Bovidae	Number
Pleistocene	*Leptobos*, *Bos*, *Bibos*, *Bubalus*, *Boopsis*, *Budorcas*, *Megalovis*, *Ovis*, *Capricornis*, *Naemorhedus*, *Gazella*, *Spirocerus*	12
Pliocene	*Gazella*, *Pachygazella*, *Sinocapra*, *Antilospira*, *Sinoreas*, *Lyrocerus*	6
Late Miocene	*Urmiatherium*, *Plesiaddax*, *Hezhengia*, *Sinotragus*, *Prosinotragus*, *Protoryx*, *Paraprotoryx*, *Palaeoryx*, *Sinoryx*, *Shaanxispira*, *Dorcadoryx*, *Tragoportax*, *Selenoportax*, *Qurliqnoria*, *Olonbulukia*, *Tossunnoria*, *Gazella*	17
Middle Miocene	*Kubanotragus*, *Turcocerus*, *Eotragus*	3
Early Miocene	*Sinopalaeocerus*	1
Middle Oligocene	*Palaeohypsodontus*, *Hanhaicerus*	2

In this paper, a new species of the large bovid, *Shaanxispira baheensis*, is briefly described, and tentative phylogenetic relationships of some bovids from North China are also discussed. The fossil localities in the synthetic profile can be referenced in Zhang et al. (2002), and the geological settings of the fossil localities in Kaakinen et al. (in press[1)]). The terminology used herein follows Gentry (1992).

All the specimens described in this paper are housed in the Institute of Vertebrate Paleontology and Paleoanthropology (IVPP), Chinese Academy of Sciences.

1) Kaakinen A, Lunkka J P (in press). Sedimentation of the late Miocene Bahe formation and its implications for stable environments adjacent to Qinling mountains in Shaanxi, China. Journal of Asian Earth Sciences.

Artiodactyla Owen, 1848
Bovidae Gray, 1821
Shaanxispira **Liu et al., 1978**
Shaanxispira baheensis **sp. nov.**
(Figs. 1～3)

Holotype IVPP V 13626, a partial skull connected with mandible.

Type locality Loc. 6, Bahe Formation, Lantian, China

Included specimens Loc. 33: a frontlet with the almost complete left horn core and about half the right one (V 13628); Loc. 6: a partial skull with the left horn core and right M3 in middle wear (V 13611); a pair of horn cores (V 13630); a frontlet with both horn cores (V 13634); a partial skull with the cranial part, orbit, base of horn cores and P3 - M3 preserved (V 13635); a frontlet with two broken horn cores (V 13636); distal part of a left horn core (V 13631); distal part of a left horn core (V 13633); a part of right mandible with p4 - m3 (V 13618); a part of upper dentition with M1 - M3 (V 13612).

Etymology Bahe —The name of the river along the sections of fossil localities.

Measurements See Table 2～4.

Table 2 Skull measurements of Shaanxispira baheensis **sp. nov.** (mm)

	V 13626	V 13635
Skull length from the P3 to the occipital	250	
Skull width across the zygomatic	128	129
Skull width across the orbital	154	
Width across the horn cores (outer edges)	139.5	
Width across the maxillae (M3)	89	
Distance between the supraorbital foramen (outer edge)	47	
Maximum width of the occipital surface	99	104
Width of cranial	80	81.5
Height of the occipital surface	75.5	88.5
Distance from the posterior end of horn core to the occipital surface	53	54
Width of the basioccipital across the posterior tuberosities	35.5	31
Width of the basioccipital across the anterior tuberosities	23.7	25.5
Distance of the anterior and posterior tuberosities (central points)	21.5	24.8

Table 3 Tooth measurements (length) of Shaanxispira baheensis **sp. nov.** (mm)

	p4	m1	m2	m3	P3	P4	M1	M2	M3
V 13626	16.1	16	18.1	31.8				18.2	27.6
V 13635					12.6	12.7	17.1	22.6	24.3
					12.4	12.4		23.7	25.7
V 13612							16.5	22.7	26.7
V 13618	14.4	16.4	21.1						

Table 4　Measurements of the horn cores of Shaanxispira baheensis **sp. nov.**　(mm)

	Left horn core		Right horn core	
	APD	TD	APD	TD
V 13626(type)	48	49	43	56
V 13630	51	52	50	52
V 13628 (60mm above the base)	35	37		
V 13611	44	55		

APD: antero-posterior diameter; TD: transverse diameter.

Diagnosis　Horn cores long and straight, with round cross section, a single prominent keel with clockwise torsion of one to one and a half circuits on the right, ascending from an antero-medial insertion; moderately divergent laterally and inclined backwards; inserted behind the orbits; pedicel short. The nasals are narrow and domed, with their posterior ends behind the level of the anterior rims of the orbit. The preorbital fossa is wide and shallow. Two furrows from the oval shaped supraorbital foremen leading to the lachrymals. The frontals are slightly raised at the anterior base of horn cores. The braincase is rather short in respect to its width, and the cranial axis is at about 90° with the facial axis. The occipital surface is wide and flat with a wide mastoid exposure, facing moderately downwards. Teeth are mesodont, without strong ribs and no basal pillars on upper and lower molars. The p4 has its metaconid situated posterior to the protoconid, and connected with the entoconid in old individuals.

Geological distribution　Early Late Miocene, Bahe Formation, Lantian County, Shaanxi Province.

Description　The holotype is a partial skull of an aged individual, connected with two lower jaws (Figs. 1～2). The anterior part of the nasals was broken and the tip of horn-cores lost. The skull has become slightly compressed from side to side after death. There is preserved only the left M3 and part of M2 and right M2 - M3 in the maxillae, the left posterior part of p3, p4 - m3, and the right m2 - m3. Another skull (V 13635) has its cranial part almost undistorted. The frontlet V 13634 has two complete horn cores, without any taphonomic distortion (Fig. 3).

The horn cores are straight, and strongly built with a round cross section. Only one prominent keel developed, which starts from the antero-medial side of the frontal and ascends with a clockwise torsion on the right. The keel twists through about one complete circuit from base to tip. The diameter of the cross section diminishes gradually from the base to the tip. In the specimen V 13634 (Fig. 3), the keel twists about one and half circuits. The horn cores are close at the base and the angle between them is about 45°. The horn cores are inclined moderately backwards, and inserted posteriorly to the orbits. Pedicles are short.

The nasals are narrow and domed, with their posterior ends behind the level of the anterior rims of the orbit. There are two long and deep supraorbital pits around each supraorbital foramen, which are oval-shaped longitudinally. Two furrows extend from the supraorbital pits to the lachrymals and pinched off. At the anterior base of the horn cores, the frontal is raised slightly, and then bent downwards between the horn cores. The preorbital fossa is wide and shallow, which makes the facial part long and narrow. No upper rim of preorbital fossa is developed. The orbits are large, with the orbital rims wide and slightly sloping. The back edge of M3 is set well anterior to the front edge of orbit. The maxillary tuberosities are prominent. The braincase is rather short in respect to its width, and bending strongly downwards. The occipital surface is almost perpendicular to the parietal. The bases and insertions of the horn cores converge anteriorly in dorsal view, with a triangular shaped part of the frontal in between. The parietal-frontal suture is dented anteriorly in its center. There is no postcornual fossa. The temporal ridges are not developed. The median vertical ridge on the occipital is low and does not persist down to the foramen magnum. The mastoid exposure is large and faces backwards. The anterior tuberosities of the basioccipital are well developed and the shape of

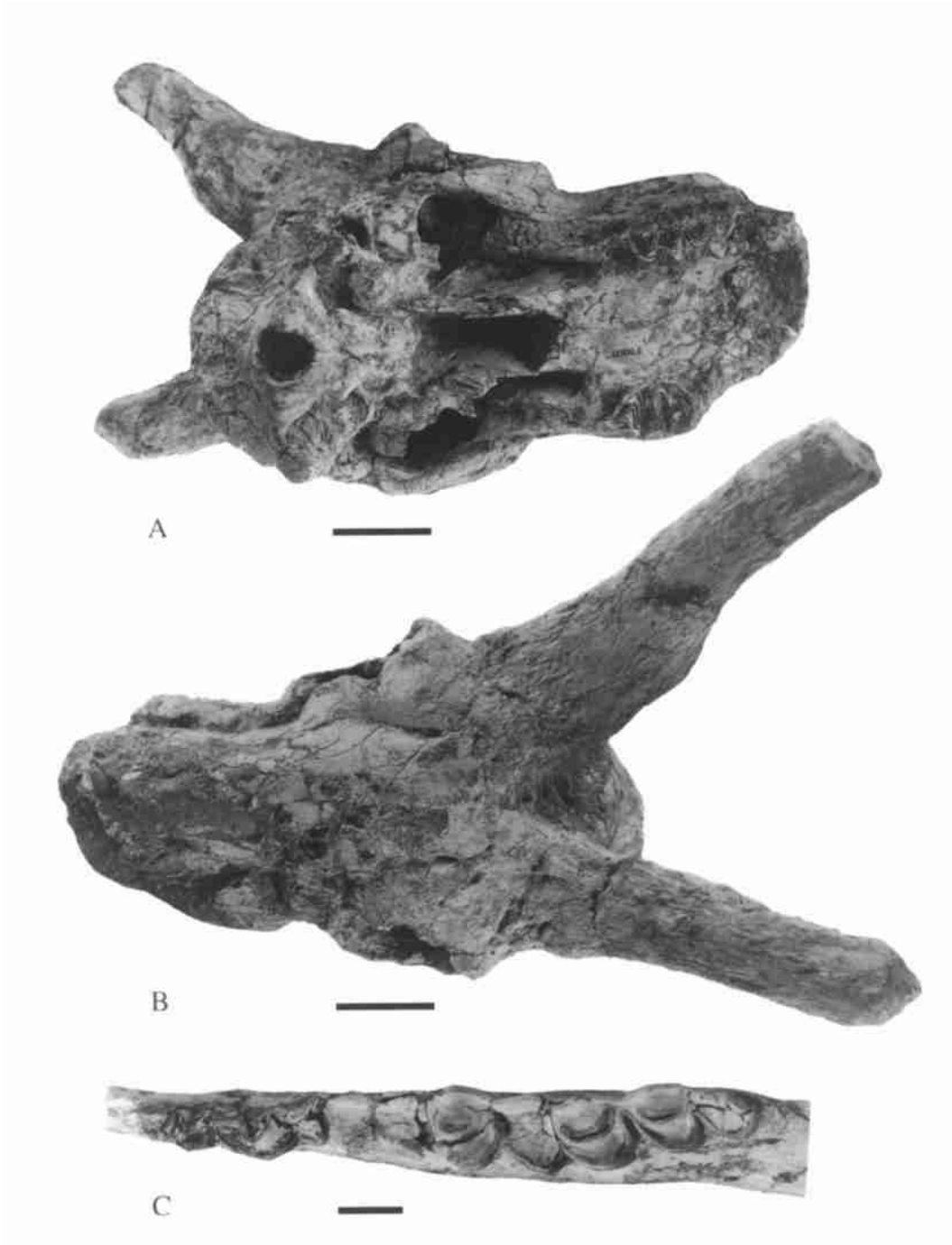

Fig. 1 *Shaanxispira baheensis* sp. nov. (V 13626, holotype)
A-B. skull, scale bar = 4cm: A. ventral view; B. dorsal view;
C. occlusal view of the left mandible, scale bar = 1cm

the basioccipital trapezoidal. A moderately deep longitudinal groove is developed on the basioccipital. The basioccipital is transversely constricted in its central region and the posterior

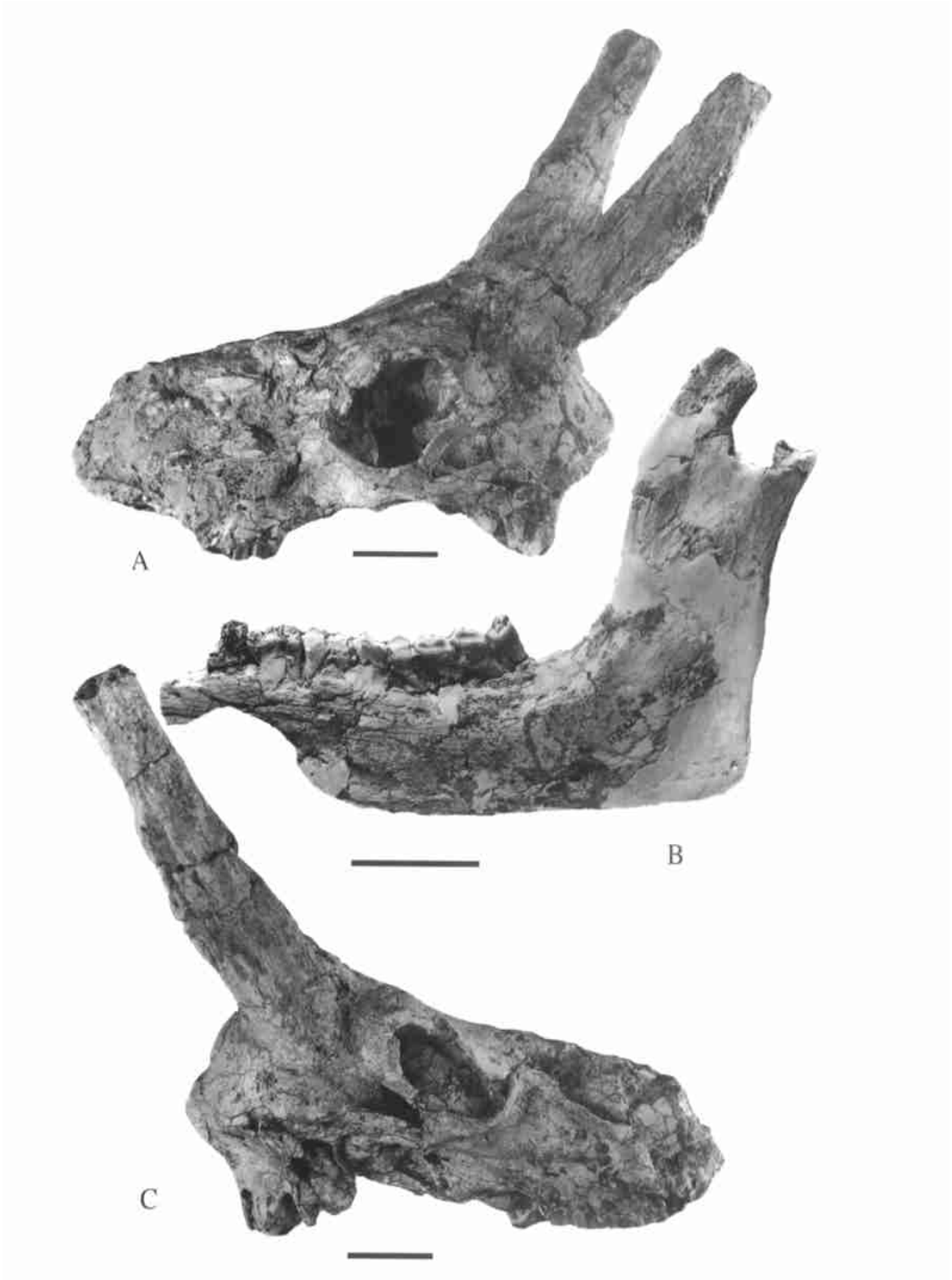

Fig. 2　*Shaanxispira baheensis* sp. nov. (V 13626, holotype), scale bar = 4cm
A, C. left and right side view of the skull; B. labial view of the left mandible

tuberosities extend laterally. The auditory bulla is small and rounded and its anterior and posterior

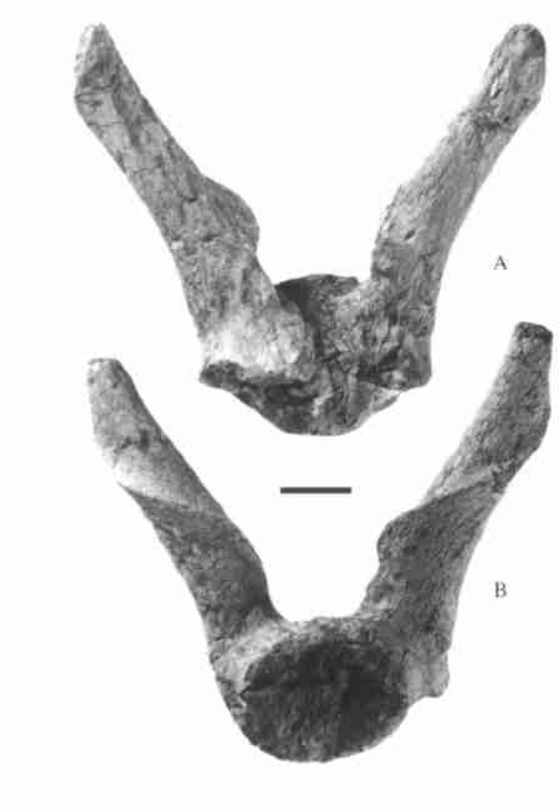

Fig. 3 Frontlet of *Shaanxispira baheensis* sp. nov. (V 13634), scale bar = 4cm
A. anterior view; B. posterior view

borders do not exceed the ranges of the anterior and posterior tuberosities. The paraoccipital processes are gracile. The median indent at the back of the palate is situated posterior to the lateral indent and both posterior to the tooth row.

The molars are mesodont when unworn, with slightly rugose enamel surfaces, especially on the lingual side of uppers. There is no basal pillar (entostyle) on upper molars. The P3 is oval shaped in occlusal view in la-ter wear, with the length exceeding the width, and the parastyle less developed than the paracone. The P4 is semicircular on the occlusal surface, with the parastyle less developed than the metastyle, and a weak rib. The M1 is basically square shaped in old individuals. The M2 is larger than the M1, with a "U" shaped central fossette. The mesotyle is the most prominent style on the labial wall. There is an enamel island between the two lobes on aged specimens. The M3 is the largest upper molar, and has a well developed parastyle and a posteriorly extended posterior flange.

The mandibles are relatively shallow below the molar row. The diastema is not fully preserved. The base of the mandible is almost straight. The coronoid process ascends with a backwards inclination. The articular process is small and transversely oriented, the angular process roughly vertical. The inferior dental foramen is large.

The premolar row is not fully preserved on the type specimen. The p2 is lost, with only the alveolar preserved, and the p3 only has the posterior part left, which shows slight lateral projection of the hypoconid and a posteriorly extending metaconid. The anterior wall of p4 is slightly turned transversely. The paraconid and the parastylid are connected. The metaconid and entoconid are connected to form a lingual wall on aged specimens. There is "V" shaped valley between the paraconid and metaconid. The hypoconid of p4 projects laterally. The metaconid is situated posteriorly to the protoconid, and does not extend forwards. Lingual walls of the lower molars are basically flat, while the labial lobes are rounded rather than angled. There is no goat fold on the lower molars. The parastylids are observable, while the metastylids and entostylids are almost absent. the lingual walls are slightly outbowed, without any ribs. The rear lobe (hypoconulid) of m3 is large and without a central fossette, and its lingual wall is offset labialwards.

Comparison and discussion By the straight horn cores and clockwise twisted keel on the right horn cores, the new materials from Lantian can readily be compared with *Shaanxispira chowi* from the Bahe Formation, Lantian, China (Liu et al., 1978).

Since the paper of Liu et al. was published in Chinese, an English translation of the diagnosis of the genus is given here: a large horned antelope, with horn cores robust, straight, inner twisted, tilted outwards.

The type and only species *S. chowi* was described based on a partial skull with two horn cores

(Liu et al., 1978, P1. 30, Fig. 3, V 3124). Other material (mandibles, maxillae, and isolated teeth) found from the same or adjacent levels were conscientiously assigned to Antelope spp. indet., but considered to be most probably of *S. chowi* in discussion.

The new materials show some similarities with those of *S. chowi* in horn core characters: robust, straight, direction of twist of the keels (clockwise on the right), and modest divergence. The major differences lie in the new species having only one prominent keel instead of two; the cross section of the horn cores being round instead of enclosing concave and convex surfaces between the two keels; and the parietal shorter than that of the type species. On the type specimen of *S. chowi*, the preserved part of the parietal is about 30mm, which is longer than the complete length of the new form (27 mm in the V 13635).

In our new collections, the dental materials can be separated into two groups by some tooth characters. One is mostly from Loc. 6, the other from Loc. 30. Loc. 30 is at the same level with the 59S6 of 1960s (=63702.L4, the type locality of *S. chowi*) by lithological correlation. However, the size difference between these two groups is not prominent (Fig. 4), though the Loc. 6 group has slightly shorter molar row. The measurements of dental materials from Loc. 30 fit well with those of *S. chowi*. Though no skull was found with these dental materials, it is highly probable that these materials from Loc. 30 all belong to *Shaanxispira chowi*.

Both *S. chowi* and *S. baheensis* share: teeth mesodont, the lingual lobes of upper and labial lobes of lower molars rounded; "U" shaped central fossettes on upper molars; premolar row short; no basal pillars and no goat folds on lower molars; rear lobe of m3 large and offset labialwards, especially on unworn teeth. The differences lie in *S. baheensis* having lower molars with less developed parastylids and metastylids and more outbowed lingual walls, metaconid of p4 not extending forwards and positioned slightly posteriorly relative to the protoconid; the valley between the entoconid and entostylid opening posterolingually rather than lingually.

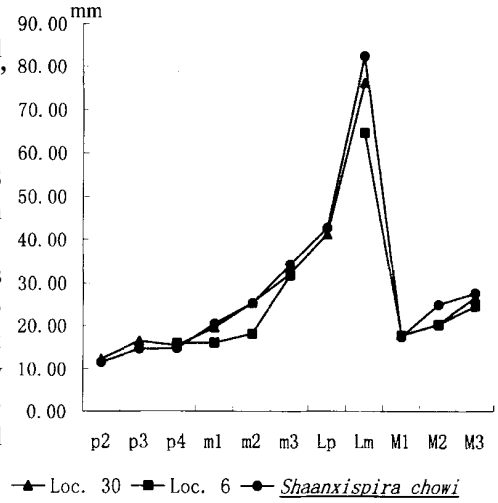

Fig. 4　Plotted diagram showing the length of the cheek teeth
Loc. 30: new materials from Lantian; Loc. 6: *Shaanxispira baheensis*; *Shaanxispira chowi*: after Liu et al. (1978) originally as Antelope spp. indet. Lp: length of the lower premolar row; Lm: length of the lower molar row

In the paper of Liu et al. (1978), a partial skull from 59S5 (V 3125), tentatively assigned to Antelope spp. indet., was thought most probably to be a species other than the *Shaanxispira chowi* by the following characters in the specimen: an old individual with partly fused frontal-parietal sutures; hornless, straight suture line between the frontal and parietal, parietal short, the distance between the suture and the occipital surface is roughly 17 mm. By the short parietal, this specimen is most probably a female individual of the new form. Unfortunately, this specimen was not figured at that time and most probably has been lost.

By the tooth characters, the present species is very similar to the *Urmiatherium* and *Plesiaddax* (Bohlin, 1935) that are common from the "*Hipparion* Red Clay" in North China. However, both these genera have very derived or extremely developed horn cores. On the *Plesiaddax*, the horn-cores are extremely short and extend laterally, while the horn-cores of *Urmiatherium* are upright and tightly closed up. The basioccipital are also developed to a more extreme extent. The posterior tuberosities are extremely large, and raised as an articular facet, together with the

prominent mastoid process and ectoccipital process on the males of *Plesiaddax*.

Hezhengia is a recently erected genus based on materials from Hezheng, Gansu Province (Qiu

inserted behind the orbits, and the base covers a large part of the frontals and parietal. The frontals between the horn cores are highly raised. The extra articulation facets on the paraoccipital process and the basioccipital are less developed than in *Plesiaddax*. This genus is different from *Shaanxispira* by its short, curved horn cores with triangular cross section, much higher raise of the frontal above the orbit. However, they share the same direction of torsion of the horn cores, horn cores positioned posterior to the orbit, short braincase, and quadrate shape of upper molars.

There are also some characters similar to the *Sinotragus wimani* from Lok. 30 of Zdansky (Bohlin, 1935). Judged by skull size, the body mass would be comparable. They both have

same. They also share some characters as follows: basioccipital structures, flat occipital surface with wide mastoid exposure, square shaped upper molars in later wear and U shaped central fossettes. However, the *Sinotragus wimani* has long and narrow tympanic bulla, anterior positioning of the median indent at the rear of the palatine, cross section of horn-cores triangular shape and short pedicle, with large coverage of the cranial roof, strong built mastoid process, and so on. All these characters seem to be derived.

By the long and straight horn cores with round cross section, inserted behind the orbits, a

materials from Lantian can easily be distinguished from the western spiral-horned Antilopini, such as the *Prostepsiceros* and *Protragelaphus*.

Pavlow (1913) described some specimens from Grebeniki, Ukraine, as *Protragelaphus skourzesi*. However, by her description and illustration, the smaller specimen (Pl. 1, Fig. 20) thought as juvenile individual, has straight horn cores with a clockwise twisted keel on the right side. Regretfully, the present author has not a chance to get access to these specimens till now. If this point of view were verified to be correct, it would be the *Shaanxispira* outside China.

Phylogenetic discussion The phylogenetic relationships of the Chinese fossil Bovidae is still under study since Bohlin (1935) and Teilhard de Chardin and Trassaert (1938) pioneered the work on this issue.

The *Shaanxispira* was originally put into the Tragelaphinae (Liu et al., 1978), by comparing with the Pliocene *Antilospira* and Pleistocene *Spirocerus*, following Teilhard de Chardin and Trassaert (1938). Gentry (1971) tentatively thought that these two latter genera could possibly be of the Antelopini. The *Antilospira* and *Spirocerus* from North China all have horn cores with anticlockwise torsion on the right and positioned above the orbit.

By the body size, skull and tooth characters, *Shaanxispira* is most probably related to *Urmiatherium*, *Plesiaddax*, and *Hezhengia* that are used to be thought as Ovibovinae. They all share the following characters: large sized among late Miocene bovids; horn cores having clockwise torsion of the keel on the right, inserted behind the orbits; preorbital fossae wide and shallow, which make the facial part narrow and the nasals transversely domed; occipital part wide and flat, with well developed mastoid process; basioccipital specialized to different degrees; molars having squared lobes and straight central sections of their fossettes. Among these, *Urmiatherium* and *Plesiaddax* are two extremely evolved genera, with reduced horn cores on specialized insertions and with the shortest premolar rows. They developed extra articular facet on the basioccipital, together with the enlarged mastoid and paraoccipital processes.

Compared with other bovid genera, *Hezhengia* is the closest to *Plesiaddax*, but shows some primitive characters: the horn cores larger and less expanded at the basal part, premolar row longer, and the posterior tuberosities less developed than in the latter genus. For the present author, *Hezhengia* is most probably an ancestral genus to *Plesiaddax*.

Sinotragus wimani was thought to be closely related to *Protoryx* by Bohlin (1935) and Gentry (1971). However, it is very different from *Protoryx*, by the horn cores being posteriorly positioned, keeled, and with clockwise twisted torsion on the right, shorter braincase, wide and flat occipital surface and strongly developed basioccipital tuberosities. All these characters suggest that *Sinotragus* is more closely related to the *Plesiaddax-Urmiatherium* group.

Later work will probably show that there existed a large bovid group (at tribal or subfamilial level) during the Late Miocene, and becoming extinct most probably at the end of the Late Miocene.

From the west of the Eurasian continent, *Criotherium*

Shaanxispira.

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