

## Records of *Stephanorhinus kirchbergensis* (Jäger, 1839) (Mammalia, Rhinocerotidae) from the Ob' River at Krasny Yar (Tomsk region, southeast of Western Siberia)

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**ABSTRACT.** Isolated teeth and some other postcranial remains, which have been discovered in Middle Pleistocene levels along the Ob' River at the village of Krasny Yar, in front of the Sargulin Island (Krivosheino District, Tomsk region, southeast of Western Siberia), are attributed to *Stephanorhinus kirchbergensis* (Jäger, 1839), better known in Russia as “Merck’s rhinoceros”. *S. kirchbergensis*, unlike other Plio-Pleistocene rhinoceroses, seems to be rare in the Russian fossil record (as well as in the rest of Eurasia), being reported from a limited number of localities only. This is the case of one of the very few records of this species from Siberia, and a second one from the Tomsk region. The co-occurrence in the Krasny Yar of *S. kirchbergensis* with *Mammuthus* ex gr. *trogotherii-chosaricus*, *Bison priscus*, *Megaloceros giganteus ruffi*, and *Equus* ex gr. *mosbachensis-germanicus* suggests a palaeoenvironment dominated by extensive grasslands and sparse trees.

**KEY WORDS:** morphology, *Stephanorhinus kirchbergensis*, Middle Pleistocene, Tobol Horizon, Tomsk region.

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## Находки *Stephanorhinus kirchbergensis* (Jäger, 1839) (Mammalia, Rhinocerotidae) из Красного Яра на реке Обь (Томская область, юго-восток Западной Сибири)

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**РЕЗЮМЕ.** Изолированные зубы и некоторые посткраниальные остатки, найденные в отложениях среднего плейстоцена реки Обь, напротив острова Саргулинский (Кривошеинский район, Томская область, юго-восток Западной Сибири), отнесены к *Stephanorhinus kirchbergensis* (Jäger, 1839), более известного в России, как «носорог Мерка». *S. kirchbergensis* — в отличие от других носорогов плио-плейстоцена на территории России является редким (также как в остальной Евразии) и известен только из небольшого количества местонахождений. Этот вид редко описывается в литературных источниках по Сибири и второй раз из Томской области. Совместное нахождение в Красном Яру *S. kirchbergensis* с другими видами — *Mammuthus* ex gr. *trogotherii-chosaricus*, *Bison priscus*, *Megaloceros giganteus ruffi*, *Equus* ex gr. *mosbachensis-germanicus* предполагает, что на данной территории существовал палеоландшафт обширных открытых пространств и редколесий.

**КЛЮЧЕВЫЕ СЛОВА:** морфология, *Stephanorhinus kirchbergensis*, средний неоплейстоцен, тобольский горизонт, Томская область.

### Introduction

Brown quartz-arkose medium-grained sands of the Tobol Horizon level (Siberian stratigraphy = Likhvin Horizon in the Eastern-European stratigraphy, MIS 11) outcrop along the right bank of the Ob' River at the Krasny Yar Village (about 50 m a.s.l.; 57°05' N, 84°30' E; Krivosheino District, Tomsk region, southeast Western Siberia, about 110 kilometers north of Tomsk, Fig. 1). Several excavations, described by Shpansky (2005, 2009), unearthed in the lower part of the deposit seven isolated rhinoceros teeth and other postcranial rhinoceros

remains in association with bone remains referred to *Mammuthus* ex gr. *trogotherii-chosaricus*, *Bison priscus* Bojanus, 1827, *Megaloceros giganteus ruffi* Nehring, 1891 and *Equus* ex gr. *mosbachensis-germanicus*.

Remains of *Stephanorhinus kirchbergensis* (Jäger, 1839) from this locality were first collected by E.V. Alekseeva (1980). She listed 17 upper teeth and provided a brief description and measurements of this material. At present, this material is inaccessible for study. This paper presents the previously described (Billia & Shpanskij, 2005) and a new material (three

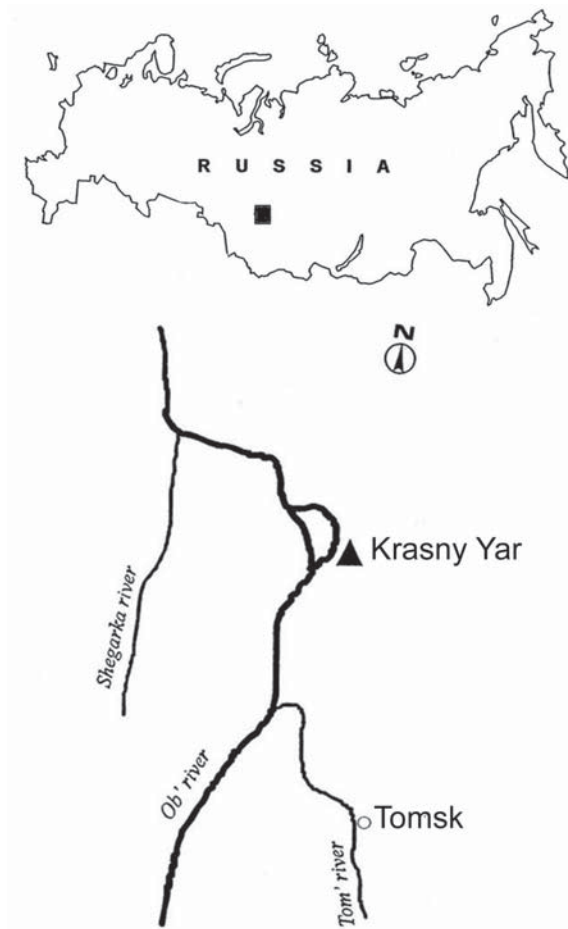


Figure 1. Index maps of the Tomsk region and localization of the Krasny Yar Village in the area.

teeth and hind limb bones). We also compare teeth and bones dimensions from Krasny Yar with specimens from the other regions.

The geology and taphonomy of the site were described by Shpansky (2006). Fine to medium-grained sands are exposed along the river bank near the Krasny Yar village. They compose the base of the second terrace over the Ob' River floodplain, referred to the Tobol Horizon (=early Aurelian). Two fragmentary *Mammuthus* ex gr. *trogotherii-chosaricus* skulls and lower jaws, *Bison priscus* skull, fragment of *Megaloceros giganteus ruffi* lower jaw, *Equus* ex gr. *mosbachensis-germanicus* metapodia, three teeth and metacarpale III of *S. kirchbergensis* were collected from these sands. The Tobolian sands are covered by Late Pleistocene-Holocene sediments. Radiocarbon dates for these sediments based on mammalian remains are  $25650 \pm 420$  yr (SB RAS-5201),  $18505 \pm 215$  yr (SB RAS-5555). In our opinion, mammalian remains of the younger, Mammoth fauna (19 species) come from these sediments. Unfortunately, because of the intensive erosion most of bone material is washed out into the sand spit, where the older material mixes with the younger one. Detect-

ing the late Middle Pleistocene bones from this mass is very difficult. Identification was based on diagnostic bones and teeth. *S. kirchbergensis* teeth and bones are clearly different from remains of *Coelodonta antiquitatis* well represented in the Krasny Yar material.

## Material

Eight isolated teeth and skeletal remains described in this paper are preserved in the collections of the Palaeontological Museum of the Tomsk State University in Tomsk, Russia (PM TSU).

### Odontological material

#### 1) PM TSU 5/1251

Large-sized and brachyodont second upper molar M2 (Fig. 2A, B), rather damaged in the mesio-lingual portion; the metaloph appears remarkably bulbous. A thin film of coronal cement cover almost all the surface of the crown, whereas the interior valley shows only its traces; where the cement is absent, the enamel appears rather smooth and opaque. Only one stylus is present in the interior valley.

#### 2) PM TSU 5/3495

Uncommonly large-sized and brachyodont first upper molar M1 (Fig. 2C, D), rather damaged at the parastyle, at the protoloph, and at the metaloph. Both the protoloph and the metaloph appear remarkably bulbous; the enamel is rather smooth and demi-opaque; some sub-vertical lines are present on the vestibular side. The cingula are absent, as well as both the anticrochet and the crista; roots are still present.

#### 3) PM TSU 5/2878

Well-preserved, large-sized and rather hypsodont fourth upper premolar P4 (Fig. 2E, F); bright, slightly rough enamel, uniformly spread on all the surface of the crown; the interior valley appears narrow; the protoloph and metaloph are bulbous (particularly the first one); mesial and lingual cingula are also present; even if damaged, roots are still present.

#### 4) PM TSU 5/2602

Second upper molar M2 (not figured) preserves the buccal wall of ectoloph. The enamel is slightly undulates. Front folds of the enamel preserve the collar fragments.

#### 5) PM TSU 5/3328

Well-preserved, uncommonly large-sized, very brachyodont third lower molar p3 (Fig. 3A, B) showing both the mesial and the distal valleys drastically reduced; the enamel is demi-smooth and semi-bright; the coronal cement is absent; a distal cingulum is also present; the roots are damaged.

#### 6) PM TSU 5/1067

Very well-preserved, large-sized, and remarkably brachyodont second lower molar m2 (Fig. 3 C, D); both

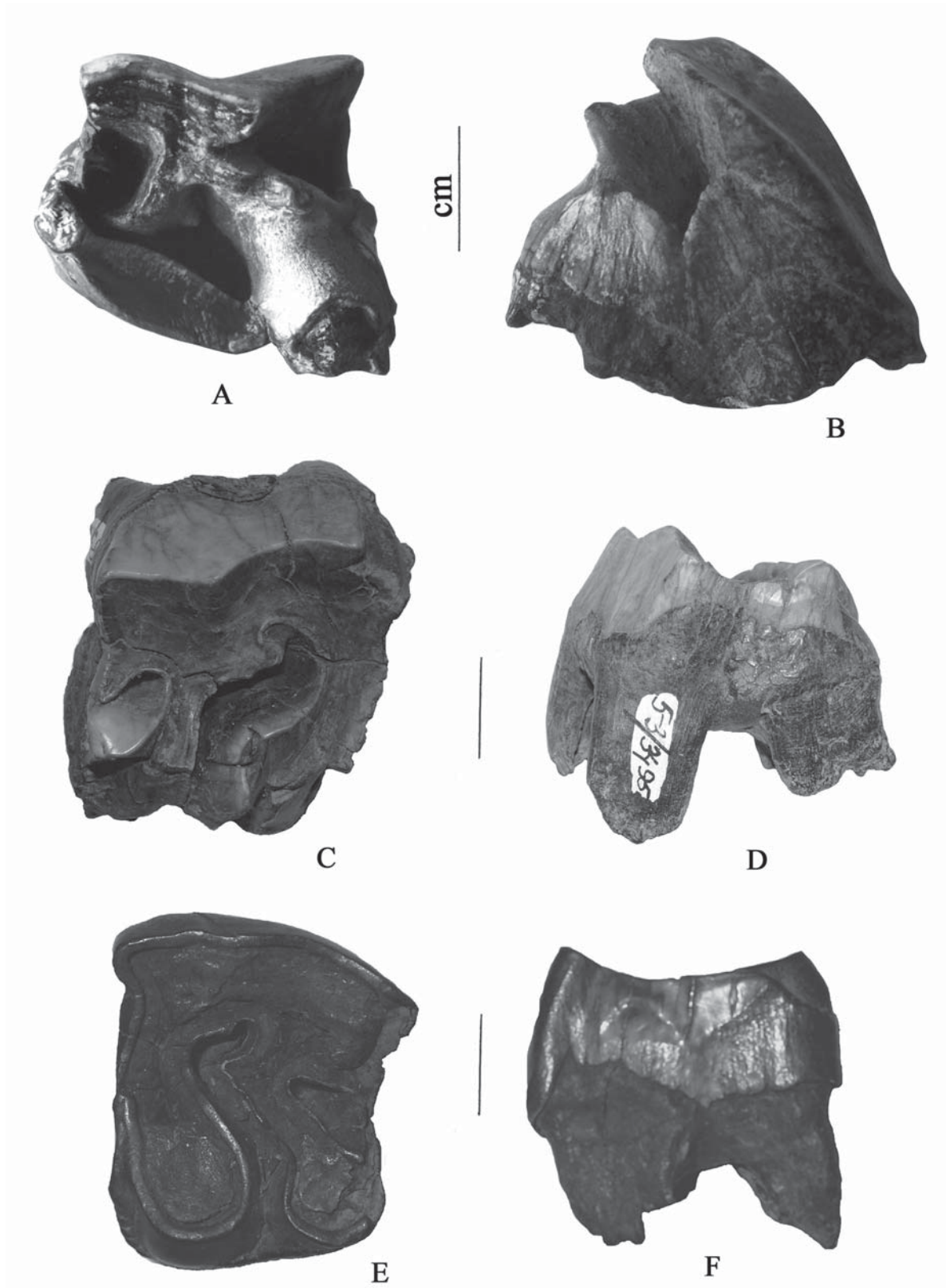


Figure 2. *Stephanorhinus kirchbergensis* (Jäger, 1839); Tobol Horizon level (=Middle Pleistocene); Ob' River at Krasny Yar (Tomsk region, southeast of Western Siberia); second upper molar PM TSU 5/1251, (A) occlusal-lingual view and (B) distal view; first upper molar PM TSU 5/3495, (C) occlusal view and (D) posterior view; fourth upper premolar PM TSU 5/2878, (E) occlusal view and (F) anterior view.

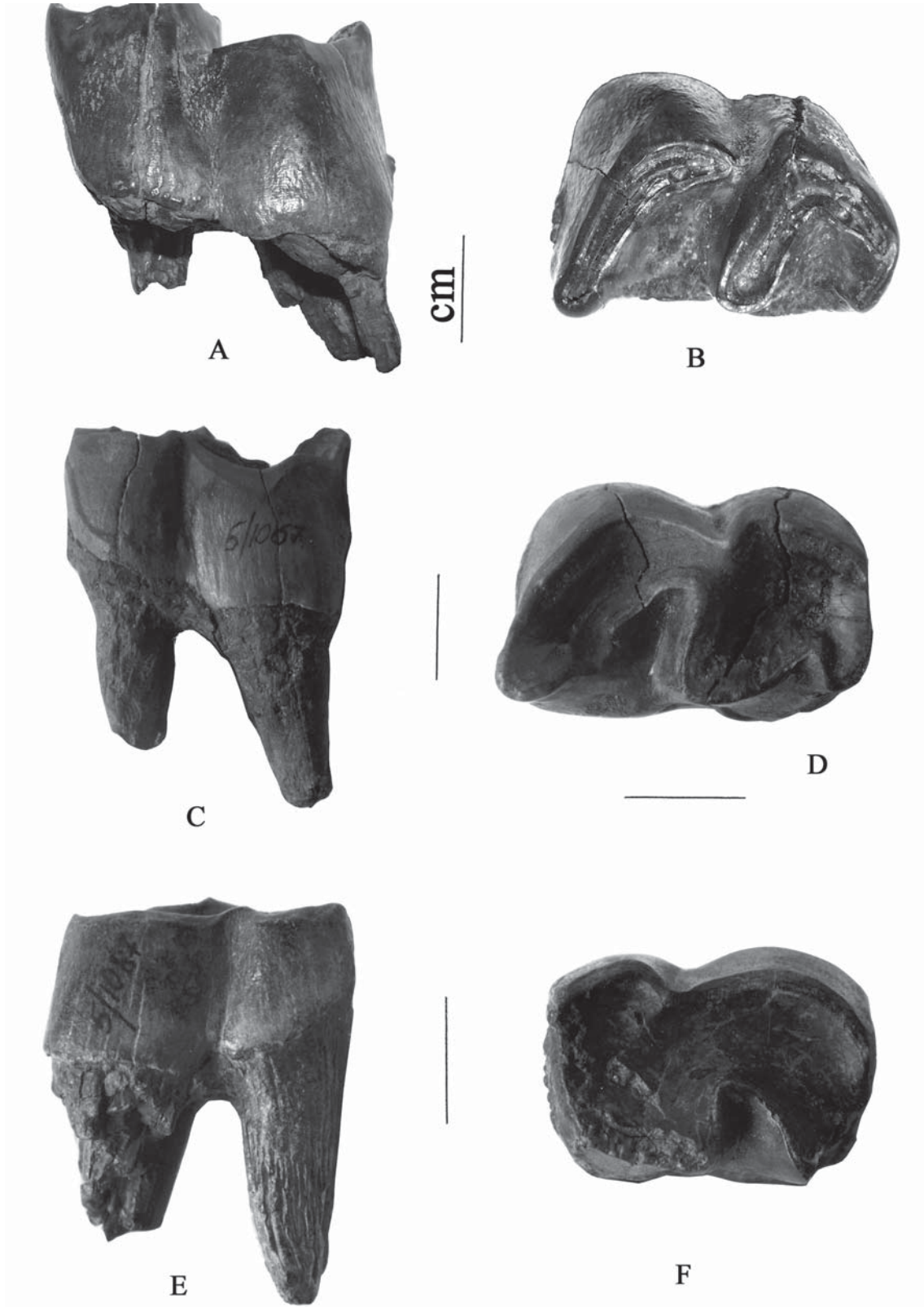


Figure 3. *Stephanorhinus kirchbergensis* (Jäger, 1839); Tobol Horizon level (=Middle Pleistocene); Ob' River at Krasny Yar (Tomsk region, southeast of Western Siberia); third lower molar PM TSU 5/3328, (A) occlusal view and (B) buccal view; second lower molar PM TSU 5/1067, (C) occlusal view and (D) buccal view; first lower molar PM TSU 5/1087, (E) occlusal view and (F) buccal view.

Table 1. Dimensions (in mm) of eight teeth *S. kirchbergensis* from the Krasny Yar.

No.	Tooth	Collection number	BL	LL	MW	DW
1	Second upper molar	PM TSU 5/1251	—	63.2	—	—
2	First upper molar	PM TSU 5/3495	61.2	48.1	76.2	62.7
3	Fourth upper premolar	PM TSU 5/2878	46.1	41.2	64.5	40.4
4	Second upper molar	PM TSU 5/2602	64.5	—	—	—
5	Third lower molar	PM TSU 5/3328	63.2	57.8	34.1	37.3
6	Second lower molar	PM TSU 5/1067	—	60.6	41.2	42.4
7	First lower molar	PM TSU 5/1087	> 54	—	36.5	38.7
8	Fourth upper deciduous premolar	PM TSU 5/2883	61.2	—	—	44.1

BL — buccal length; LL — lingual length; MW — mesial width; DW — distal width.

the mesial and the distal valleys are drastically reduced; the enamel is smooth and semi-bright; the coronal cement is absent; mesial and distal cingula are also present; the roots are still present.

#### 7) PM TSU 5/1087

Large-sized, very brachyodont first lower molar m1 (Fig. 3E, F) slightly damaged in its mesial and distal portions; both the mesial and the distal valleys are drastically reduced. The dimensions are very close to those of the molar 5/1067; as on 5/1067, the enamel is smooth and semi-bright, the coronal cement is absent; roots still present.

#### 8) PM TSU 5/2883

Large-sized, very brachyodont fourth upper deciduous premolar dP4 (not figured) damaged in its lingual portion; semi-opaque, slightly rough enamel, uniformly spread on all the surface of the crown; the metacone is remarkably bulbous; even if seriously damaged, the protocone allows to have an inkling of a remarkable bulbosity. A distal cingulum is also present.

Measurements of the eight teeth are given in Table 1. Comparison of *S. kirchbergensis* teeth measurements from Krasny Yar with teeth from other localities and other species, are given in Table 2.

### Postcranial material

#### 1) PM TSU 5/2723

Uncommonly well-preserved, remarkably large-sized, rather slender third metacarpal (Fig. 4 A, B). In proximal aspect, the proximal articular surface appears, proportionally, more stretched dorso-palmarly than latero-medially; in cranial aspect, the bone distally shows an abrupt progressive enlargement followed by a drastic contraction immediately before the distal articular surface, therefore the width of the distal epiphysis by comparison with the width of the distal articulation is remarkably wider. The width of the distal articulation is 64 mm. The medial ridge of the distal articulation begins from the lowest point of the distal face smoothly increasing posteriorly close to the highest point on its edge. In comparison with *Coelodonta antiquitatis*, the *S. kirchbergensis* metacarpal preserves the ridge on lower part of the palmar surface, where it continues up

to 1/3 of the length becoming broader. In lateral (and/or medial) aspect, the diaphysis appears narrow and flat through all its extension; in caudal aspect, on touch, it is flat and almost smooth, only the mean crista shows, distally, a slight relief.

Position, shape and sizes of faces on the proximal epiphysis are very close to *C. antiquitatis*. In *S. kirchbergensis*, the third metacarpal epiphysis is close in width to *C. antiquitatis* but it differs in relative width as to the proximal epiphysis, which is considerably smaller in *S. kirchbergensis*. In *S. kirchbergensis*, the proximal epiphysis width index (TD/ML, see Tab. 3) is less than 28%, while in *C. antiquitatis* it exceeds 36%. The third metacarpal from Krasny Yar shows both the TDde and mTDd parameters very close to the homologous one belonging to *S. kirchbergensis* from Mosbach (Mosbach-II, NMM 1955/520) (Fortelius *et al.*, 1993) even if it presents a considerably larger length.

The original structure of the *S. kirchbergensis* metacarpal shows a considerable wideness of the distal part of forelimbs (especially in the specimen from Krasny Yar), that may reflect its adaptation to movement on soft moist ground.

Measurements of the third metacarpal from Krasny Yar along with those of the *S. kirchbergensis* third metacarpal from Mosbach (NMM 1955/520) are given in Table 3.

#### 2) PM TSU 5/3040 — 3) PM TSU 5/740 — 4) PM TSU 5/3205

Three, on the whole, well-preserved skeletal bones, respectively patella, astragalus (os tarsi tibiale), and calcaneum (os tarsi fibulare). The three remains show exceptional dimensions and a remarkable massive character.

The patella left (PM TSU 5/3040) (Fig. 4C, D), damaged in its apex, is much wide (121.5 mm) latero-medially, very high (98 mm) dorso-ventrally and very thick (68 mm) dorso-plantarly. These sizes are larger than the largest from Taubach (Tab. 4). The dorsal surface of the bone is more prominent, than in *C. antiquitatis*. Articular surface is wider and shifts on the medial side.

The uncommonly well-preserved right astragalus (PM TSU 5/740) (Fig. 4E, F) is very much enlarged (113 mm) latero-medially and rather thick (mm 62)

Table 2. Dimensions (in mm) of rhinoceros's teeth from Krasny Yar and other localities.

Dimensions	<i>S. kirchbergensis</i>										<i>S. etruscus</i>		<i>C. antiquitatis</i> (Tomsk region)	
	Krasny Yar	Krasny Yar (Alexseva, 1980)	Kemerovo region (Billia, 2007)	Vilyuy River (Dubrov, 1957)	Koshkungan (Hisarova, 1963)	Shennongjia (Tong & Wu, 2010)	Pugachev (Strizheva, 1991)	Cherny Yar (Gromova, 1935)	Kolkotova Balka (David, 1980)	Taubach (Kahlke, 1977)	Psekups River*	Mosbach (Schoeder, 1903)	Krasny Yar n=2-5	Sergeevo (Shpansky & Pecherskaya, 2009)
P4 buccal length/ mesial width	46.1/64.5	53/74	=	44/58		48.3/67.1	52/65		46.6-52.9/ 69.2-71.3	31?/57?	37/55	38-43/ 45-46	40.5/50.5	
M1 buccal length/ mesial width	61.2/76.2	42-57/ 65-72	=		42/?	56.9/71.6			51.3/ 68.4-69.8			38.5-48/ 60	44-47/ 55-55.5	
M2 buccal length/ mesial width	63.2-64.5/?	55-62/ 69-73	66.2/69.8	59.8/67	72/76	68.9-69.6/ 69.4-77.1	66/74.5		58.1-68.5/ 71.9-72.4	46/50	46-51/ 57-62	55/56	53-53.6/ 60-60.5	
M3 buccal length/ mesial width	=	58-63.5/ 64-72	71.2-72.6/ 62.5-67.3		?/55-80?	63-70/ 52.1-66.6			69.3-70/ 65.2-66.7				51/55.5	
m1 length max/ width max	>54/38.7	=			54/35	41.8-47.9/ 33.1-37		49-51.3/ 38.2-38.5	46.2-51.8/ 36.3-38.1	37/28.5	36/30	43-44/ 32-32.5	41/29	
m2 length max/ width max	60.6/42.4	=			60-62/ 36-47	51.8-56.5/ 34.6-36.3		52-53/ 35-39.5	52.6-60.5/ 36.8-40.2	44/29	41-47/31	46-50.5/ 33.7-34	52/30	
m3 length max/ width max	63.2/37.3	=			63/32	52.1-60.4/ 32.6-35.7		59-61.5/ 35-40.3	55.3-61.8/ 35.8-37.4	44/27.5	45/30		54.5/28.5	

\* measurements of the upper teeth follow Dubrovo, 1957; lower teeth measurements are after Gromova, 1935.

dorso-plantarly; the trochlea is also very broad (92 mm). The lateral calcaneal facet has a sharp dorsal edge without a prominent edge bended downward, as in *C. antiquitatis*.

The very well-preserved right calcaneum (PM TSU 5/3205) (Fig. 4G, H), exceptionally large, dorsally appears latero-medially very much enlarged (104 mm), very high (>126 mm), and stretched caudally; the summital tuberosity and the sustentaculum tali are considerably massive. Calcaneum of *S. kirchbergensis* differs from that of *C. antiquitatis* by the greater ruggedness, the height of its body and head, and tapered shape of the head.

By comparison, the taphonomical features of the skeletal remains are the same of those of the odontological elements.

## Results

**Teeth.** The bulbous metacone, the remarkable brachyodonty, and the undulation of the ectoloph of 5/1251, 5/2883, and 5/3495, the hypsodonty and the bulbous protocone and metacone of 5/2878, the much reduced valleys and the remarkable brachyodonty of 5/1067, 5/1087, and 5/3328 are morphological traits suggestive of *Stephanorhinus kirchbergensis* (Jäger, 1839), the Pleistocene "tandem-horned" Eurasian interglacial rhinoceros, better known in Russia and in the former Soviet Union as Merck's rhinoceros ("nosorog Merka" in Russian). Seven isolated teeth attest to the occurrence of at least three individuals.

Together with the above remains, a whole buccal portion of a second upper molar (PM TSU 5/2602) has also been recovered; the profile of its ectoloph appears as characteristic of *S. kirchbergensis*.

*S. kirchbergensis* upper teeth differs from *S. etruscus* Falconer by the larger sizes, presence of the cingulum only on the front and posterior-buccal surfaces of the crown and their remarkable height. From *C. antiquitatis* teeth it differs by the larger sizes, presence of the cingulum at the crown base, taper-shaped structure of protocone and hypocone, unmerged elements of the crown until the last stages of tooth wear, triangular incision of grinding surface, and smooth, porcelain-like surface of crown enamel. Lower teeth are also very large and high crowned. The width of crown at the base of the crown is larger than at its top because of a slight incline of the buccal

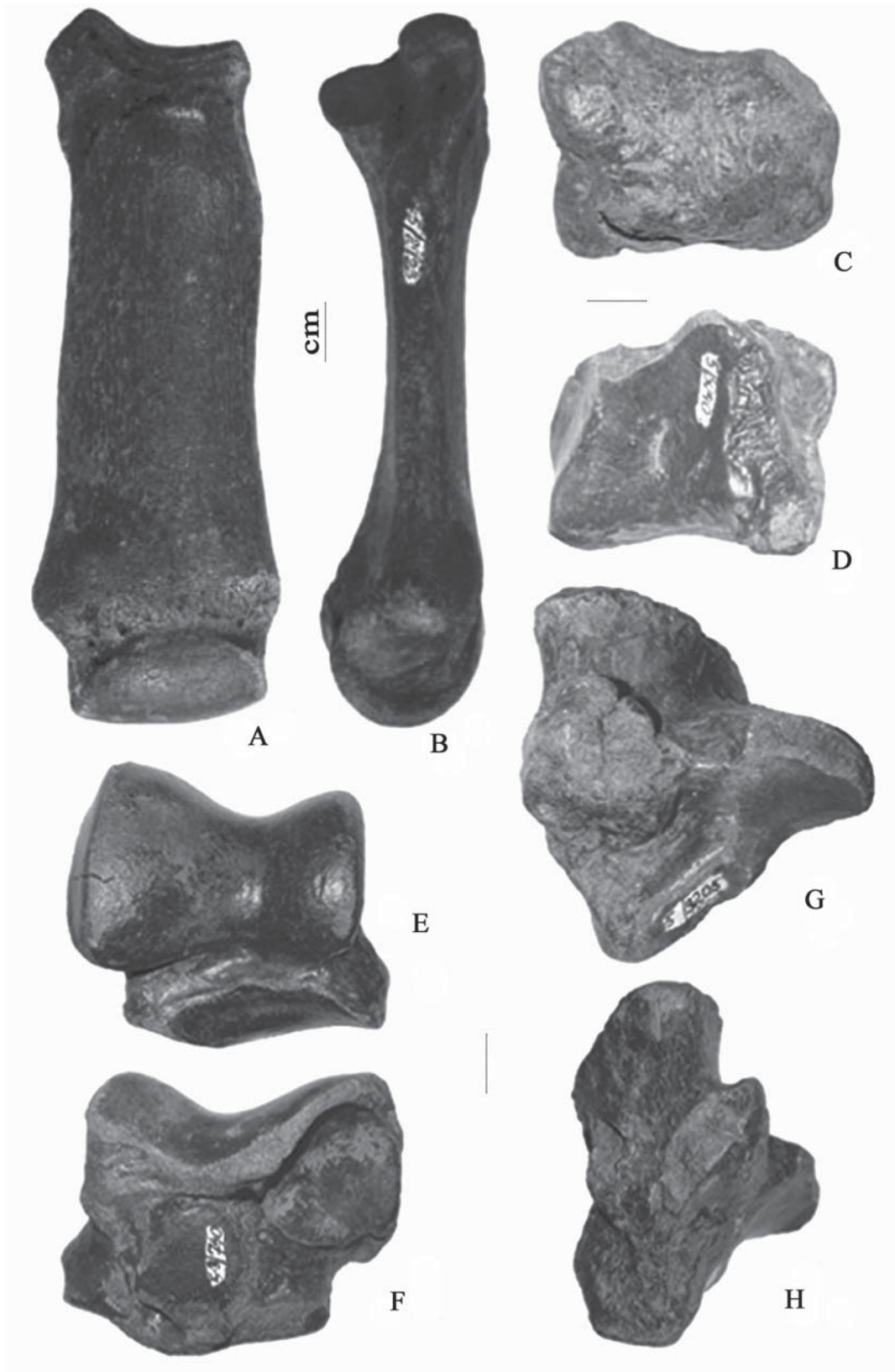


Figure 4. *Stephanorhinus kirchbergensis* (Jäger, 1839); Tobol Horizon level (=Middle Pleistocene); Ob' River at Krasny Yar (Tomsk region, southeast of Western Siberia); third metacarpal, (A) cranial view and (B) lateral view; patella, (C) cranial view and (D) articular view; astragalus, (E) dorsal view and (F) plantar view; calcaneum, (G) dorsal view and (H) lateral view.

Table 3. Dimensions and indexes of the Krasny Yar third metacarpal in comparison with third metacarpals of *S. kirchbergensis* from other localities and *C. antiquitatis* from the Krasny Yar.

No.	Locality, species	Collection	Dimensions, mm							Indexes, %		
			ML	APD	TD	APDde	TDde	TDdj	mTDd	TD/ML	TDde/ML	mTDd/ML
1	Krasny Yar (QII)	PM TSU, No. 5/2723	229	56.6	63	56	80.4	64	60.5	27.5	35.1	26.4
2	Rybinsk (Beljaeva, 1939)	Paleontological Institute RAS, Moscow	225	64	80	64	90	70	72	35.6	40	31.1
3	Shennongjia (Tong & Wu, 2010)	Nat. Hist. Mus. Shennongjia, n=2	188.7–202.2									
4	Mosbach-II	Nat. Hist. Mus. Mainz, No. 1955/520	263	–	71.7	–	80.4	–	60.9	27.3	30.6	23.2
5	Taubach (Kahlke, 1977)	IQ Weimar, n=2	204.2	63.7–67.8	63.7–67.8		73.9	59.1	53.5–55.7	31.2	36.2	26.2
6	Krasny Yar (QIII) <i>Coelodonta antiquitatis</i>	PM TSU, n=7	164–198	42–58	58.2–79	41.8–55	55–71	–	48–58	33–39.9	31.9–36.2	28.2–30.1

ML — maximum length (in sagittal plane); APD — antero-posterior diameter of the proximal epiphysis; TD — transverse diameter of the proximal epiphysis; APDde — antero-posterior diameter of the distal epiphysis; TDde — transverse diameter of the distal epiphysis; TDdj — transverse diameter of the distal joint; mTDd — transverse diameter of the diaphysis (in the middle).

Table 4. Dimensions (in mm) of the Krasny Yar patella, astragalus and calcaneus in comparison with *S. kirchbergensis* from other localities and other species.

Dimensions, bones	<i>S. kirchbergensis</i>			<i>S. etruscus</i>	<i>C. antiquitatis</i>
	Krasny Yar	Taubach (Kahlke, 1977)	Baryshnikov & Guerin, 1986	Baryshnikov & Guerin, 1986	Krasny Yar
<b>Patella</b>	No.5/3040	n=7			n=4
Height dorso-ventrally	98	76.2–90.1			75–95.5
Width latero-medially	121.5	100.8–122.5			95–119
<b>Astragal</b>	No.5/740	n=10			n=39
Width latero-medially	113	87.7–114			82–111
Width of a cuboideonavicularis surface of a joint	93	80.5–92.9			=
Width of block surface	96	83.5–111.3			85–98
Length max	104	80.4–100.5			79–98
<b>Calcaneus</b>	No.5/3205	n=5	n=11	n=27	n=22
Length max	C126	130.8–146.7	131.5–152.5	110–131	119–137
Width in coracoideum shoot	104	?	72–94	64–80	68–90
Width of top	C56	54–61.2	51–61	43–58	46–60

surface, especially on m2 and m3. *C. antiquitatis* is characterized by the constant width of crowns. Teeth from Krasny Yar are the largest for *S. kirchbergensis*. I2 and m2 from Koshkurgan (South Kazakhstan) (Hisarova, 1963) and M2 from Shennongjia (China) (Tong & Wu, 2010) are similar or slightly larger.

**Postcranial remains.** The previous enumerated morphological characteristics of the third metacarpal from Krasny Yar are peculiar to *S. kirchbergensis*.

On the basis of the morphological characters, including the exceptional dimensions, remarkable massive character of the patella, astragalus, and calcaneum, these skeletal remains may confidently be attributed to

*S. kirchbergensis*. The sizes of bones from Krasny Yar are similar to the largest samples from Europe (Tab. 4).

The patella, at least as far as the Pleistocene rhinoceroses are concerned, along with metapodials, astragal, and calcanea would seem to be the most significant postcranial skeletal parts to separate (morphologically as well as biometrically) *S. kirchbergensis* from the other species (Billia, 2011).

## Remarks

The presence of *S. kirchbergensis*, *Mammuthus* ex gr. *trogontherii-chosaricus*, *Bison priscus*, *Equus* ex



gr. *mosbachensis-germanicus*, as well as *Megaloceros giganteus ruffi* altogether suggests that widespread grasslands and sparse trees existed in the Krasny Yar area (Alekseeva, 1977; Shpansky, 2006, 2009).

In the environs of Krasny Yar, few kilometers to the north of this deposit, seventeen *Dicerorhinus kirchbergensis* (= *S. kirchbergensis*) upper teeth were discovered in 1970's by E.V. Alekseeva (Alekseeva, 1980: 58–60, figs 7, 8).

As to the Russian Federation, remains of *S. kirchbergensis*, taxon often included in the so-called "Tiraspolian" and "Singilian" Eastern European faunal complexes (Alekseeva, 1977), and "Priirtyshskaya" Fauna (Shpansky, 2009), are recorded, at least, from other nine localities. Four of them are located in the Russian European area, the other five are in the Siberian part of the country. In the Russian literature, some other localities, which would yield remains ascribed to *S. kirchbergensis*, are also mentioned, but at present this material is unfortunately unavailable (Billia, 2008).

The rarity of *S. kirchbergensis*, despite of its wide spread in the Eurasian continent, has been witnessed in Russia (Billia, 2005, 2008), as well as elsewhere in Europe (Billia, 2011).

Unfortunately, well-dated both cranial and postcranial remains of *S. kirchbergensis* are, de facto, very few everywhere. Moreover, at least at present, the fossil materials described in literature and assigned to this taxon are only partly available in Eurasian museum collections (Billia, 2011).

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