Амурский зоологический журнал, 2023, т. XV, № 4
Amurian Zoological Journal, 2023, vol. XV, no. 4
www.azjournal.ru

https://www.doi.org/10.33910/2686-9519-2023-15-4-894-906
http://zoobank.org/References/447C65AD-A7ED-45C0-B66E-408EDC23CAB0

UDC 569.325.2 (571.6)

New finds of the fossil genus representatives of *Tonomochota* Tiunov et Gusev, 2021 (Lagomorpha, Ochotonidae) in Korydornaya Cave (Jewish Autonomous Oblast, Far East of Russia)

A. E. Gusev✉, M. P. Tiunov

Federal Scientific Center of the East Asia Terrestrial Biodiversity, Far Eastern Branch of the Russian Academy of Sciences, 159 Stoletiya Vladivostoka Ave., 690022, Vladivostok, Russia

Authors

Alexander E. Gusev
E-mail: uraziosutoku@mail.ru
SPIN: 4692-2817
Scopus Author ID: 57219868393
ORCID: 0000-0001-7110-1384

Mikhail P. Tiunov
E-mail: tiunov@biosoil.ru
SPIN: 1205-8249
Scopus Author ID: 36961720700
ORCID: 0000-0002-4276-4266

Abstract. Paleontological excavations in Korydornaya Cave, located on the southern side of the Pompeyev Mountain Ridge in the Jewish Autonomous Oblast, Russia, and the resulting material analysis allowed to significantly expand the Late Pleistocene range of the recently described *Tonomochota* pika genus (Tiunov, Gusev 2021). This research describes a new species of this genus. Besides the new species *Tonomochota khinganica* **sp. nov.**, the bone remains of *Tonomochota khasanensis* Tiunov et Gusev, 2021 and *Ochotona hyperborea* Pallas, 1811 were discovered in cave deposits. The cave deposits were formed mainly during a warm period of the Karginsky interstadial about 50,000 years ago.

Keywords: Far East of Russia, Jewish Autonomous Oblast, cave deposits, Late Pleistocene, Ochotonidae

Новые находки представителей ископаемого рода пищуховых *Tonomochota* Tiunov et Gusev, 2021 из пещеры Коридорная (Еврейская автономная область, Дальний Восток России)

А. Е. Гусев✉, М. П. Тиунов

Федеральный научный центр биоразнообразия наземной биоты Восточной Азии ДВО РАН, пр-т 100-летия Владивостока, д. 159, 690022, г. Владивосток, Россия

Сведения об авторах

Гусев Александр Евгеньевич
E-mail: uraziosutoku@mail.ru
SPIN-код: 4692-2817
Scopus Author ID: 57219868393
ORCID: 0000-0001-7110-1384

Тиунов Михаил Петрович
E-mail: tiunov@biosoil.ru
SPIN-код: 1205-8249
Scopus Author ID: 36961720700
ORCID: 0000-0002-4276-4266

Аннотация. Палеонтологические раскопки в южной части Помпеевского хребта в Еврейской автономной области в пещере Коридорная и анализ полученного материала позволили значительно расширить позднеплейстоценовый ареал недавно описанного рода пищуховых *Tonomochota* Tiunov et Gusev, 2021. Приводится описание нового вида из этого рода. Кроме нового вида *Tonomochota khinganica* **sp. nov.** в пещерных отложениях из пищуховых обнаружены костные остатки *Tonomochota khasanensis* Tiunov et Gusev, 2021 и *Ochotona hyperborea* Pallas, 1811. Пещерные отложения сформировались в основном во время теплого периода Каргинского интерстадиала около 50 тыс. лет назад.

Ключевые слова: Дальний Восток России, Еврейская автономная область, пещерные отложения, поздний плейстоцен, Ochotonidae

Introduction

The recently described finds of representatives of a new pika genus, named *Tonomochota* (*T. khasanensis* Tiunov et Gusev, 2021, *T. sikhotana* Tiunov et Gusev, 2021, *T. major* Tiunov et Gusev, 2021), in the cave deposits of Primorsky Krai, allowed a different look at the biodiversity of the fossil pika of the Far East of Russia (Tiunov, Gusev 2021). In the Late Pleistocene, the representatives of this genus dwelt together with the northern pika, *Ochotona hyperborea* Pallas 1811. Until recently, it was assumed that their spread was limited to the mountainous regions of the coastline.

During the paleontological excavations in the Jewish Autonomous Oblast, tens of thousands of mammalian bone remains were extracted from the loose deposits of Korydornaya Cave, including a large number of pika remains. A preliminary examination of the fossil material showed that most of the third lower premolars of the pika have a characteristic that is specific to the genus *Tonomochota*, i.e., a labial fold on the anteroconid filled with cement. The bone remains of the *Tonomochota* genus representatives from Korydornaya Cave is the first find of this extinct genus outside Primorsky Krai.

The present work aims to identify and analyze the fossil material on the pika from the Late Pleistocene-Holocene cave deposits of the Jewish Autonomous Oblast with evidence taken from Korydornaya Cave.

Geological setting and dating

Korydornaya Cave is located in the Jewish Autonomous Oblast on the southern side of the Pompeyev Mountain Ridge (Fig. 1), on the right side of the Stolbukha River (48°00´N, 130°59´E).

The entrance to the cave is located at an altitude of 230 meters. The entrance begins with a gentle slope, turning into an ascent around the middle part of the cave. The total length of the cave is about 45 meters (Yushmanov et al. 2009). The floor is covered with clay. The excavation site was laid before the start of the ascent (Fig. 2A, 2B).

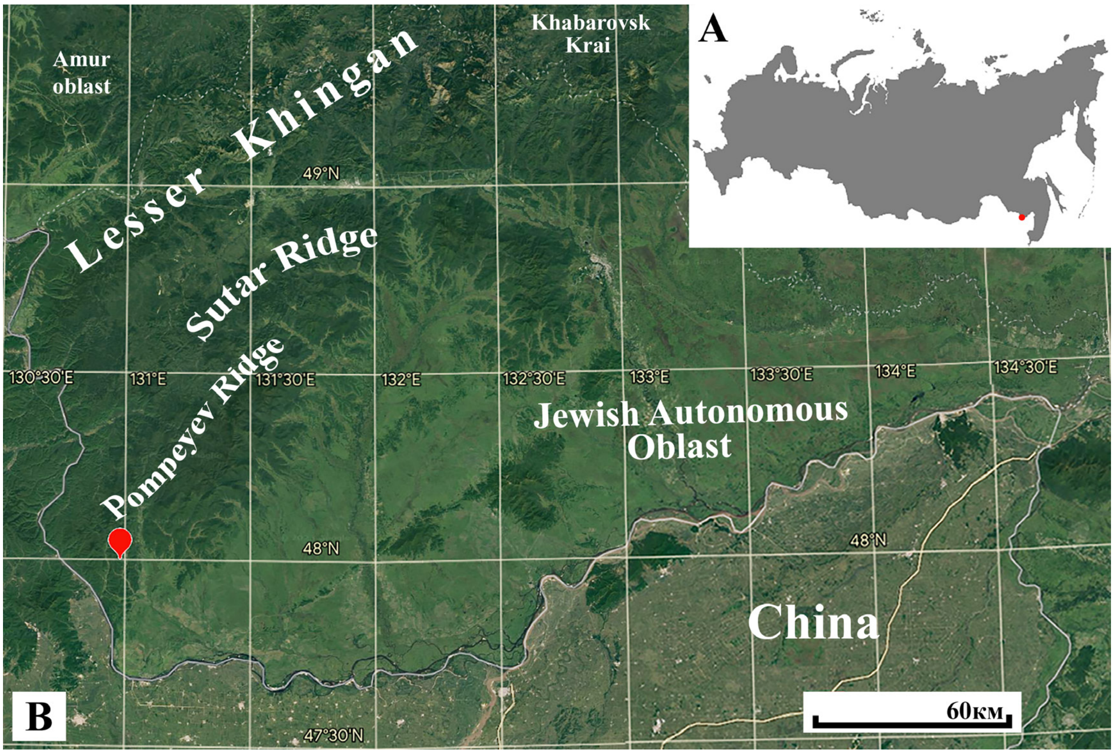

Fig. 1. Geographical location of Korydornaya Cave on the map of Russia (A) and in the west of the Jewish Autonomous Oblast (B)

Рис. 1. Географическое расположение пещеры Коридорная на карте России (А) и на западе Еврейской автономной области (В)

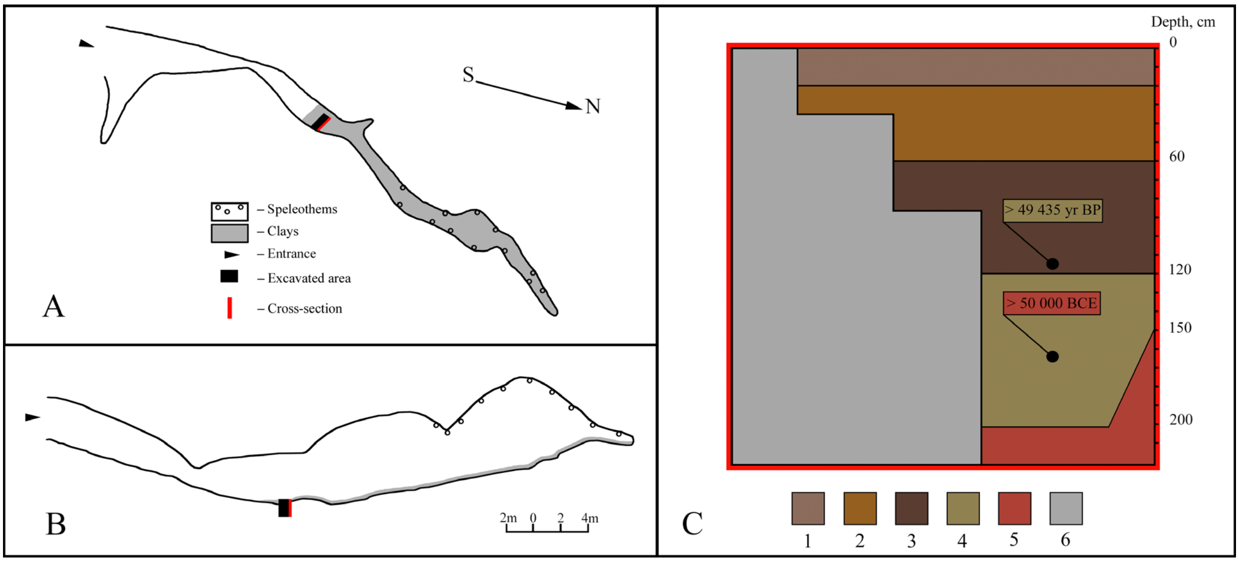

Fig. 2. Plan (A) and section (B) of Korydornaya Cave and a sketch of the section along the northeast wall of the pit (C). The description of the lithologic layers: 1 — light-brown medium loam; 2 — brown-ochre heavy loam; 3 — brown heavy loam; 4 — yellow-brown clay; 5 — red crumbly clay, a lot of small well-rounded pebbles; 6 — cave deposits. Black circles indicate the places of fossil remains for which dating was obtained.

Рис. 2. План (А) и разрез (В) пещеры Коридорная и эскиз разреза по северо-восточной стенки шурфа (С). Описание литологических слоев: 1 — светло-бурый средний суглинок; 2 — буро-охристый тяжелый суглинок; 3 — бурый тяжелый суглинок; 4 — желто-бурая глина; 5 — красная рассыпчатая глина, много мелкой хорошо окатанной гальки, 6 — пещерные отложения. Черными кругами обозначены места находок ископаемых остатков, для которых были получены датировки

The initial excavation area was 1.7x1.1 meters. The excavation area was reduced to 1.2x1.1 at a depth of 0.35 meters; the excavation area was 0.8x1.1 meters at a depth of 0.8 meters and below. The total depth of the excavation was 2.1 meters (Fig. 2C). The description of the lithologic layers is given in the caption to Figure 2C.

A roe deer metacarpal bone (depth is approximately 110–120 cm) was 14 C-dated by the AMS method to ca. >49,435 yr BP. AMS analyses of the roe deer metacarpal bone (IGANAMS-7598) were performed using the equipment from the Research Resource Centre of the Laboratory of Radiocarbon Dating and Electronic Microscopy of the Institute of Geography, Russian Academy of Sciences (Moscow, Russia), and the Centre for Applied Isotope Studies of the University of Georgia (CAIS; Georgia, USA) (Voyta et al. 2020). One more radiocarbon dating was established by a fragment of the horse bone (depth 160-170 cm), dating to >50,000 BCE (Kusliy et al. 2020).

Material and methods

All fossil materials were obtained and described from the clay deposits of Korydornaya Cave. During the excavation, the soil was removed with approximate horizons of 10 cm. All extracted material was sifted through a sieve with a mesh of 1 mm. The analysis of the sifted concentrate was conducted in the laboratory. All the findings are currently stored in the collection of the Laboratory of Theriology of the Federal Scientific Center for Biodiversity of Terrestrial Biota of East Asia of the FEB RAS (Far Eastern Branch of the Russian Academy of Sciences).

Excavations in Korydornaya Cave were conducted in 2017 and 2018. A number of fossil remains of pikas were collected, represented by isolated teeth and fragments of the upper and lower jaws. The morphological analysis identified 63 third lower premolars (P_3), 17 second upper premolars (P^2), 66 third upper premolars (P^3), and 75 second upper molars (M^2), as

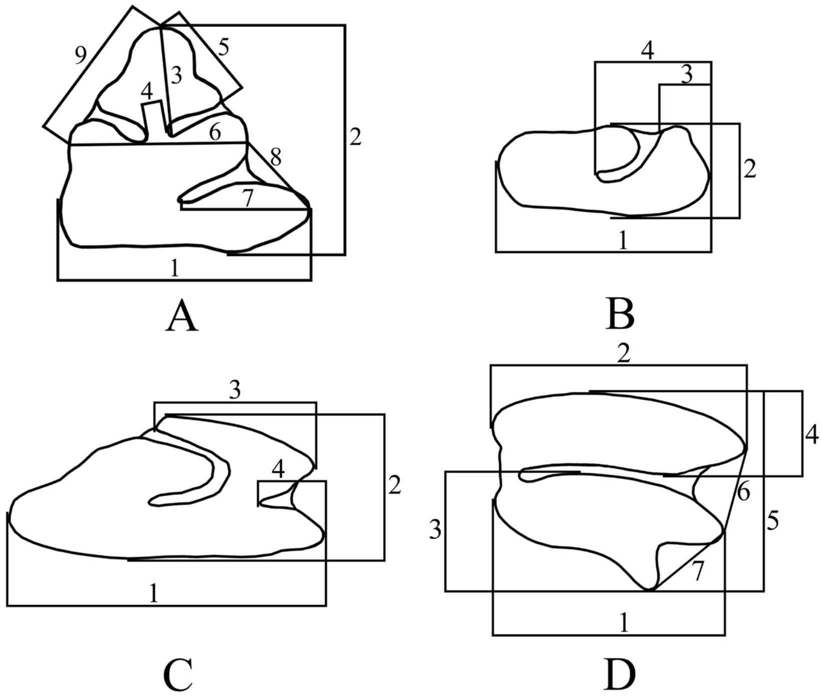

Fig. 3. Occlusal view of P_3 (A), P^2 (B), P^3 (C), M^2 (D) and measurements: (A) *1* — tooth width; *2* — tooth length; *3* — anteroconid length; *4* — isthmus width; *5* — distance between the most nasal and labial points of the of the anteroconid; *6* — distance from the metaconid to the protoconid; *7* — distance between the most labial point of the hypoconid and the deepest point of the hypoflexid; *8* — distance from the protoconid to the hypoconid; *9* — distance from the metaconid to the apex of the anteroconid; (B) *1* — tooth width; *2* — tooth length; *3* — distance from the beginning of the paraflexus to the hypercone; *4* — distance between the deepest point of the paraflexus and the most lingual point of the hypercone; (C) *1* — tooth width; *2* — tooth length; *3* — anterior loph width; *4* — hypoflexus width; (D) *1* — posterior loph width; *2* — anterior loph width; *3* — posterior loph length; *4* — anterior loph length; *5* — tooth length; *6* — distance between the most lingual point of the posterior loph and the most lingual point of the anterior loph; *7* — distance between the most lingual point of the posterior loph and the most lingual point of the postero-lingual process

Рис. 3. Окклюзионный вид P_3 (A), P^2 (B), P^3 (C), M^2 (D) и проведенные измерения: (A) *1* — ширина зуба; *2* — длина зуба; *3* — длина антероконида; *4* — ширина перешейка, соединяющего антероконид и постероконид; *5* — расстояние между наиболее назальной и лабиальной точками на антерокониде; *6* — расстояние от метаконида до протоконида; *7* — расстояние между самой лабиальной точкой гипоконида и самой входящей точкой гипофлексида; *8* — расстояние от протоконида до гипоконида; *9* — расстояние между самой лингвальной точкой метаконида и самой выступающей точкой на вершине антероконида; (B) *1* — ширина зуба; *2* — длина зуба; *3* — расстояние от самой начальной точки парафлексуса до самой лингвальной точки гиперкона; *4* — расстояние между самой глубокой точкой парафлексуса и самой лингвальной точкой гиперкона; (C) *1* — ширина зуба; *2* — длина зуба; *3* — ширина переднего гребня; 4 — ширина гипофлексуса; (D) *1* — ширина заднего гребня; *2* — ширина переднего гребня; *3* — длина заднего гребня; *4* — длина переднего гребня; *5* — длина зуба; *6* — расстояние между самой лингвальной точкой заднего гребня и самой лингвальной точкой переднего гребня; *7* — расстояние между самой лингвальной точкой заднего гребня и самой лингвальной точкой отростка на заднем гребне

well as the presence of three different species of the pika in the cave deposits.

We used the terminology from the works of Lopez-Martinez (Lopez-Martinez 1986), Fostowicz-Frelik (Fostowicz-Frelik 2008), and Cermak (Cermak 2009) to describe the occlusal surface of teeth. All surveys of teeth are in millimeters. Only adults were used for metric analysis (Lissovsky 2004). Photos of the teeth were obtained using the SteREO Discovery.V12. The final illustrations were post-processed to improve contrast and brightness using Adobe® Photoshop® software.

Linear discriminant analysis was used to classify teeth groups. During the analysis, nine surveys for the third lower premolar, four surveys for the upper second premolar, four surveys for the third upper premolar and seven surveys for the second upper molar were used as independent variables (Fig. 3).

Eight P_3 of *Tonomochota khinganica* sp. nov., 20 premolars of *T. khasanensis*, and 22 premolars of *Ochotona hyperborea* were analyzed from the deposits of Korydornaya Cave. For comparison, the analysis included premolars of the already described species *T. sikhotana, T. khasanensis,* and *O. hyperborea* from Sukhaya Cave and Tetyukhinskaya Cave (Tiunov, Gusev 2021). All the calculations were performed in the Statistica® 13.

Systematic paleontology

Order **Lagomorpha** Brandt, 1855
Family **Ochotonidae** Thomas, 1897
Subfamily **Ochotoninae** Thomas, 1897
Genus ***Tonomochota*** Tiunov et Gusev, 2021

***Tonomochota khinganica* sp. nov.**

https://zoobank.org/NomenclaturalActs/3EB8153A-D728-4F72-B5AE-B3DF32E35717

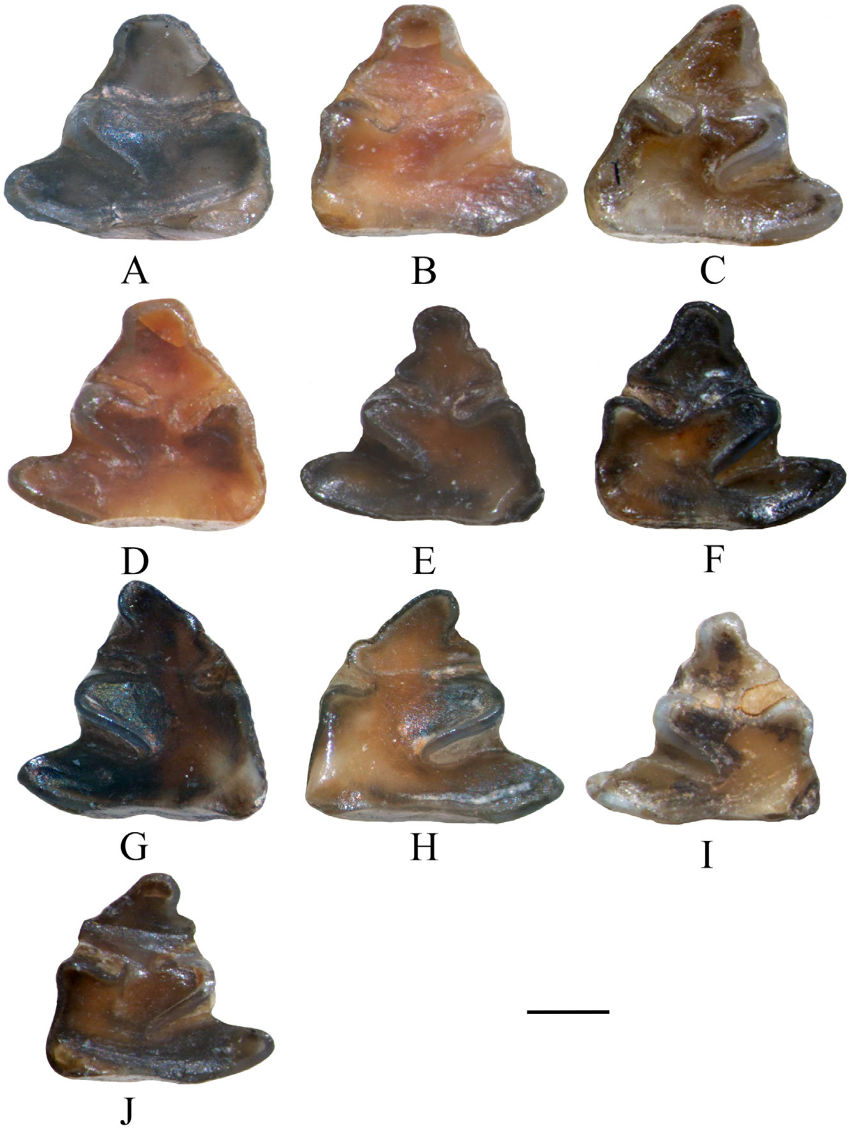

Fig. 4. Occlusal views of P_3, *Tonomochota khinganica* **sp. nov.** *A* — FSC RJARV–KorC–02, left P_3; *B* — FSC RJARV–KorC–03, right P_3; *C* — FSC RJARV–KorC–04, right P_3; *D* — FSC RJARV–KorC–05, left P_3; *E* — FSC RJARV–KorC–06, left P_3; *F* — FSC RJARV–KorC–07, right P_3; *G* — FSC RJARV–KorC–08, left P_3; *H* — FSC RJARV–KorC–09, right P_3; *I* — FSC RJARV–KorC–10, left P_3; *J* — FSC RJARV–KorC–11, right P_3. Scale bar = 0.5 mm

Рис. 4. Жевательная поверхность P_3 *Tonomochota khinganica* **sp. nov.** *A* — FSC RJARV–KorC–02, левый P_3; *B* — FSC RJARV–KorC–03, правый P_3; *C* — FSC RJARV–KorC–04, левый P_3; *D* — FSC RJARV–KorC–05, левый P_3; *E* — FSC RJARV–KorC–06, левый P_3; *F* — FSC RJARV–KorC–07, левый P_3; *G* — FSC RJARV–KorC–08, левый P_3; *H* — FSC RJARV–KorC–09, правый P_3; *I* — FSC RJARV–KorC–10, левый P_3; *J* — FSC RJARV–KorC–11, правый P_3. Масштабная линейка 0,5 мм

 https://www.doi.org/10.33910/2686-9519-2023-15-4-894-906

Table 1

Teeth measurements (mm) of *Tonomochota khinganica* sp. nov., *T. khasanensis*, *Ochotona hyperborea* and *O. hyperborea* (recent)

Таблица 1

Измерения (мм) зубов для *Tonomochota khinganica* sp. nov., *T. khasanensis*, *Ochotona hyperborea* и *O. hyperborea* (современный)

Tooth	Measurements	*Tonomochota khinganica* sp. nov.			*Tonomochota khasanensis*			*Ochotona hyperborea*			*Ochotona hyperborea* (recent)		
		n	Mean ± SD	Min – Max	n	Mean ± SD	Min – Max	n	Mean ± SD	Min – Max	n	Mean ± SD	Min – Max
1	2	3	4	5	6	7	9	10	11	12	13	14	15
P_3	1	9	1.56 ± 0.06	1.50 – 1.66	24	1.39 ± 0.06	1.31 – 1.53	20	1.34 ± 0.05	1.23 – 1.41	19	1.33 ± 0.08	1.16 – 1.44
	2		1.40 ± 0.04	1.35 – 1.46		1.38 ± 0.06	1.30 – 1.47		1.32 ± 0.06	1.21 – 1.39		1.26 ± 0.10	1.06 – 1.36
	1/2		1.12 ± 0.05	1.05 – 1.22		1.01 ± 0.03	0.96 – 1.08		1.02 ± 0.05	0.90 – 1.12		1.07 ± 0.07	0.96 – 1.23
	3		0.64 ± 0.02	0.60 – 0.66		0.62 ± 0.03	0.55 – 0.69		0.56 ± 0.04	0.48 – 0.63		0.54 ± 0.09	0.32 – 0.66
	4		0.18 ± 0.06	0.14 – 0.31		0.15 ± 0.03	0.10 – 0.22		0.16 ± 0.05	0.05 – 0.26		0.16 ± 0.04	0.08 – 0.24
	5		0.54 ± 0.04	0.49 – 0.61		0.53 ± 0.08	0.40 – 0.78		0.48 ± 0.05	0.41 – 0.62		0.42 ± 0.10	0.22 – 0.56
	6		1.10 ± 0.05	1.00 – 1.18		1.04 ± 0.07	0.94 – 1.18		0.95 ± 0.06	0.84 – 1.03		0.92 ± 0.09	0.76 – 1.06
	7		0.79 ± 0.05	0.72 – 0.87		0.71 ± 0.05	0.65 – 0.83		0.70 ± 0.05	0.61 – 0.80		0.68 ± 0.05	0.60 – 0.76
	8		0.63 ± 0.03	0.58 – 0.67		0.60 ± 0.05	0.53 – 0.75		0.59 ± 0.03	0.53 – 0.66		0.55 ± 0.05	0.46 – 0.60
	9		0.96 ± 0.06	0.86 – 1.03		0.92 ± 0.07	0.78 – 1.09		0.84 ± 0.05	0.74 – 0.95		0.84 ± 0.11	0.70 – 1.00
P^2	1	1	–	1.64	4	1.46 ± 0.01	1.45 – 1.48	12	1.28 ± 0.09	1.12 – 1.38	103	1.25 ± 0.11	1.00 – 1.40
	2		–	0.74		0.66 ± 0.02	0.63 – 0.69		0.66 ± 0.05	0.56 – 0.71		0.61 ± 0.06	0.44 – 0.76
	3		–	0.35		0.36 ± 0.08	0.28 – 0.43		0.34 ± 0.05	0.22 – 0.38		0.37 ± 0.05	0.24 – 0.50
	4		–	0.82		0.68 ± 0.01	0.66 – 0.69		0.62 ± 0.07	0.53 – 0.74		0.58 ± 0.07	0.40 – 0.76
P^3	1	7	2.47 ± 0.07	2.40 – 2.56	11	2.32 ± 0.05	2.23 – 2.39	48	2.14 ± 0.15	1.83 – 2.38	108	2.07 ± 0.14	1.70 – 2.38
	2		1.13 ± 0.04	1.06 – 1.17		1.16 ± 0.04	1.10 – 1.25		1.07 ± 0.05	0.94 – 1.16		1.02 ± 0.06	0.82 – 1.14
	3		1.33 ± 0.13	1.14 – 1.47		1.29 ± 0.17	1.10 – 1.56		1.25 ± 0.19	0.92 – 1.68		1.20 ± 0.14	0.82 – 1.52
	4		0.54 ± 0.04	0.48 – 0.58		0.56 ± 0.06	0.48 – 0.66		0.43 ± 0.05	0.34 – 0.63		0.58 ± 0.06	0.44 – 0.75

Table 1. End
Таблица 1. Окончание

1	2	3	4	5	6	7	9	10	11	12	13	14	15
M^2	1	11	1.86 ± 0.09	1.70 – 2.01	26	1.74 ± 0.09	1.55 – 1.91	38	1.63 ± 0.14	1.23 – 1.88	118	1.71 ± 0.12	1.40 – 2.00
	2		2.06 ± 0.10	1.93 – 2.28		1.98 ± 0.09	1.79 – 2.10		1.85 ± 0.11	1.53 – 1.98		1.92 ± 0.11	1.60 – 2.12
	3		0.90 ± 0.04	0.85 – 0.99		0.82 ± 0.03	0.75 – 0.86		0.73 ± 0.06	0.51 – 0.80		0.74 ± 0.06	0.60 – 0.80
	4		0.58 ± 0.03	0.54 – 0.64		0.56 ± 0.03	0.51 – 0.60		0.51 ± 0.05	0.41 – 0.65		0.51 ± 0.02	1.32 – 1.40
	5		1.55 ± 0.04	1.52 – 1.65		1.44 ± 0.02	1.41 – 1.49		1.30 ± 0.09	1.01 – 1.40		1.32 ± 0.07	1.10 – 1.40
	6		0.73 ± 0.03	0.69 – 0.78		0.69 ± 0.03	0.58 – 0.74		0.65 ± 0.03	0.58 – 0.73		0.64 ± 0.04	0.50 – 0.72
	7		0.68 ± 0.07	0.50 – 0.73		0.64 ± 0.05	0.54 – 0.72		0.59 ± 0.06	0.47 – 0.68		0.57 ± 0.05	0.50 – 0.70

Note: n — number of instances, SD — standard deviation; surveys 1–9 of P_3 as in Fig. 2A, ½ — the ratio of width to tooth length; 1–4 of P^2 as in Fig. 2B; 1–4 of P^3 as in Fig. 2C; 1–7 of M^2 as in Fig. 2D

Примечания: n — количество экземпляров, SD — стандартное отклонение; промеры 1–9 для P_3 — как на Рис. 2A, ½ — отношение ширины от длины зуба; 1–4 для P^2 — как на Рис. 2B; 1–4 для P^3 — как на Рис. 2C; 1–7 для M^2 как на Рис. 2D

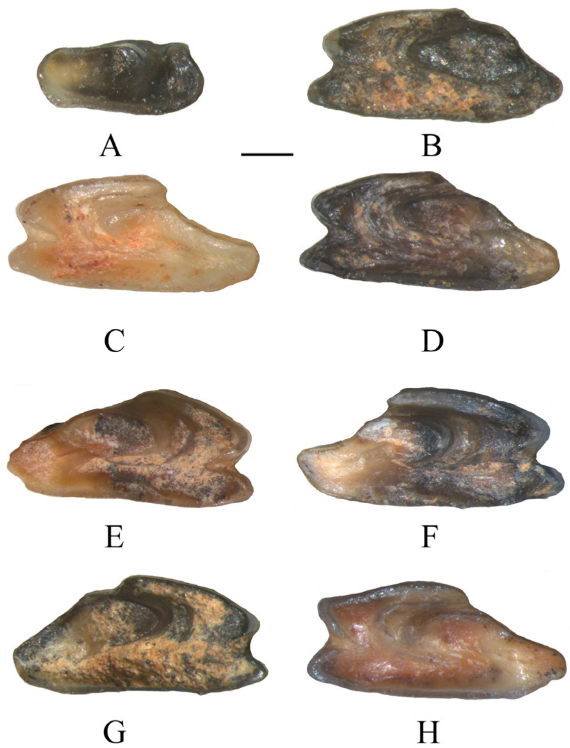

Fig. 5. Occlusal views of P^2 and P^3, *Tonomochota khinganica* **sp. nov.** *A* — FSC RJARV–KorC–12, right P^2; *B* — FSC RJARV–KorC–13, left P^3; *C* — FSC RJARV–KorC–14, left P^3; *D* — FSC RJARV–KorC–15, left P^3; *E* — FSC RJARV–KorC–16, right P^3; *F* — FSC RJARV–KorC–17, right P^3; *G* — FSC RJARV–KorC–18, right P^3; *H* — FSC RJARV–KorC–19, left P^3. Scale bar = 0.5 mm

Рис. 5. Жевательная поверхность P^2 и P^3 *Tonomochota khinganica* **sp. nov.** *A* — FSC RJARV–KorC–12, правый P^2; *B* — FSC RJARV–KorC–13, левый P^3; *C* — FSC RJARV–KorC–14, левый P^3; *D* — FSC RJARV–KorC–15, левый P^3; *E* — FSC RJARV–KorC–16, правый P^3; *F* — FSC RJARV–KorC–17, правый P^3, *G* — FSC RJARV–KorC–18, правый P^3; *H* — FSC RJARV–KorC–19, левый P^3. Масштабная линейка 0,5 мм

https://www.doi.org/10.33910/2686-9519-2023-15-4-894-906

Etymology. The name of the species is related to the Greater Khingan Mountain Range.
Type locality. Korydornaya Cave
Holotype. FSC RJARV–KorC–02
Age. Late Pleistocene.
Other material. Collected together with the holotype: five left P_3 and five right P_3; one left P^2; seven P^3, eleven M^2 (Fig. 4, Fig. 5, Fig. 6).
Diagnosis. A medium-sized pika. The ratio of width to length of the occlusal surface is on average 1.13 mm, which makes the tooth look slightly flattened.

Description. A medium-sized pika. The occlusal surface of the third lower premolar tooth has a triangular shape. The width of the occlusal surface of the tooth is greater than its length (Table 1). The ratio of width to length of the occlusal surface varies from 1.05 to 1.22 mm, on average 1.13 mm (n=8). The anteroconid is variable in its shape, it can be triangular, diamond-shaped or trapezoidal (Fig. 4). The labial fold on the anteroconid is filled with cement. This fold together with the cement is clearly visible in FSC RJARV–KorC–08 and

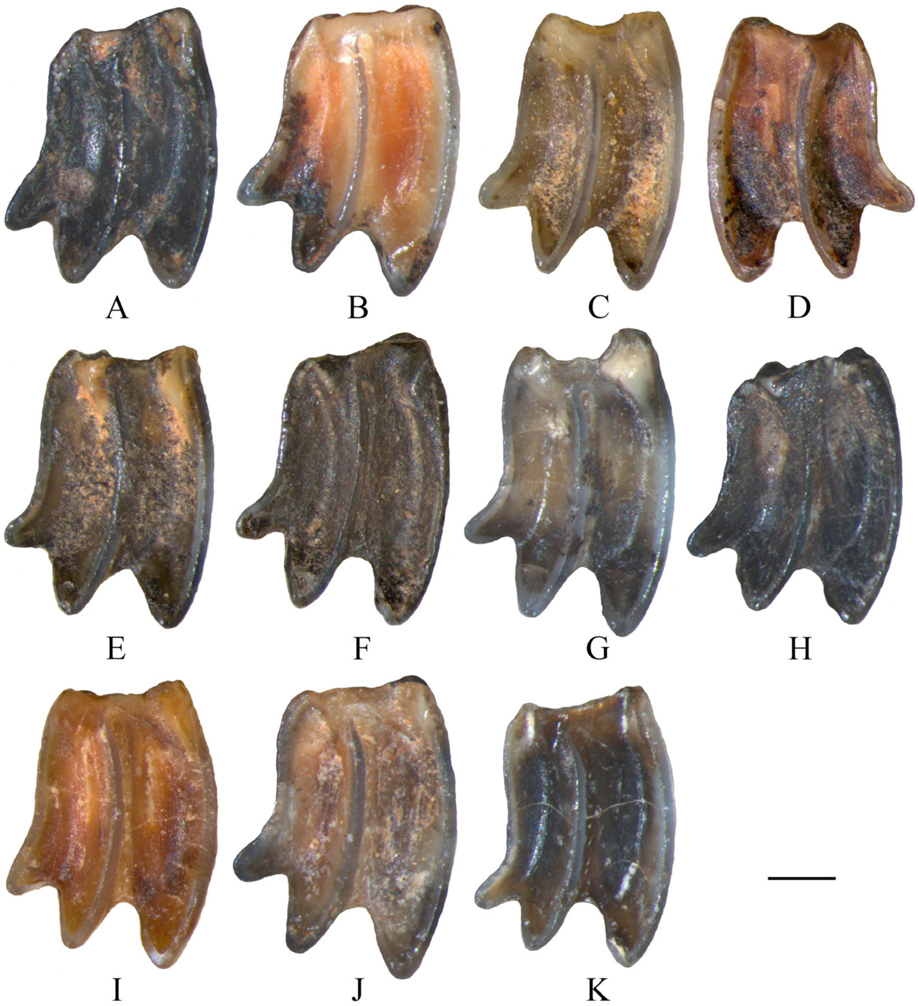

Fig. 6. Occlusal views of M^2, *Tonomochota khinganica* **sp. nov.** *A* — FSC RJARV–KorC–20, right M^2; *B* — FSC RJARV–KorC–21, right M2; *C* — FSC RJARV–KorC–22, right M^2; *D* — FSC RJARV–KorC–23, left M^2; *E* — FSC RJARV–KorC–24, right M^2; *F* — FSC RJARV–KorC–25, right M^2; *G* — FSC RJARV–KorC–26, right M^2; *H* — FSC RJARV–KorC–27, right M^2; *I* — FSC RJARV–KorC–28, right M^2; *J* — FSC RJARV–KorC–29, right M^2; *K* — FSC RJARV–KorC–30, right M^2. Scale bar = 0.5 mm

Рис. 6. Жевательная поверхность M^2 *Tonomochota khinganica* **sp. nov.** *A* — FSC RJARV–KorC–20, правый M^2; *B* — FSC RJARV–KorC–21, правый M^2; *C* — FSC RJARV–KorC–22, правый M^2; *D* — FSC RJARV–KorC–23, левый M^2; *E* — FSC RJARV–KorC–24, правый M^2; *F* — FSC RJARV–KorC–25, правый M^2; *G* — FSC RJARV–KorC–26, правый M^2; *H* – FSC RJARV–KorC–27, правый M^2; *I* — FSC RJARV–KorC–28, правый M^2; *J* — FSC RJARV–KorC–29, правый M^2; *K* — FSC RJARV–KorC–30, правый M^2. Масштабная линейка 0,5 мм

FSC RJARV–KorC–09, unlike the rest of the specimens (Fig. 4G, 4H). In the three specimens FSC RJARV–KorC–02, FSC RJARV–KorC–05 and FSC RJARV–KorC–06 cement is almost invisible on the occlusal surface of the tooth, yet, it is present when viewing the specimens from the side. All the studied specimens also have a lingual fold, but only FSC RJARV–KorC–05, FSC RJARV–KorC–07, and FSC RJARV–KorC–09 have it filled with cement. The isthmus connecting the anteroconid with the posteroconid is variable, its width varies from 0.14 to 0.31 mm (Table 1). 7 out of 8 specimens have a weakly pronounced mesoflexid, which is noticeable only when viewing the lateral wall of the tooth. Of all the specimens, only FSC RJARV–KorC–05 has it filled with cement. Two specimens, FSC RJARV–KorC–10 and FSC RJARV–KorC–11, were not included in the statistical analysis because the width of their occlusal surface is smaller than that in the remaining specimens. At the same time, the ratio of the width of the tooth to its length in these specimens is the same as in the other teeth assigned to the species that we describe, *T. khinganica* sp. nov. (Fig. 4I, 4J).

The occlusal surface of the second upper premolar P^2 has an elongated oval shape with a narrow paraflexus filled with cement (Fig. 5A). The paraflexus originates from the upper part of the hypercone and is directed towards the posterior cheek area. The width from the very lingual point of the hypercone to the deepest point of the paraflexus is equal to half the width of the tooth itself (Fig. 3B). The enamel is thin (narrow) along the entire border of the occlusal surface.

The occlusal surface of the premolar P^3 is trapezoidal (Fig. 5B–H). The anteroloph is approximately 54% of the tooth width (N = 7). The U-shaped paraflexus starts from 1/4 and ends at 1/3 or 1/2 of the width of the occlusal surface of the tooth relative to the cheek area. The hypercone is narrow, short, filled with cement.

The second upper premolar M^2 is wide, the length varies from 1.52 to 1.66 mm, on average 1.55 mm (Table 1). The process on the posteroloph of M^2 is large and well-developed (Fig. 6A–K).

The other teeth of the upper and lower jaws are morphologically similar to the corresponding teeth of the genus *Ochotona*. The upper molars P^4-M^1 consist of two lophs separated in the middle by a deep hypoflexus filled with cement. The teeth of the lower jaw P_4-M_2 are formed by two lophs (trigonid and talonid) connected by cement.

Comparisons. In size and shape of the occlusal surface P_3, the new species is the closest to P_3 *T. khasanensis.* It should be noted that the main measurements of P_3 (length and width of the tooth) of *T. khasanensis* from the deposits of Korydornaya Cave are smaller than those from the deposits of Sukhaya Cave (Table 1, 2). That can be due to the geographical variability of this species. In *T. major* and *T. sikhotana*, this tooth is larger than in *T. khinganica* sp. nov. The most important is the ratio of width and length of the third lower premolar in *T. khinganica* sp. nov., which is of the greatest importance among the species of this genus.

According to the morphological structure of individual isolated third lower premolars, the presence of two more species of the pika was established in the cave deposits: *T. khasanensis* и *O. hyperborea*. It should be noted that in addition to P_3, a significant number of other teeth were collected. In this regard, an attempt was made to determine their species. Considering that the size of P_3 *T. khinganica* sp. nov. is larger than the corresponding tooth in *T. khasanensis* and *O. hyperborea* from the deposits of this cave (Table 1), it is obvious that the rest of the teeth in this species should be larger.

To compare the groups, we conducted a discriminant analysis based on the metric features P_3, P^3 and M^2. The percentage of correctly identified instances for P_3 was 81% (Wilk's = 0.04, R = 0.93, $\chi^2 = 271.10$, $p < 0.01$), for P^3 70 % (Wilk's = 0.47, R = 0.93, $\chi^2 = 127.3$, $p < 0.01$), for M^2 77 % (Wilk's = 0.33, $\chi^2 = 205$, $p < 0.01$). The dispersion graphs of the first and second canonical roots are shown in Figure 7A-7C. According to the analysis results, measurements 1, 2, 3, 4, 5 for P_3 (Fig. 3A), measure-

 https://www.doi.org/10.33910/2686-9519-2023-15-4-894-906

Table 2

Teeth measurements (mm) of *Tonomochota khinganica* sp. nov., *T. major*, *T. sikhotana*, *T. khasanensis* (from Sukhaya Cave)

Таблица 2

Измерения (мм) зубов для *Tonomochota khinganica* sp. nov., *T. major*, *T. sikhotana*, *T. khasanensis* (from Sukhaya Cave)

Tooth	Measurement	*Tonomochota khinganica* sp. nov.			*Tonomochota major*		*Tonomochota sikhotana*			*Tonomochota khasanensis* (from Sukhaya Cave)		
		n	Mean ± SD	min – max	n	Min – max	n	Mean ± SD	Min – max	n	Mean ± SD	Min – max
P_3	1	8	1.56 ± 0.06	1.52 – 1.66	1	2.27	6	1.61 ± 0.07	1.52 – 1.71	25	1.46 ± 0.09	1.23 – 1.58
	2		1.39 ± 0.05	1.35 – 1.45		2.45		1.79 ± 0.08	1.66 – 1.89		1.48 ± 0.08	1.28 – 1.65
	1/2		1.13 ± 0.05	1.07 – 1.22		0.93		0.90 ± 0.03	0.86 – 0.95		0.98 ± 0.06	0.83 – 1.08
	3		0.64 ± 0.02	0.60 – 0.66		1.25		0.86 ± 0.06	0.80 – 0.94		0.66 ± 0.06	0.52 – 0.76
	4		0.19 ± 0.06	0.14 – 0.31		0.44		0.32 ± 0.03	0.28 – 0.37		0.22 ± 0.03	0.17 – 0.26
	5		0.53 ± 0.04	0.50 – 0.61		0.82		0.66 ± 0.07	0.56 – 0.75		0.51 ± 0.06	0.41 – 0.64
	6		1.10 ± 0.05	1.00 – 1.18		1.77		1.16 ± 0.05	1.11 – 1.24		1.02 ± 0.06	0.91 – 1.17
	7		0.79 ± 0.05	0.72 – 0.87		1.34		0.81 ± 0.06	0.69 – 0.88		0.73 ± 0.06	0.62 – 0.82
	8		0.62 ± 0.03	0.58 – 0.66		0.90		0.67 ± 0.07	0.56 – 0.78		0.60 ± 0.04	0.51 – 0.71
	9		0.96 ± 0.06	0.86 – 1.03		1.75		1.21 ± 0.10	1.10 – 1.34		0.97 ± 0.06	0.84 – 1.07

Note: n — number of instances, SD — standard deviation; surveys 1–9 of P_3 as in Fig. 2A

Примечания: n — количество экземпляров, SD — стандартное отклонение; промеры 1–9 для P_3 — как на Рис. 2A

ments 1, 2, 3, 4 P^3 (Fig. 3C), and measurements 1, 4, 5, 7 M^2 (Fig. 3D) were essential to the species discrimination.

By metric parameters, P^2 *T. khinganica* sp. nov. is larger than P^2 *T. khasanensis* and *O. hyperborea* (Table 1). According to the occlusal surface morphology, P^2 *T. khinganica* sp. nov. is similar to *T. khasanensis,* they have a rounded anterior edge on the hypercone but are distinguished by a paraflexus reaching up to half of the tooth. The anterior edge of hypercone P^2 *Ochotona hyperborea* differs from *T. khinganica* sp. nov. in a pointy shape. Specimens of *O. hyperborea,* in which the anterior edge of the hypercone was erased, differed well in smaller tooth proportions (Table 1).

Discussion

According to the results of morphological and morphometric analyses in Korydornaya Cave deposits, we found the bone remains of three species of the pika. The fossils of these species are found throughout the depth of the pit (Fig. 8).

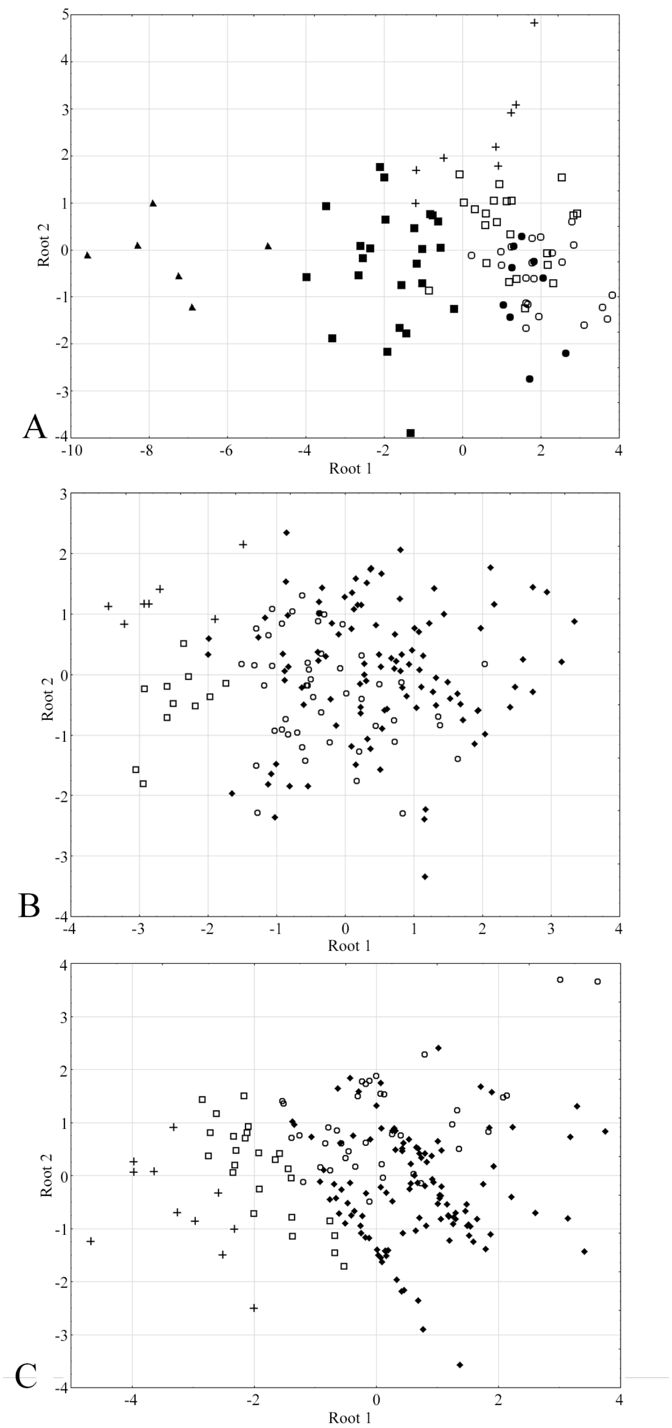

Fig. 7. Scatter plots for different groups of pica teeth. A — distribution of the third lower premolars, B — distribution of the third upper premolars, C — distribution of the second upper molars; black triangles — *Tonomochota sikhotana*; black squares — *T. khasanensis* (from Sukhaya Cave); black circles — *Ochotona hyperborea* (from Sukhaya Cave); black rhombuses — *Ochotona hyperborea* (recent); pluses — *T. khinganica* **sp. nov.**; white squares — *T. khasanensis* (from Korydornaya Cave); white circles — *O. hyperborea* (from Korydornaya Cave)

Рис. 7. Диаграммы рассеивания для различных групп зубов пищуховых. Обозначения: A — распределение третьих нижних премоляров, B — распределение третьих верхних премоляров, C — распределение вторых верхних моляров; черные треугольники — *Tonomochota sikhotana*; черные квадраты — *T. khasanensis* (пещера Сухая); черные круги — *Ochotona hyperborea* (пещера Сухая); черные ромбы — *Ochotona hyperborea* (современные); плюсы — *T. khinganica* **sp. nov.**, белые квадраты — *T. khasanensis* (пещера Коридорная); белые круги — *O.hyperborea* (пещера Коридорная)

 https://www.doi.org/10.33910/2686-9519-2023-15-4-894-906

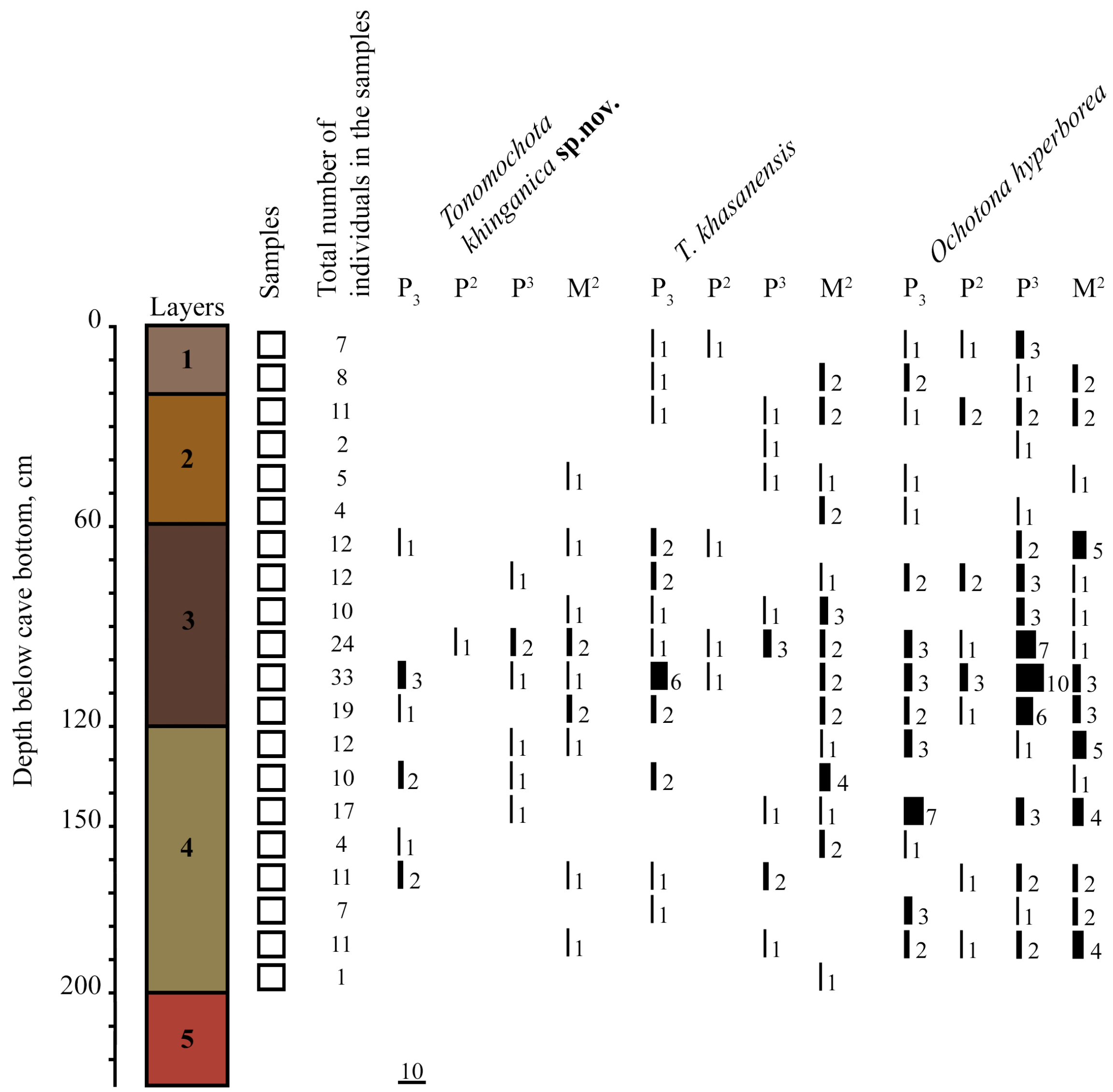

Fig. 8. Vertical distribution of pica fossils in Korydornaya Cave. The layers correspond to the layers from the excavation section (Fig. 2C)

Рис. 8. Вертикальное распределение ископаемых остатков пищуховых в пещере Коридорная. Слои соответствуют слоям из разреза раскопа (Рис. 2C)

The largest number of remains belong to the northern pika *O. hyperborea*, *T. khasanensis* comes second, the remains of *T. khinganica* sp. nov. are the smallest in number. The largest number of the pika teeth were found at the end of the 4th and at beginning of the 3rd layers of the pit, at a depth from 130 to 90 cm. The radiocarbon dates obtained from these layers correspond to the time between the cold early Wurm and the warm middle Wurm, or Karginsky interstadial (= Chernoruchinsky stage (Korotky et al. 2005). In the above (layer 2) and underlying (lower part of layer 4) deposits, the amount of bone remains is significantly smaller. It is obvious that all the main Korydornaya cave deposits were formed mainly during the Karginsky interstadial (MIS 3) and only the upper part was formed due to the admixture of a small number of Holocene deposits (MIS 1). From other mammals, bone remains of the following species were found in these cave deposits: *Beremendia minor*, grey red-backed vole (*Craseomys rufocanus*), northern red-backed vole (*Clethrionomys rutilus*), reed vole (*Alexandromys* gen.), Chinese striped hamster (*Cricetulus barabensis*), Siberian chipmunk (*Eutamias sibiricus*), red squirrel (*Sciurus vulgaris*), brown rat (*Rattus* *norvegicus*), harvest mouse (*Micromys minutus*), wood lemming (*Myopus schisticolor*), Transbaikal zokor (*Myospalax psilurus*), sable (*Martes zibellina*), red fox (*Vulpes vulpes*), gray wolf (*Canis lupus*), brown bear (*Ursus arctos*), wild boar (*Sus scrofa*), Siberian musk deer (*Moschus moschiferus*), red deer (*Cervus elaphus*), elk (*Alces alces*), and horse (*Equus* sp.). The Karginsky interstadial in this area is characterized by a warmer climate than today. The fact that the cave deposits were formed mainly at that time is also evidenced by the presence at different depths of the pit of *Crocidura lasiura, Cricetulus barabensis, Rattus norvegicus,* and *Micromys minutus*, thermophilic species of open spaces.

Acknowledgements

We thank Alexander Gladchenkov for his participation in the excavations in Koridornaya Cave.

Funding

The research is part of the state-commissioned assignment of the Ministry of Science and Higher Education of the Russian Federation (theme No. 121031000153-7).

References

Cermak, S (2009) *Lagomorpha (Mammalia) of the Pliocene and Pleistocene of Europe: a revision of selected taxa. PhD dissertation (Biology)*. Prague, Charles University, 214 p. (In Czech)

Fostowicz-Frelik, Ł. (2008) Review of the earliest Central European Ochotona (Mammalia: Lagomorpha), with a description of a new species from Poland. *Mammalia*, vol. 72, pp. 71–81. (In English)

Korotky, A. M., Volkov, V. G., Grebennikova, T. A. et al. (2005) Far East. In: A. A. Velichko, E. P. Nechaev (eds.). *Cenozoic Climatic and Environmental Changes in Russia*. Boulder: Geological Society of America Publ., pp. 121–138. (In English)

Kusliy, M. A., Tishkin, A. A., Khan. N. et al. (2020) Predvaritel'nyj analiz drevnej DNK 170 osteologicheskikh obraztsov ot loshadej, obitavshikh v Azii [Preliminary ancient DNA analysis of 170 horse osteological remains from Asia]. In: N. P. Matveeva, N. E. Ryabogina (eds.). *Ekologiya drevnikh i traditsionnykh obshchestv. Materialy VI Mezhdunarodnoj nauchnoj konferentsii [Ecology of ancient and traditional societies. Proceedings of VI International scientific conference].* Tyumen: Tyumen Scientific Centre SB RAS Publ., pp. 182–188. (In Russian)

Lissovsky, A. A. (2004) Contribution to age determination of pikas (Lagomorpha, Ochotonidae, *Ochotona*). *Russian Journal of Theriology*, vol. 3, no. 1, pp. 43–48. (In English)

Lopez-Martinez, N. (1986) The mammals from the Lower Miocene of Aliveri (Island of Evia, Greece). VI The ochotonid lagomorph *Albertona balkanica* n. gen. n. sp. and its relationships. *Proceedings of the Koninklijke Nederlandse. Akademie van Wetenschappen*, vol. 89, no. 2, pp. 177–138. (In English)

Tiunov, M. P., Gusev, A. E. (2021) A new extinct ochotonid genus from the late Pleistocene of the Russian Far East. *Palaeoworld*, vol. 30, no. 3, pp. 562–572. https://doi.org/10.1016/j.palwor.2020.08.003 (In English)

Voyta, L. L, Omelko, V. E, Tiunov, M. P, Vinokurova, M. A. (2021) When beremendiin shrews disappeared in East Asia, or how we can estimate fossil redeposition. *Historical Biology*, vol. 33, no. 11, pp. 2656–2667. https://doi.org/10.1080/08912963.2020.1822354 (In English)

Yushmanov, Yu., Panov, S., Denega, E., Kolnookaya, E. (2009) Karstovye peshchery Malogo Khingana — Geologicheskie pamyatniki prirody Yevrejskoj Avtonomnoj Oblasti [Carstic caves Malay Khingan — geologic monuments of the nature of the Jewish Autonomous Region]. *Vestnik Dal'nevostochnoj Gosudarstvennoj Sotsial'no-Gumanitarnoj Akademii — Bulletin of the Far Eastern State Social and Humanitarian Academy*, vol. 2, no. 3, pp. 47–62. (In Russian)

For citation: Gusev, A. E., Tiunov, M. P. (2023) New finds of the fossil genus representatives of *Tonomochota* Tiunov et Gusev, 2021 (Lagomorpha, Ochotonidae) in Korydornaya Cave (Jewish Autonomous Oblast, Far East of Russia). *Amurian Zoological Journal*, vol. XV, no. 4, pp. 894–906. https://www.doi.org/10.33910/2686-9519-2023-15-4-894-906

Received 28 July 2023; reviewed 10 December 2023; accepted 12 December 2023.

Для цитирования: Гусев, А. Е., Тиунов, М. П. (2023) Новые находки представителей ископаемого рода пищуховых *Tonomochota* Tiunov et Gusev, 2021 из пещеры Коридорная (Еврейская автономная область, Дальний Восток России). *Амурский зоологический журнал*, т. XV, № 4, с. 894–906. https://www.doi.org/10.33910/2686-9519-2023-15-4-894-906

Получена 28 июля 2023; прошла рецензирование 10 декабря 2023; принята 12 декабря 2023.