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INVESTIGATIONS ON DISTRIBUTION, OCCURRENCE AND THREATS OF *Varanus griseus caspius* (EICHWALD, 1831) AT THE NORTH-EASTERN PERIPHERY OF ITS GEOGRAPHICAL RANGE (KAZAKHSTAN)

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Studies in 2008 – 2016 clarified the northeastern border of the range of the subspecies *Varanus griseus caspius* (Eichwald, 1831) within Kazakhstan territory and provided the data on its occurrence. New data showed that the monitor is wide-spread in more eastern regions than it was known previously, reaching as far as Saryagash town (Southern Kazakhstan Region). At the north-eastern periphery of its geographical range, desert monitor inhabits turfed hilly sands, foothill steppes, gullies and residual mountains. Occurrence on road surveys was 0.02 – 0.1 spec./km, and 0.3 – 1.3 spec./km on walking routes. The major threats to the desert monitor in Kazakhstan is a direct destruction by humans. Between 2008 and 2016, in total, we encountered 28 dead specimens on the road. The interviews showed that near shepherds' houses in Kyzylkum Desert about one to two desert monitors are killed every year. For the first time for Kazakhstan has been obtained information about illegal hunting of *V. griseus* for alternative medicine purposes. The organization of specially protected natural areas on territories most favorable for desert monitor, alongside with systematic advocacy of their protection among the local population are recommended.

Keywords: *Varanus griseus*; Kazakhstan; northern boundary of distribution; biotope; threats.

INTRODUCTION

Rare and endangered species are the most vulnerable elements of biodiversity, susceptible to habitat destruction, traffic, and other results of human impact on the environment. Prerequisites for the development of effective conservation measures include information on their geographical distribution, occurrence, the most favorable territories and main risk factors.

Varanus griseus (Daudin, 1803), the desert monitor lizard, is wide-spread in North Africa, India, Southwest Asia, Pakistan and throughout Central Asia. Three subspecies are currently recognized: *V. g. koniecznyi* Mertens, 1942, *V. g. griseus* (Daudin, 1803) and *V. g. caspius* (Eichwald, 1831) (Mertens, 1954; Bennett, 1995; Ananjeva et al., 2004; Sindaco and Jeremčenko, 2008).

V. g. caspius (Fig. 1) inhabits territories from the eastern coast of the Caspian Sea, in the deserts of Central Asia, to Northern Iran, Western and Southern Afghanistan, and Western Pakistan (Leviton and Anderson, 1970; Bennett, 1995; Khan, 2004). The northern border of their geographical range lies across Kazakhstan territory (Brushko, 1995; Sindaco and Jeremčenko, 2008). This subspecies is the only representative of the Varanidae, the family of more than 70 species, that is found living in Kazakhstan and other Central Asian countries (Uetz et al., 2017).

V. griseus is listed in the Red Book of Kazakhstan (Brushko and Chirikova, 2010) as an endangered; in the Red Book of Uzbekistan (Nuridzhanov, 2009) as an endangered, patchily distributed Central Asian subspecies; in the Red Book of Kyrgyzstan (Mil'ko and Panfilov, 2006) as an endangered subspecies represented by scarce populations; in the Red Book of Tajikistan (Kurbonov

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Fig. 1. Male *Varanus griseus*. North-Eastern Kyzylkum, 2015. Photo by M. V. Pestov.

and Toshev, 2015) as an endangered species; and in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Currently, this species does not have a Red List status according to the IUCN criteria (http://www.iucnredlist.org). We provided new information on the status of populations in Kazakhstan at the IUCN's meeting on reptiles in April 2016 in St. Petersburg to help in this work.

Various studies of *V. g. caspius* in Central Asia were undertaken between 1960 and 1990 (Bogdanov, 1960; Jadgarov, 1968; Riumin, 1968; Said-Aliyev, 1979; Ataev, 1985; Bondarenko, 1989; Tsellarius et al., 1991; 1995; 1997; Tsellarius and Tsellarius, 1996, 1997). At the same time, the subspecies has been studied in Kazakhstan (Paraskiv, 1956; Brushko et al., 1990; Brushko, 1995). In the middle of the 20th century, there were only five known areas of its occurrence, concentrated in the southern part of the Kyzylkum Desert (Paraskiv, 1956) (this area is now part of Uzbekistan). As a result of the studies by Z. K. Brushko and colleagues in the late 1980s and early 1990s (Gvozdev, 1986; Brushko et al., 1990; Brushko, 1995), it was revealed that the geographical range in Kazakhstan is significantly broader than previously thought, covering the whole eastern part of the Kyzylkum Desert and extending as far as the eastern bank of the Syrdarya River. Additionally, the same authors obtained information on the species population density.

This paper summarises the known information and presents new data on the distribution, preferred biotopes, occurrence of *V. griseus* at its north-eastern periphery in Kazakhstan, and, additionally, shows human impact on their population.

MATERIAL AND METHODS

To determine the current distribution of *V. griseus* at the north-eastern periphery of its geographical range, several field trips to Kyzylorda and South Kazakhstan Regions of Kazakhstan were undertaken: eastern part of the Kyzylkum Desert (in April 2008, June 2009, May and August – September 2012, May-June 2014, May – beginning of June and August – beginning of September 2015, and May 2016), northern part of Kyzylkum Desert (May 2016), the eastern bank of Syrdarya River (Izakuduk Sands, Beltau and Darbaza residual mountains, Saryagash town) (June 2016), the western part of Muyunkum Desert (August – beginning of September 2015). The routes and seasons of the research are shown in Fig. 2. Total survey distance along the roads in the south-eastern part of the Kyzylkum Desert was over 3000 km, and in addition to that, there was 250 km of walking routes. The length of road surveys in Northern Kyzylkum Desert was 406 km; in the Muyunkum Desert it was 150 km; plus 300 km along the eastern bank of the Syrdarya River.

For each record of the desert monitors' traces (i.e., prints of paws and tail, lairs, excrements, remains of molting skin, and remains of dead animals), the following data were collected: coordinates, date, time of day

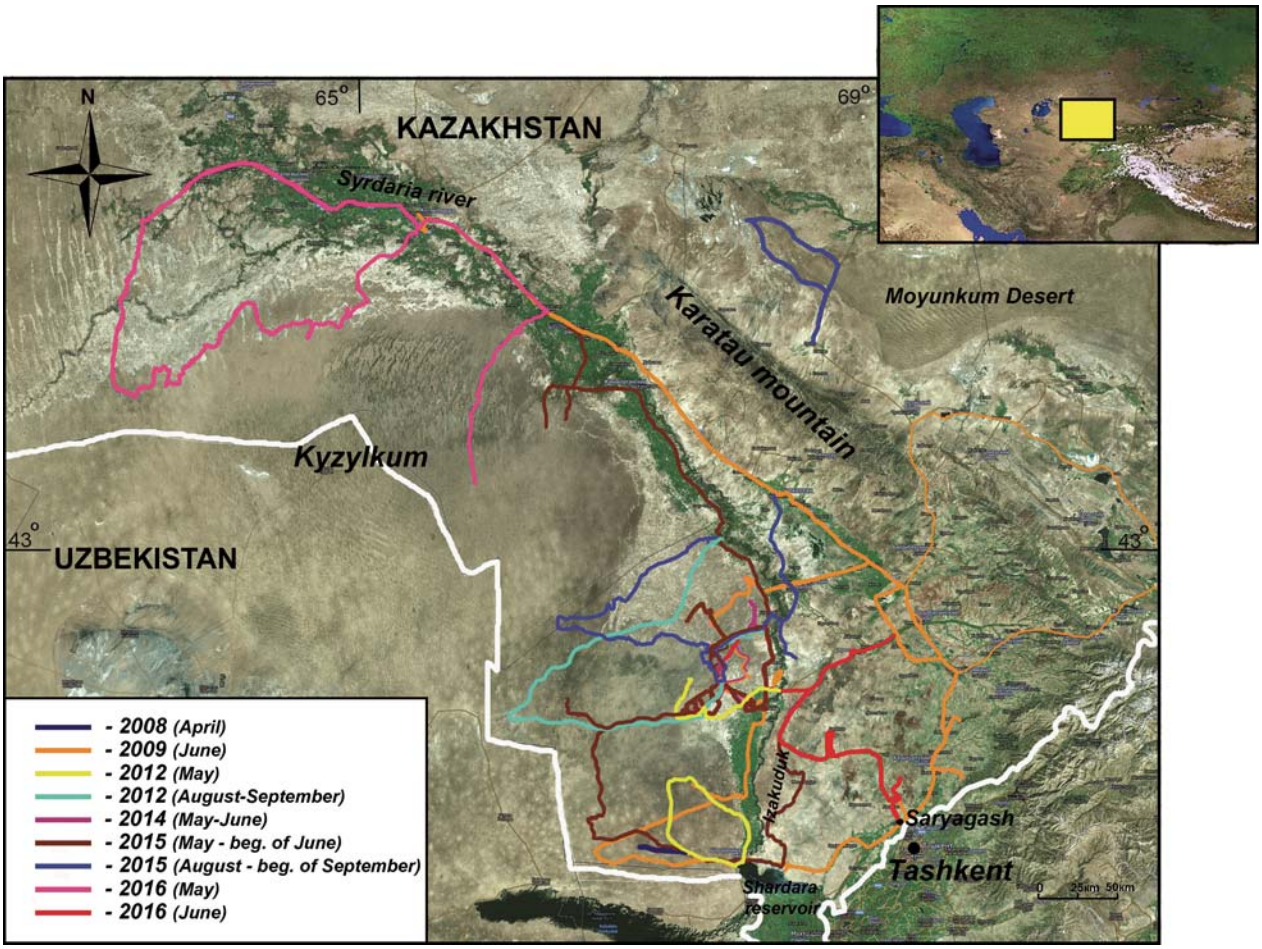

Fig. 2. Study routes in Kazakhstan.

(Fig. 2). In order to determine coordinates of the records from literature sources and survey of local people, topographic maps in the program SAS Planet were used (http://www.sasgis.org).

Various methods were used to study the occurrence of *V. griseus*. The line transect method (route surveys) was used most often; the results were then recalculated as values per hectares (Bondarenko, 1989; Khodzhayev, 1989; Brushko, 1995). However, the most objective data on abundance of *V. griseus* can be obtained by recording on test field sites. Comparison of data on abundance obtained by different methods should be carried out cautiously (Tsellarius et al., 1991). According to our observations (unpublished data), data on line transects and its recalculation (per hectares) can distort the actual abundance. We have surveyed a fairly large area, so we have conducted only route surveys (road routes and walking routes), and, as an indicator of the species abundance, in this paper we give the number of specimens per 1 km (referred to below as occurrence).

During road surveys, desert monitors were observed up to 10 m away on each side of the vehicle, and short-term walking trips up to 1 – 4 km were made periodically; the width of the walking routes ranging from 10 to 20 m, depending on the density of the vegetation cover and features of the relief. To the north of the residual mountains Karaktau (eastern edge of the Kyzylkum Desert), multiple records of monitors were collected during road surveys of 20 – 100 km length, and walking routes of 311 km (Table 1).

ArcMap 9.3 program was used to create a map for analysis of the desert monitor's distribution. We used the occurrence records from three major sources: published data (Gvozdev, 1986; Brushko et al., 1990; Brushko, 1995), personal communications from specialists (forestry enterprise employees, KazTransGas JSC employees, environmental agency inspectors, border control

TABLE 1. Results of the Accounting of the Desert Monitor

Survey location	Period (Route)	Route distance, km	Living specimens	Dead specimens	Fresh traces	specimens/km
W of Shardara Reservoir, along Uzbekistan border	April 2008	45			1	0.022
	20 – 24.06.2009	200	2		21	0.11
	22 – 28.05.2012	150	3	3	2	0.053
	21 – 24.05.2015	120	3		4	0.058
:					**Average**	**0.06**
SW of Karaktau Mountains, eastern border of Kyzylkum Desert**	18.05.2015	10	1		1	0.2
	27.05.2015	10	1		1	0.2
	13.05.2016	7	1	1	1	0.42
	14.05.2016	6	2		1	0.5
	15.05.2016	5	2		1	0.6
:					**Average**	**0.76**
Baymakhan well**	29.06.2016	3			4	1.33
SE of Karaktau Mountains**	01.07.2016	11	3			0.27
:					**Average**	**0.8**
N of Karaktau Mountains, road to Tabakbulak settlement)*	14.05.2014	50	2			0.04
	15.05.2014	50	2			0.04
	22.05.2014	50	2			0.04
	23.05.2014	50	3			0.06
	29.05.2014	50	5			0.1
	17.06.2014	50	2			0.04
	21.06.2014	50	1			0.02
	17.05.2015	50	1			0.02
	18.06.2015	50	2			0.04
	27.06.2015	50	3			0.04
	28.05.2016	45	3	2		0.11
	31.05.2016	50		1	1	0.04
	01.06.2016	280	7	4		0.04
	02.06.2016	40	3	2		0.12
	03.06.2016	50	1			0.02
	04.06.2016	50	2	1		0.06
	05.06.2016	50	1			0.04
	10.06.2016	50	3	1		0.08
	12.06.2016	60	3			0.05
	19.06.2016	50	1			0.04
	20.06.2016	68		7		0.1
	22.06.2016	60	2	1		0.05
	23.06.2016	50	1	1		0.02
:					**Average**	**0.052**
N of Karaktau Mountains **	03.07.2016	3			4	1.3
	04.07.2016	3	2			0.7
:					**Average**	**1.0**
Kyzylorda Region, NE area (40 km SW of Zhanakorgan settlement)	26 – 27.05.2012	80	1			0.012
Kyzylorda Region, NE of Kyzylkum border (20 km to S of Bulanbaybayuy settlement)	28.05.2015	23			2	0.086
	29.05.2015	23	2			0.086
:					**Average**	**0.086**
From Uzbekistan border north to 42° N	25 – 27.05.2015	80	1	3		0.05
Darbaza mountain area**	04.05.2016	6	4			0.66

* Road monitoring by car (along the roads with solid cover).

** Walking surveys.

staff, and zoologists) and local residents (60 people), and our own unpublished field data (observation of specimens, prints of paws and tail, dens, excrements, remains of molting skin, and remains of dead animals). Published data is marked on the map with black dots, personal communications from specialists and local residents — with yellow dots, and our own unpublished field data — with red dots. Besides, we identified the reasons for mortality of *V. griseus* and the local residents' attitude toward these issue.

All captured monitors were photographed from several perspectives. Their sex, body length (SVL) and tail length (TL) were determined. Statistical analyses were performed using Statistica 10.0 program.

RESULTS

Distribution of *V. griseus* in Kazakhstan

Figure 2 presents a map with the known places of where the desert monitor has been observed. Published data is represented by 48 points, data received through the survey — 20 points, and the places where we spotted the animals or their traces on our field trips — by 159 points.

The majority of new records of *V. griseus* was found in the southern and south-eastern parts of the Kyzylkum Desert. Two specimens were spotted in the far north-east of the desert, 20 km to the south of the Bulanbaybauy settlement in the Kyzylorda Region (Fig. 3, point 5). No traces of desert monitors were found to the west of this point in the Kyzylkum Desert. Evidences of the monitor lizards were identified in the central part of Kyzylkum Desert, 20 km north-west of the Bosaga cordon (Fig. 3, point 7), and there is also information from border control employees on the presence of monitor near Dalakuduk well (Fig. 3, point 6).

We received information on *V. griseus* occurrence in the western part of Muyunkum Desert from the Inspector of State Enterprise "Okhotzooprom." During the studies of the Muyunkum sands in August 2015, neither monitors, nor traces were found (Fig. 3, point 4). Records of desert monitor in the south-eastern areas of the Karatau Mountain ridge need further clarification (Fig. 3, point 8) (Zh. S. Dautaliyev, personal communication). Information on monitor's distribution on the right bank of the Syrdarya River in the Izakuduk Sands and the Beltau Mountains (Gvozdev, 1986; Brushko et al., 1990) were confirmed (Fig. 3, point 9), and new habitats near Saryagash town (Darbaza Mountains, gardens near Saryagash town) were identified (Fig. 3, points 10 and 11) (Zima, 2016).

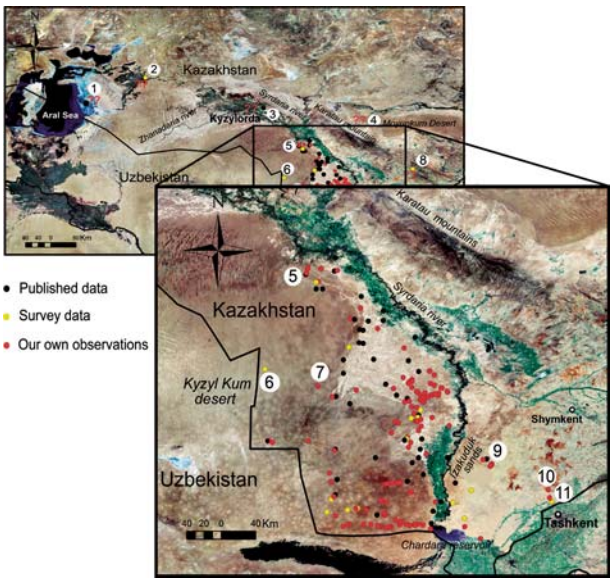

Fig. 3. Distribution of *Varanus griseus* in the north-eastern periphery of its geographic range in Kazakhstan. Numbers on the map are designated locations discussed in the text: 1, former Aral Sea islands (Kaskakylan Island, 45.6555° N 60.9568° E; Mataj and Tailya-dzhuzgen islands, 45.2629° N 61.6237° E) (Zarudny, 1915); 2, Kazalinsk City area (45.7833° N 62.24° E); 3, Kzylorda City area (44.86666° N 65.66° E) (Brushko, 1995); 4, western border of Muyunkum desert (44.562447° N 68.723238° E); 5, 20 – 22 km to the south of Bulanbaybayuy settlement (43.78457° N 66.62671° E); 6, border control station (Dalakuduk well) (42.7907° N 66.18176° E); 7, 20 km north-west of former Bosaga village (42.518° N 66.8833° E); 8, borders of Leontyevka village (43.05695° N 69.84583° E); 9, Beltau and Darbaza mountains (41.59491° N 68.33043° E; 41.85211° N 68.54166° E); 10, Darbaza station area (41.60146° N 69.13491° E); 11, Saryagash City area (41.4834° N 59.17° E).

In 2015, there was 5 males and 3 females among 8 specimens. In 2016, there was 8 males and 4 females among 12 specimens. Body length of males ranged from 41.0 to 57.0 cm (50.68 ± 1.48 cm, $n = 13$), tail length ranged from 58.5 to 71.0 cm (65.18 ± 1.31 cm, $n = 12$). The largest male had a total length of 127.0 cm. Body length of females was 36.0 – 44.5 cm (40.92 ± 1.00, $n = 7$), and tail length was 51.0 – 60.0 cm (55.71 ± 1.32, $n = 7$). Thus, males on average are larger than females ($p = 0.0002$). On June 20th, 2009, one specimen with a body length of 14 cm and a tail length of 20 cm was found dead along the road to the north of the Shardara Reservoir; on April 13th, 2012, three and on April 2017 seven juvenile monitors with body lengths of about 10 – 13 cm were found in Karaktau Mountain area (Fig. 4). We believe that in order to clarify the morphological variability of desert monitor on the northern periphery of its range, additional data is needed.

Fig. 4. Juveniles of *Varanus griseus*. Eastern Kyzylkum, 2012. Photo by A. E. Gavrilov.

Preferred Biotopes of *V. griseus*

In the southern part of the Kyzylkum Desert, *V. griseus* lives in hilly sands with vegetation dominated by sedge (*Carex physodes*), white saxaul (*Haloxylon persicum*), various species of calligonum (*Calligonum* sp.), sand acacia (*Ammodendron* sp.) and salt tree (*Halimodendron halodendron*) (Fig. 5A, B). The desert monitor was recorded in cellular and hilly sands with grass and bush vegetation. The most common biotope inhabited by desert monitor in the eastern part of the Kyzylkum Desert are hilly sands. Some animals were encountered on takyrs (flat clay surfaces) where vegetation was represented by biyurgun (*Anabasis salsa*) and, closer to sands, by wormwood (*Artemisia* sp.). Monitors were observed regularly in the Karaktau mountain area that consists of metamorphosed Paleozoic shales, limestones, granites (Fig. 5C).

The desert monitor was found in sands with sand acacia, calligonium and white saxaul on the right bank of the Syrdarya River in Izakuduk Sands (Fig. 5D). Other places with sands that had been heavily trampled by cattle, with no bush vegetation, showed no traces of monitors. To the south-east of Izakuduk sands in the Darbaza mountain area and Darbaza station, desert monitors were observed in mountains in gullies and clay cliffs with wormwood, wheat grass and saltwort (Fig. 5E). We encountered *V. griseus* and its traces several times in landscapes that had been anthropogenically modified: sands trampled by cattle, near shepherds' houses (Fig. 5F), koshars, on soil roads and asphalt roads. Some specimens were observed near Saryagash town in heavily modified agricultural landscapes represented by gardens, vineyards, greenhouses and agricultural fields.

In areas affected by fire over recent years, with only grass cover was restored (i.e., with no shrubs and with a low density of gerbils and ground squirrels' habitats), monitors have not been found during our research. The species have not been observed either on the large barkhans and the massifs of very high barkhans (over 10 m).

Results of Recording the Desert Monitor Occurrence

The results of the research on *V. griseus* are presented in the Table 1. In the far south of the Kazakhstan part of the Kyzylkum Desert, along the border with Uzbekistan, on the soil and sand roads, the occurrence of monitor lizard in 2008, 2009, 2012 and 2015 ranged from 0.02 to 0.10 spec./km^2, and on average was 0.06 spec./km^2. In the other studied areas of Kyzylkum Desert, the occurrence of desert monitors equaled 0.05 – 0.09 spec./km^2 (Table 1). Occurrence of *V. griseus* to the north of the Karaktau Mountains on the asphalt road during 2014 –

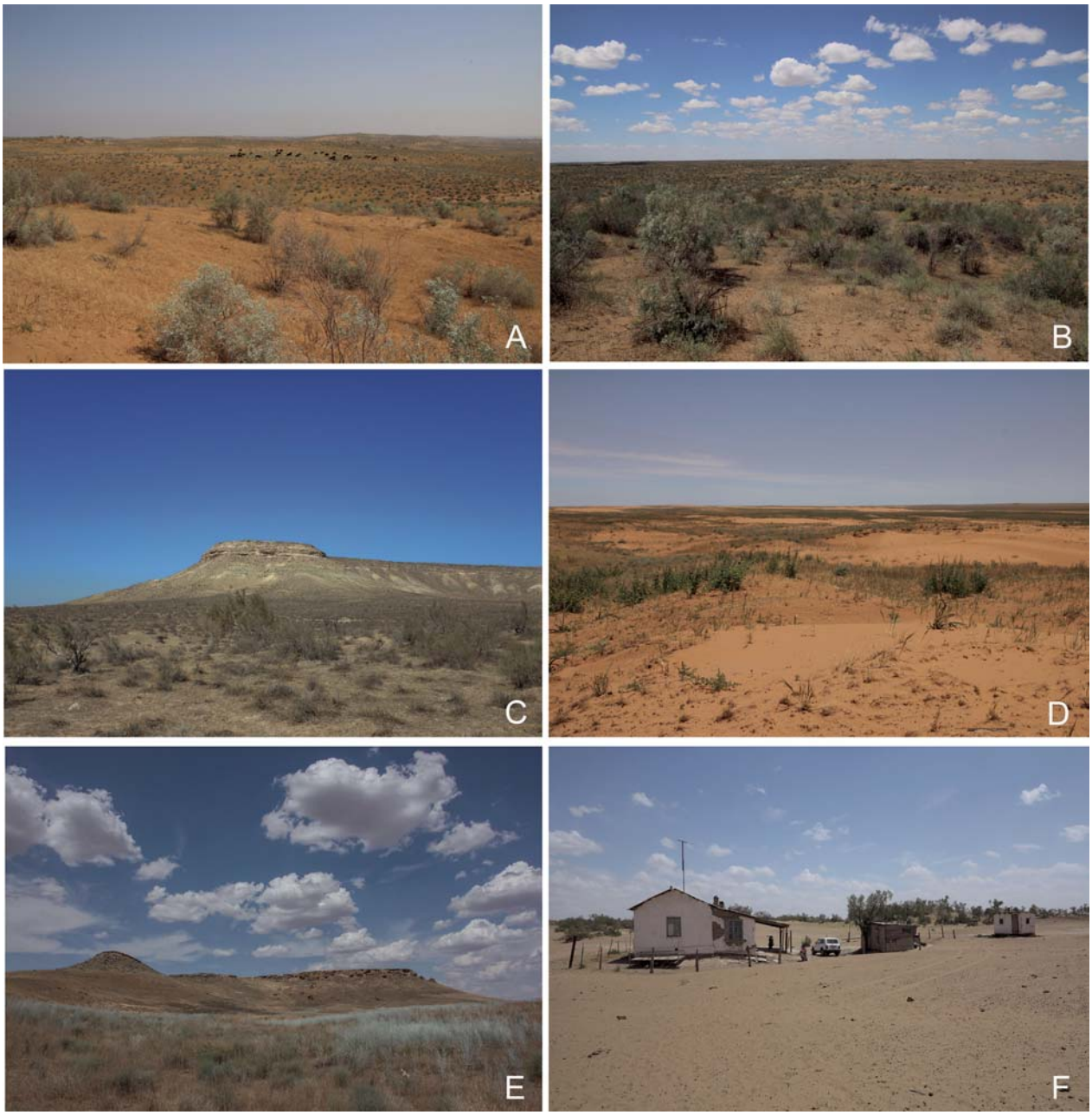

Fig. 5. Biotopes occupied by *Varanus griseus* in the north-eastern periphery of its geographic range in Kazakhstan: A, turfed hilly sands, South-Eastern Kyzylkum; B, flat land sands, Eastern Kyzylkum; C, Karaktau Mountains; D, Izakuduk sands; E, Darbaza Mountain; F, sands trampled by cattle near shepherd's house. Photos by M. V. Pestov, Yu. A. Zima, V. A. Fedorenko and M. A. Chirikova.

2016 ranged from 0.04 to 0.2 spec./km, and on average was 0.05 spec./km. During monitoring walks in the Karaktau mountain area, occurrence ranged from 0.20 to 1.33 spec./km and averaged at 0.60 spec./km. On the eastern bank of the Syrdarya River, near the Darbaza Mountains, the occurrence was 0.66 spec./km.

Human Impact on the Desert Monitor

All cases of desert monitor deaths that have been observed were apparently caused by human factor. Between 2008 and 2016, in total, we encountered 28 dead specimens on the road. In 2012, on the road west to Shardara Reservoir (length of 50 km) we found three specimens that were crushed by car. In 2015, on the road 80 km to

the north of the Uzbekistan border, 4 specimens were found dead (Table 1). In May – June 2016, we found 21 dead desert monitors north and north-west of the Karaktau Mountains across 90 km of road. This road leads to the "Zarechny" uranium deposit. Twice we found desert monitors in dry wells where they could not get out from.

The interviews with shepherds from 22 shepherds' houses located across the distance of 200 km in the southern part of Kyzylkum Desert showed that about one to two desert monitors are killed at each location every year. We also met a local hunter in the course of survey, and according to him, illegal hunting of *V. griseus* happens for alternative medicine purposes (personal observation). One hunter catches and sells at least 15 specimens per year. Monitor lizards are supplied predominantly to major cities such as Shymkent, Almaty, and Taraz. Additionally, according to the hunter, monitors are shipped to China. Blood and meat of desert monitors, and on rare occasions, fat and eggs, are used for alternative medication purposes (personal observation).

On the other note, the survey demonstrated that *V. griseus* has been traditionally associated with negative sentiments and attitudes amongst the local population. The majority of interviewed shepherds believe that monitors brings unhappiness and illness; that they may cause infertility if they run between human legs; that they take milk from sheep and goats; about half of the shepherds believe that if one kills seven desert monitors, it will bring absolution from one's sins. The most grounded reason for the local residents' negative attitude to monitors includes regular attempts by these large reptiles to visit hen houses and hunt the chicks (our survey data).

DISCUSSION

New data made it possible to clarify the northern and north-eastern border of the desert monitor range. Records on the northern border of the monitor's geographic range in Kazakhstan were ambiguous. In the early 20th century, *V. griseus* was discovered on Barak, Mantay, Taylya-Dzhilen and Kaska-Kulan islands in the Aral Sea (Zarudny, 1915). D. N. Kashkarov (1932) stated that the desert monitor does not reach the Syrdarya River and it was not found in Muyunkum Desert behind the Karatau Ridge. Later, V. G. Krivosheyev (1958) pointed out that *V. griseus* had not been found in the area from the eastern shore line of the Aral Sea to the Kuandarya and Zhanadarya river deltas during research performed in 1952 and 1954 – 1955. However, in the 1970s, there was information about desert monitor occurrence near Kazalinsk town, near the northern border of Kyzylkum Desert (Brushko, 1995) (Fig. 3, point 2). In this region, the desert monitor was observed in 1989 (I. I. Temreshev, personal communication). The monitor was also spotted in the Kyzylorda area (Fig. 3, point 3) (Gvozdev, 1986). Z. K. Brushko (1995) believed *V. griseus* occurrence near Kazalinsk and Kyzylorda was due to human activity (accidental or intentional release into nature). Based on the results of our survey, we believe that the desert monitor does not occur in the Northern Kyzylkum. Here, its distribution is limited by climatic factors and corresponds to the border of Eastern and Northern Kyzylkum regions (Puzyreva, 1975). East Kyzylkum region has the precipitation that is minimum in the summer and maximum in the early spring. The summer in the Eastern Kyzylkum region is 1.5 – 2 months longer, whereas the summer in Northern Kyzylkum region is shorter, and the annual precipitation is more even in distribution. This indicates a direct dependence of the desert monitor's distribution on climatic factors in the north of its range. Research in this direction is required, and will be presented in a separate article. In the central part of the Kyzylkum Desert, where the desert monitor has not been discovered until recently, we recorded the occurrence of this reptile (Fig. 3, points 6 and 7). We made an assumption that *V. griseus* is wide-spread in this region, and that the lack of record is associated with difficult access to this remote area resulting in the low degree of exploration.

New data demonstrated that desert monitor is widespread in more eastern regions than it was known previously, reaching as far as Saryagash town and Darbaza station in the southern part of the South Kazakhstan Region near the Uzbekistan border (Fig. 3, points 10 and 11). These last two habitats are approximately 80 km further towards the east compared to the existing records. About 60 years ago, *V. griseus* was observed within proximity of the Tashkent City area (Bogdanov, 1960) (Fig. 3). Intensive development of this region admittedly has led to the disappearance of the species (Bannikov et al., 1977, Nuridzhanov, 2009).

Thus, based on literature data (Bannikov et al., 1977; Sindaco and Jeremčenko, 2008; Nuridzhanov et al., 2016) and our own study, we assume, that the northern border of the geographic range of *V. griseus* is from the eastern shore line of the Caspian Sea in Turkmenistan, along the southern cliffs of Ustyurt until the southern part of the Aral Sea, further along the northern part of Kyzylkum Desert in Uzbekistan, where, approximately in the region of Dalakuduk well (Fig. 3, point 6), the species spreads into North-Eastern Kyzylkum Desert in Kazakhstan. Further, the border of its geographic range extends north towards the Syrdarya River. Desert monitor's habitat continues in Kazakhstan towards the east and is defined by western foothills of the Tian Shan Mountains. Potential areas to be included into the range are the

Fig. 6. Desert monitor near Darbaza station. Photo by V. A. Fedorenko.

Northern Kyzylkum Desert in Uzbekistan, the Southeastern Aral Sea Region, the southern foothills of the Karatau Ridge, and the Muyunkum Desert in Kazakhstan.

At the north-eastern periphery of its geographical range, in Kyzylkum Desert desert monitor inhabits turfed hilly sands with shrub vegetation, and residual mountains, sometimes takyrs (clay desert). On the eastern bank of the Syrdarya River *V. griseus* lives in the foothill steppe, in residual mountains and in gullies with no shrub vegetation. Generally, we observe a significant correspondence with biotopes in the southern parts of the range of this subspecies (Tsellarius et al., 1991; Bogdanov, 1960; 1965; Ataev, 1985).

According to some authors (Tsellarius et al., 1991; Brushko, 1995), monitor prefers areas near the colonies of gerbils (*Rhombomys opimus*), which we have observed in several places in the Kyzylkum Desert. However, in areas where gerbils are scarce or absent, desert monitor uses burrows of large-toothed suslik (*Spermophilus fulfus*) and long-clawed ground squirrels (*S. leptodactilus*). According to our data, the South of Kyzylkum Desert, the Izakuduk Sands, Beltau and Darbaza mountains represent such territories. This is consistent with the data of theriologists who, in their study of yellow susliks in Kyzylkum Desert, have found desert monitors in 65% of the burrows (Ismagilov, 1962).

Thus, desert monitor prefers biotopes with favourable conditions for finding food, shelter, hibernation and incubation. This can explain why monitor has not been found in areas exposed to fire and in barchan dunes. In the Karaktau Mountains, there are many habitats suitable for hibernation, with the slopes housing numerous gerbil colonies. Residual mountains and cliffs on the right bank of the Syrdarya River provide similarly suitable habitats for desert monitor (Fig. 6). In Anatolia, several specimens were spotted among big calcareous rocks at the edge of cultivated areas and in gravel plains (Ilgaz et al., 2008).

Motor ways use desert monitors for hunting and as a place for thermoregulation, which is characteristic of many reptiles (Butov et al., 2006). They also eat other animals that have been killed by vehicles. It is known that *V. griseus* eats dead animals both in captivity and natural conditions (Gorelov, 1973; Stanner and Mendelssohn, 1987; Brushko et al., 1990). We observed desert monitors eating dead steppe agama (*Trapelus sanguinolentus*). The high mortality of the monitor on roads, noted in 2016, may have been connected, on the one hand, with the increase in the flow of motor vehicles to uranium deposit. On the other hand, the spring and summer period of 2016 was rainy and there was a high grass stand. In the more southerly regions, it was also observed that in years with heavy rainfall, because of the high grass stand, the monitors are forced to go to the roads more often (Gorelov, 1973).

In the different sections of the Kyzylkum Desert that we surveyed, there were no significant differences in the occurrence of the monitor. The average occurrence on road surveys was no more than 0.1 spec./km, with an average of 0.05 spec./km. Multiple road trips along the

same parts of the road to the north of the Karaktau Mountains in 2014 – 2016 brought similar results (0.02 – 0.1 spec./km, average — 0.05 spec./km). However, in the same region, occurrence was higher 0.2 – 1.33 spec./km when counting through walking, with an average of 0.6 spec./km (Table 1). Such results were compared with 1950s data: it was 1 monitor per 2 km of road in Southern Kyzylkum Desert (0.5 spec./km) (Paraskiv, 1956). Higher occurrence was observed in 1987 – 1989 in some areas of Kyzylkum Desert; for example, in the Orynbay settlement area, 3 specimens of desert monitor were observed across 1.5 km (0.5 spec./km) and, on the second route, 3 specimens were observed across 200 m. In 1987, 20 adult monitors lived on 2-km^2 area near Baymakhan artesian well, south of the Karaktau Mountains (Brushko et al., 1990). In 2016, fresh traces from 4 different individuals were recorded on the same territory on 3-km route (Table 1). Overall, comparing the former population density and the current occurrence can be noted a slight decline numbers of desert monitor in Kyzylkum Desert.

On the eastern bank of the Syrdarya River, near the Darbaza Mountains, the occurrence was 0.66 spec./km. In 1983, four desert monitors were found here during 4 h of walking (Gvozdev, 1986). That is, the species occurrence in this territory has not decreased over the last 30 years. In addition, reliablae information is received about constant occurrence of desert monitors in the Saryagash town area. That is, there is a viable monitor population on the western bank of the Syrdarya River, with species occurrence not lower than in the Kyzylkum Desert.

Occurrence of *V. griseus* in the south is lower; for example, in Tajikistan (Protected Zone "Tigrovaya Balka") in March – April, 4 – 6 lizards were found per 14 – 18 km (about 0.3 spec./km) (Said-Aliyev, 1979); in 1999, one specimen was found during a 3 – 5-h trip (Khabilov, 2012). In Karakum only 2 – 4 individuals of desert monitor were found in Turkmenistan during a survey (Shammakov, 1981), according to other data occurrence was 0.3 – 1.0 spec./km (Tsellarius et al., 1991). In the Badkhyz hills, occurrence was 0.1 spec./km, in reinforced sands — 0, 5 spec./km (Ataev, 1985). Significantly higher occurrence of desert monitor was observed in Uzbekistan where in April – June 4 – 6 spec./km (Khodzhayev, 1989; Bondarenko, 1989), in Western Kyzylkum Desert at a site of 2 km^2 there were 6 lizards (Tsellarius et al., 1991). In addition, the density of the desert monitor is relatively higher within the foothill valleys (0.37 spec./ha) than in the open sandy soils and hilly sands (0.08 spec./ha) (Bondarenko, 1989). Although, during the last ten years, species occurrence in some areas of Uzbekistan have decreased (Nuridzhanov and Nuridzhanov, 2008).

The daily activity of desert monitors is of individual nature. Monitors can come to the surface for a short time, or do not appear on the surface for several days, hiding in their burrows (Brushko, 1995). In light of this, the final count of the occurrence of *V. griseus* in Kazakhstan will be possible after further comprehensive monitoring studies at the field sites.

Due to their large size and protective behaviour, adult *V. griseus* do not have a large number of natural enemies. Young desert monitor is hunted by red fox (*Vulpes vulpes*) and jungle cat (*Felis chaus*) (Ishunin, 1968), short-toed snake eagle (*Circaetus gallicus*), black kite (*Milvus migrans*), and cinereous vulture (*Aegypius monachus*) (Shammakov, 1981; Ataev, 1985). Human activity significantly reduces the population of monitors. In 1937, almost entire population of desert monitors was caught in the Tekebay well area (Uzbekistan) for reptile leather production, and only by the 1950s did it start to grow again (Paraskiv, 1956). In the 1980s, the population of *V. griseus* decreased again as a result of cultivation and land irrigation in the Fergana and Vakhshskaya meadows, in the Golodnaya Steppe (Uzbekistan) (Bogdanov, 1965; Said-Aliyev, 1979) and the Shardara Steppe (Kazakhstan) (Brushko, 1995). The habitats of *V. griseus* in sand deserts have been less subjected to agricultural development. Here, this species has suffered predominantly from direct destruction by humans (Brushko, 1995). Reasons for destroying these large lizards by humans vary; they include fear, use of their meat and other derivatives for medical purposes, hunting lizards for sale (Mil'ko and Panfilov, 2006; Nuridzhanov, 2009; Koch et al., 2013; Welton et al., 2013; Ghimire and Shah, 2014; Rastegar-Pouyani et al., 2015). However, as confirmed by our survey in Kazakhstan, the major reason is traditional negative attitude towards this reptile. If we take into account that, at each shepherds' houses, 1 – 2 desert monitors are killed on average per year, then over 20 specimens are killed by shepherds in the southern part of Kyzylkum Desert in total. And this is only 1/6 of the area of distribution of the monitor in Kazakhstan. At the same time, a large number of desert monitors die on the roads because of vehicles. On earth roads (without asphalt covering), 2 – 3 specimens die per 100 km (Fig. 7); on asphalted roads in places of industrial development, over 10 specimens die per 100 km in a month. All dead monitors that we found were adults. Extrapolating this data to the whole area of monitor's distribution in Kazakhstan, we assume that over one hundred deaths of desert monitor is caused by humans each year.

The unexpected result of the surveys was information on the illegal hunting of *V. griseus* for the purposes of al-

Fig. 7. The desert monitor that died under vehicle's wheels. Kyzylkum, 2016. Photo by M. V. Pestov.

ternative medicine in Kazakhstan. It was known for Uzbekistan and Kyrgyzstan (Mil'ko and Panfilov, 2006; Nuridzhanov, 2009), but for Kazakhstan such information has been obtained for the first time.

Suggested Protection Measures for *V. griseus* in Kazakhstan

A significant part of the geographic range of *V. griseus* in Kazakhstan lies within the limits of specially protected natural areas of Southern Kazakhstan, Arys and Karaktau. However, in accordance with the status of these areas, for the most part of their territory there are practically no restrictions on economic activities (except hunting). The land is used to grazing sheep; there is a network of roads, lots of transport and, according to our observations, the death rate of the monitor due to human factors is still high. In this regard, it is necessary either to expand the zones within the South Kazakhstan, Arys and Karaktau Protected Areas where any human activity is prohibited, or to create new protected areas with limited human activities.

Currently, we are investigating the most suitable habitats of *V. griseus* in Kazakhstan. Creation of new specially protected natural areas in Kyzylkum Desert or expansion of specially protected natural area in the South Kazakhstan will enable protection of both *V. griseus* and desert ecosystem on the whole.

Moreover, it is necessary to achieve a change in the negative attitude of the local population towards monitors. This is possible only as a result of systematic educational work with the local community, distribution of special printed products, the publication of information about this unique animal in the local media. As the experience of other countries has shown, such actions bring positive results (Arijit and Silanjan, 2015). In 2012, we started this work with the support of the Rufford Foundation (http://www.rufford.org/rsg/projects/marina_chirikova), and continued it in 2015 – 2016. We also consider it appropriate to install billboards with images of *V. griseus* on a section of an asphalt road from the Koksaray village to the Zarechny uranium deposit, which is the place of mass death of monitors under the wheels of cars.

Currently, *V. griseus* is not included in any of the red list categories of the International Union for Conser-

vation of Nature (IUCN). Therefore, we recommend to evaluate this species in accordance with the IUCN criteria.

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APPENDIX 1. Coordinates of the Finds of Desert Monitor in Kazakhstan

Published data

1. E Priaralye, Kaska-Kulan Island [45.66666° N 61.0° E] (Zarydny, 1915);

2. Neighborhood of Kzyl-Orda town [44.86666° N 65.6° E] (Gvozdev, 1986);

3. 50 – 60 km SW of the vill. Yanykurgan [43.58333° N 66.71666° E] (Gvozdev, 1986);

4. Neighborhood of Bakhtiyar vill. [43.58333° N 66.78333° E], 15.05.1982 (Gvozdev, 1986);

5. The vicinity of the well Shibyk and 7 km W [43.26583° N 67.25957° E] (Gvozdev, 1986);

6. The vicinity of the Ujaly vill. [42.88333° N 67.0° E], (Gvozdev, 1986);

7. 10 – 30 km S Ujaly vill. [42.75° N 67.0° E], (Gvozdev, 1986);

8. Well Dzhejuder [43.04614° N 67.20659° E] (Gvozdev, 1986);

9. Bajteke and 3 km S [43.17554° N 67.20487° E], (Gvozdev, 1986);

10. Between Bajteke and Ujaly [43.05211° N 67.16230° E] (Gvozdev, 1986);

11. Neighborhood of Kumuyan Fortress [43.36666° N 67.41666° E] (Gvozdev, 1986);

12. Between Kumuyan Fortress and Ujaly [43.18333° N 67.16666° E] (Gvozdev, 1986);

13. 10 km SE Shardara Reservoir [41.21203° N 67.90847° E] (Gvozdev, 1986);

14. 5 km SW Shardara town, [41.26666° N 67.91666° E] (Gvozdev, 1986);
15. 14 km W Tabakbulak vill. [42.5° N 67.66666° E] (Brushko et al., 1990, Brushko, 1995);
16. Konguzu well [42.45° N 67.06666° E] (Brushko et al., 1990);
17. Akdala well [42.0000° N 66.91666° E] (Brushko et al., 1990);
18. Karaozek well [41.91666° N 67.33333° E] (Brushko et al., 1990);
19. Zhibekshi vill. [41.7° N 66.93333° E] (Brushko et al., 1990);
20. Naiman-Bukharbaj well [41.55° N 66.91666° E] (Brushko et al., 1990);
21. Bimirzakkuduk vill. [41.35° N 67.35° E] (Brushko et al., 1990);
22. Between Bimirzakkuduk vill. and Ak-Altyn vill. [41.68333° N 67.6666° E] (Brushko et al., 1990);
23. W Komsomolskiy collective farm [41.75° N 67.83333° E] (Brushko et al., 1990);
24. W Kyzylkumskiy collective farm [41.91666° N 67.78333° E] (Brushko et al., 1990);
25. 30 km W Bairkum vill. [42.1° N 67.81666° E] (Brushko et al., 1990);
26. Izakuduk Sands [41.6666° N 68.1666° E] (Brushko et al., 1990);
27. 15 km from Kyzylpanton vill. [42° N 67.8° E] (Brushko et al., 1990);
28. Baimakhan well [41.86666° N 67.71666° E] (Brushko et al., 1990);
29. 7 km from Zhusaly well [42.33333° N 67.78333° E] (Brushko et al., 1990, Brushko, 1995);
30. Sutkent vill. [41.91666° N 68, 08333° E] (Brushko et al., 1990);
31. 20 km from Orynbai collective farm [42.08144° N 66.21252° E] (Brushko et al., 1990);
32. 10 – 15 km north of Bel'tau [41.90322° N 68.49414° E] (Brushko et al., 1990);
33. 42 – 48 km NW Koksarai vill. [42.87420° N 67.67768° E] (Brushko et al., 1990);
34. 99 km SW Koksarai vill., Askarly well [42.52130° N 66.92176° E] (Brushko et al., 1990);
35. 53 km SW Koksarai vill., Adyr well [42.53404° N 67.55424° E] (Brushko et al., 1990);
36. Dauranbek well [42.64218° N 67.44152° E] (Brushko, 1995);
37. Zhaugashty vill. [42.88815° N 67.31444° E] (Brushko, 1995);
38. Tulubergen well [43.283° N 67.116° E] (Brushko, 1995);
39. Karasan mosque [43.76015° N 66.90571° E] (Brushko, 1995);
40. 22 km S Bulanbajbauy vill. [43.72662° N 66.60931° E] (Brushko, 1995);
41. Between Baltykul and Ovzevod [43.10643° N 67.74826° E] (Brushko, 1995);
42. 33 km NW Koksarai vill. [42.76717° N 67.78399° E] (Brushko, 1995);
43. Bajkenzhe vill. [43.89163° N 66.91541° E] (Brushko, 1995);
44. Apankalak vill. [43.50868° N 67.18604° E] (Brushko, 1995);
45. Arystanbaj [43.27159° N 67.41444° E] (Brushko, 1995);
46. Zhautkan well [42.0905° N 67.6365° E], 1988, 1989 (Brushko, 1995);
47. Koksu collective farm [41.48° N 68.02° E] (Brushko et al., 1990);
48. Voskhod collective farm [41.38857° N 67.93514° E] (Brushko et al., 1990)

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49. 60 km S Shiili vill. [43.65° N 66.7166° E] E. S. Tashibaev;
50. Neighborhood of the village of Zharynyas (Leontievka) [43.05695° N 69.84583° E] Dautaliev;
51. Near the village of Kumzhyek [45.7833° N 62.24° E], 18.08.1989, I. I. Temreshev;
52. South-Kazakhstan region [42.10158° N 67.65666° E], 26.09.2012, G. Shakula;
53. South-Kazakhstan region [42.10125° N 67.65650° E] 26.09.2012, G. Shakula;
54. South-Kazakhstan region [42.10373° N 67.66037° E], 27.09.2012, G. Shakula;
55. South-Kazakhstan region [42.10349° N 67.66168° E] 27.09.2012, G. Shakula;
56. South-Kazakhstan region [42.10205° N 67.65747° E], 27.09.2012, G. Shakula;
57. South-Kazakhstan region [42.31627° N 67.77703° E], 30.09.2012, G. Shakula;
58. Abai vill., near Saryagash town [41.4834° N 59.17° E], autumn 2014, summer 2015, Sarylhan, local resident;
59. Izakuduk sands [41.47022° N 68, 13923° E], 19.05.2015. Data of workers serving the gas pipeline;
60. Mountain Beltau, Bozai vill. [41.59491° N 68.33043° E], 2015, Data from local residents;
61. Kyzylkum desert [41.41827° N 67.14841° E], 23.05.2015, Data from local residents;
62. Kyzylkum desert [41.39973° N 67.04397° E], 23.05.2015, Data from local residents;
63. Kyzylkum desert [41.37972° N 66.82812° E], 23.05.2015, Data from local residents;
64. Kyzylkum desert [41.5066° N 66.87518° E], 24.05.2015, Data from local residents;
65. [42.38666° N 67.8048° E], 27.05.2013, G. Shakula;
66. [42.30516° N 67.7055° E], 28.05.2013, G. Shakula;
67. [43.00826° N 67.0569° E], 02.06.2015, G. Shakula;
68. Dalakidik well [42.7907° N 66.18176° E], 2015, Interviews of border guards.

Own Data

69. [41.95212° N 67.86316° E], 24.05.2007;
70. [42.01846° N 67.67725° E], 25.05.2007;
71. [42.68964° N 67.71495° E], 26.05.2007;
72. [43.39619° N 67.17826° E], 28.05.2007;
73. [43.19222° N 67.35669° E], 28.05.2007;
74. [42.65067° N 67.9058° E], 31.05.2007;
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