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SYSTEMATIC STUDY OF ARID TERRITORIES

In Memoriam of Viktor Arsent'evich Tokarskii

Distribution of the Bobak Marmot across the Russian Plain in the Historical Past: Mapping Review

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Abstract—The historical variations in distribution of the bobak marmot (*Marmota bobak* Müll.) across the Russian Plain continue to attract the attention of specialists. The available studies largely report data with respect to locations of encounters with the bobak marmot during a particular time period in the form of narrative descriptions, which seriously hampers the perception and analysis of this material. The only solution to the problem is the use of modern mapping techniques. This work summarizes the available data on the historical distribution of the bobak marmot in a cartographic form with the current GIS technologies. Subsequent analysis of the findings could substantially contribute to clarify details on the distributional patterns of the bobak marmot on the Russian Plain over the historical period, in particular, those in connection with natural features of habitats preferred by the marmot.

Keywords: bobak marmot, *Marmota bobak* Müll., Russian Plain, historical changes of distribution, mapping techniques, GIS technologies

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INTRODUCTION

The historical variations in distribution of the steppe marmot or bobak marmot (*Marmota bobak* Müll.) across the Russian Plain continue to attract the attention of specialists (Bibikov and Rumyantsev 1997; Bibikov et al., 1990; Rumyantsev et al., 1996). A detailed review of the pertinent publications and archive materials for the period from the late 17th through the first third of the 20th century was conducted by Kirikov (1959, 1966, 1980). Valuable published and archival data about the past distribution pattern of the bobak marmot within the borders of contemporary Ukraine were summarized by Tokarskii (1997a and 1997b).

These studies reported data on the bobak-marmot distribution in the form of rather wordy textual descriptions of points or areas of bobak-marmot finds during a particular time period, often using outdated geographical names. This significantly hampers the perception of these data and, consequently, their generalization and analysis with respect to the natural conditions of the bobak-marmot habitats and anthropogenic transformation of the latter. The only solution to the problem is the use of modern mapping techniques.

The goal of the present study is to generalize the available data on the historical distribution patterns of the bobak marmot in cartographic form with current GIS technologies. The objectives included systematization of the available materials and their compilation, if possible, in a computer database; localization of the known locations of the bobak-marmot finds on the map; the creation of a single base map; and mapping of the known localities with GIS resources.

EXPERIMENTAL

The textual data contained in the publications of Kirikov (1959, 1966, 1980) and Tokarskii (1997a and 1997b) served as the basic material and was structured and generalized in a cadastre in Table 1. Each mention of the bobak marmot in the inventory (cadastre) was localized on a map with accuracy due to the narrative proper and the available cartographic sources.

In addition to the cadastre, we employed the findings of the analysis of data contained in a sample from *Economic Notes to the General Land Survey of the Russian Empire* (EN GLS), which we organized earlier in a GIS (Rumiantsev et al., 2013, 2018a; Rumyantsev et al., 2014, 2015a, 2015b, 2018).

Of special interest is an unpublished manuscript by A.V. Chernai, *Description of Animals Known as Susliks or Marmots*, which was discovered in the archives of Kharkov State University (Tokarskii, 1997a and 1997b). The paper summarizes research conducted by Chernai

Table 1. Abstract from the database of the GIS cadastre of bobak-marmot finds in the historical past

ID	*Vek* (century)	*Vek_N* (century_num)	*Period*	*Adres* (Address)	*Strana* (Country)	*Str_Chast* (Part of the country)	*Pervoistoch* (Primary sources)[1]	*Istochnik* (Sources)	*Prime-chan* (Notes)
1	19	19	1860s	Kievskii *uezd* (county) near Belaya Tserkov'	Ukraine	West of the Dnieper River	Poznanskii, 1878	Kirikov, 1980	Northern limit
2	XVIII	18	Late	Close to the Kiev–Nezhin roadway	Ukraine	East of Dnieper	Guldenstadt, 1791	Kirikov, 1980	Northern limit
3	XVIII	18	Late	In the vicinity of Baturin	Ukraine	East of Dnieper	Guldenstadt, 1791	Kirikov, 1980	Northern limit
4	XX	20	1917–1919	Near Pliska (Pitki) station long the Nezhin–Bakhmach roadway	Ukraine	Easter of Dnieper	Ognev, 1947	Kirikov, 1980	Northern limit
5	XIX	19	Early	Boundary between Orel *guberniya* (governorate) (Karachevskii and Volkhovskii *uezd*s) and Kaluga governorate (Zhizdrinskii and Kozel'skiii *uezd*s)	Russia	To the right of the Volga River	Zel'nitskii, 1804	Kirikov, 1980	Northern limit
6	XIX	19	Mid	Ryazan' governorate, vicinity of Mikhailovo town	Russia	To the right of the Volga River	Village chronicle (*Sel'skaya letopis*'), 1854	Kirikov, 1980	Northern limit
7	XIX	19	Mid	Vicinity of Sergach town	Russia	To the right of the Volga River	Eversmann, 1850	Kirikov, 1980	Northern limit
8	XIX	19	Mid	Vicinity of Buinsk town	Russia	To the right of the Volga River	Village chronicle, 1854	Kirikov, 1980	Northern limit
9	XIX	19	First quarter	Along the upper reaches of Stepnoi Zai on the lands of Niznyaya Makhtoma, Tikhaya Erykla, Nizhnyaya Nadyrova, Al'met'eva (now town of Al'met'evsk), and Bazasheva villages	Russia	To the right of the Volga River	Archival data	Kirikov, 1980	Northern limit
10	XIX	19	First quarter	Along the left bank of the Baza downstream (tributary of Belaya) and in the Baza and Kuvash interfluve	Russia	To the left of the Volga River	Archival data	Kirikov, 1980	Northern limit
11	XIX	19	First quarter	60 km northeast of Birsk town on the lands of Shaganaeva, Verkhnyaya Sorokina, Irsaeva, and Staraya Mishkina villages	Russia	To the left of the Volga River	Archival data	Kirikov, 1980	Northern limit
12	XIX	19	1822–1843	Vicinity of Krasnoufimsk town 56°30′ N	Russia	Pre-Urals	EN GLS	Kirikov, 1980	Northern limit
13	XIX	19	1822–1843	60 *versts* south of Kamensk-Ural'skii city in steppes, adjoining the Mayak, Aly-Kul', and Uelgi lakes	Russia	Pre-Urals	EN GLS; Kirikov, 1959	Kirikov, 1980	Northern limit
14	XIX	19	1815	Close to the Ust'-Uisk and Zverinogolovskaya fortifications (toward Kurgashtau Mountain)	Russia	Pre-Urals	Archival data	Kirikov, 1980	Northern limit
15	XVIII	18	Before 1769	Steppes between lower reaches of the Bug and Dnieper	Ukraine	West of the Dnieper	Archival data	Kirikov, 1980	Southern limit
Total of 85 records									

[1]Primary sources are not included in the list of references.

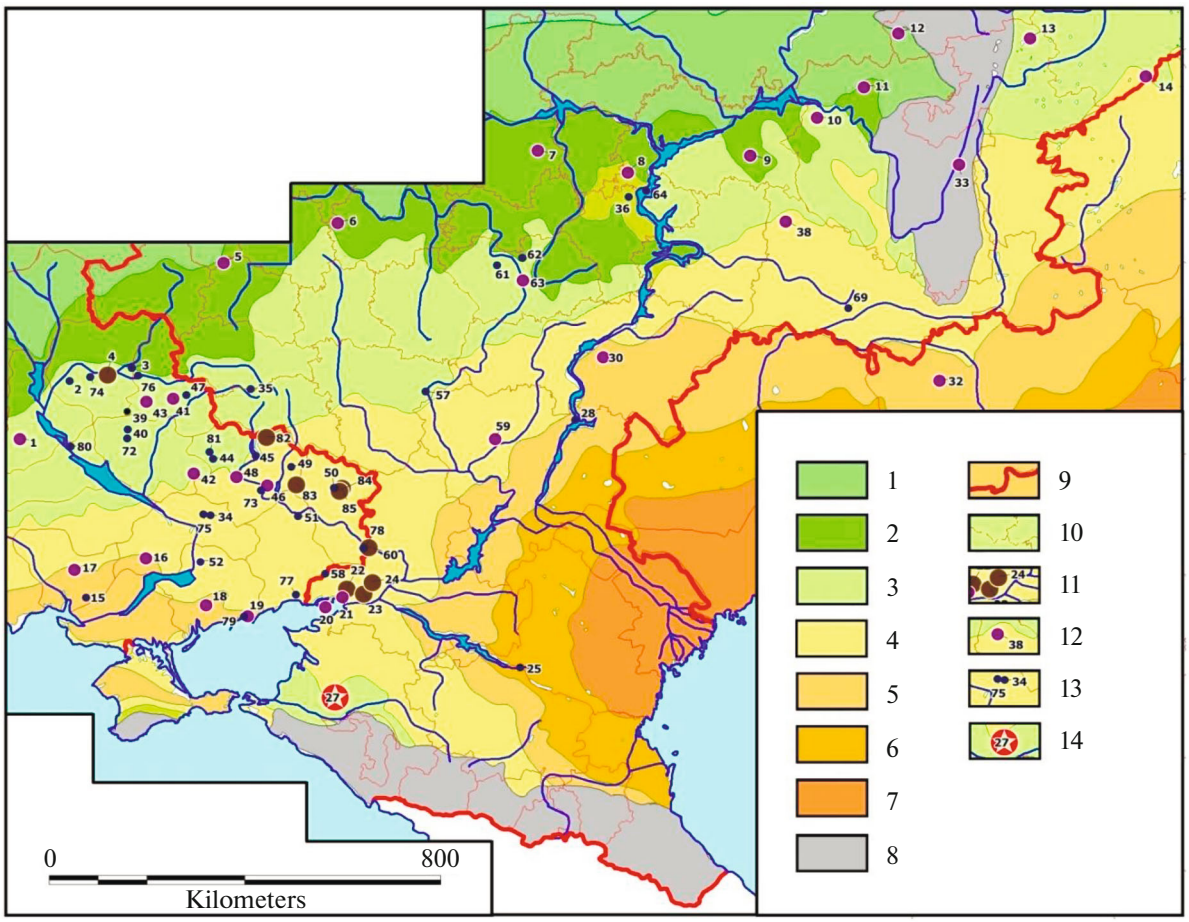

Fig. 1. Point localizations of the bobak-marmot habitats according to the cadastre on a modern GIS map (modern hydronetwork with water reservoirs). (1)–(7) modern vegetation zones: (1) broad-leaved and coniferous (mixed) forests, (2) broad-leaved forests, (3) forest steppes, (4) northern (bright colored grasses–forbs) steppes, (5) midlatitude (dry) steppes, (6) southern (desertified) steppes, (7) deserts; (8) mountainous territories (*Zony i tipy* ..., 1999); (9) contemporary borders of the Russian Federation; (10) boundaries of the modern national (administrative) units; (11)–(14) the marmot colonies in the cadastre (the numbers on the map are numbers assigned to localities in the cadastre): (11) the 20th, (12) 19th, (13) 18th centuries; (14) suspected find, time is unknown (Ognev, 1947; Kirikov, 1980).

in southern Russia over 1845–1853 and is accompanied by a distribution map of two suslik species and the bobak marmot. A scribal copy of this map kindly provided by Tokarskii was digitized and incorporated in the GIS. Narrative descriptions published by Tokarskii (1997a and 1997b) were used in the preparation of the cadastre.

A digitized version of the map *Zones and Types of Altitude Vegetation of Russia and Adjacent Territories* (*Zony i tipy* ..., 1999) were used as a natural GIS basis. The GIS incorporated digital maps of the current administrative and state borders of the countries inhabited by the bobak marmot; a digital map of the administrative-territorial division of the Russian Empire on the cusp between the 18th and 19th centuries; and a schematic map of the recent hydrological network. These served as the basis for the compilation of a series of the GIS maps of bobak-marmot finds on the Russian Plain from the late 17th through first third of the 20th century.

The GIS was prepared and processed with the MapInfo Professional 15.0.1 package. An attribute database was developed with Visual FoxPro 9.0 DBMS.

RESULTS AND DISCUSSION

Two types of data compose the cadastre.

1. *Data that allowed localization at particular places* (*points*). These data had identified the location of spots on the map. The accuracy was determined by the character of the textual descriptions and the availability of the corresponding base maps (Fig. 1).

2. *Data characterizing particular areas.* These include (a) administrative-territorial units of the Russian Empire (*gubernia*, *uezd*, etc.) with explicit boundaries; (b) territories with no definite boundaries that were

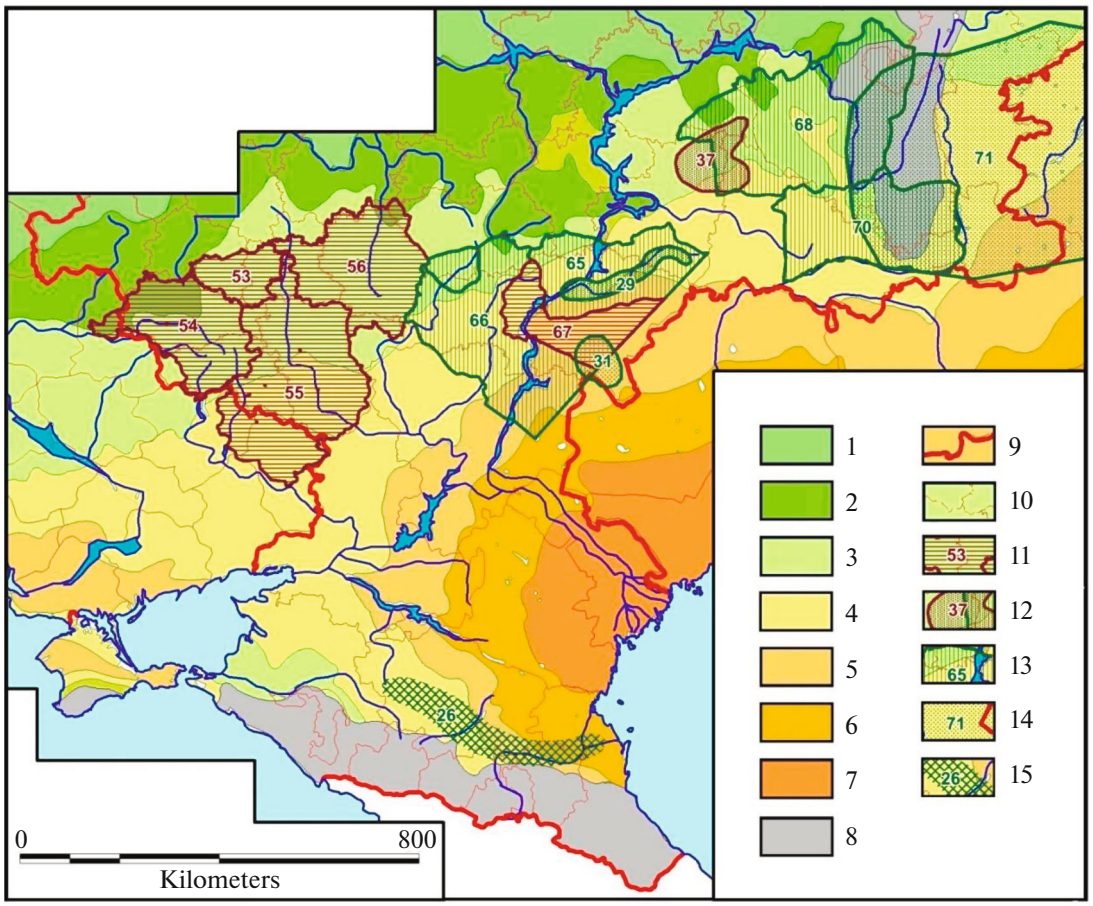

Fig. 2. Areal localization of bobak-marmot habitats on a modern GIS-map (modern hydronetwork with water reservoirs). (1)–(7) modern vegetation zones: (1) broad-leaved and coniferous (mixed) forests, (2) broad-leaved forests, (3) forest steppes, (4) northern (bright colored grasses–forbs) steppes, (5) midlatitude (dry) steppes, (6) southern (desertified) steppes, (7) deserts; (8) mountainous territories (*Zony i tipy* ..., 1999); (9) contemporary borders of the Russian Federation; (10) boundaries of the modern national (administrative) units; (11)–(15) marmot colonies in the cadastre (the numbers on the map are numbers assigned to localities in the cadastre): (11) 18th century, governorates/*uezd*s in which the marmot was recorded, (12) 18th century, territories of an undefined area in which the marmot was recorded, (13) 19th century, governorates/*uezd*s in which the marmot was recorded, (14) 19th century, territories of undefined area in which the marmot was recorded, (15) suspected colonies in the 19th century (Ravinskii, 1809; Kirikov, 1980).

characterized more or less loosely by the sources, e.g., "in the Trans-Volga region along the Sok, Dymka, and Bol'shaya Kinel' and Malaya Kinel' rivers" (*see* no. 37 in the cadastre and on the map, Fig. 2).

The discussion of the case in point had already referred previously to materials from the *General Land Survey* (Kirikov, 1959, 1980; Tokarskii, 1997a and 1997b), but those were primarily fragmentary data. Beginning 2011, they were subjected to systematic processing, including data on the animal kingdom (Golubinskii et al., 2011). A representative sample for mammals was created and analyzed with respect to mentions made of separate species (Rumiantsev et al., 2013, 2014, 2018a, 2018b). Results on the bobak marmot have already been published (Rumyantsev et al., 2015a, 2015b) (Fig. 3); therefore, we will not elaborate on the point. These materials do not only make it possible to delineate areas of bobak-marmot encounters on the map, but also, at some level of approximation, to facilitate the estimation of their abundance, i.e., to judge the studied areas in which the marmot population was larger or smaller during a given period (Tables 2 and 3).

The marmot is not mentioned for the enrolled *uezd*s (counties) of the Orel, Tambov, and Tula governorates (*gubernii*), where it appears to have occurred at that time (Kirikov, 1980; Tokarskii, 1997a). As recorded by Kirikov (1959, 1980), the marmot occurred "in all forest–steppe *uezd*s of Tambov governorate." He was also the one to point out the presence of marmot "in all *uezd*s" of the Voronezh and Kursk governorates (recorded in the cadastre), which is not perfectly in line with data from our sample (Table 2 and 3; Fig. 3). Ryazan' governorate, where the marmot appears to have also occurred on the cusp of the 18th and 19th centuries (Kirikov, 1980), was not part

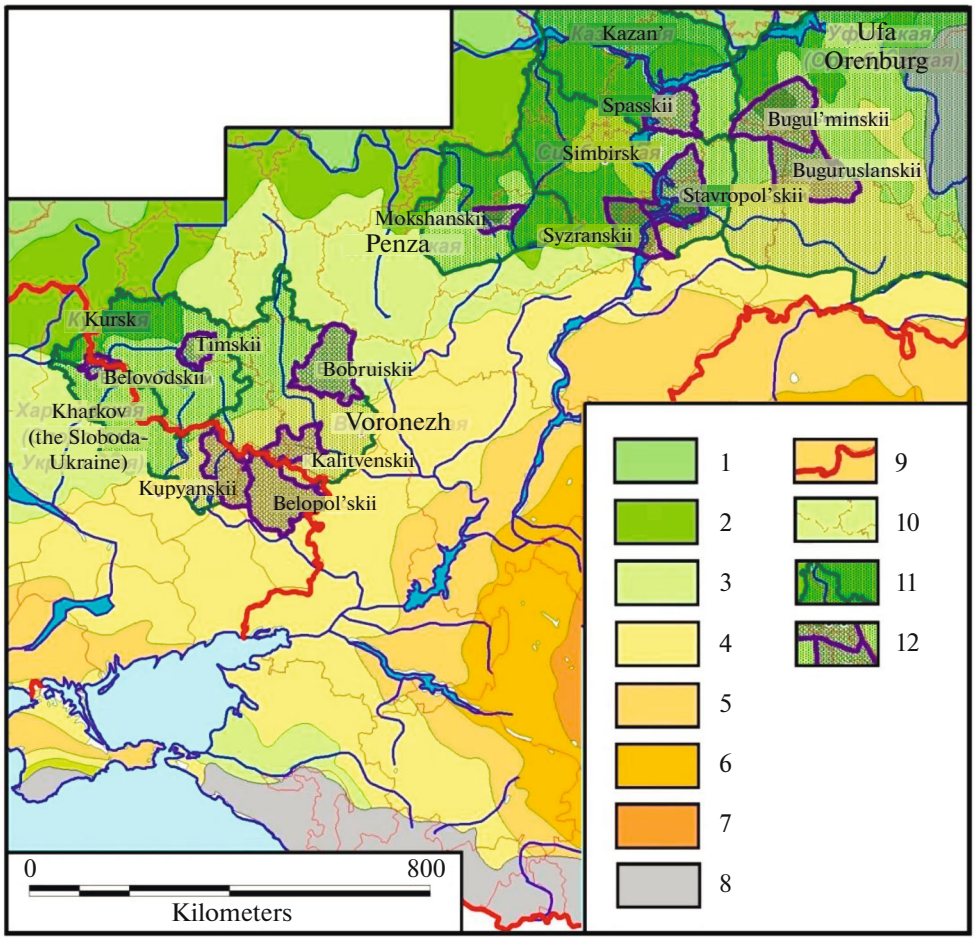

Fig. 3. Distribution of the bobak marmot in a sample from EN GLSP on a modern GIS map (modern hydronetwork with water reservoirs). (1)–(7) modern vegetation zones: (1) broad-leaved and coniferous (mixed) forests, (2) broad-leaved forests, (3) forest steppes, (4) northern (bright colored grasses–forbs) steppes, (5) midlatitude (dry) steppes, (6) southern (desertified) steppes, (7) deserts; (8) mountainous territories (*Zony i tipy* ..., 1999); (9) contemporary borders of the Russian Federation; (10) boundaries of the modern national (administrative) units; (11) governorates included in sample, for which the marmots were mentioned; (12) *uezd*s of these governorates, for which the marmots were mentioned.

of the sample. Regretfully, the same applies to some territories in which the bobak marmot now ranges, and this apparently occurred during the considered period[1]. This concerns Saratov governorate, as well as the Cossack lands (primarily, the territory of modern-day Rostov oblast), which were not covered by the General Survey.

Marmot colonies are marked on a map compiled by Chernai in the second half of the 19th century. It reflects the distribution pattern of the species at the relevant time (Tokarskii, 1997a and 1997b) (Fig. 4) within the boundaries of the Tambov and Saratov governorates and Cossack lands. Even though an in-depth analysis of the review findings is beyond the scope of the present paper, some of these results should be outlined.

On closer examination of Fig. 1, it is obvious that certain localities of the marmot finds (primarily for the 19th century) are found far north of the traditionally accepted range, i.e., the steppe and forest steppe. They are located within the limits of zones of the broad-leaved and even broad-leaved and coniferous forests.

Singular finds are also localized within the mountainous Ural regions. Note, however, that, first, the vegetation-zone boundaries may have significantly changed over the past centuries and, second, the delineation of boundaries on a map proper is usually subjective; while the localization of points on a map sometimes lacks accuracy. Additionally, in both the steppes and forest steppes, localities are spaced rather unevenly for the entire period under consideration.

[1] Only "abridged" *Economic Notes* are available for Ryazan' governorate, which do not contain any data on animal kingdom. Saratov governorate and Cossack lands were not measured altogether.

Table 2. Frequency of marmot mentions in the sample by governorates

Governorates	*Uezd*s			*Dacha*s*		
	*Uezd*s with the marmot	total *uezd*s	share of *uezd*s with the marmot, %	land holdings (*dacha*s) with the marmot	total *dacha*s	share of *dacha*s with the marmot, %
Voronezh	3	10	30	12	68	17.6
Kazan’	1	11	9.1	1	112	0.9
Kursk	1	14	7.1	1	121	0.8
Penza**	1	3	33.3	2	18	11.1
Simbirsk	2	10	20.0	3	141	2.1
Ufa	2	7	28.6	3	76	3.9
Kharkov	2	15	13.3	4	107	3.7
Total	**12**	**70**	**17.1**	**26**	**643**	**4.0**

* *Dacha* is an elementary measured unit (actual land holding). No analogies exist in the contemporary understanding of terms; ** according to Kirikov (1980).

Table 3. Frequency of the marmot mentions in sample by *uezd*s

Governorates	*Uezd*s	*Dacha*s with marmot	Total *dacha*s	Share of *dacha*s with marmot, %
Voronezh	Belovodskii	2	4	50.0
	Bobrovskii (Bobruiskii)	9	28	32.1
	Kalitvinskii	1	3	33.3
Kazan’	Spasskii	1	9	11.1
Kursk	Timskii (Timskoi)	1	8	12.5
Penza*	Mokshanskii	2	7	28.6
Simbirsk	Stavropol’skii	2	2	100.0
	Syzranskii	1	1	100.0
Ufa	Bogoruslanskii (Buguruslanskii)	1	12	8.3
	Bugul’minskii	2	14	14.3
Kharkov	Belopol’skii	1	5	20.0
	Kupyanskii**	3	9	33.3
	TOTAL	**26**	**102**	**25.5**

* After Kirikov (1980). ** During the time of General Survey, the *uezd* was a part of the Voronezh or Kharkov governorates. It is viewed here as a part of Kharkov governorate.

According to Figs. 2 and 3, the marmot habitat is roughly in line with its modern distribution (Bibikov et al., 1990), at least with regards to existing beliefs on its distribution pattern before the depression of the mid-20th century and after the large-scale operations on its reintroduction to the former habitats in the second half of the 20th century (Rumyantsev, 1997). The same applies to the Chernai’s map (Fig. 4). In addition, the insights into the relative marmot abundance based on the General Survey (Tables 2 and 3, Fig. 3) are consistent with the modern situation in the species distribution.

As seen in Fig. 4, as compared to the map representing point localities in the cadastre (Fig. 1), the spacing of points of marmot finds here over the same period is uneven and less dense, particularly in western part of the territory. In some instances, the points do not coincide at all. This appears to be due to the fact that Chernai mapped findings of his own investigations, which could not possibly cover such an extensive territory. Importantly, as in Fig. 1, the localities were spread unevenly within the steppe and forest–steppe boundaries, but they are not seen further northward.

Nearly all of the localities of finds of marmot colonies in the early 20th century (Fig. 1) are located in

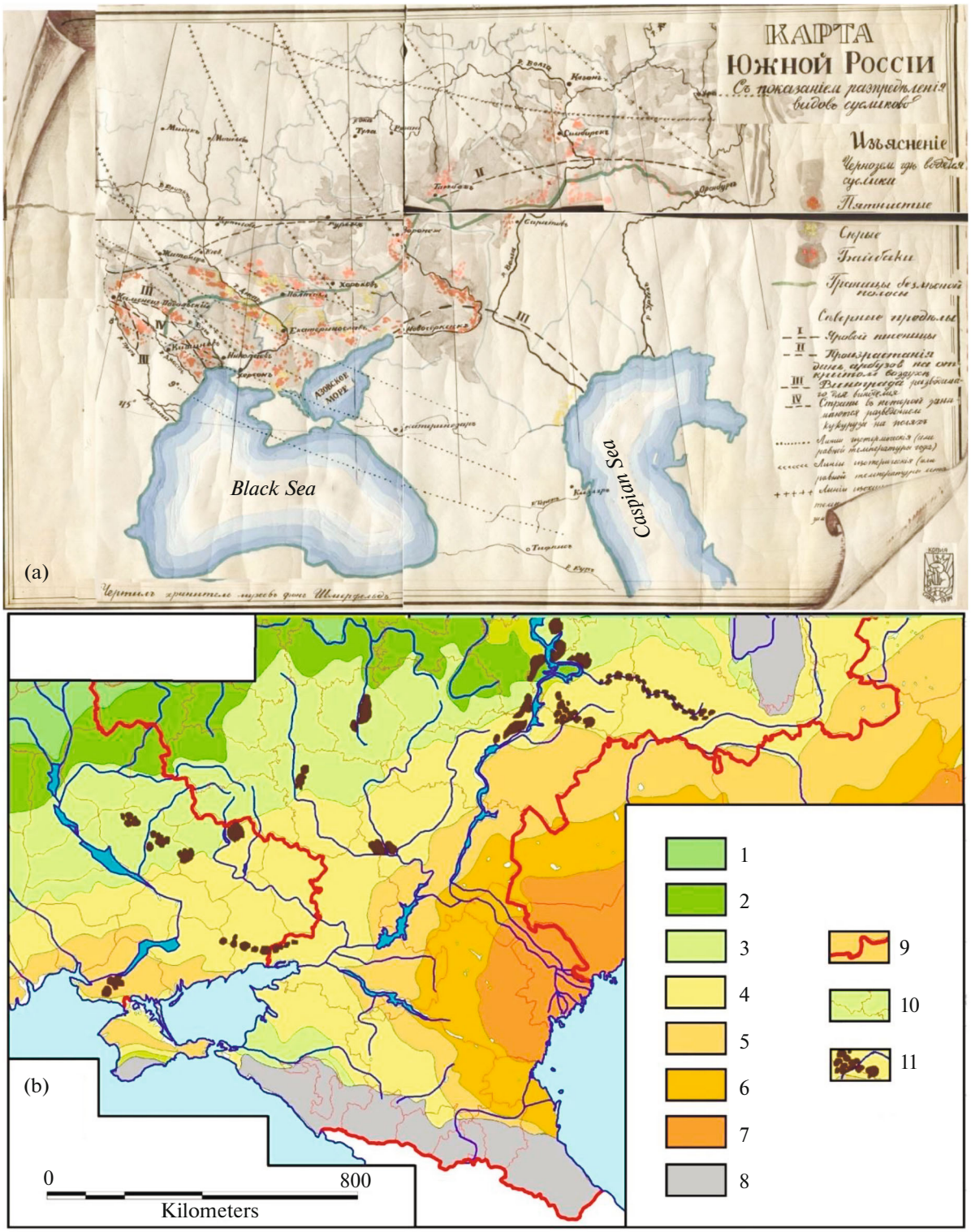

Fig. 4. Distribution of the bobak marmot after Chernai (Tokarskii, 1997a and 1997b): (a) scribal copy of Chernai's map; (b) bobak-marmot colonies after Chernai on a modern GIS map (modern hydronetwork with water reservoirs): (1)–(7) modern vegetation zones: (1) broad-leaved and coniferous (mixed) forests, (2) broad-leaved forests, (3) forest steppes, (4) northern (bright colored grasses–forbs) steppes, (5) midlatitude (dry) steppes, (6) southern (desertified) steppes, (7) deserts; (8) mountainous territories (*Zony i tipy* ..., 1999); (9) contemporary borders of the Russian Federation; (10) boundaries of the modern national (administrative) units; (11) bobak-marmot colonies.

close proximity to the contemporary borders between Russia and Ukraine. Apparently, the marmot range had already been significantly reduced by that time, while the eastern part of the range was not explored.

In addition, the cadastre includes "arguable" locations of marmot colonies in the North Caucasus (Figs. 1 and 2). The marmot occurrence in this region in the historical past has not been confirmed and remains debatable up to the present day (Bibikov et al., 1990; Rumyantsev et al., 1996). The material examined by us does not contain data on the marmot presence on the territory of Crimea in the historical past.

CONCLUSION

The mapping review of data on the distribution of the bobak marmot across the Russian Plain in the historical past allows the following preliminary conclusions.

1. During the considered period within the territory encompassed by the review, the bobak marmot largely occupied areas in which it currently occurs, i.e., steppes and forest steppes. Despite the sporadic localities found northward, those colonies were most probably confined to the steppificated sites. The position of vegetation zonal and subzonal boundaries is known to change with time, while their delineation on map has always been somewhat subjective. At present, the marmot is locally present beyond the northern margins of steppe and forest steppe in places of its introduction in the second half of the 20th century (Rumyantsev, 1997; Bibikov et al., 1990; Rumyantsev et al., 1996).

2. The marmot distribution within the steppe and forest–steppe boundaries was not ubiquitous during the analyzed period. The foregoing data indicates that, similarly, the marmot colonies in the 18th-early 20th century appear to have occupied only habitats favorable for the species, which is consistent with inferences made earlier (Kirikov, 1980).

Further in-depth analysis of the presented materials with the involvement of other available sources with geoinformation technologies will presumably contribute to a more precise representation of the bobak-marmot distribution pattern on the Russian Plain in the historical period, particularly with respect to natural and anthropogenic features of the habitats of the confinement of colonies of this species.

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COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interests. The author declares that he has no conflict of interests.

Statement on animal welfare. This article does not contain any studies involving animals performed by the author.

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