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Daily and seasonal activity patterns in steppe marmot (*Marmota bobak*, Sciuridae, Rodentia) in central part of European Russia.

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ABSTRACT

The article presents the characteristics of the ground daily and seasonal activity of the local steppe marmot populations scattered in the north of the area in central part of European Russia. Revealed the alternation of single-phase and two-phase loops terrestrial activity *Marmota bobak* during the spring-summer period. For April and June marked single-phase active and revealed a biphasic activity for May, July and August. On average, marmots come out of the holes in the morning 28 minutes after sunrise. They hide in burrows marmots in the evenings, on average 1 hour 16 minutes before sunset.

Keywords: marmot, daily activity, seasonal rhythm, local population, *M. bobak*

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INTRODUCTION

Volga Height occupies part of the East European plain along the right bank of the river Volga from Nizhny Novgorod to Volgograd. The heights of the relief can exceed 350 meters. In the north-western part of the hill, represented fragments of the territories of three regions: the Nizhny Novgorod region, the Republic of Mordovia and Chuvashia, is the northern boundary of the range of the steppe marmot *Marmota bobak* (Muller, 1776). Marmots inhabit here slopes, gullies, ravines, that is various agricultural uncomfortable. In the twentieth century the area of the animal fell sharply due to the disappearance of this species in the cultivated agriculture Eurasian steppes (Bibikov 1989 Rumyantsev et al. 1996). The sub-optimal conditions of the north-western part of the Volga Height marmot lives in a fragmented and isolated from each other by the local populations, formed mostly as a result of re-acclimatization (Bibikov et al. 1997, Morozova 2010, Andreychev et al. 2015, Dimitriev et al. 1994).

From the genus *Marmota* daily and seasonal activity was studied in the most of the southern marmot (*M. monax*) (Bronson 1962, Fall 1971, Hayes 1976, Zervanos & Salsbury 2003), of the yellow-bellied marmot (*M. flaviventris*) (Edwards 1997), of the alpine marmots (*M. marmota*) (Perrin et al. 1993, Hume et al. 2002). The daily and seasonal activity of the steppe marmot in different regions in central part of European Russia has not been studied. It is known that the life of marmots is divided into two main periods: the active (spring-summer) and the rest (autumn-winter) (Mashkin 1997). Seasonal rhythms depending on habitat conditions can vary substantially. The question arises, what is the cyclical nature of daily and seasonal activity on the border of marmot habitat in conditions far from optimal? Based on this goal of our work was to study the daily and seasonal activity marmot in scattered local populations on the northern border of its range.

MATERIAL AND METHODS

The studies were conducted in the city «Saransk» district, Dubenskii, Lyambirskii, Bolsheignatovskii, Bolshebereznikovskii district of the Republic of Mordovia, in Krasnooktyabrskii district of the Nizhny Novgorod region, and Yadrinskii, Ibresinskii district of the Chuvash of Republic in the snowless period 2007-2015 years. Here are the coordinates of points daily activity registration marmots in Mordovia in habitats in Dubenskii near the village Osipovka (54°18' N, 46°26' E), the village Nikolaevka (54°20' N, 46°30' E); Lyambirskii - near the village Atemar (54°09' N; 45°21' E); Bolsheignatovskii - near the village Arzhadeevo (55°06' N, 45°34' E) and Bolshebereznikovskii - near the village Simkino (54°15' N, 46°11' E) and urban districts «Saransk» near the village Taneevka (54°07' N, 45°25' E). The coordinates of the registration of the daily activity of marmots in the Nizhny Novgorod region in the habitats in the Krasnooktyabrskii district near the village Endovischi (55°23' N, 45°29' E), near the village Klyuchischi (55°20' N, 45°34' E). The coordinates of the registration of the daily activity of marmots in Chuvashia in habitats in Yadrinskii near the village Aleshkino (55°49' N, 46°24' E) and Ibresinskii - near the village Lightning (55°24' N, 47°08' E) areas. Distance to the nearest points of the installation of recording devices in local populations of neighboring regions is from 24 km to 104 km (Fig. 1).

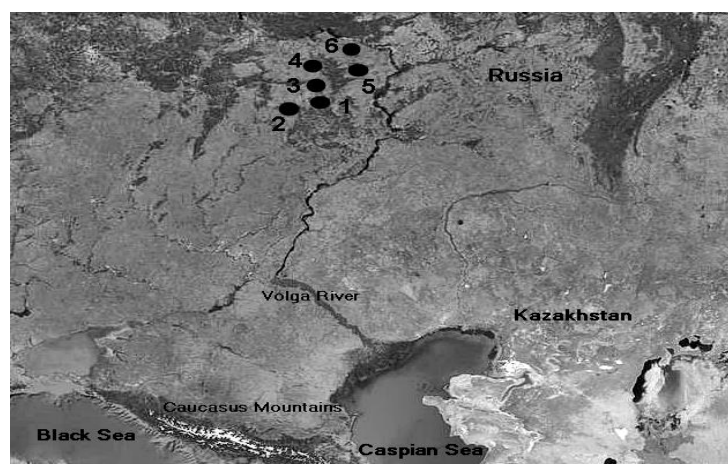


Fig. 1. Recording locations: (1) Dubenskii region; (2) Lyambirskii region; (3) Bolsheignatovskii region; (4) Krasnooktyabrskii region; (5) Ibresinskii region; (6) Yadrinskii region.

Initially conducted the identification and mapping of the contours marmot inhabited settlements and isolated families, mapping of settlements in the OziExplorer program. Search marmot family plots to identify the daily activities carried out by car and on foot. Were performed as direct observation with binoculars (BPC 10 × 40) and registration of the daily activity of marmots using camera traps (photo / video recorders) Acorn LTL-5210MC, Acorn LTL-8210A, Hunting Trail Camera, digital voice recorders Olympus VN-416PC, VN-712PC.

When you install tracking devices on the ground was taken into account the behavior of individuals. We know that when anxiety marmots of the same family running up to one hole, or close spaced holes. This fact was decisive for the priority of the installation of devices in certain holes or paths. In the absence of visual registration of the animals themselves to some family plots in selecting locations for the recording device guided by indirect signs, such as size emissions from land burrows and crisp footsteps of life. Camera traps often set at a pre-dug into the ground peg so that the lens coverage fell as much as possible holes, of which assumed the appearance of animals. After installing the peg and attached to it with the help of camera traps disguised plants. Plants often weed species, dug or cut directly on the ground and peg them tied fishing line, so that the leaves do not obscure the lens camera traps. In cases where the marmots on the site grew shrubs and individual trees, using these natural plant sites for attachment of camera traps.

Dictation previously included, were placed in plastic containers (plastic bottles of 0.5 liters) with holes for the microphone. The role of the container was to be protected from moisture and dirt. Then they were buried at a depth of 4-6 cm directly in those butanes, where marmots have been seen before. Containers attached a small wooden peg, so that in the case of excavations marmots exclude losses recorders. However, as shown by the results of the work, the role of fastening pegs minimized, since no animal hill not unearths tape recorders. Perhaps this influenced quiet operation of the recording device or ongoing care camouflage us.

For subsequent detection photo / video recorders installed and portable audio recorders used the device of satellite navigation (GPS). As shown by the results of the most appropriate time of day for the installation of recording devices in order to reduce the disturbance to the animals by researchers is the evening when the animals begin to hide in burrows at night. This technique allows you to eliminate errors in the displacement cycle due to the researcher, as the animals appear only in the morning and in the evening anxiety is insignificant.

During studies worked out 506 camera traps / day and 87 voice recorder / day, which is more than 14,000 hrs of observation. When postprocessing of the results of the program used Audacity and Aimp 1.75 (2007).

Identify possible impact on the duration of activity of ground meteorological conditions .Was used as the environmental factors temperature (°C), strength (m / s) and wind direction, precipitation as rain or snow, cloud cover (%), pressure (mm Hg). To characterize the climate using data from the weather station (<http://rp5.ru>; <http://nuipogoda.ru>). To identify the relationship between the activity of the woodchuck weather conditions and parameters used correlation analysis (r_s - Spearman's rank correlation). Software packages were AtteStat 8 (2002) and Past 2.04 (2010).

RESULTS

In the context of the north-western part of the Volga Height spring exit from adult marmot burrows in the earth's surface is recorded from year to year within the period of 29 March to 5 April. During this period, the negative temperature does not drop below -7°C . In comparison to the same period of marmots in Kazakhstan dates from April 5-8 (Shubin 1962). Period of opening all holes from the winter traffic jams stretched up to the third decade of April. Since the activity of marmots at different points was comparable and the criterion showed false values from different points of entry in the aggregate sample is considered. Similarly, it is not revealed, depending on meteorological activity marmots environmental conditions ($p > 0.05$). In April, marked by a single-phase uninterrupted activity of marmots from 7.00 to 18.00 hr (Fig. 2).

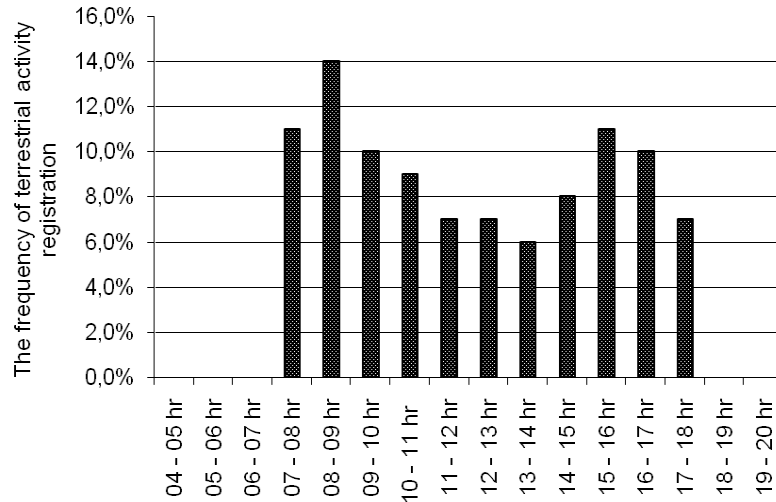


Fig. 2. The total share of the terrestrial activity of marmots on the hours of the day during April.

In May, there is a two-phase activity of animals. The first period runs from terrestrial activities 5.20 hr to 9.00 hr. After marmots hide in burrows up to 11.00 hr, when it begins the second phase of activity. It is completed by 19.00 hours. In May exits surchat (usually from 2 to 5 animals) to the soil surface. The first registration dated 11 May. It should be noted that in the spring (April-May), marmots are most active in the morning from 7.00 - 9.00 hr (Fig. 3).

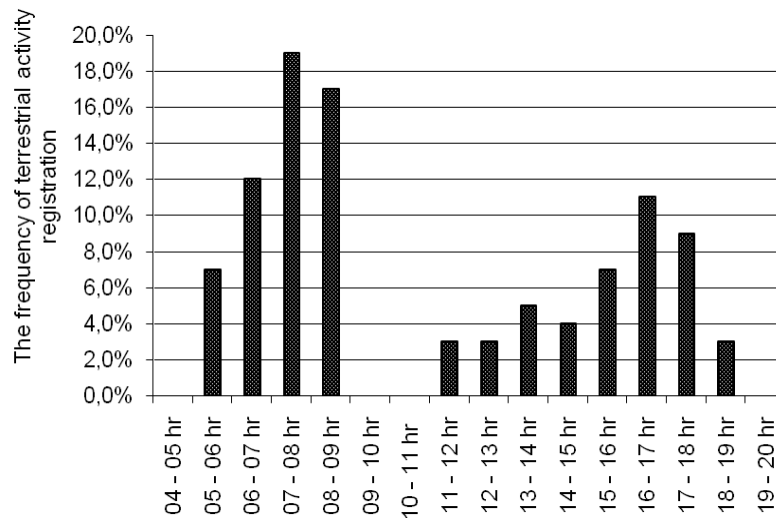


Fig. 3. The total share of the terrestrial activity of marmots on the hours of the day during May.

In June, marmots activity, as well as in April, has a continuous character and lasts from 4.00 until 20.00 hr. However, unlike the spring period the highest peak ground activity in the first summer month is shifted to the afternoon - from 14.00 to 16.00 hours. The smallest number of registrations observed from 11.00 to 12.00 hr and from 18.00 to 19.00 hr (Fig. 4).

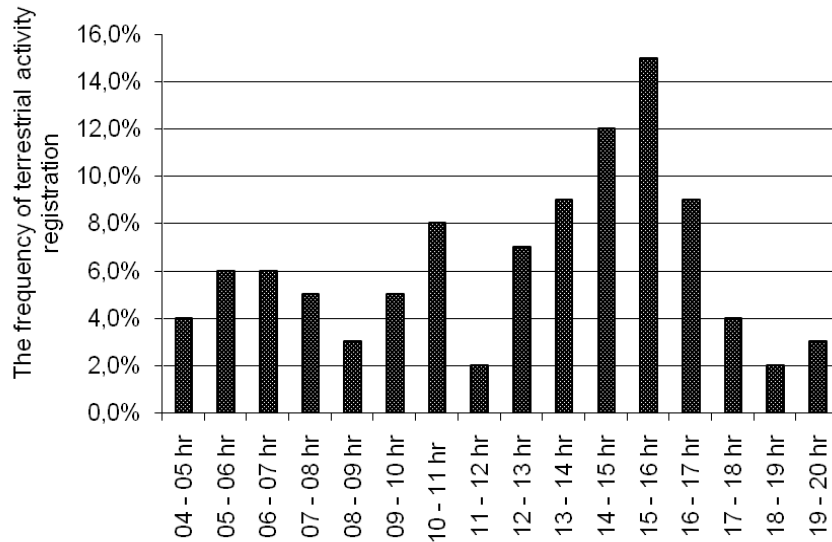


Fig. 4. The total share of the terrestrial activity of marmots on the hours of the day during June.

In July and August, the activity of marmots on the soil surface is greatly reduced. There are several separate periods aperiodic animal activity: 1) from 6.00 to 9.00 hr; 2) from 13.00 to 15.00 hr; 3) from 19.00 to 20.00 hr. In August, marmots virtually absent from the surface of the soil, while in the burrows. Our results on the low activity marmot in late summer are consistent with the work of other researchers (Mashkin 1997, Minoransky & Sidelnikov 2004). Dates animal bedding to sleep stretched out, plugging holes with plugs lasts from August, 26 to 14 October, the largest part of the animal occurs in September (Fig. 5).

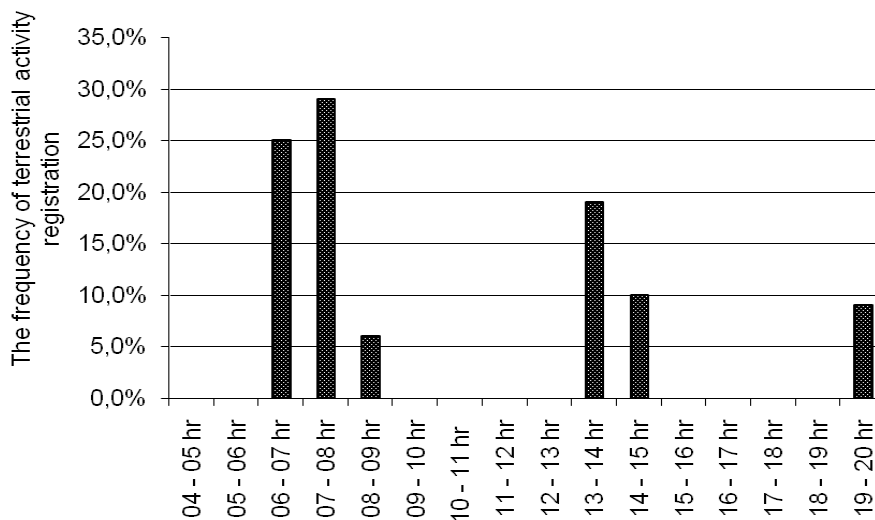


Fig. 5. The total share of the terrestrial activity of marmots on the hours of the day during July and August.

It is without a doubt be considered the steppe marmot on the daily activity of the daily view, because for observation is not a single case of registration at night. However, we have attempted to answer the question about the possible impact of sunrise and sunset at the beginning and end of the daily activity of a marmot. We were able to compare the time of the first outputs of the animals from their burrows in the morning and the last entry into the holes with the sunrise and sunset. It was found that depending on the association of different seasons. In April, the marmots come out of the holes in the morning 30 minutes after sunrise (Fig. 6). In May and June marmots appear on the soil surface for 15 and 30 minutes before sunrise. In July and August, marmots come out much later than the rising of the sun (from 47 to 98 minutes). In the later months of activity is necessary to ascertain the absence of dependence of the yield of the holes from the rising of the sun, because they themselves are infrequent outputs are non-periodic and transient.

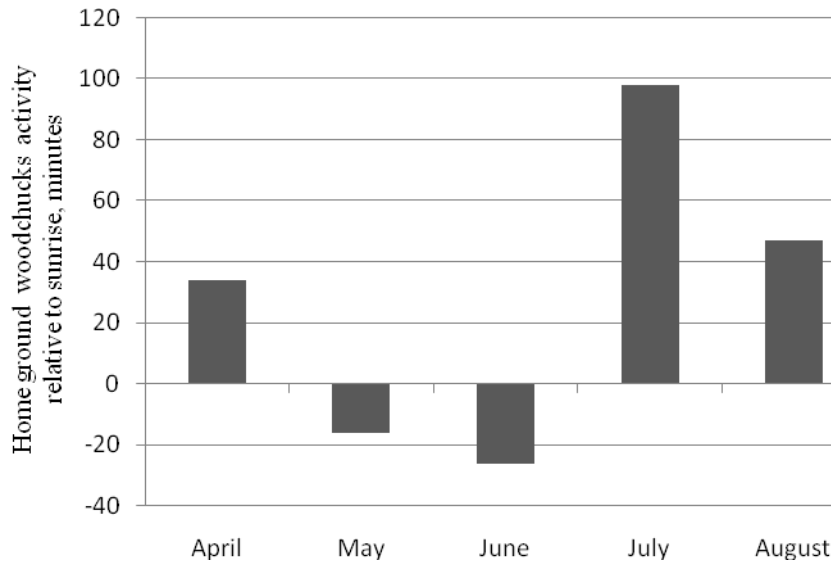


Fig. 6. – Total confinement start of the daily terrestrial activity marmots relatively sunrise.

Evening visits in the last hole of the sun before sunset celebrated throughout the year (1 - 1.5 hr) (Fig. 7). The latter fact suggests a greater role in the early twilight activation completion terrestrial activities of animals, compared to the influence of sunrise at the beginning of the activation morning outputs of holes. Perhaps the reason for this phenomenon lies in the more active predators in the evening.

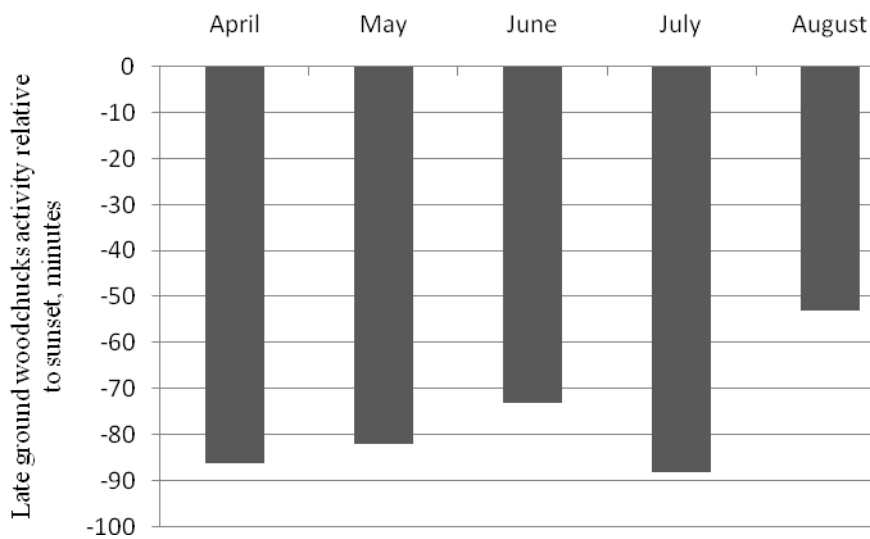


Fig. 7. Total confinement end of the daily terrestrial activity marmots against sunse.

The life expectancy of adults ground active marmots of about 6 months. In fingerlings marmot activity is shorter - about 4.5 months (from mid-May to late September).

DISCUSSION

Florant in papers have shown that marmots in the field exposed to the light, because they are addicted to the daily light-dark cycle (Florant et al. 2000). Our results once again confirm this with the example of the steppe marmot (*M. bobak*) in the central part of European Russia. We have identified the alternation of single-phase and two-phase loops terrestrial activity *M. bobak* during the spring-summer period of the year is similar to the daily activity of *M. monax monax* in northwestern Arkansas. However, of the southern marmot a unimodal cycle was characteristic of activity from 1 May through 14 June and 1 October through 19 November,

whereas a bimodal cycle described activity from - 15 June through 30 September (Hayes 1976). Thus, the two species of marmots per year for the duration of the two-phase single-phase cycle dominates.

Changes in the activity of the steppe marmot can be explained from the perspective of power, depending on the intensity of the growing season. In studies in Fall of the southern marmot shows how changing food intake in the course of the year (Fall 1971). In central Russia in April growing season is just beginning, and therefore hungry marmots are forced to spend a long time on the soil surface in search of food. A key reason for the activity of this month is not the availability of food and exhaustion after hibernating animals. In May and June, the growing process is intensive, and therefore the activity of the largest steppe marmot. In this case, the main activity in our opinion is a prerequisite to an abundance of succulent food.

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