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Preliminary prospects of assessment using telemetry in the study of gerbils' mobility in natural plague focus

Abstract: The article shows that a relatively quick obtaining direct and most importantly absolutely accurate data on individual movements of marked individuals, based on field research in 2012-2014 makes telemetry a very promising direction in mobility study of the potential plague hosts in natural focus of this infection. It is concluded that methods of telemetry are likely applicable not only for rodents but also for any other small mammals, for which catch methods on alive animals are practiced.
Key words: great gerbil, radio beacon, movements and GPS-data logger.

Introduction

The role of the great gerbil (*Rhombomys opimus* Licht.) as a main host of *Yersinia pestis* infectious agent has long been recognized as a key to the present time in Central Asian desert natural plague foci, including the Southern Balkhash region, where our observations were conducted [1-3]. Great gerbil is a landscape forming species due to mass character, active burrowing activity, family and colonial lifestyle with complex burrows, for which a name colonies was fixed in literature. Favourable conditions for the interspecies exchange with ectoparasites, especially by fleas are created because of rich fauna of ectoparasites in its burrows and visit them almost by all animals that are potential hosts of the plague infection [3].

Four types of mobility is isolated from great gerbils: 1) prospecting of surrounding area and its neighbouring burrows with a duration of up to several days; 2) migration to nearest burrows – colonies; 3) migration within the ecological population; 4) vagrancy, eviction outside of the territory, which is annually used by ecological population [4]. Great gerbils can go for a long distance from their colonies and they are even able to negotiate water obstacles during the migration [5, 6]. Thereby they are expanding their range, which has a great epizootic value. In spite of predominantly settled group life [7], great gerbil are able to pass a considerable distance (up to 12 km within 7-8 months; maximum – 17 km for 1 month according to observations of tagged animals) [8]. For example, the expansion of its range in Western Kazakhstan passed with speed to 4-5 km, sometimes up to 13 km per year [9]. Even then, a settled portion of the population is in constant movement because the great gerbils' family rarely satisfied with one burrow and uses from 2-3 to 11-12 colonies [10, 11]. At the same time accepted that the bulk of gerbils' movements occur within only 100-500 m [7].

Thereby, one of limiting factors for the emergence and fading of epizootics is a great gerbil's mobility [12]. Despite the fact that over the past decade, hundreds or even thousands of papers on Biology and epidemiological role of this species published, but precisely this aspect of great gerbil's life still little known. In particular, there is a very little information about the character of great gerbil's migration activity. There are almost no quantitative characteristics of great gerbil movements, including a distance, which it is able to move. There is no data on their time spent on the surface and underground of colonies, frequency and regularity running on neighbouring colonies, and so on. The main reason for this lies in the great complexity of direct gerbils' mobility observations by labelling. That is why the great bulk of data that published in the literature obtained predominantly by various indirect methods (prolonged visual observations on fixed routes and sites, constantly operating line of catch tools, long roundup of inhabited and uninhabited colonies and so on). Whereby the data for this section of great gerbil ecology is initially conditional and insufficiently accurate in many ways.

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In connection with the outlined, the relevance of bringing modern technologies becomes apparent to get answers for questions posed above. The first such attempt took place in the southern Balkhash region very recently [13]. However, it is clearly appeared unsuccessful because the technology of works in essence, was little different from conventional labelling and instead of cutting off fingers used chips with electronic tags. It complies with bioethics, but there are no advantages in terms of getting factual data, because in this case, as in ordinary labelling, there are needs for multiple recapture marked individuals, but a return of labels usually takes a small place. Meanwhile the telemetry techniques can allow obtaining far more accurate data on gerbils' migratory activity. The main purpose of this work was to test this possibility.

Materials and methods

Works were carried out in the Southern Balkhash on Bakanas ancient delta plain and plain Akdala for the period 2012-2014. There had originally been tested the possibility of using a pretty massive GPS-loggers (10-15% of an adult great gerbil body weight) and worked out ways more comfortable for animals their attachment in April 2012 (Figures 1 and 2). At the same time there was verified the effectiveness of radio direction finding of tagged animals that were in burrows.

The basic works were started only after obtaining positive results. 151 great gerbils, 30 midday jirds (*Meriones meridianus*), 1 lybian jird (*M. libycus*) and 1 tamarisk jird (*M. tamariscinus*) were caught in 2013. 42 great gerbils were caught in 2014, on 30 of them were fixed radio beacons and on 12 – GPS-loggers. However, full analyses of obtained data beyond the scope of this work, because their technical processing is not yet completed due to the fact that demands a lot of time. In this is not difficult to see by the illustration below. Here we give only fragmentary information, which as a rule do not keep within settled representations and indicate a particular value of telemetry techniques to study gerbils' mobility as potential hosts of plague infection in nature.

To catch the animals were used traditional zoological methods that are widely used for such purposes. Zaitsev traps were used to catch great gerbils – 5 traps on the colony. Sherman traps were used to catch jirds. They were deployed in 10 rows, with an interval of 10 m between traps, forming a kind of «network». It allowed revealing the spatial structure of tagged animals and boundaries of their individual plots during recapture.

GPS-loggers (TechnoSmart Company, Italy) due to their massiveness have been fixed only on great gerbil. VHF-radio beacon (Very High Frequencies, Advanced Telemetry Solutions, USA), with a frequency of 30-300 MHz signal whose weight does not exceed 5% of animal body weight was fastened with nylon tape on midday jirds and small great gerbils. Each radio beacon had individual frequency by which the animal was then taped, with noting the coordinates of its location as well. Radio receiver with antenna manufactured by *Title Scientific (Australis 26k Tracking receiver)* has been used for detecting beacon signal.

Figure 1 – Great gerbil with a GPS-logger (photo taken by A.B. Eszhanov)

Figure 2 – The same gerbil, which appeared on the surface after 20 minutes following the release (photo taken by L.A. Burdelov)

After attaching the GPS-logger or beacon animals were placed in a cage and kept there for some time to check their reactions to collar with the device. The device is removed from the animal in case of misbehaviour. Animals with normal reaction were released at the site of capture. Then, in order to minimize stress and avoid unnatural behaviour, animals were not disturbed during 5 days.

For signal presence and location of the animal twice a day, morning and evening has checked by the antenna each individual of great gerbil with beacon. In the case where a signal from a particular animal is missing, the search is extended covering more and more territory. As for jirds, due to their twilight-night activity, monitoring was conducted from sunset and till late night with an interval of 2 hours during the period approximately from 20 pm to 02 am. Moreover, there has been tested labelling technique on midday jirds by using different colours fluorescent powders. Animals were placed in a bag or a plastic bag and then powder was coated onto the animal using a small brush. Animals' movements had been tracked with UV light lamp at the night by fluorescent particles of the powder, which were left on the ground. However, this method appeared practically ineffective due to the rapid powder fall from gerbils because of its total small amount and obviously low power of the ultraviolet lamp. Therefore, it was excluded from further consideration.

Results and their discussion

Field trials on direction finding location of animals with radio beacons by using a portable antenna showed that the signal reception is very strongly influenced by terrain relief features. Thus, the signal reception range in some cases amounted to 700 meters, with the proviso that a man with antenna is located in an elevated. On the plain, the signal can be caught at a distance of 300 meters. Signal reception significantly deteriorated in areas with dense shrubs and in open terrain, the antenna sensitivity is again increased. The signal from the ground, when animals were in burrows, recorded at a depth of 1 m. During tracking on a radio signal it was able to establish that labelled female great gerbil with number 1080 covered a distance of 1.2 km in two days from the initial place of capture to the point of her latest discovery. This animal, leaving its burrow occupied empty, and apparently, had settled there for a long time, because the signal proceeded until the end of observations from the same burrow. And traces of the active life is becoming increasingly visible on the surface of the colony – there were cleared inlets, appeared trails and feed tables, number of excrement increased as well. It is also remarkable that the maximum movements range in this case is fixed at the female, but according to the literature, females of great gerbils have a lower migratory activity due to its clearly expressed territorial behaviour. Other individual covered a distance of 850 m during the day. Despite the fact that the biggest distance of movement was recorded at the female (roguish type activity), males of gerbils during the breeding season compared with females, still generally have a greater migration activity. It was possible via VHF-radio beacon to establish that the male of midday gerbil (*Meriones meridianus*) per night covered a distance of 600 meters, by moving short dashes with frequent stops from the burrow to burrow. Animal shows clear signs of search activity because the animal practically did not eat on its way and encountering empty burrows after a short their examination continued its movement.

However, the use of GPS-loggers promises the most interesting results. This method may force reconsideration existing views on speed and range of great gerbils' migrations. To verify this it is sufficient to look carefully to Figures 3 and 4. Now we have immediately to doubt on the phenomena plaguing views on the overall low mobility great gerbils in common conditions of, in particular the range missiles of their local movements within 100-500 m.

Unfortunately, there are certain serious obstacles to massive use of GPS-loggers, such as: – their insufficient miniature size and high cost (used model costs about € 1000, and the smaller device is more expensive);

– small battery life, possibility of obtaining erroneous data during the period when marked individuals on surface of the ground in a state of prolonged immobility

– inability to fix rodents movements under the ground and, of course, obligatory animals recaptures to return the device and read information from them.

At the same, time the advantages that reveal this method to study the mobility of rodents in general and hosts of the plague in particular, are so obvious that more than justify efforts to overcome these difficulties. Furthermore, although in use of GPS-loggers, as in ordinary tagging recapture is required; they are performed only within 2-3 days after the beginning of each new observations cycle within one field visit. This greatly facilitates the return of expensive devices and their reuse.

The transition from use of GPS-loggers to use GPS-trackers is very tempting, which can independently transfer accumulated information to satellite. However, it is clear that the main obstacle for this will an even greater energy expenditure, which generates all the same necessity to recaptures of animals for resumption the charge of batteries.

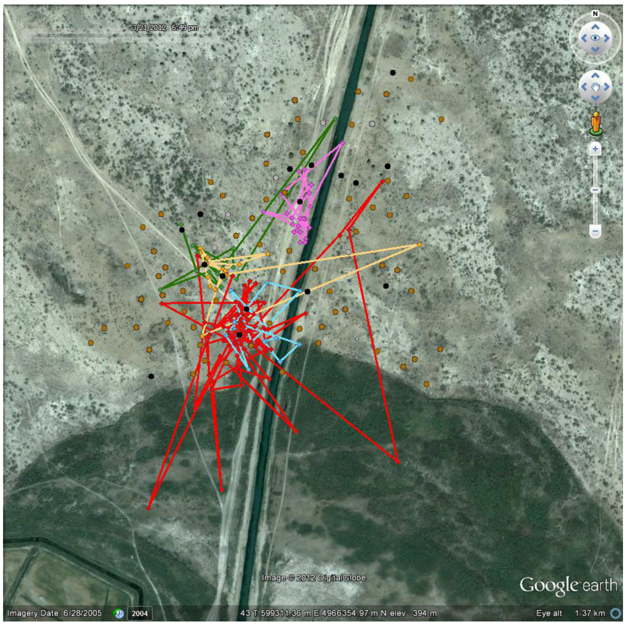

Figure 3 – Movements of five great gerbils in one-cycle observations (usually 2-3 days due to limited battery life) in real space

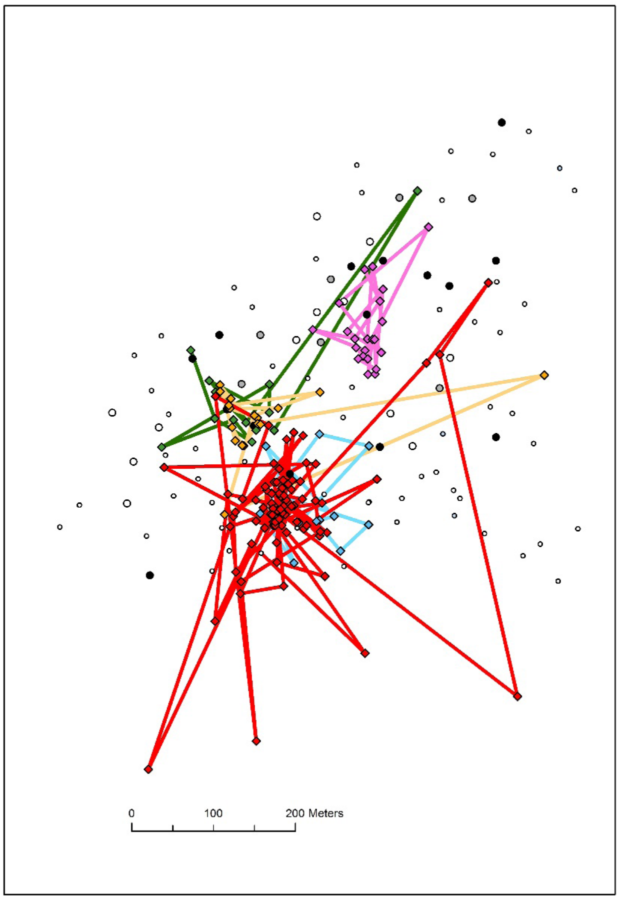

Figure 4 – The same movements of five great gerbils in scheme, allowing to assess their real distance

Conclusion

Based on our research it can be concluded that:

1. Despite on encountered difficulties of using telemetric techniques to a relatively fast obtain straight and, most importantly, absolutely accurate data on individual movements of marked individuals make a telemetry very promising direction in mobility study of potential hosts of the plague in the natural foci of this infection;

2. Our experience shows that telemetry methods are applicable is likely not only to rodents but also to any other small mammals, for which capture methods live animals are practiced;

3. Using a radio telemetry to study migrations, its character and range at small desert mammals such as gerbils, showed their high informative value and based on which this method can be recommend for more widespread use.

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