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NATALIA V. SIDORCHUK^{1*}
MICHAIL V. MASLOV²
VYACHESLAV V. ROZHNOV¹

Role of badger setts in life of other carnivores

Summary

A study of interspecific interactions of European (*Meles meles*) and Asian (*M. leucurus*) badgers with other carnivores at badger setts was carried out in Darwin Reserve (European part of Russia) and in Ussuriisk Reserve (Russian Far East) in 2006–2011. We used camera traps for the registration of visits of carnivore mammals to the badger setts. Overall, 11 species were recorded. In both reserves, badger setts attract carnivore species during the whole year. Some predators visit badger setts regularly. The visitors can be divided into two groups: species searching shelter, or searching prey. The first group includes raccoon dog *Nyctereutes procyonoides* and red fox *Vulpes vulpes*. Raccoon dog was the most frequent visitor in both study areas (34 visits in Darwin reserve and 73 in Ussuriisk reserve). The second group includes lynx *Lynx lynx* and wolf *Canis lupus* in Darwin reserve and Asiatic black bear *Ursus thibetanus*, brown bear *U. arctos*, yellow-throated marten *Martes flavigula aterrima* and lynx *Lynx lynx* in Ussuriisk reserve. Smaller predators are also included into the second group because they can find prey at badger setts too: leopard cat *Prionailurus bengalensis euptilura*, sable *Martes zibellina* and siberian weasel *Mustela sibirica* in Ussuriisk reserve and European pine marten *Martes martes* in Darwin reserve. No cases of aggressive interactions between the badgers and the visitors were recorded.

¹ Russian Academy of Sciences, A.N. Severtsov Institute of Ecology and Evolution, Leninskij Prosp. 33, 119071 Moscow, Russian Federation, *e-mail: sidorchukn@gmail.com

² Russian Academy of Sciences, Ussuriisk National Natural Reserve, Nekrasov St.19, 692519 Ussuriisk, Russian Federation.

But we noted two cases of change of sett owners and one case when raccoon dog removed dead badger cubs from the sett.

Key words: *Meles meles*, *M. leucurus*, sett, carnivores, camera trap

1. Introduction

Underground setts of badgers *Meles meles* and *M. leucurus* are one of the largest among the mammal shelters. Setts are used by badgers throughout all their life for winter sleep, reproduction and as daytime shelters. Badgers spend 70% of their time underground (Roper 2010). A sett is an important resource, handed down from generation to generation within the same social group. As a result, setts can be continuously occupied for centuries and be very large. Badger setts often consist of several galleries or tunnels isolated from each other, with many entrances, and occupy the space up to several hundred m² (Likhachev 1956, Gorshkov 1997, Roper 2002, Sidorchuk and Rozhnov 2010).

Badger setts attract different predatory mammals. Red fox *Vulpes vulpes* and raccoon dog *Nyctereutes procyonoides* are the most frequent guests (Ivanova 1965, Gorshkov 1975, Borodin 1985, Kauhala *et al.* 1998, Goszczyński and Wójtowicz 2001, Macdonald *et al.* 2004, Kowalczyk *et al.* 2008). These predators use badger setts for reproduction and protection against adverse weather conditions in winter. Sometimes also wolves use badger setts for cubs raising (Kaletskaya 1973).

In Russia, the main research was connected with relationships of European badger with red fox and raccoon dog (Ivanova 1965, Gorshkov 1975, Borodin 1985), to assess consequences of the introduction of raccoon dog into the European part of Russia. In the Russian Far East some data on interactions between the Asian badger, red fox and raccoon dog are given by Yudin (1977, 1986). There is no data concerning visits of other carnivores to the badger setts.

This work presents some data on interspecific interactions of European and Asian badgers with other carnivores visiting their setts, as obtained by means of camera traps. For an Asian badger the

material is collect within the program of studying of the Amur tiger in the Russian Far East as the badger is one of victims of this predator.

2. Study areas

The study was carried out in two natural reserves. Darwin Reserve is situated in the north-west of the European Russia, on a peninsula within the Rybinsk reservoir. The landscape is unusual for badgers: peat bogs cover the major part of the territory and ground waters are mostly at depths of 0–2 meters. Such conditions are unfavourable for sett construction, and badgers dig setts in old charcoal bunkers – now ring-shaped soil risings (the remains of XIX coal industry). The climate is moderate characterized by a cool summer and moderately frosty winter (average temperature of the warmest and coldest months is 17.4 and –12.2°C, respectively). Mean annual precipitation is 522 mm year⁻¹. Plant cover is mainly bog vegetation and pine woods. Population density of European badger in Darwin reserve is 6.8 ind. on 10 km² (Sidorchuk and Rozhnov 2010).

Ussuriisk Reserve is located in the south of the Russian Far East. It covers the area of 400 km². The relief of the reserve is low-mountain. The altitude varies from 158 to 700 m a.s.l. Nearly entire area of the Ussuriisk reserve is covered by coniferous-deciduous forests. The climate is monsoon. Most of the precipitation falls in the warm season. Snow cover is thin (on average 20–25 cm). The mean annual temperature is 2.7°C. The coldest month is January (mean temperature –17.9°C), and the warmest month is July (+19.7°C) (Tarankov 2006). Such conditions are favorable for the badgers. In the Far East Asian badgers achieve the highest density in Russia – 15–25 ind. on 10 km² (Yudin 1977). The population density of Asian badger was not studied in Ussuriisk reserve up to 2011 when it was 12.7 ind. on 10 km² (after a depression in November 2008).

3. Materials and methods

We used camera traps for registration of carnivore visits to the badger setts. Usually, such records are based on indirect signs of activity: footprints, excreta or strands of wool on entrance walls. The results of such inspections depend on the experience of the researcher. Often no traces are left during the visits, which therefore are missed. Camera trap is a convenient tool recording even short-term visits of mammals to the setts. A continuous presence of the observer is not needed, thus the behavior of animals remains natural. Besides, the use of camera traps reduces the number of researcher visits to the setts (Sidorchuk and Rozhnov 2010).

The surveys were carried out at 9 main and secondary badger setts in Darwin reserve in 2006–2009 and at 17 main badger setts in the Ussuriisk reserve in 2010–2011.

Camera traps were fixed on tree trunks near sett entrances, which animals used frequently. We surveyed the setts once in 14–20 days and, if necessary, moved camera traps from one place to another (when animals had changed the area of activity or sett entrances). In cases when the trap did not cover all the needed area, we also carefully examined all the entrances for the registration of indirect signs of mammal visits.

Camera traps worked from April to October in Darwin reserve, and from March to December in Ussuriisk reserve. We used different models of fototraps in different reserves: Wild view Xtreme II, Leaf River DC-2BU and Leaf River DC-3BU, Reconix RapidFire RC55 in Darwin reserve, and Reconyx RapidFire RC60 in Ussuriisk reserve. Camera traps differ by the speed of operation. Here we present only a qualitative analysis of the photographic material.

Camera traps worked for 2548 days in Darwin reserve, and 5278 days in Ussuriisk reserve and collected 136 photos of carnivore visits to the badger setts in Darwin reserve, and > 3000 photos in Ussuriisk reserve.

Besides the camera data, we also used data of annual (in 1956–1993) observations of badger setts in Darwin reserve. Seasonal pattern of

sett use by badgers was estimated on the basis of camera traps and sett observations. For a further analysis of photographic material in Ussuriisk reserve for each settlement, the number of days when it was actively (the inhabited settlement) or seldom (the uninhabited settlement) visited or used by badgers was counted.

For a comparison of relative frequencies of visits of different carnivore species to the badger setts of different status (inhabited or uninhabited) test of two proportions was calculated (Rebrova 2002).

The nomenclature of mammals follows Pavlinov and Lissovsky (2012).

4. Results

In Darwin reserve, badger setts were visited 46 times by 5 carnivore mammal species: raccoon dog *Nyctereutes procyonoides*, fox *Vulpes vulpes*, lynx *Lynx lynx*, wolf *Canis lupus* and marten *Martes martes*. In Ussuriisk reserve 239 visits of carnivore mammals to badger setts were recorded. Nine species were involved: raccoon dog *N. procyonoides*, fox *V. vulpes*, Asiatic black bear *Ursus thibetanus*, brown bear *U. arctos*, leopard cat *Prionailurus bengalensis euptilura*, siberian striped weasel *Mustela sibirica*, siberian sable *Martes zibellina*, yellow-throated marten *M. flavigula aterrima* and lynx *Lynx lynx*. No visits of tiger were recorded.

Raccoon dog comes to badger setts more often than other carnivores in both study areas (34 visits in Darwin reserve and 73 visits in Ussuriisk reserve, Tab. 1). This species appeared throughout the entire period of survey in both study areas, more often in summer and in summer – autumn in Ussuriisk reserve.

We tracked a change of sett owners twice in Darwin reserve. Shelter was occupied by badger in spring both times. In the first case then camera trap located at entrances registered badger and raccoon dog at the end of May. Badger left the sett in June. Then raccoon dogs started to use it for cubs raising without delay. In the second case badger was registered on sett on June 2 and then left it. On June 4 raccoon dog transferred to the same entrance 7 cubs. In June and July only pairs

of raccoon dogs with cubs were noted at sett. Badger returned to sett in August. Raccoon dog left this shelter at that time already.

Tab. 1. Number of visits of predatory mammals to the badger setts in Darwin and Ussuriisk reserves.

Species	Ussuriisk reserve	Darwin reserve
Raccoon dog	73	34
Red fox	33	4
Lynx	2	4
Wolf	*	22
Broun bear	3	-
Asiatic black bear	33	*
Yellow-throated marten	8	*
Leopard cat	37	*
Siberian weasel	24	*
Sable	21	*
European pine marten	*	2

* – the species is absent in the reserve

In Ussuriisk reserve a case was recorded when raccoon dog removed two dead badger cubs from a setts. These cubs regularly appeared near the shelter entrance until June 23. On June 27 a raccoon dog came to the shelter and took dead cubs out one by one. The dog buried the second cub in the litter and returned for it on July 5. No such cases have been described in the literature.

Red fox comes often to badger setts (Tab. 1), but during the different year seasons in the different study areas: in Darwin reserve in spring and summer, in Ussuriisk reserve in autumn and in winter. In Ussuriisk reserve foxes more often appeared at uninhabited (23 visits) than inhabited setts (10 visits). In Darwin reserve fox appeared on inhabited badger setts twice and on uninhabited badger setts also twice. But the sample is too small for statistical analysis.

Larger predators visited badger setts as well (Tab. 1). In Darwin reserve, lynx and wolves visited both inhabited and uninhabited shelters of badge setts in different year seasons. In Ussuriisk reserve bears

visited badger setts more often than other large predators (Tab. 1). In total 41 visits are registered (33 visits of Asiatic black bear and 3 visits of brown bear, of which in 5 cases the species was not defined), 31 visit was to inhabited and 10 visits to uninhabited setts. In one case a reaction of badgers to approach of a bear was recorded: the badgers coupled before the bear arrival, they heard it or felt its smell 3 minutes before its appearance and went inside sett. If the bear has not caught badgers on a surface, it can try to dig them out. Indeed, such a behavior was recorded on one of the setts. Besides, we found traces of excavation of entrances by bears on 82% of the badger main setts in Ussuriisk reserve.

Yellow-throated marten visited the setts more often in autumn (Tab. 1). Leopard cat is a frequent guest (Tab. 1), most often in summer. Only 3 visits were recorded in late autumn and winter. Probably, the leopard cat does not use setts as the shelters during the cold season in Ussuriisk reserve.

Usually, leopard cat came to the badger setts at twilight or night. Sometimes, it had a short rest near entrances on the soil emissions formed after sett cleaning by badgers, or looked into the entrances. A female with 4 kittens twice came to one of sett on August 27: the family appeared at 7 a.m. and at 5 p.m. Animals spent more than 2 hours at the sett (the kittens played around the entrances and climbed inside) and left only when the badger came.

European pine marten is an only mustelid representative, which visits badger setts in Darwin reserve (Tab. 1). In Ussuriisk reserve two mustelid species (sable and siberian weasel) often visited the setts (Tab. 1). Sables came to the setts during the whole year, whereas Siberian weasel more often appeared in autumn. The behavior of these animals was similar – both looked inside the entrances sometimes, climbed inside, left scent marks, but they spent no more than 1–2 minutes near the entrance.

5. Discussion

Our study showed that both inhabited and uninhabited setts of European and Asian badgers are visited by different carnivores during the whole year. Conditionally, these visitors can be divided into two groups: animals coming in search of a shelter, or in search of a prey.

Raccoon dog and fox are included into the first group. Many studies are devoted to interspecific interactions between these animals and badgers when they use badger shelters in Europe and European Russia (Ivanova 1965, Gorshkov 1975, Borodin 1985, Kauhala *et al.* 1998, Goszczyński and Wójtowicz 2001, Macdonald *et al.* 2004, Kowalczyk *et al.* 2008). Some researchers use a term "denning predators" (Yudin 1977, Gorshkov 1975, Kowalczyk *et al.* 2008) for raccoon dog, fox and badger to emphasize a certain similarity in their ecology. A particular interest to this group was connected with the need to estimate consequences of the raccoon dog introduction in the European Russia. Various researchers concluded that the raccoon dog entered successfully into the ecosystems of the introduction regions and did not affect densities of species with close ecological niches, first of all the badger (Borodin 1985, Kauhala *et al.* 1998, Kowalczyk *et al.* 2000).

Our study showed that raccoon dog was the most frequent guest of the badger setts within its natural geographic range in Ussuriisk reserve. In the Far East, it does not frequently dig own burrows and tries to use uninhabited badger setts (Yudin 1977). Raccoon dog keeps the similar interest to badger setts in the regions of its introduction (Kaletskaya 1957, Ivanova 1965, Gorshkov 1975, Borodin 1985, Kauhala *et al.* 1998, Goszczyński and Wójtowicz 2001, Kowalczyk *et al.* 2008). This is confirmed by our data from Darwin reserve. Some of the Russian researchers have suggested that raccoon dog is interested in badger setts only in summer (for cubs raising) and in winter (for the winter sleep) (Gorshkov 1997). However, in Poland and Finland this predator comes to badger setts during the whole year (Kauhala *et al.* 1998, Kowalczyk *et al.* 2008).

Our surveys both in Ussuriisk and in Darwin reserves confirmed the data of Kauhala *et al.* (1998) and Kowalczyk *et al.* (2008): raccoon

dog's visits in late spring and beginning of summer were connected with search of a shelter for cubs raising. At that time, raccoon dogs appeared in pairs. Pairs with the cubs can change shelters. For example, in Ussuriisk reserve a pair of adult raccoon dogs with a cub came to one of the badger setts several times in June, and female with two cubs visited it in July. The grown-up cubs can check badger setts alone.

Raccoon dog continues to visit badger setts in autumn when it looks for a winter shelter. Possibly, the same purpose attracts foxes to badger setts in the end of autumn and in winter. Foxes and raccoon dogs can use badger setts in winter together with the badger (Goszczyński and Wójtowicz 2001). For example, in Białowieża Primeval Forest 88% of badger setts were occupied by both European badger and raccoon dog in winter. However, overwintering badger and raccoon dog used different parts of the sett (Kowalczyk *et al.* 2008). Similar cases were noted in the Far East (Yudin 1977).

Besides, raccoon dog, European badger and fox can use one sett during the period of cubs raising. Such cases were recorded in Tatarstan (Gorshkov 1997). In Darwin reserve 50 similar cases were noted during 38 years (Sidorchuk and Rozhnov 2010): of those, more often European badger and raccoon dog shared the setts (27 cases). European badger and fox shared the setts 12 times, and raccoon dog and fox 11 times.

It is necessary to note that the latter data were obtained during the annual records of badger density in Darwin reserve, and are based on single surveys of setts in the beginning of summer. However, this research method can cause errors in assessing of sett sharing by different species, since during the single survey of setts only signs of activity (footprints, faeces or hair and prey remains) but not animals themselves can be seen. Thus, the decisions on the sett sharing by denning predators may in fact be strongly subjective.

Our survey in Darwin reserve has confirmed such mistakes. We had not recorded any cases when different species lived in one sett. However, we noted two cases of change of sett owners. In both cases, signs of activity of badger and raccoon dog were present together during a short period (end of May – beginning of June, when raccoon

dogs only checked the sett). If a researcher visits such a shelter during this period once, a wrong conclusion may be drawn that both species live in one sett together. Thus, conclusions on sett sharing by different species should be verified by direct observations or radio-tracking.

In Ussuriisk reserve we noted only one case when a pair of raccoon dogs used the inhabited badger sett in November. The badger host was sleeping at this time already. Also we did not obtain any photo of direct contacts of badgers and raccoon dogs in the sett area. It is considered that badger and fox are stronger than raccoon dog and expel it from the shelters (Yudin 1977). There are no literature data on attacks of raccoon dogs at badgers. However, we have recorded a case when a raccoon dog removed dead badger cubs from the sett. By photos, it is difficult to decide how the puppies had died. Probably, they were killed by the raccoon dog in the shelter. However, the dog may have only pulled out already dead badger cubs from the shelter. In any case, such an activity of the dog could become possible only in the case of death of badger female and is an exclusive event.

The competitive relations are more intense between badgers and foxes. The fox can expel the European badger from its sett. Gorshkov (1997) has noted such cases in Tatarstan. Other researchers noted aggressive behaviour of the European badger killing cubs of foxes or raccoon dogs, though such cases are rare (Likhachev 1956, Kowalczyk *et al.* 2008). Macdonald *et al.* (2004) studied interspecific interactions between the European badger and fox within an artificial feeding site and in the vicinity of badger setts. In most cases, the animals ignored each other. But in the conditions of food depletion, badgers aggressively protected food, and foxes always conceded never showing aggression.

There are no data on aggressive interactions between foxes and Asian badgers in the Far East. However, foxes happen to occupy uninhabited badger setts for cub raising (Yudin 1986).

During our survey, no cases of direct contacts between badgers and foxes were recorded at the setts. In Ussuriisk reserve fox appeared on uninhabited badger setts mainly during the cold season. Possibly, in Ussuriisk reserve foxes do not use for cubs raising the

setts periodically visited by Asian badger. We did not find any traces of excavations of sett entrances by foxes in Ussuriisk reserve. In Darwin reserve foxes use uninhabited setts of badgers for cub raising regularly and sometimes excavate sett entrances (Kaletskaya 1957). Therefore, foxes visit badger setts in May; however, they come to the setts after the period of cub raising, as well.

Badgers, foxes and raccoon dogs can visit setts occupied by another intra-guild carnivore or use the same sett replacing each other. But we hypothesize that these animals do not compete with each other for shelters in both reserves. In Darwin reserve the amount of charcoal pits (where badgers dig setts) is very high and the badgers use no more than 20% of them (Sidorchuk and Rozhnov 2010). Probably, in Darwin reserve badgers and raccoon dogs use the same setts only in the areas of shelter deficit. For example, a badger and a raccoon dog used one sett in a small forest island surrounded with a bog.

In Ussuriisk reserve there is a lot of temporary uninhabited badger setts and other shelters (hollow trees, rocks) where raccoon dogs and foxes can raise cubs. Besides, badgers, foxes and raccoon dogs prefer different biotopes in Ussuriisk reserve. In the Far East foxes and raccoon dogs prefer river valleys (Yudin 1977, Yudin 1986, Sidorchuk *et al.* unpublished), whereas Asian badgers dig setts on hill slopes (Astafyev and Potikha 1979, Antonov 1989, Sidorchuk *et al.*, unpublished).

Badgers can be hunted by larger predators. There is no literature data on visits of large predators on badger setts. Therefore, our data are unique. In Darwin reserve lynx and wolf visit both inhabited and uninhabited setts throughout the whole period of badger activity. Besides, we noted several cases of use of uninhabited badger setts by wolves for cub raising after expanding the sett entrances.

In Ussuriisk reserve large predators which come to badger setts are Asiatic black bear, brown bear, yellow-throated marten and lynx. Asiatic black bear comes to badger setts mostly in the end of summer and in autumn. This is the period when the bears accumulate resources before overwintering. We have repeatedly found badger's wool and claws in excrements of the bears. Bears visit badger setts also

in spring, after they exit from a den. We have observed such a case trailing a bear on snow on March 30. Besides, 5 visits of females with cubs to the sets were recorded. In these cases bears remained at the setts for several minutes. Bear cubs surveyed entrances and tried to climb inside.

Lynx came to badger setts in Ussuriisk reserve very seldom. Possibly, this indicates a low level of lynx predation on badgers. Yellow-throated marten appeared at badger setts in Ussuriisk reserve more often than lynx. Probably, it does not disturb adult badgers, but can be dangerous for badger cubs. One visit of a yellow-throated marten on badger sett with cubs was recorded in June. Badger cubs did not leave the sett yet. The predator climbed inside the sett, but we did not record it murdering the badger cubs (neither on photos, nor by the signs of its activity).

Smaller predators (such as pine marten in Darwin reserve, or leopard cat, sable and Siberian weasel in Ussuriisk reserve) visit badger setts searching for rodents. Rodents were often recorded at badger setts in Ussuriisk reserve, but not in Darwin reserve. Probably it depended on features of different models of camera traps. We suggest that mustelid species came to badger setts more often in Ussuriisk reserve because the density of rodents here was higher than in Darwin reserve.

Our study has shown that badger setts attract different carnivores during the whole year in both reserves. Some predators visit badger shelters regularly in search of shelter or prey. An information on badger setts passes from parents to offspring. This suggestion is based on regularly observed visits of females with cubs (raccoon dog, Asiatic black bear, brown bear and a leopard cat). Usually animals do not spend at setts more than 1–3 minutes. But females with cubs are an exception. Almost all the visitors survey entrances and the area around them. Small predators climb inside entrances sometimes, as well as cubs of bears, leopard cat and raccoon dog.

Thus, camera traps at badger setts allowed to obtain information on interspecific interactions of European and Asian badgers with other predatory mammals. The data on badger – fox and badger – raccoon

dog relationships represent a special interest. Camera traps provide extensive data on visits of predatory mammals to the badger setts and help to avoid mistakes in making decisions on possible sharing of the setts by different predators. They also make it possible to study the ecology of the rare and cryptic species (for example of leopard cat).

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