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Dispersal and home range shifting of adult raccoon dogs (*Nyctereutes procyonoides*) – observations in Brandenburg, Germany

Key words: *Nyctereutes procyonoides*, dispersal, invasive species, radio telemetry, Brandenburg

1. Introduction

The raccoon dog is a medium sized canid and member of the East Asian fauna. Caused by intended settlements carried out in the former Soviet Union outside its natural range during 1928–1945 mainly in the Ukraine (Lavrov 1971), this neozoon meanwhile is distributed in Fennoscandia, Eastern Europe and parts of central Europe (Kauhala & Saeki 2004). First evidences even exist from southern European countries e.g. Italy (Lapini 2006), the former Yugoslav Republic of Macedonia (Ćirović 2006) and Spain (ANSE 2010). In literature many observations are described, which demonstrate the wide spaced expansion of the raccoon dog.

These data are mainly collected randomly and mostly based on hunting statistics or relocations of eartagged individuals (Nowak 1973; Sutor 2008). Drygala et al. (2010) analyzed dispersal behaviour by radio collaring juvenile raccoon dogs. Radio tracking is a method, which enables a sytematically collection of data on behaviour and some aspects of demography (Kenward 2001).

In contrast to migration, which is defined as a regular movement of animals, for instance between seasonal home ranges, dispersal is a movement without return when an individual leaves its natal site or an area which it has occupied for some time (White & Garrott 1990). This behaviour has "important ecological and evolutionary consequences, including the ability of species to change or expand their ranges" (Kokko & López-Sepulcre 2006).

In a long-term telemetry study on raccoon dogs in Finland, dispersal of adult raccoon dogs have never been observed (Kauhala pers. comm.). Also in Mecklenburg-Western-Pomerania/Germany none of the adult individuals dispersed during the five year lasting study period and radio collared individuals tended to use their home ranges for several years (Drygala et al. 2008).

In the present study dispersal behaviour and home range shifting of adult raccoon dogs is shown.

The purpose of this telemetry study was to analyze the seasonal habitat use and the seasonal home range sizes of raccoon dogs living in an agricultural landscape in Germany.

2. Material and methods

Between February 2001 and July 2004 a telemtry study took place in the Southern part of the

Federal State of Brandenburg in East Germany. The 33 km² sized study area is part of the so called area "Lug" (13°56'E, 51°37'N), a plain basin, in average at 110 m above sea level, passable by a network of gravel roads and located in the district "Oberspreewald-Lausitz".

In total 15 adult raccoon dogs (5 males, 10 females) have been radio collared and eartagged with continuously numbered circular plastic eartags (diameter 180 mm). Raccoon dogs were caught in wooden trap boxes and immobilized with the "Hellabrunner Mischung", at a dose of 0.1 ml Xylazin/ kg body weight and 0.07 ml Ketamin/ kg body weight (Hatlapa & Wiesner 1982).

The battery life of the radio collars (Biotrack, UK, 151–152 MHz,150g i.e. 2–4 % of body weight, depending on sexual and seasonal variation) lasted an average of about 1.5 years. The localizer set consisted of a flexible three-element Yagi-antenna and the biotag receiver "Mariner 57" (Biotrack, UK).

The age estimation was based on the degree of abrasion of the teeth, which becomes more evident with increasing age; during the first year of life the incisor teeth of canids are ragged at the top (Ansorge 1998; Wandeler & Lüps 1993).

For calculating an average speed, raccoon dogs were radio tracked at regular intervals during their nightly dispersal. Distances were measured by connecting successive tracking points with straight lines.

3. Results

Dispersal of adults

In Brandenburg the first evidence of the dispersal of an adult male raccoon dog (M) was documented in a preliminary study. Within a further telemetry study (2001–2004) two adult male raccoon dogs (M1, M2) showed the same behaviour, as already published (Sutor 2008). Nevertheless we added these observations in the current publication by giving a more comprehensive description.

An adult male (M1) was radio tracked within the study area "Lug" from 23.1. to 23.3.2002. During night at 24.4.2002 this individual left its 137 ha sized home range (MCP1) and dispersed with an average speed of 1.35 km/h to a new area, 10 km in airline distance northwards to its former home range (Fig. 1). In contrast to its original home range with agricultural landscape structure, M1 established a new home range within a forest which is dominated by pine trees (MCP2). Southwards of MCP2 an area with meadows and small carp ponds was located. Until 27.6.2002 M1 could be tracked in its new home range, which had been 316 ha in size. After this date no signals could be received anymore, although the entire area was searched by aircraft.

A second adult male raccoon dog (M2) – estimated to be 3–4 years old –, radio collared at 7.10.2002, could be detected only for one week in the study area. Ten months later, at 21.7.2003, this male was hunted near the town Wittenberg in Saxony-Anhalt, about 90 km in airline distance to its marking location. M2, with a body mass of 8 kg at the day of its radio collaring, seemed to be in a good physic condition at its marking day.

In Brandenburg the first observation of an adult raccoon dog's dispersal was documented in 1999. Within the scope of a preliminary study an adult male (M), about two years old and with a body weight of 8 kg, had been radio collared at 18.1.1999. M was trapped in the Great bustard (*Otis tarda*) protection reserve "Havelländisches Luch" in the county Havelland (12°33'E, 52°34'N). This male remained only one day and one night in the nature reserve and then started to leave the area southwards. During one night (24./25.1.1999) we watched its way along a big lake: with an average speed of 2.7 km/h this male covered a distance of 16 km during three hours. After tracking this raccoon dog once again at 26.1.1999 nearby the river Havel at the town Brandenburg, we finally lost it.

Home range shifting

Additionally to the dispersal of adult raccoon dogs, the shifting of an adult females home range could be observed. Between December 2002 and February 2003 two female raccoon dogs were frequently radio tracked in a small coniferous forest. F3, radio collared at 7.10.2001 and F4, marked at 8.6.2002 and col-

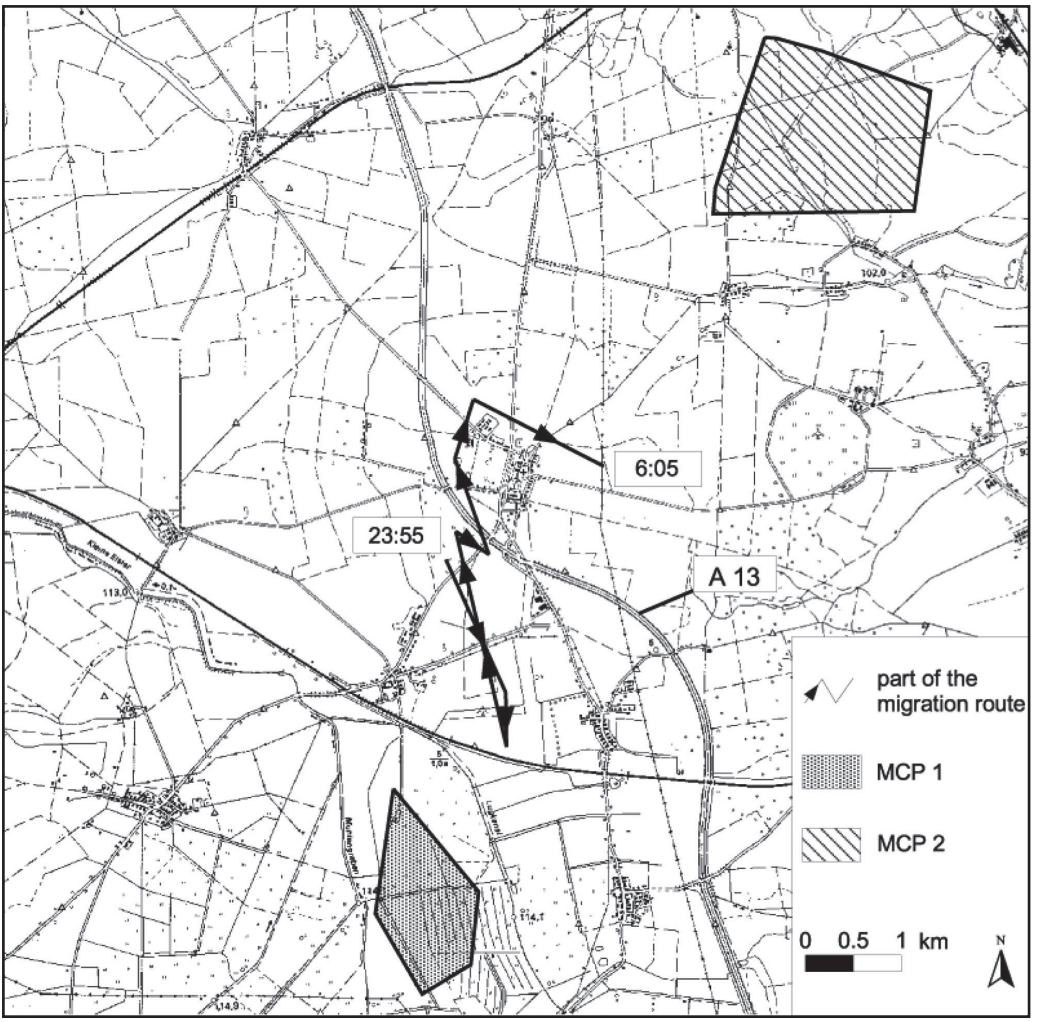

Figure 1 Movement of an adult male raccoon dog (M1) during night 24.4.2002 to 25.4.2002. Distance covered between 23:55 and 6:05 was 8072 m, calculated by connecting the successive locations. Old home range (MCP1) and new home range (MCP2) presented as minimum- convex-polygon.

lared secondly at 21.3.2003, used together an abandoned badger den in this forest. During raccoon dog's mating season, at the end of February, both individuals started to roam around in the neighbouring meadows and fields, sometimes even together. At the mid of March 2003 both females finally separated. F3 enlarged its home range northwards and westwards, shifted its activity centre and used another abandoned badger den. This den was localized in a forest, about 2 km in air line distance to the den used during winter. A small forest with little ponds near the motorway A13 Berlin-Dresden was also part of its home range. At 27.3.2003 the last tracking point of F3 was received.

F4 kept a home range size between August to October 2002 of 2.75 km² (95 % fixed Kernel density) and reduced it during winter 2002/2003 (0.54 km², 95 % fixed Kernel density), as it is shown in Figure 2.

During one night (9.2.2003) F4 moved 3 km westwards and established a new home range

(Fig. 2). F4 was radio tracked once again in its former home range during night of 27.4.2003. After this temporary return this female could be localized in its new home range (0.47 km², 95 % fixed Kernel density) until 2.5.2003. After this day we received no signals anymore.

4. Discussion

Dispersal of adults

We documented dispersal of three adult male raccoon dogs. Dispersal finally is a mechanism for spatial expansion and constitution of metapopulations (Kokko & López-Sepulcre 2006). In animal populations those dispersal movements are carried out by juveniles and adults (Begon et al. 1991). Usually canids are very mobile carnivores and the dispersal distance covered by small species, such as raccoon dogs, are a dozen kilometers or more (Wayne et al. 2004).

But intraspecific competition as well as searching for mates and suitable areas with enough food supply and hiding places may also promote the dispersal (Caughly & Sinclair 1994). Since raccoon dogs show a high degree of intraspecific tolerance (Drygala et al. 2008; Holmala & Kauhala 2006), it can be supposed that some juveniles may stay in their parental home ranges for some time. This assumption is supported by dispersal data collected in this study area, which proofed that some juveniles remained in the area even after they have reached sexual maturity (Sutor 2008). M1 presumably was a juvenile of the previous year and therefore had been tolerated near the den used by a raccoon dog pair. Obviously this young male remained in its natal home range until the new pup rearing season started. In contrast, M2 – estimated to be 3 – 4 years old – possibly only traversed the study area. The short time of its stay within the area during autumn indicated, that M2 was unpaired and without an estab-

Figure 2 Home range shifting of an adult female raccoon dog (F4) in Southern Brandenburg in Germany (13°56'E, 51°37'N). Home ranges presented as 95 % fixed Kernel densities.

lished home range. A similar observation had been documented in a preliminary study. Also this young male presumably was unpaired and trapped in the Great Bustard nature reserve while it possibly searched for a female and traversed this area. The localization of the last tracking point indicated that this adult male continued its way eastwards along the river Havel opposed to the town Brandenburg. This observation supports the hypothesis that raccoon dogs use watercourses as migration routes (Sutor 2008).

Home range shifting

During winter period 2002/2003 both adult females, F3 and F4, shared the same home range and an abandoned badger den, centered in this home range. While radio tracking both females have been observed roaming around together repeatedly. These facts encouraged our assumption, that these individuals being related and obviously were unpaired.

According to seasonal activity raccoon dogs home range sizes were different. In comparison with Drygala et al. (2008), we observed maximum average home range size of F4 during August to October. Both raccoon dogs, F3 and F4, separated in spring 2003 and F4 finally held a new home range. The size of this new home range between February and April of 2003 was 0.47 km² and in comparison to its former home range during February and April 2002 (2.47 km²) it was remarkably small. On the one hand this raccoon dog started to establish a new home range and otherwise this female was infected with sarcoptic mange.

The adult female F3 enlarged its home range gradually and occasionally used another abandoned badger den by day. This hiding place was located in a small forest near the motorway A13. At 5.4.2003, the carcass of F3 was detected on the other side of the A13; presumably F3 was killed while passing the motorway.

It is conceivable that the shifting of females' home ranges was caused by interactions with other raccoon dogs. At a December evening a hunter – while waiting for foxes near a carcass of hoofed game – observed two earmarked raccoon dogs being attacked by three unmarked raccoon dogs at this place, which was located nearby the abandoned badger den used by F3 and F4 during winter. When F3 at 11.1.2003 and F4 at 21.3.2003 had been caught again, evident tracks of scraping and biting in their faces and at their radio collars indicated those attacks. Beside these injuries, F3 and F4 were infected with sarcoptic mange in a critical stage: except legs, head and small parts at their backs, their bodies were hairless. This probably influenced seriously the fitness of both individuals. Therefore these females neither have been able to defend their den nor to establish new home ranges in far distances.

We can conclude that shifting of home ranges and activity centres of these females were caused by intraspecific aggression and additionally by competition with the badger *Meles meles*. The abandoned badger den, used commonly by both females during winter, had been occupied again by an adult male badger at the beginning of March 2003.

Conclusions

Within a few decades raccoon dogs settled in many regions of Europe (Nowak 1984). It can be supposed that such range extension in a rather short time is not only based on the dispersal of juveniles, but also on similar activity of adult raccoon dogs. An impressive example is given by Nowak (1973): a raccoon dog earmarked in the western Ukraine in 1953 was hunted in Poland in the district of Łodž in 1957, about 500 km in distance to its marking place. Beginning in 1928, mainly in the Ukraine, 9,100 raccoon dogs were released in several areas of the former Soviet Union outside their natural range (Lavrov 1971). For instance in the district of Petersburg in two counties raccoon dogs were released and three years later this species was observed already in 22 counties (Nowak 1973). Beside range extension, dispersal especially in far distances may promote the transmission of diseases, such as rabies, and parasites e.g. *Echinococcus multilocularis*.

Obviously dispersal is an important requirement for colonizing new areas. But the mechanism of this behaviour still is not completely understood; nevertheless subordinate young-

sters seem to be the most likely to dispers and in many canid species males are the one with far distance dispersal (Macdonald et al. 2004). Although these are the first records for dispersal of adult raccoon dogs in Germany, this behaviour may be a common and important part in the colonizing process. The presented examples demonstrate clearly the raccoon dog's ability for fast range extension enabling this canid to be a successful invasive species.

Summary

The dispersal of adult raccoon dogs in Brandenburg/Germany was documented by radio tracking for the first time. This behaviour was observed from three males estimated to be 1–4 years old. Distances, measured as straight lines between tracking points, covered during night were 10 km respectively 16 km. The farthest registered airline distance between marking place and relocation place was 90 km. Additionally to this records the shifting of home ranges of two adult females within the study area could be observed. This behaviour was probably caused both by interspecific and intraspecific competition.
Since raccoon dogs settled in many regions of Europe within a few decades, it can be assumed that the expansion of this invasive species is based both on dispersal of juveniles and adults.

Zusammenfassung

Abwanderung und Verlagerung von Streifgebieten adulter Marderhunde (*Nyctereutes procyonoides*) – Beobachtungen aus Brandenburg, Deutschland

Erstmalig wurde durch die Radiotelemetrie die Abwanderung adulter Marderhunde in Brandenburg/Deutschland dokumentiert. Dieses Verhalten zeigten drei männliche Tiere mit einem geschätzten Alter von 1–4 Jahren. Die nächtlich zurückgelegten Wegstrecken, gemessen als geradlinige Verbindung zwischen den Peilpunkten, waren 10 km bzw. 16 km lang. Die längste ermittelte Abwanderungsdistanz – Luftlinie zwischen Markierungsort und Fundort – betrug 90 km. Zuzüglich zu diesen Nachweisen, konnte auch eine Streifgebietsverlagerung von zwei adulten weiblichen Individuen beobachtet werden. Dieses Verhalten wurde wahrscheinlich sowohl durch innerartliche als auch zwischenartliche Konkurrenz verursacht.
Nachdem der Marderhund innerhalb weniger Jahrzehnte viele Gebiete Europas besiedelt hat, liegt die Vermutung nahe, dass die Ausbreitung dieser invasiven Art sowohl auf der Abwanderung von Jungtieren als auch auf der von Alttieren beruht.

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