

Behavioural observations of interactions in a free-ranging lynx *Lynx lynx* family at kills

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The behaviour of a free-ranging female lynx *Lynx lynx* Linnaeus, 1758 and her kittens at 12 different kills was studied for 44 hours of observation from September 1996 to March 1997. The development of interactions at kills of a lynx family group showed the following pattern: until the end of September we often observed two lynx, usually both kittens, feed from the kill at the same time. After the age of four months aggression between kittens was observed frequently, with the bigger kitten being dominant. From September the kittens were never again seen feeding together at the kill. However, we never observed fighting, and aggressive behaviour did not increase with the age of the kittens. Whereas until December one of the kittens was always first at the kill, from January onwards it was mostly the adult female who ate first. She introduced her kittens to the home range of a neighbouring female where the family break-up occurred. The kittens were last seen together with their mother on 26 March. Dispersal seemed to be initiated by the female abandoning the kittens.

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Introduction

Adult European lynx *Lynx lynx* Linnaeus, 1758 live as solitary individuals with exclusive home ranges. The male does not take part in parental care (Breitenmoser *et al.* 1993). At the end of May, the female bears litters of one to exceptionally four cubs in a breeding den where they are maintained for approximately 6–9 weeks. In August, when meat becomes an important part of kitten's diet, the young lynx accompany the mother to the kill (Schmidt 1998). Lynx kittens stay with their mother until they are 10–11 months old. The family break up coincides with the lynx's mating season in February–March (Schmidt *et al.* 1997, Zimmermann 1998).

Most descriptions of direct observations in feeding order of a lynx family group were based on data from enclosures (eg Naidenko 1998). Direct observations of lynx in the wild are rare and they seldom last for more than few minutes. We had the unique opportunity to observe an adult female lynx with her two kittens at kills in the wild from September 1996 to March 1997. This paper describes the development of interactions at kills until the family break up.

Material and methods

The study was conducted in the Jura Mountains, a secondary chain of limestone mountains forming the north-western border of Switzerland with France. The most important prey species for lynx in the Jura Mountains were roe deer *Capreolus capreolus* (69%) and chamois *Rupicapra rupicapra* (22%; Jobin *et al.* 2000). Lynx usually fed for several days on an ungulate kill.

In December 1990, the adult female lynx "Aida" was caught in the Swiss Jura Mountains with foot-snares installed at a fresh kill and fitted with a radio-collar (Breitenmoser *et al.* 1993). Until 31 December 1995, she was located on average every 2.8 days. During these 5 years she was re-captured twice with foot-snares and four of her kittens were caught with the same system, which proved to be very efficient. However, when Aida had to be caught the fourth time in order to change the radio-collar in the winter of 1995/96, we were not able to catch her with the snares, as she became trap-wise. We therefore had to change the capture technique: when we found a fresh kill made by her, we put up a tent 4–8 m from the kill and waited inside with a blowpipe for Aida to come to feed. Aida was re-captured with the blowpipe method on 16 February 1997.

The observer in the tent recorded the feeding succession and aggressive interactions of the different lynx. To be able to observe the lynx after dusk we installed a small torch above the kill. The signal from Aida's radio-collar allowed us to estimate her distance to the kill even when we were not able to see her. We continued our observations until family break-up with the same method even after the capture of Aida.

Results

In May 1996, Aida gave birth to three kittens: two males and one female. From September 1996 to March 1997 we observed Aida and two of her kittens at 12 different kills for 44 hours. One of the two kittens was clearly bigger than the other; the third kitten presumably died before September. We started the observations on 14 September. Both kittens arrived at the same time. They spent a total of 85 min on the kill, of which 45 min together, they did not seem to eat a lot of meat. From the radio-signal we knew that Aida was nearby, but she only came to eat when her kittens had apparently lost interest. The next day, both kittens arrived before Aida and fed together at the kill. After a pause of two hours they restarted feeding, this time, however, not together but alternating, with the smaller kitten feeding longer than the bigger one. One hour later – when the kittens had finished feeding – Aida arrived. While she fed, the bigger kitten played around with the kill. As soon as Aida finished, both kittens restarted feeding before they all left. This detailed description shows the typical feeding behaviour and rank order in which the lynx fed (Table 1). On 26 September it was the bigger kitten which fed first, followed by the smaller one. While the smaller one fed, the other kitten snarled and showed his teeth. The smaller kitten retreated immediately. On 1 November we observed an interaction between Aida and the bigger kitten: before it approached the kill Aida was eating at, it rubbed against her, then they faced each other pushing their heads together. It was only afterwards that it started to feed. We also observed how the smaller kitten tried to feed while the bigger one was on the kill. However, the bigger kitten no longer tolerated the smaller one nearby. The smaller kitten had only access to the kill when the bigger one had finished feeding.

Table 1. Development of feeding order in a free-ranging lynx family from 14 September until family break-up in March. K1 – bigger kitten, K2 – smaller kitten, Aida – adult female, K1-K2 – both kittens together, Aida-K1 – female and bigger kitten together. The time one or more lynx were observed at the kill is given in hours and minutes.

Date	Time at kill	Feeding order
14 September	04.50	K1, K2, K1-K2, Aida
15 September	05.40	K1-K2, K2, K1, K2, K1, K1-K2, Aida, Aida-K1, K1-K2
26 September	03.20	K1, K2, K1, K2, Aida
1 November	02.25	Aida, Aida-K1, K1, K2, K1, K2
28 November	04.40	K1, K2, K1, K2, Aida
6 December	01.40	K1, K2
7 January	02.30	Aida, K1, K2, Aida
23 January	02.25	K2, K1, Aida, K2
31 January	03.15	Aida, K2, K1, K2
4 February	00.40	Aida
16 February	04.05	Aida, K2, K1
10 March	03.10	Aida, K2, K1, K2, K1
18 March	04.40	Aida, K2

From 7 to 22 November we found four foxes and one hare killed and eaten by Aida, but no sign of the kittens. But on 28 November we found an ungulate kill where the whole family was together again. At this kill we observed a similar pattern as previously: the bigger kitten ate first; but as soon as the small one approached, it was chased off; Aida fed last. On the kill found on 6 December only the two kittens were observed (Table 1). The next day we found another kill nearby that Aida presumably used while the kittens fed on the old kill.

By the end of January 1997, Aida started to make excursions with the kittens out of her usual home range. She first travelled north-eastwards along the edge of the neighbouring female's home range, where we found a roe deer fawn killed, but already completely consumed (28 January). The next kill on 31 January was even further away from her home range. Aida fed first and when the small kitten tried to approach, she chased it off. And as soon as the smaller one tried to feed it was chased off by the bigger one. When this kill was finished the lynx family headed south-westward and turned back to their usual home range, where we observed Aida alone on a roe deer doe kill. She then traversed her home range quickly, still heading south-westwards into the former home range of the female "Elsa", who had been poached 5 months previously. Aida and her kittens were to stay in the former home range of Elsa until the family break-up. On the following kills Aida always fed first, the kittens only came near the kill when Aida had left. On 10 March we observed the family for the last time together at the same kill. On 18 March Aida again ate first; afterwards the small kitten fed, called several times without receiving an answer, and then left as well. The kill was then abandoned

and we had no indication that the big kitten had fed on this kill. On 26 March we observed tracks of Aida and the two kittens travelling further south-westward. On 1 April Aida was back in her usual home range – alone.

Discussion

We described the development of interactions at kills of a lynx family group in the Jura Mountains. While until December one of the kittens was usually first at the kill, from January onwards it was mostly the adult female Aida who ate first. The hierarchy changed when the kittens were around 7 months old. An apparent feeding order with the largest lynx eating first and the smallest last was also observed at a kill found at the end of December (Literak *et al.* 2000).

Sokolov and coauthors (1994) observed fights between sibling kittens 6–9 weeks old that led to significant traumas and sometimes to death. When we started our observations, kittens were already 17 weeks old, and aggressive interactions observed were always followed by immediate retreat of the recipient. In fact, the older the kittens were, the more the family members tended to avoid one another and to show increasing independence just before the time of dispersal. According to Schmidt (1998) there is no gradual loosening of contact between the mother and her kittens towards the end of the raising period: kittens leave their mothers suddenly, without an initial phase of separation. However, as early as November kittens were observed to spend time away from the mother, when Aida might have reinforced her hunting effort to make parallel kills to ensure constant access to food for her kittens, where the kittens were using the old kill and Aida the new one.

The majority of the literature on juvenile dispersal assumes or presumes that resource and/or reproductive competition occur between adults and juveniles and thus juvenile dispersal is forced by resident adults of the same sex. However, Wolff (1993) pointed out that very few mammal studies have documented that juvenile dispersal results from adult aggression. According to our observations, lynx dispersal seemed to be initiated by the female abandoning the kittens. The only aggressive behaviour of Aida towards a kitten at a kill was observed two months before separation. In cougars *Felis concolor*, Beier (1995) did not observe aggression of the female towards the kittens either: the mother often left her kitten(s) 0–3 km at the edge of her home range while she moved to the opposite edge of her home range.

In the Jura Mountains, most separations of lynx kittens from their mothers occurred within the home range of the mother, where the kittens stayed for 31 ± 25 days after separation (Zimmermann 1998). Aida's excursions beginning at the end of January may be explained by resource competition: as Aida already competed with her daughter of the previous year who took over her core area (Swiss Lynx Project, unpubl.), she introduced her kittens into an area where, presumably, no female was present. This example showed that dispersal might be influenced by a

variety of social and environmental conditions. In conclusion, we suggest that dispersal in lynx is not caused by female parent aggression.

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