



Original Investigation

Foraging activity and food selection in Asiatic black bear orphaned cubs in absence of social learning from a mother



Liya Pokrovskaya*

Laboratory of Animal Behaviour, Department of Vertebrate Zoology, Faculty of Biology, Lomonosov Moscow State University, Moscow, Russia

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ABSTRACT

In different groups of mammals the role of social learning in ontogeny of foraging behaviour is variable. Normally developed foraging skills are necessary for the survival of orphaned cubs, released into the wild after rehabilitation. The development of foraging behaviour in Asiatic black bears (*Ursus thibetanus*) has been poorly studied, and the role of learning from the mother remains undefined. Here we investigated the ontogeny of three aspects of foraging behaviour (foraging activity, diet composition and food selection) and compared our observations with literature data on wild adult bears. Two observers (including the author) reared three orphaned Asiatic black bear cubs from the age of three to 20 months in a natural environment in the Far East of Russia. We performed *ad libitum* observations of the cubs' foraging behaviour during daily excursions in the forest, totaling 2000 h of visual observations. The crop of trees and shrubs was estimated visually in grades (0–5) every 10 days. We found that the seasonal dynamics of the cubs' foraging activity correlated with food abundance and their nutritional requirements, allowing fattening for winter survival. The diet composition of the orphaned cubs was species-specific, close to that of wild conspecifics, although showing age-related and geographical specificity. The cubs assessed the edibility of foods via taste and olfaction analyzers, trying various food items and selecting those consumed by wild bears. We conclude that in the ontogeny of Asiatic black bear foraging behaviour, the seasonal dynamics of diet composition and foraging activity are based on inborn mechanisms, while food preferences develop through trial and error, i.e. individual learning. Therefore, we discovered that Asiatic black bear orphaned cubs, grown in a natural environment under the limited care of two observers and with supplemental feeding, are able to learn feeding on natural foods from the age of five months.

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Introduction

Behaviour is a combination of innate, individually and socially learned components (Krushinskiy, 1960; Mazur and Seher, 2008; Zentall and Galef, 1988), but their contribution to the behavioural ontogeny remains a controversial issue in animal behavioural ecology. Inborn, or genetically determined, elements in foraging behaviour exist in most animals and represent inherited behavioural predispositions to forage in certain areas on certain foods (Boissy, 1995; Fragaszy and Visalberghi, 1996). Individual learning through trial and error is the primary mechanism of learning, documented for most vertebrate species (Fox, 1969; Thorpe, 1956; Van der Post and Hogeweg, 2006). Social learning from a mother and from unrelated conspecifics in the ontogeny of

foraging behaviour is wide-spread in different orders of mammals, such as Chiroptera (Page and Ryan, 2006; Wright et al., 2011), Primates (Boinski and Fragaszy, 1989; Lefebvre, 1995; Luef and Pika, 2013; Voelkl et al., 2006), Rodentia (Aisner and Terkel, 1992; Galef and Clark, 1972), Cetacea (Sargeant and Mann, 2009), Carnivora (Mazur and Seher, 2008) and Artiodactyla (Hessle, 2009). Currently the rehabilitation of large mammalian carnivores is a rapidly developing method in wildlife conservation, especially concerning Ursidae species (Beecham, 2006; Rogers, 1985; Van Dijk, 2005). Orphaned animals grow in absence of a mother and other close adult relatives, thus having fewer opportunities for social learning than cubs reared in a family group. Understanding the mechanisms of foraging behaviour development and the role of social learning in it is a keystone in successful rehabilitation of animal orphans, because their survival depends on the adequacy of their foraging skills.

Most species of bears are omnivorous, opportunistic feeders, whose diets vary seasonally, yearly, geographically, and by habitat (Hwang et al., 2002). Contrary to other carnivores, bears need

* Correspondence to: 119234 Leninskiye Gory, 1/12, Moscow, Russia.
Tel.: +7 925 1751657/+49 1575 5321543.
E-mail address: alopex@mail.ru

to consume large amounts of different plant foods and invertebrates, which forces them to move constantly in search of food sources and to develop various skills of food discovery and manipulation (Huber, 2010). Bears are characterized by large brain size, well-developed memory, behavioural plasticity and curiosity (Gilbert, 1999; Gittleman, 1986), and all these traits usually correlate with high learning ability (Fragaszy and Visalberghi, 1996; Lefebvre and Giraldeau, 1996; Reader, 2003). The share of learned skills compared to inherited ones in bears seems to be greater than in other carnivores (Huber, 2010). Annual foraging activity in adult brown bears (*Ursus arctos*) is graded into 4 periods: hibernation, walking hibernation, normal activity and hyperphagia (Nelson et al., 1983). No reliable data is available concerning the foraging activity of wild bear cubs living with a mother. It was suggested that food selection in wild brown bear cubs is based on the inborn knowledge about taste and smell of some components of the environment, but also developed with the help of trial and error, individual learning and imitation of their mother's behaviour (Pazhetnov, 1990). In American black bears (*Ursus americanus*), the hypothesis that food-conditioned foraging behaviour is transmitted vertically from sows to cubs was not proved. Food conditioning in young bears was strongly affected by their rearing conditions, but not by their mother's behaviour (Mazur and Seher, 2008). In any case, the process of decision making about edibility of food items has not yet been studied comprehensively in bears.

The Asiatic black bear (*Ursus thibetanus*) is listed as a vulnerable species on the IUCN Red List of Threatened Species; currently its population declines due to high rates of poaching and habitat degradation (Garshelis and Steinmetz, 2008). Foraging behaviour of wild Asiatic black bears has been intensively studied in Russia (Bromley, 1965, 1956; Khramtsov, 1997; Kolchin, 2011; Pizyuk and Seryodkin, 2008; Pizyuk, 2006; Seryodkin et al., 2003, 2002; Skripova, 2013, 2006; Tkachenko, 2002), Japan (Hashimoto et al., 2003; Huygens and Hayashi, 2001; Huygens et al., 2003; Mizukami et al., 2005), Taiwan (Hwang et al., 2002) and China (Malcolm et al., 2014). The full list of the food items, consumed by wild adult Asiatic black bears in the Russian Far East, was provided by G.F. Bromley (Bromley, 1965, 1956). Based on visual observations of rehabilitated orphaned Asiatic black bear cubs in the Ussurijskiy State Reserve (Primorskiy region, Russia), K.V. Skripova registered 50 plant species and presence of insects (unidentified ants and wasps) in their diet (Skripova, 2006). Only 13 plant species overlapped in these two lists of diet composition (Bromley, 1965; Skripova, 2006). Besides the studies in Ussurijskiy Reserve (Skripova, 2006) and our own research (Kolchin, 2011; Pokrovskaya, 2013), the ontogeny of Asiatic black bear foraging behaviour has unlikely been ever studied. The role of social learning from a mother or other conspecifics in development of food habits remains unstudied. In the Russian Far East, annually dozens of cubs become orphans after the winter den hunt and are fated to death or imprisonment (Kolchin, 2011). Orphaned bear cubs under rehabilitation represent a perfect model for investigating the development of foraging behaviour in absence of social learning through imitation of a mother's behaviour.

The goal of our study was to investigate whether social learning is obligate for normal development of species-specific food habits (foraging activity, food choice and food selection) of orphaned Asiatic black bear cubs. To this aim, we compared food habits of orphaned cubs from our experiment and that of wild adult conspecifics in other areas of Russian Far East (Bromley, 1965, 1956; Kolchin, 2011; Seryodkin et al., 2003; Tkachenko, 2002). In particular, we explored the following questions: (1) do orphaned cubs feed on the same foods as wild adult conspecifics in that region, (2) do they show similar seasonal trends in diet composition and foraging activity as wild bears do and (3) how do

they estimate the edibility of food items in absence of a mother. Because of the rehabilitation goals of the entire project, we had to follow certain procedures and precautions, not necessary in our study design, such as the permanent presence of observers to provide the cubs with protection from predators, accompanying the cubs in the most productive feeding patches according to seasonal phenology of plant foods, supplemental feeding, making tree sap available to them to drink and using an outdoor enclosure. This approach forced us to deviate somehow from an ideal study design aimed to assess if the foraging behaviour of orphaned cubs would develop normally in the absence of their mother, and we considered this issue in the discussion section.

Material and methods

Study area

The study was conducted on the western slopes of Central Sikhote-Alin Mountains in the watershed of the river Durmin (48°04' N, 135°50' E), on the territory of the game preserve «Durminskoe». The study area represents the typical habitat of Asiatic black bears in the southern part of the Russian Far East. Highland relief, drained by the Durmin river and its tributaries, characterizes it. Prevailing altitudes are 400–500 m a.s.l. Climate is ultra-continental with prolonged cold winters and rainy summers (Petrov et al., 2000). The study area was situated in the northern subzone of coniferous-broadleaf forests of the Russian Far East (Kolesnikov, 1969). The main assemblage is formed by broadleaf cedar forests, modified by anthropogenic activity. The most typical tree species on the mountain slopes are Mongolian oak (*Quercus mongolica*) and Korean pine (*Pinus koraiensis*), accompanied by elm (*Ulmus japonica*), birches (*Betula alba*, *B. costata*), asp (*Populus tremula*), Mandshurian walnut (*Juglans mandshurica*), ash (*Fraxinus mandshurica*), maples (*Acer mono*, *A. tegmentosum*) and Amur linden (*Tilia amurensis*) (Kolesnikov, 1969) in the river bottomland.

Ethics statement

This study was carried out in accordance with the recommendations of the Civil Code of the Russian Federation, Article 26 «Keeping and breeding of wildlife in semi-free conditions and artificially created habitat». In March 2009 we obtained an approval for transportation and rearing Asiatic black bear cubs from the Federal Service for Veterinary and Phytosanitary Surveillance in Primorsky Krai and Sakhalin Oblast.

Subjects and rearing conditions

Our study was conducted within the orphaned Asiatic black bear cubs rehabilitation pilot project (Pizyuk and Sagatelova, 2009). The conditions of our experiment differed from ideal ones, because the safety and fitness of the cubs were the first priorities in the rehabilitation process. In March 2009 three Asiatic black bear cubs (two males and one female) aged 2.5–3 months were taken for rehabilitation after their mothers were killed during the winter den hunt. One male cub (Yasha) came from Primorskiy region, and twins (male Shum and female Shiksha) came from Khabarovskiy region. The cubs were reared using the original methods of Dr V.S. Pazhetnov (Pajetnov and Pajetnov, 1998), who has conducted the rehabilitation of brown bear cubs in European Russia for over 30 years. According to these methods, the cubs were raised until weaning age (20 months) under the limited care of two observers (including the author), being constantly exposed to natural surroundings. To prevent human habituation, we minimized tactile

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