

ECOLOGY AND BEHAVIOR OF 3 WILD ORPHANED BROWN BEAR CUBS IN SPAIN

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Abstract: We monitored 3 wild brown bear (*Ursus arctos*) cubs orphaned in July 1991 (approximately 6 months old) in the Cantabrian Mountains over autumn, denning, and den emergence periods, totalling 57 observation days and more than 113 hours time-in-sight. Their diet followed that reported in bear diet studies from the area and included items unknown to them. They denned from 8 December to 18 March and separated in early May 1992, at least 1 year earlier than other litters. Their home range from October 1991 to May 1992 was 0.82 km². We suggest that they limited themselves to a previously known, small area to maximize their security to the detriment of their feeding opportunities.

Int. Conf. Bear Res. and Manage. 9(2):85–90

Key words: brown bear, Cantabrian Mountains, cub behavior, denning, dispersal, orphans, Spain, *Ursus arctos*.

The brown bear is a typical K-selected species, with a long life and low birth rate. Maternal care includes nutrition and protection and almost certainly conditions later adaptive behavior. In European populations maternal care extends for about 18 months and weaning occurs at 1 year (Camarra 1989).

The study of wild, motherless bear cubs provides insight into instinctive versus learned behavioral patterns. For the small, fragmented South European brown bear populations that presumably are near or under minimum viable population numbers (see Berduco 1990 for a review), this information can help managers decide whether to leave alone or capture orphaned cubs, which could be used for reinforcement programs.

The survival of orphaned black (*U. americanus*) and brown bear cubs older than 5 months has been reported by Erickson (1959), Johnson and Leroux (1973), Payne (1975), and Jonkel et al. (1980). As far as we know, however, detailed information on monitored wild orphan cubs has never been published. This study provides general information on the ecology and behavior of 3 wild orphaned brown bear cubs over autumn, denning, and den emergence periods, including details on diet, habitat use, and interspecific relationships.

The research was promoted and funded by the Government of Asturias. We thank the ranger service of Somiedo Natural Park, A. Fernández and J. Carral for field assistance. L. Ashcroft assisted with the English version.

STUDY AREA

This study was conducted in Somiedo Natural Park on the north slope of the Cantabrian Mountains (Fig. 1). The

mountains, with 70–90 protected brown bears, have been described elsewhere (Clevenger et al. 1987, Palomero et al. 1993).

Somiedo Natural Park (Asturias province) is a 300-km² area of steep valleys and rugged physiography with patches of deciduous mixed forest, bush, grassland, and rocky outcrops (Fig. 2). Elevations range from 400 to 2,194 m. At 1,200 m, average maximum and minimum temperatures are 11.3 and 3.5 C, and annual precipitation is 1,619 mm with an average of 23 days snow cover. The Park has 40 small villages with approximately 1,700 inhabitants, mainly engaged in raising livestock. Wild boar (*Sus scrofa*), roe deer (*Capreolus capreolus*), red deer

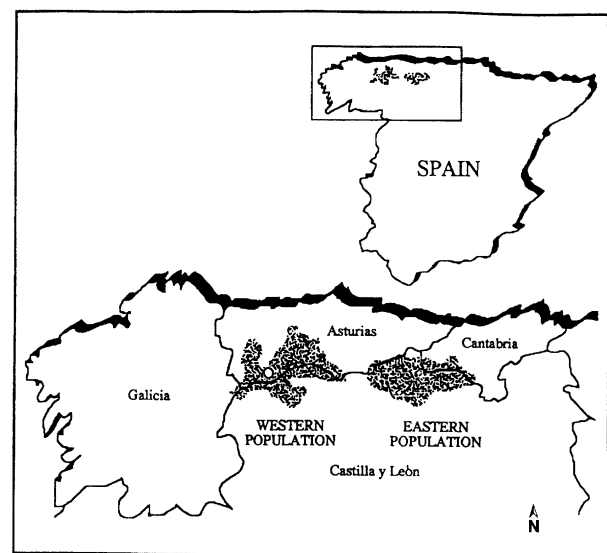


Fig. 1. Cantabrian brown bear population (dark area) and Somiedo Natural Park (open circle), Spain, 1992.

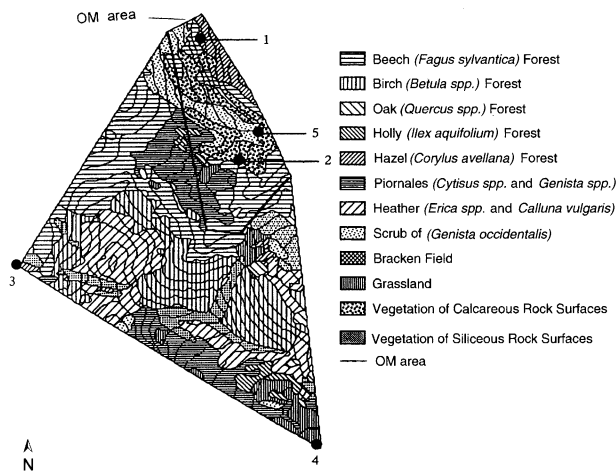


Fig. 2. Area (3.87 km²) encompassing all locations used by 3 orphaned brown bear cubs in the Cantabrian Mountains, Spain; (May 1991–November 1992). The small (Oct–May) area (0.82 km²) includes the 53 locations recorded from Oct 1991 to 6 May 1992; 1 and 2 are locations of the cubs with their mother (May 1992), 3 and 4 are orphan locations in July 1991, 5 is the den location.

(*Cervus elaphus*), chamois (*Rupicapra pyrenaica*), wolves (*Canis lupus*), and bears are common. The probability of orphan contact with wolves or other bears was high.

METHODS

We located the orphaned cubs during summer 1991 while monitoring breeding females. We monitored them sporadically during the summer, and regularly from 3 October 1991 to 6 May 1992 (70 field-days). From 9 May to 1 November 1992, we spent 35 field-days looking for the yearlings (Table 1).

We observed the cubs with binoculars and telescopes (20–60X) during day hours from an opposite slope 300–1,000 m away to avoid disturbing the cubs. Scarce cover in much of the cubs' range and availability of good observation sites increased sighting opportunities. When we did not locate the cubs, we surveyed paths for tracks. We explored their den in August 1992, 3 months after the bears left the area.

We recorded data on a vegetation map (1:25,000) based on aerial photography and fieldwork. The map was digitalized and incorporated into the geographic information system (GIS) of the Instituto de Ordenación del Territorio (INDUROT [Univ. Oviedo]), and included layers of altitude, slope, and orientation, allowing us to computerize data processing.

We estimated home range size by the minimum area polygon method. Habitat selection was measured with *G*-test for goodness-of-fit (Sokal and Rohlf 1981) and *D* selectivity index; *D* varies from -1 to +1 from maximum negative to maximum positive selection (Jacobs 1974).

RESULTS

The 3 cubs were sighted with their mother on 23 and 26 May 1991. The female, easily identified by her missing hind leg, had been regularly observed in the area since 1984, with litters in 1984 and 1989. From late July 1991 the cubs were always observed unaccompanied and the female was no longer located. Given her previous observability, her disappearance strongly suggested that she had died. From 3 October 1991 to 6 May 1992, the orphans were sighted on 47 days (109 hours and 52 minutes of observation time), and their recent tracks were located 6 other days. From 9 May to 1 November bears were observed on 7 days and their tracks detected on 4 other days (Table 1).

Autumn

From 3 October 1991, when regular monitoring began, to 3 December 1991, when denning started, the cubs were observed for 27 hours and 45 minutes. They spent 97.5% of observation time foraging, 1.5% walking, and 1.5% playing. In October we observed them feeding only on hazelnuts (*Corylus avellana*) ($n = 6$ days); in November, on rowan (*Sorbus aucuparia*) berries (37.5% of the observation days), grass (37.5%), and hazelnuts (25.0%; $n = 16$ days); and in December, on grasses (75.0%) and rowan berries (25.0%; $n = 4$ days). To feed on hazelnuts and rowan berries they often climbed trees, showing great skill in handling branches despite their lack of knowledge of never having eaten such fruits. They were active during all daylight hours, but mainly in the early hours of the morning and late in the afternoon; if these observations roughly reflected their daylight activity pattern, it was similar to that of the radiotagged Cantabrian adult male studied by Clevenger (1991). Cubs were always sighted walking and foraging a short distance apart and were never located at the den. Their general appearance was excellent, and they obviously gained weight.

Denning

Den entrance occurred from 5 to 8 December 1991, during which we always saw them near the den. In 3 days' monitoring from sunrise to sunset, they were observed outside the den an average of 2 hours 10 minutes daily, always in the middle of the day. They spent

Table 1 . Number of days when 3 bears orphaned in the Cantabrian Mountains, Spain, were located and time-in-sight for 4 periods from 3 Oct 1991 to 1 Nov 1992.

	Autumn (3 Oct–3 Dec 1991)	Denning (5 Dec–8 Mar 1991)	Den emergence (18 Mar–6 May 1992)	Dispersal (9 May–1 Nov 1992)
Prolonged observation (days)	17	7	18	3
Sporadic sightings (days)	3	0	2	4
Recent tracks (days)	6	0	0	4
Max. period without location (days)	15	60	19	122
Total time-in-sight (hours)	27.75	8.03	74.08	3.57
Mean daily period in-sight ^a (hours)	1.63	0.37	4.12	1.18

^a Considering prolonged observation days

93.4% of observation time scratching up vegetation (mainly grasses) and carrying it to the den, 3.3% feeding on grasses and 3.3% inactive. They showed increasing signs of lethargy and made stereotypical scratching up movements, suggesting a strong instinctive behavior.

During 3 days of observation from 9 to 23 December, the cubs were not sighted, suggesting that they were hibernating. From 24 December 1991 to 7 February 1992 fieldwork was suspended.

Between 8 February and 8 March 1992 the cubs were located near the den 4 of 6 observation days for a daily average of 35.5 minutes (range = 5–67 min), mainly between 1100 and 1500 hours. The cubs spent 78.3% of observation time sunning and grooming limbs and 21.7% feeding on grasses. Signs of lethargy gradually decreased and, as in the den entrance period, orphans were always together.

The den was in a natural limestone cave on a 60° slope with a north–northeast orientation at 1,250 m elevation. The single nest measured 110 x 95 cm by 25 cm deep and consisted of herbaceous plants, mainly *Brachypodium rupestre* and *Festuca rubra*.

Den Emergence

From 18–22 March (5 days monitoring) the orphans, now yearlings spent long periods in the den. After 11 April they were no longer located at the den and spent 67.4% of observation time foraging (always herbaceous plants), 19.4% resting, 4.2% sunning and grooming, 3.5% walking, 3.4% scanning and sniffing and, 2.1% playing. The activity period showed a clear peak from 1500 hours to dusk; most resting occurred from 1100 to 1500. They were usually near each other, but sometimes 1 foraged 200 m away. In such cases the latter would stand bipedally and, after locating the others by scent and sight, rejoin them. They seemed to be in good condition.

Dispersal

On 6 May the yearlings were seen foraging, but 1 was >1 kilometer from the others. On 9 May only 1 orphan was observed in the area. After that the siblings were not sighted together but on 7 occasions we saw a lone yearling. During prolonged observations between 12 May and 29 June it fed on grasses, and on 1 November 1992 it was feeding on Sessile oak (*Quercus petraea*) acorns. Each sighting was outside the area shown in Fig. 2 but close to point 4. In all cases the orphan(s) seemed to be in very good condition.

Home Range Size and Habitat Selection

The area encompassing all locations recorded during the 57 days the orphans were observed together measured 3.87 km² (minimum area polygon method). However, locations recorded between 3 October 1991 and 6 May 1992 (i.e., 47 observation days and 6 recent-track days) occurred in a small range of 0.82 km² (Oct–May [OM] area), where the den was located. In autumn the orphans positively and significantly selected for the hazel patches (Table 2); in spring, all locations were on the vegetation of calcareous rock surfaces (Fig. 2).

Table 2. Habitat selection of cubs orphaned in the Cantabrian Mountains, Spain, in autumn 1991. *D* = Selectivity index varying from +1 to -1 from max. positive selection to max. negative selection; *G* = goodness-of-fit test.

Vegetation type	% locations		<i>D</i>	<i>G</i>	
	% area	(<i>n</i> = 26)			
Hazel forest	9.3	38.5	+0.727	4.806	<i>P</i> <0.05
Beech forest	28.3	34.6	+0.146	0.043	n.s. ^a
Grassland	3.3	3.8	+0.083	0.000	n.s.
Rock surfaces	31.6	23.1	-0.211	0.139	n.s.
Scrub	27.5	0	–	–	–

^a n.s.= not significant

The OM area elevations ranged from 1,100 to 1,650 m, and average slope (49°) was steeper than that of the surrounding area (41°), with a corresponding decrease in accessibility. The locations averaged 670 m (SD = 355) from a village of 77 inhabitants, and 750 m (SD = 184) from a paved road with little traffic. Nevertheless, the steep slope largely prevented human access.

The OM area was much smaller than the average (192.8 km², $n = 10$) and the minimum (8.5 km²) home ranges of female grizzlies with cubs recorded in the literature reviewed by LeFranc et al. (1987). It was also much smaller than the home range size (50.9 km², minimum area polygon method using 39 locations recorded by sightings and track observations from 21 Sep 1991 to 10 May 1992; Palomero [1993]) of a Cantabrian female with 2 cubs-of-the-year monitored in Fuentes Carrionas Reserve in Palencia, Spain in the same period.

Intra- and Interspecific Interactions

Several times we recorded interactions between the orphans and other potentially dangerous species. On 13 April 1992, when the yearlings were about 15 months old, they encountered an adult bear. The adult and the yearlings watched each other from 100 m apart for 2 minutes. Following a small landslide nearby, they ran off in opposite directions. On several occasions we noticed the presence of wolves in the same area as the orphans, but we did not observe an interaction. The orphans shared the range with wolves for months without injury. Free-ranging dogs also were present. On 12 May 1992, an orphan stopped grazing and ran away from sheep dogs.

We recorded 2 types of interactions with humans. Most of the time the orphans could hear the usual noises from the village and the road <1 kilometer away. Even when noises were especially loud (shouting, car horns), the bears appeared attentive only for a few seconds. However, on 6 occasions they noticed the unusual presence of people (wardens, hikers, researchers) 100–500 m away. On these occasions they were alert, looking around and sniffing. In addition, once they moved away, once hid in bushes, and once ran away; but they always reassumed their activity in the same area when danger disappeared. Thus, they seemed able to distinguish non-dangerous from potentially dangerous human presence. In developed areas cubs may learn this behavior early from their mother.

The attitude toward chamois, roe deer, and cows was indifference or curiosity. Once a chamois group ran away startled and once a roe deer looked alarmed and barked near them; the cubs always ran away and hid in bushes, suggesting an interspecific recognition of alarm signs.

DISCUSSION

Since cubs were not radiotagged, we could not obtain some of the data that this method usually provides. Thus, we could not find out about their nocturnal activity, their behavior in dense cover, further details on denning behavior, and their location and behavior after the siblings' separation. Nevertheless, the high number of hours-in-sight from October 1991 to May 1992 enabled us to offer a consistent description of their general behavior during this period.

The survival of orphaned bear cubs in the wild has been recorded previously by several authors. Erickson (1959) reported 4 transplanted, motherless black bear cubs which were self-sufficient by 5 months of age and overwintered successfully in Michigan. Johnson and Leroux (1973) reported that a grizzly cub survived motherless for 1 year when transplanted at 7 months of age. Payne (1975) showed that orphaned male black bear cubs survived for 1 year after the death of their mother when they were 8 months old. Russell and Martinka (Jonkel et al. 1980) reported the survival of litters of 3 and 2 grizzly cubs orphaned in July and late autumn, respectively.

The orphans' seasonal feeding habits (mainly fruits in autumn and herbaceous plants in spring) agreed with diet studies carried out in the Cantabrian Mountains (Braña et al. 1988, Clevenger et al. 1992). In autumn, the cubs ate fruits (hazelnuts and rowan berries) previously unknown to them, suggesting instinctive behavior. Our observations of denning behavior agreed with findings of Kolenosky and Strathearn (1987:313) on black bears: "Cubs orphaned during the spring hunt and consequently never exposed to den selection or construction process, instinctively constructed dens." Likewise, the sporadic activity during denning seemed normal in brown bears (Huber and Roth 1997).

Before May 1992, the siblings seemed to depend on each other, as Russell (Jonkel et al. 1980) observed on orphaned grizzly cubs, which panicked when they became separated. Nevertheless, social bonds appeared to break very quickly after yearlings' den emergence.

The orphans spent a low percentage of observation time playing. Although we have no quantified data, our circumstantial sightings suggest that play rates were much higher for non-orphaned Cantabrian bear cubs. Likewise, Fagen and Fagen (1990) reported that brown bears in Alaska spent 1–20% of time-in-sight playing and reviewed studies showing that stressed wild animals played less and differently than nonstressed animals. In addition, evidence suggests that variations in early social play may affect the strength and maintenance of bonds within the

litter, and inability to develop social bonds with siblings predisposes individuals to disperse (Bekoff 1989, Harris and White 1992). Thus, the absence of the mother may have inhibited the orphans' play behavior and caused unusually early group disintegration.

The orphans separated when they were 16 months old, at least 1 year before the usual separation date for brown bear juvenile siblings in the Cantabrian Mountains (G. Palomero, unpubl. data). This may be related to an inability to maintain bonds, an instinctive tendency to separate after the first motherless den emergence, or both.

One of the most striking findings is the very small size of the OM home range. We suggest that the orphans limited themselves to a previously known, small area to maximize their security. This could have reduced their feeding opportunities and resulted in an early den entrance.

Cub predation by adult bears (LeFranc et al. 1987) was probably the main danger for the orphans. Previous knowledge of territorial habitat has been shown to be very important in territory acquisition, both in birds (Yasukawa 1979, Birkhead and Clarkson 1985) and reptiles (Stamps 1987 and references therein). Stamps (1987) reported that settlement success of new juvenile *Anolis aeneus* lizard arrivals was dramatically lower than that of comparably-sized previous residents. New arrivals were attacked and chased by larger individuals, but residents avoided encounters with lizards larger than themselves. Some evidence suggests that cubs spent the first months of life in the OM area and were familiar with it: they were sighted there twice in May 1991 with their mother (Fig. 2), who was also observed there 5 times in May and June 1989 with 3 cubs. In autumn, neither orphans nor tracks were spotted in a Sessile oak forest with a good acorn crop <1 kilometer from the OM home range. This forest is visited every autumn by different bears. The orphans' confinement to a small, known area could have minimized dangerous encounters with other bears and wolves.

During October and early November, cubs were observed feeding mainly on high-caloric hazelnuts and rowan berries. However, between 19 November and 3 December (on 6 monitoring days), they were always observed grazing except for a few hours feeding on hazelnuts. This shifting from fruits to low energy grass suggests a depletion of nuts and berries in the OM area.

Den entrance date seems to be associated with hard weather conditions, fruit crop failure, and individual factors (Miller 1990). Nevertheless, during the late autumn and, early winter the weather was unusually sunny, snowfall was almost absent and general fruit availability in the area was high. The early den entrance and the long den-

ning period for the orphans contrasted with the female with 2 cubs monitored in Fuentes Carrionas Reserve in the same months, which were active all winter (Palomero 1993). Although other factors cannot be excluded, we suspect that orphans' early den entrance may be due in part to food shortage in the very small OM area.

MANAGEMENT IMPLICATIONS

Bear cubs older than 5–7 months can survive motherless. When orphans of this age in good condition are found, they should be left in the wild to avoid the imprinting resulting from pen-rearing.

Younger orphans should probably be taken into captivity until they are self-sufficient, although they should be prevented from regarding people as a source of food. Roth (1977), Jonkel et al. (1980), Alt and Beecham (1984), and Carney and Vaughan (1987) reviewed introduction methods and problems and stressed that pen-reared cubs tend to seek people and cause conflicts when released. Thus, in the developed Southern European areas, the imprinting problem must be solved before planning releases. In addition, these authors considered fattening the cubs in captivity and releasing them during periods of food abundance to be key factors in successful introductions. Our data also suggest that release in areas previously known to cubs may improve their survival.

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