

FAMILY BREAKUP IN BROWN BEARS: ARE YOUNG FORCED TO LEAVE?

BJØRN DAHLE* AND JON E. SWENSON

Department of Zoology, Faculty of Chemistry and Biology, Norwegian University of Science and Technology, N-7491 Trondheim, Norway (BD)

Department of Biology and Nature Conservation, Agricultural University of Norway, Post Box 5014, N-1432 Ås, Norway, and Norwegian Institute for Nature Research, Tungasletta 2, N-7485 Trondheim, Norway (JES)

Present address of BD: Department of Biology and Nature Conservation, Agricultural University of Norway, N-1432 Ås, Norway

In brown bears (*Ursus arctos*), nursing of young >1 year of age has a positive effect on their growth rate but is energetically costly for mothers and reduces the number of litters a female can produce during her lifetime. We followed radiomarked families to study their behavior during the period of family breakup. Yearlings separated from their mothers during the mating season and most family breakups were associated with the presence of an adult male, suggesting that termination of maternal care was not initiated by offspring.

Key words: brown bear, family breakup, parent–offspring conflict, *Ursus arctos*, weaning

Conflicts may arise between parents and offspring over parental investment (Trivers 1974). The theoretical foundation for conflict is sound, but conflicts are seldom observed in nature (Bateson 1994; Mock and Parker 1997). Most studies on parent–offspring conflict have focused on sex-ratio adjustment or parent–offspring communication in small organisms (Mock and Parker 1997); relatively little information is available for large long-lived species, in which conflicts between parent and offspring might be expected due to high fitness differential between them (Clutton-Brock 1991; Clutton-Brock et al. 1982).

In brown bear (*Ursus arctos*), offspring separate from their mothers at 1–3 (occasionally 4) years of age (McLellan 1994). Females do not mate until after they separate from their offspring, so maternal care beyond the mating season could impose a fitness cost by increasing the interval between litters, which is the most important

factor determining reproductive rate in the species (Swenson and Sandegren 1999). As in other large, slowly reproducing species (e.g., bison, *Bison bison*—Green and Rothstein 1991), prolonged nursing in the brown bear contributes to increased rate of growth of yearlings (B. Dahle and J. E. Swenson, in litt.).

Hilderbrand et al. (2000) reported that body mass and body fat content in autumn were similar for brown bear mothers with cubs or yearlings, and both were lower than those for lone females (without offspring). This suggests that energetic costs associated with tending cubs and yearlings are similar. In addition, tending yearlings reduces the number of litters a female can produce during her reproductive life. For these reasons, a conflict between mothers and offspring over the timing of family breakup might be expected. Very little is known about the behavior of females and their offspring at this time.

Clevenger and Pelton (1990) and Rogers (1987) reported on the breakups of several

* Correspondent: bjorn.dahle@ibn.nlh.no

families of the American black bear (*U. americanus*), but none was observed closely, so behavior associated with the breakups was unknown. Rogers (1987) argued that the mother was probably responsible for breakups because all yearlings separated from the mother at about the same time. Clevenger and Pelton (1990) noted that breakup of families took place before and during the mating season. Herrero and Hamer (1977) reported that a pair of twin yearling brown bears accompanying their mother moved away when an adult male approached the family.

Based on Rogers' (1987) suggestion that mothers prompt breakups of families, we predicted that sibling yearling brown bears should separate from the mother almost simultaneously. Furthermore, if mothers initiate breakup as they enter estrus, they should be accompanied by adult males during or soon after family breakup. The same predictions can be made if males chase away yearlings to mate with their mother or if yearlings benefit by staying with their mother as long as possible but separate from her when she is ready to mate, allowing her to produce a new litter. Predictions of these hypotheses overlap, but the last one predicts that little aggression is involved in breakup.

MATERIALS AND METHODS

The study was performed in Dalarna and Gävleborgs counties in southcentral Sweden from 1987 to 2000. The study area (61°N, 18°E) is dominated by coniferous forests of scotch pine (*Pinus sylvestris*) and Norway spruce (*Picea abies*), with deciduous species including birch (*Betula* species). In mid-April, female brown bears and their yearling offspring were darted with immobilizing drugs (a mixture of tiletamine, zolazepan [Virbac Laboratories, Carros, France], and medetomidine [Orion Corporation Farnos, Espoo, Finland]) from a helicopter. Bears were fitted with radiotransmitters on neck collars, or these were implanted into the body cavity. Family groups were located from the ground using receivers and handheld 6-element antennas (Macdonald and Amlaner 1980). All

bears were located weekly, and many were located 1 to several times per day during the mating season. Movements of and distances between mothers and offspring were estimated with the Ranges V computer package (R. E. Kenward and K. H. Hodder, in litt.).

RESULTS AND DISCUSSION

Timing of family breakups.—We recorded family breakups of 33 families, 19 within ± 12 h and others up to ± 3.5 days. Breakups occurred from 3 May to 15 July (median 22–28 May, when grouped in 7-day periods; Table 1; Fig. 1). This period corresponds with the mating season, which we defined as the period when radiomarked adult males and females were observed together (Fig. 1). There was no difference between median date of family breakup and observation of adult pairs (Mann–Whitney *U*-test, $Z = 0.35$, $n = 33$ and 50, respectively; $P = 0.73$). In contrast, family breakup in the American black bear might be instigated by the mother before the mating period (Clevenger and Pelton 1990).

In our study, 24 of 33 litters had >1 yearling, and all yearlings within a litter separated from their mother within the same week, with 2 exceptions: both were males in mixed-sex litters that separated 1–2 weeks earlier than their siblings (Table 1). Of the 13 most intensively studied families with >1 yearling, all siblings separated within 24 h. Sixty of 63 litters separated from their mothers as yearlings and the remainder as 2-year-olds, as in most European brown bear populations (B. Dahle and J. E. Swenson, in litt.). In contrast, most young separate from their mothers as 2- or 3-year-olds in North American populations of the species (McLellan 1994). Conflict between mother and offspring over the timing of family breakup might be expected to be less in the latter situation because the gain in fitness of offspring resulting from staying with the mother probably decreases with age, and offspring are more likely to benefit through inclusive fitness if the mother breeds again. Murie's (1981) obser-

TABLE 1.—Breakup of brown bear family groups in central Sweden, 1987–2000.

Mother's ID no.	Year	Litter size	Date of family breakup	Adult male present?	All yearlings separated at the same time?	Time siblings remained together after family breakup (days)
1	1987	1	19 May	Yes		
2	1992	3	30 June–1 July	Unknown ^a	Yes	1–3
2	1994	2	28 May–29 May	Yes	Yes	3
2	1996	3	18–23 May (1), 31 May–2 June (2)	Unknown ^a	No	0
2	1999	2	24–25 May	No	Yes	7
3	1989	2	1 June	Yes	Yes	7
3	1992	2	21–23 June	Unknown	Yes	1
4	1997	1	1 June	Unknown ^a		
5	1991	1	9–10 May	Unknown ^a		
5	1993	3	17–18 May	Yes	Yes	5
5	1995	3	20–25 May	Unknown	Yes	7–13
5	1997	2	6–11 May	Unknown	Yes	
5	1999	3	26–27 May	No	Yes	4
6	1989	2	29 April–7 May	Unknown	Yes	
7	1992	2	4–12 June	Unknown	Yes	1
8	1997	2	14 May	Yes	Yes	0
8	1999	2	28 June–2 July	Unknown		
9	2000	3	28–31 May	Unknown		
9	1994	2	26–27 May	Unknown ^a	Yes	0
9	1996	3	26–27 May	Unknown ^a	Yes	2
9	1998	2	17–18 May	Yes	Yes	5
10	1998	1	25–27 May	Unknown		
11	1996	2	12–18 July	Unknown	Yes	
12	1997	2	8–15 June	Unknown	Yes	10–22
13	1998	2	25 April–3 May (1), 10–13 May (1)	Unknown	No	
14	2000	1	10–13 May (1)			
15	1993	2	8 June	Unknown ^a		
15	1995	3	18–19 June	Yes	Yes	0
15	1999	1	22–29 June	Unknown	Yes	
16	1998	1	2–10 June	Unknown		
17	2000	2	8–16 June	Unknown		
18	1999	2	31 May	Yes	Yes	6
19	1999	2	9 June	Yes	Yes	0
			25 June	Unknown ^a	Yes	

^a Breakups ascertained with an accuracy of 24 h and where no radiomarked males were present (about 56% of adult males were radiomarked).

vations of a mutual inclination of brown bear families to break up with 2- and 3-year-old offspring support this view.

Factors associated with family breakups.—For the 19 breakups estimated to ± 12 h, mothers were located with a radiomarked adult male in 7 cases or observed with an unmarked adult bear (suspected to be a male) twice within 24 h after the family was last located together (Table 1). These observations suggest that yearlings were forced to depart when the family ap-

proached or were approached by an adult male. Two females were observed alone 10 h after they were last located with their yearlings, suggesting that no adult males were present when their families broke up. In 8 cases no radiomarked adult male was present during family breakup. However, because the females were not observed and only about 56% of adult males were radiomarked during the study (Swenson et al. 2001), it is possible that unmarked adult males were present when many of the fam-

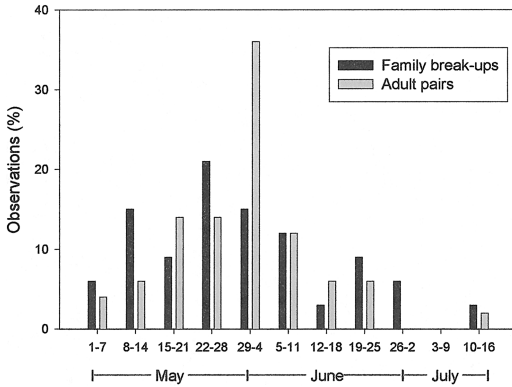


FIG. 1.—Timing of brown bear family break-up ($n = 33$) and observations of radiomarked adult males and females together ($n = 50$) in southcentral Sweden. Only the 1st observation of a pair was included for each year.

ilies broke up. Family breakups of brown bears in North America also have been associated with the presence of adult males (Egbert and Luque 1975; Herrero and Hamer 1977; Murie 1981), and Rogers (1987) reported that 3 female American black bears were joined by males 1–4 days after family breakup.

Whether yearlings are chased away by the male or by the mother is not known, but in 2 cases, yearlings were observed near the top of scotch pine trees after family breakup. In 1 case, the mother and an adult male were resting 300 m away; in the other, no radiotagged adult male was nearby and the mother was observed alone 10 h later, so the mother may have chased her yearling into the pine. Ternent and Garshelis (1998) observed that a female American black bear turned her aggression toward her yearlings and separated from them after initially defending them against an approaching male. In the family breakup reported by Herrero and Hamer (1977), yearlings made several attempts to reunite with the mother by approaching her and the adult male, but each time they ran away, on 1 occasion in response to a threatening approach by the male. Yearlings have reason to fear males because intraspecific predation is common

in our study population, and the risk of juveniles being killed is highest during the mating season (Swenson et al. 2001).

Clutton-Brock (1991) and Clutton-Brock et al. (1982) showed that fitness of yearling red deer (*Cervus elaphus*) calves (in terms of growth and overwintering survival) is enhanced if they continue suckling, but fitness of the mother is maximized (in terms of lifetime production of surviving offspring) if she is impregnated each year. This is held to be the weaning conflict with the most convincing field data (Mock and Parker 1997). The situation we report seems similar, but we do not know the effect of prolonged nursing on yearlings except that their growth is increased.

Relationship of siblings and reassociations of families.—After separation from their mother, yearlings in 13 of 18 litters with >1 young stayed together for 1–22 days before they separated from one another (Table 1). In other litters, yearlings separated from their mother and siblings simultaneously. Similarly, Murie (1981) reported that brown bear littermates often associated (for up to 2 years) after separation from the mother. In contrast, it is uncommon for yearlings of the American black bear to stay together for even a few days (Clevenger and Pelton 1990; Rogers 1987).

We observed that yearlings tried to reunite with the mother after family breakup in 2 families. Three siblings were with their mother at 1200 h on 30 June, but at 1730 h on 1 July they were 7 km from her. One of the male yearlings was with the mother at 1630 h on 2 July. However, at 1645 h on 4 July the mother was with a radiomarked adult male, and the male yearling was 18 km away. In the 2nd case, a single male yearling was with his mother at 0750 h on 8 June, but at 1640 h on 8 June the yearling was near the top of a scotch pine, 1.2 km from the mother; she moved 7 km the night of 8 June, but the yearling followed her and rejoined her in the morning. The yearling followed his mother for 4 days, falling behind when she moved (in total, more than

50 km during these 4 days), but catching up with her when she rested. Clevenger and Pelton (1990) documented reassociations of 2 American black bear families, but Rogers (1987) reported that only 1 of 51 American black bear families reunited after family breakup, so reunion is probably not common in bears.

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