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# Early primiparity in brown bears

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We documented 2 cases of unusually early primiparity in brown bears *Ursus arctos* Linneaus, 1758 in an introduced population in central Austria. Two females gave birth at the age of 3 years.

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## Introduction

Age of primiparity is one of the key parameter in life history theory (Stearns 1992). To our knowledge, the earliest age of first birth in brown/grizzly bears *Ursus arctos* Linneaus, 1758 recorded in North America is 4.4 years from the Alaska Peninsula (McLellan 1994). The earliest age of first birth in Europe is a single record of a female brown bear in Croatia giving birth at 3 years of age (Frković *et al.* 2001). We present data suggesting early primiparity (3 years of age) in a brown bear population in central Austria.

## Material and methods

The study was conducted in a bear population of 15–20 bears in central Austria, which is the result of a reintroduction effort in 1989–1993 (Rauer and Gutleb 1997, Zedrosser *et al.* 1999, Rauer *et al.* 2001). Because there is male-mediated interchange, this population is considered a subpopulation of the Alpine-Dinaric-Pindos population (Swenson *et al.* 2000, Zedrosser *et al.* 2001). The release area is managed intensively for roe deer *Capreolus capreolus* and red deer *Cervus elaphus*, and deer feeding stations are distributed evenly throughout the whole area. The main food items provided are corn *Zea mays*, oats *Avena sativa*, barley *Hordeum vulgarae*, wheat *Triticum aestivum*, and commercially produced deer food. Bears utilize these feeding stations to a great extent. A scat-analysis revealed that 39 to 85% of the seasonal diet is comprised of food from feeding stations (Rauer and Gutleb 1997).

The population has been monitored since the first release in 1989. All released bears were radio-collared and marked with ear-tags (Rauer 1997). For management reasons additional trapping (Aldrich foot snares) was carried out from 1994–1998, and three more individuals born in the area were radio-collared and ear tagged. Bears were radio-tracked on average 10 times/month for 4–29 months and visually observed on average < 10 times/year. Radio-tracking and the ability to individually recognize certain bears by ear tags enabled us to keep good track of population development, individual fates, and cub production.

A genetic population analysis was started in 2000 using 7 microsatellites and two sex-specific loci. Hair samples were gathered at deer feeding sites and hair traps (Woods *et al.* 1999). In addition, samples of known individuals (released, captured, shot) were analyzed. From the eight individuals included in this investigation (see Fig. 1), six were known individuals (released or captured), from which blood samples for the genetic investigation were obtained. One individual (F5) was identified from hair samples in the field. No sample was available from male M1. DNA extraction was carried out using methods described in Taberlet *et al.* (1993, 1997), Ennis and Gallagher (1994), and Paetkau *et al.* (1995).

## Results and discussion

Three to four different alleles were found per locus. Each individual was unambiguously identified by a specific genotype combination with differences at two to seven microsatellite loci. The sex of all previously trapped individuals was proven by the genetic analysis, and individual F5 (never captured) was confirmed to be female. A pedigree of the sampled individuals was deduced from the genetic results combined with the monitoring data (Fig. 1).

Female F1 was the first individual released in the study area and she had 3 cubs each in 1991 and 1993 before she died in September 1993. Two of the three cubs born in 1991 disappeared during the summer of 1991; the fate of the remaining cub is unknown. Genetic evidence shows that females F2 and F3 are both offspring of F1 and M1 (a male naturally occurring in the reintroduction area). F2 was trapped, ear-tagged, and radio-collared in September 1994. Her age was determined to be 1 year 9 months by counting tooth annuli cementum layers (Đ. Huber, pers. com.), thus F2 was born in 1993. The year of birth for female F3 was not determined. However, the identical size and mass of F2 and F3 when both captured in spring/early summer 1995 (F2: body length 134 cm, body mass 74 kg; F3: body length 132 cm, body mass 72 kg) suggest that they were littermates from 1993 (the year of birth verified for F2). Two-year-old females in the Dinaric Mountains (also part of the Alps-Dinaric-Pindos population – Swenson *et al.* 2000; Zedrosser *et al.* 2001) weigh on average 60–70 kg in spring (J. Swenson, M. Adamič and Đ. Huber, pers. comm.). Visual observations of female F3 (identified by ear-tags) showed that she gave birth to at least 2 cubs in 1996. Thus, following the genetic, monitoring and physical evidence provided above, F3 mated as 2 year old in spring 1995 and gave birth the following year at the age of 3 years.

Female F4 was trapped in spring 1997 and was determined to be a yearling by the stage of her tooth development (Jonkel 1993). Female F5 was never captured, but a genetic analysis of hair samples showed that both females F4 and F5 are offspring of female F3 and M2 (the introduced male). As shown above, female F3

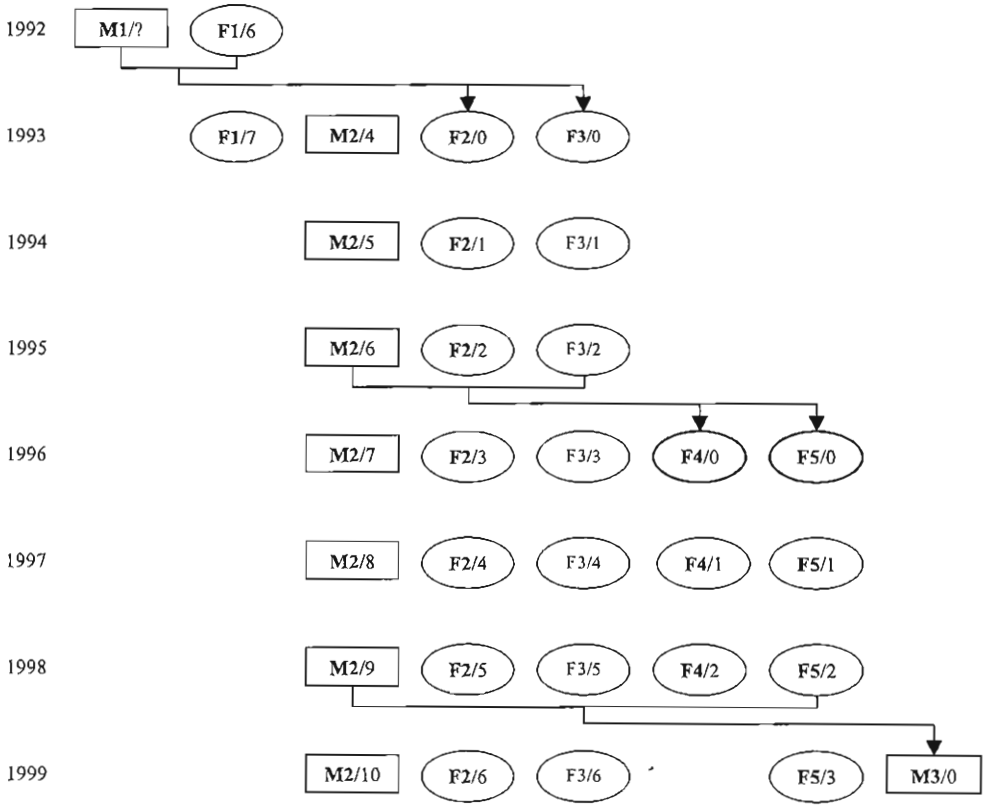


Fig. 1. Pedigree of female brown bears giving birth at the age of 3 years in central Austria. Male bears are presented as squares, females as ellipses. Cubs born by 3-year-old mothers are marked in bold. The individual bears are named as in the text, the number after the slash represents age, and solid lines show parental relationships.

gave birth to her first litter in 1996, thus females F4 and F5 have to be littermates born in 1996 (the year of birth verified for F4).

In spring 1999, male M3 was found as an abandoned cub-of-the-year. Genetic analyses showed that M3 was an offspring of female F5 and male M2. Thus, female F5 mated for the first time at the age of 2 years and gave birth at the age of 3 years. Genetic analysis could not exclude F4 (the sister of F5) as mother of M3, but F4 was killed illegally in 1998, a year before M3 was born.

Our data suggest that wild female brown bears are sexually mature in their 2nd year and able to reproduce at the age of 3 years. The genetic monitoring performed continuously over 3 years has always been consistent with the field data. Primiparity at the age of 3 years has rarely been documented in wild bears in general, and brown bears specially. Kordek and Lindzey (1980) found five 2.8 year-old pregnant American black bears *Ursus americanus* in Pennsylvania.

Frković *et al.* (2001) presented anecdotal evidence of one female brown bear in Croatia reproducing on her third birthday and Tsubota *et al.* (1989) report corpora albicantia in a 2-year-old female brown bear from Japanese.

McLellan (1994) has calculated overall mean ages of primiparity for wild North American brown/grizzly bear populations, which averaged 6.6 years for interior and 6.4 years for coastal populations, with earliest recorded births at 4.4 years. In Europe, Swenson *et al.* (2001) report that the mean age of primiparity in south--central Sweden was 4.5 years and 5.4 years in northern Sweden.

Captive bears living on a rich diet develop more rapidly than wild ones (Dittrich and Kronberger 1963, Curry-Lindahl 1972, Rogers 1976). The nutritional condition of females has been reported to influence the age of first birth in many wild populations of American black bears (Jonkel and Cowan 1971, Rogers 1976, 1987, Beecham 1980, Kolenosky 1990, Stringham 1990a), polar bears *U. maritimus* (Ramsey and Sterling 1988), and grizzly/brown bears (Stringham 1980, 1990b, Bunnel and Tait 1981). The unusually early ages of primiparity in Austrian brown bears occurred in a recently introduced population with year-round access to cereals at deer feeding stations.

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## References

Beecham J. J. 1980. Some population characteristics of two black bear populations in Idaho. [In: Bears – their biology and management. C. J. Martinka and K. L. McArthur, eds]. Proceedings of the International Conference on Bear Research and Management 4: 201–204.

Bunnel F. L. and Tait D. E. N. 1981. Population dynamics of bears – implications. [In: Dynamics of large mammals populations. C. W. Fowler and T. D. Smith, eds]. John Wiley and Sons, New York: 75–98.

Curry-Lindahl K. 1972. The brown bear (*Ursus arctos*) in Europe: decline, present distribution, biology and ecology. [In: Bears – their biology and management. S. Herrero, ed]. Proceedings of the International Conference on Bear Research and Management 2: 74–80.

Dittrich L. and Kronberger H. 1963. Biologisch-anatomische Untersuchungen über die Fortpflanzungsbiologie des Braunbären (*Ursus arctos* L.) und anderer Ursiden in Gefangenschaft. Zeitschrift für Säugetierkunde 28: 129–192.

Ennis S. and Gallagher T. F. 1994. A PCR-based sex-determination assay in cattle based on the bovine amelogenin locus. Animal Genetics 25: 425–427.

Frković A., Huber Đ. and Kusak J. 2001. Brown bear litter sizes in Croatia. Ursus 12: 103–106.

Jonkel J. J. 1993. A manual for handling bears for managers and researchers. Office of Grizzly Bear Recovery, U.S. Fish and Wildlife Service, Natural Sciences 312, University of Montana, Missoula, Montana: 1–175.

Jonkel C. L. and Cowan I. M. 1971. The black bear in the spruce-fir forest. Wildlife Monographs 27: 1–57.

Kolenosky G. B. 1990. Reproductive biology of black bears in east-central Ontario. [In: Bears – their Biology and Management. Darling L. M. and Archibald W. R., eds.) Proceedings of the International Conference on Bear Research and Management 8: 385–392.

Kordek W. S. and Lindzey J. S. 1980. Preliminary analysis of female reproductive tracts from Pennsylvania black bears. [In: Bears – their biology and management. C. J. Martinka and K. L. McArthur, eds]. Proceedings of the International Conference on Bear Research and Management 4: 159–161.

McLellan B. 1994. Density-dependent population regulation of brown bears. [In: Density-dependent population regulation of black, brown and polar bears. M. Taylor, ed.] Proceedings of the International Conference on Bear Research and Management 9, Monograph Series No. 3: 15–24.

Paetkau D., Stirling I. and Strobeck C. 1995. Microsatellite analysis of population-structure in Canadian polar bears. Molecular Ecology 4: 347–354.

Ramsey M. A. and Stirling I. 1988. Reproductive biology and ecology of female polar bears (*Ursus maritimus*). Journal of Zoology, London 214: 601–634.

Rauer G. 1997. First experiences with the release of 2 female brown bears in the Alps of eastern Austria. Proceedings of the International Conference on Bear Research and Management 9 (2): 91–95.

Rauer G., Aubrecht P., Gutleb B., Kaczensky P., Knauer F., Plutzar C., Slotta-Bachmayr L., Walzer C. and Zedrosser A. 2001. Der Braunbär in Österreich II. Federal Environment Agency – Austria, Monograph Series No. 110: 1–102.

Rauer G. and Gutleb B. 1997. Der Braunbär in Österreich. Federal Environment Agency – Austria, Monograph Series No. 88: 1–64.

Rogers L. L. 1976. Effects of mast and berry crop failures on survival, growth, and reproductive success of black bears. Transactions of the North American Wildlife and Natural Resources Conference, Wildlife Management Institute, Washington, D.C. 41: 431–438.

Rogers L. L. 1987. Effects of food supply and kinship on social behavior, movements, and population growth of black bears in northeastern Minnesota. Wildlife Monographs 97: 1–72.

Stearns S. C. 1992. The evolution of life histories. Oxford University Press, New York: 1–249.

Stringham S. F. 1980. Possible impacts of hunting on the grizzly/brown bear, a threatened species. [In: Bears – their biology and management. C. J. Martinka and K. L. McArthur, eds]. Proceedings of the International Conference on Bear Research and Management 4: 337–349.

Stringham S. F. 1990a. Grizzly bear reproductive rate relative to body size. [In: Bears – their biology and management. L. M. Darling and W. R. Archibald, eds]. Proceedings of the International Conference on Bear Research and Management 8: 433–443.

Stringham S. F. 1990b. Black bear reproductive rate relative to body weight in hunted populations. [In: Bears – their biology and management. L. M. Darling and W. R. Archibald, eds]. Proceedings of the International Conference on Bear Research and Management 8: 425–432.

Swenson J. E., Gerstl N., Dahle B. and Zedrosser A. 2000. Action plan for the conservation of the brown bear in Europe. Council of Europe, Strasbourgh Cedex, Nature and Environment No. 114: 1–69.

Swenson J. E., Sandegren F., Brunberg S. and Segerström P. 2001. Factors associated with loss of brown bear cubs in Sweden. Ursus 12: 69–80.

Taberlet P., Camarra J. J., Griffin S., Uhres E., Hanotte O., Waits L. P., Dubois-Paganon C., Burke T. and Bouvet J. 1997. Noninvasive genetic tracking of the endangered Pyrenean brown bear population. Molecular Ecology 6: 869–876.

Taberlet P., Mattock H., Dubois-Paganon C. and Bouvet J. 1993. Sexing free-ranging brown bears *Ursus arctos* using hairs found in the field. Molecular Ecology 2: 399–403.

Tsubota T., Xanagawa H., Mano T. and Aoi T. 1989. Corpora albicantia and placental scars in the Hokkaido brown bear. [In: Bears – their biology and management. L. M. Darling and W. R. Archibald, eds]. Proceedings of the International Conference on Bear Research and Management 8: 125–128.

Woods J. G., Paetkau D., Lewis D., McLellan B. N., Proctor M. and Strobeck C. 1999. Genetic tagging of free-ranging black and brown bears. Wildlfe Society Bulletin 27: 616–627.

Zedrosser A., Dahle B., Swenson J. E. and Gerstl N. 2001. Status and management of the brown bear in Europe. Ursus 12: 9–20.

Zedrosser A., Rauer G. and Gerstl N. 1999. Brown bears in Austria. 10 years of conservation and actions for the future. Federal Environment Agency – Austria, Monograph Series No. 117: 1–42.

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