

## COMMENTARY

Death Among Geladas (*Theropithecus gelada*): A Broader Perspective on Mummified Infants and Primate Thanatology

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Despite intensive study in humans, responses to dying and death have been a neglected area of research in other social mammals, including nonhuman primates. Two recent reports [Anderson JR, Gillies A, Lock LC. 2010. *Pan* thanatology. *Current Biology* 20:R349–R351; Biro D, Humle T, Koops K, Souse C, Hayashi M, Matsuzawa T. 2010. Chimpanzee mothers at Bossou, Guinea carry the mummified remains of their dead infants. *Current Biology* 20:R351–R352] offered exciting new insights into behavior toward dying and dead conspecifics in our closest living relatives—chimpanzees. Here, we provide a comparative perspective on primate thanatology using observations from a more distant human relative—gelada monkeys (*Theropithecus gelada*)—and discuss how gelada reactions to dead and dying groupmates differ from those recently reported for chimpanzees. Over a 3.75-year study period, we observed 14 female geladas at Guassa, Ethiopia carrying dead infants from 1 hr to  $\geq 48$  days after death. Dead infants were carried by their mothers, other females in their group, and even by females belonging to other groups. Like other primate populations in which extended ( $> 10$  days) infant carrying after death has been reported, geladas at Guassa experience an extreme climate for primates, creating conditions which may favor slower rates of decomposition of dead individuals. We also witnessed the events leading up to the deaths of two individuals and the responses by groupmates to these dying individuals. Our results suggest that while chimpanzee mothers are not unique among primates in carrying their dead infants for long periods, seemingly “compassionate” caretaking behavior toward dying groupmates may be unique to chimpanzees among nonhuman primates (though it remains unknown whether such “compassionate” behavior occurs outside captivity). *Am. J. Primatol.* 71:1–5, 2010. © 2010 Wiley-Liss, Inc.

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## INTRODUCTION

Care for dying conspecifics, grief, and other complex responses to dying and death are considered by many to be defining characteristics of humanity [Dobzhansky & Boesiger, 1983; Holt & Formicola, 2008; Pearson, 2003]. Despite intensive study in humans [Bryant, 2003; Counts & Counts, 1991; Kutscher et al., 1987], death and its aftermath has been a neglected area of research in other social mammals. Scattered reports from the wild suggest that dying individuals of several species, including African elephants and giant otters, may receive help from groupmates [Davenport, 2010; Douglas-Hamilton et al., 2006]. In addition, observations of African elephants suggest that some individuals exhibit intense curiosity about the remains of dead conspecifics [Bates et al., 2008].

Among nonhuman primates, reports of responses to dying and dead conspecifics come mostly from captive populations [Zeller, 1991], with observations from the wild limited to a few species [ringtailed lemurs: Nakamichi et al., 1996; Japanese macaques: Sugiyama et al., 2009; chimpanzees: Teleki, 1973; mountain gorillas: Warren & Williamson, 2004].

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Accounts from the wild suggest it is not uncommon for primate mothers to carry the bodies of dead infants for up to several days after death. In the most extensive study on this topic to date (a 24-year study of provisioned Japanese macaques), Sugiyama et al. [2009] found that 10% of infants continued to be carried by their mothers after death, with a mean carrying duration of 3.3 days (range = 1–17 days). Furthermore, recent research suggests that (like in humans) the loss of a close relative may be “stressful” for some nonhuman primates. Specifically, Engh et al. [2006] reported that female baboons at Moremi, Botswana, showed short-term increases in the stress hormones glucocorticoids after the death of close female relatives.

Two recent reports [Anderson et al., 2010; Biro et al., 2010] focusing on chimpanzee behavior toward dying and dead conspecifics offered intriguing new insights into mortality in our closest living relatives. In one study, chimpanzees in captivity quietly groomed and caressed a dying groupmate, behaviors interpreted as indicating respect, care, and anticipatory grief [Anderson et al., 2010]. In a second report, a 30-year study of provisioned chimpanzees at Bossou, Guinea, three adult females were observed carrying and caring for their long dead (19, 27, and 68 days) infants [Biro et al., 2010].

Here, we provide comparative observations from a wild population of a more distant human relative, gelada monkeys (*Theropithecus gelada*). Our findings provide a comparative perspective on primate thanatology, broadening the context for recent observations of reactions to the death of conspecifics in chimpanzees. As with recent reports for Japanese macaques [Sugiyama et al., 2009] and mountain gorillas [Warren & Williamson, 2004], our results suggest there may be nothing unique about chimpanzees carrying dead infants for long periods. However, our observations suggest that seemingly “compassionate” behavior toward dying individuals may potentially be unique to chimpanzees among nonhuman primates, though it remains unknown whether such “compassionate” behavior exists outside captivity.

## GELADA BEHAVIOR TOWARD DEAD INFANTS

From January 2007 to September 2010, we witnessed 14 female geladas at Guassa (a large alpine grassland in the Ethiopian Highlands [Ashenafi et al., 2005; Fashing et al., 2010]) carrying dead infants for periods of as little as 1 hr to as long as  $\geq 48$  days after death. We also witnessed the events leading up to the deaths of two individuals and the responses by groupmates to these dying individuals.

Most gelada females carried their dead infants (mean infant age at death = 46 days; range = 1–180 days;  $n = 6$  infants of known age) for  $\sim 1$ –4 days after

death before abandoning the carcass, a pattern not uncommon among nonhuman primates [Sugiyama et al., 2009; Warren & Williamson, 2004]. However, like the chimpanzees at Bossou [Biro et al., 2010], three gelada females at Guassa carried their infants for long periods [13 days (Fig. 1a),  $\geq 16$  days, and  $\geq 48$  days, respectively], following death. In all three instances, the infants underwent mummification (Fig. 1b) and, in the latter case, the mother continued to carry her infant long after the flesh had rotted away from most of its skull (Fig. 1c). Like in the chimpanzees at Bossou [Biro et al., 2010], gelada mothers at Guassa continued to groom their infants (Fig. 1d) for weeks after death and were not avoided by other members of their group, despite the powerful smell of decay emanating from their infants. Also like in chimpanzees, even long dead infant geladas were carried with one hand or in the mouth, techniques never used for transporting live infants.

Dead gelada infants evoked considerable interest from female groupmates as well as occasionally from females in other groups. On one occasion, a juvenile female emerged from her group’s sleeping cliff holding a dead infant belonging to another female in her group (Fig. 1e), and spent several hours that morning carrying and repeatedly grooming the carcass without interference from its mother. On another occasion, a juvenile female was observed carrying the dying infant of a female groupmate, and was subsequently seen two days later carrying and repeatedly grooming the infant after its death (Fig. 1f). On a third occasion, a nulliparous adult female ascended from the sleeping cliff carrying a dead infant belonging to a female in a *different* group. The nulliparous female groomed the dead infant repeatedly and occasionally allowed a juvenile female to also carry and groom the dead infant. Carrying and grooming of dead infants by groupmates of the mother was also observed among chimpanzees at Bossou [Biro et al., 2010] and among mountain gorillas at Karisoke, Rwanda [Warren & Williamson, 2004]. However, to our knowledge, our study provides the first observations of a primate taking care of a dead infant belonging to another group.

Biro et al. [2010] suggest that dead chimpanzee infants are eventually abandoned owing to hormonal changes associated with the termination of lactation and the resumption of cycling. If ovarian cycling promotes infant abandonment, we would not expect mothers who have resumed cycling to continue to carry their dead infants. However, the gelada female who carried her dead infant for  $\geq 48$  days resumed mating activity  $\sim 2$  weeks *before* abandoning her infant’s mummified carcass, copulating repeatedly while clutching its body with one hand. These observations suggest that hormonal changes associated with a return to estrus are not necessarily linked to the abandonment of dead infants in geladas.



Fig. 1. (a) An adult female gelada at Guassa holding her mummified infant on its tenth day after death. She finally abandoned the infant 13 days after it died. (b) A close-up view of a mummified infant. (c) An adult female gelada and her mummified infant which she carried for  $\geq 48$  days after its death. The arrow indicates where the skin had rotted away from the infant's skull. (d) Adult female grooming her dead infant. Like several other females who cared for dead infants, she directed considerable attention to (grooming and picking at) the infant's eyes. (e) Juvenile female carrying the dead infant of another female in her group. (f) Juvenile female grooming the dead infant of another female in her group.

Curiously, all primate populations in which extended ( $> 10$  days) infant carrying after death has been reported occur at sites characterized by rather extreme climatic conditions. Geladas, Japanese macaques, and mountain gorillas inhabit unusually cold environments for primates [Fashing et al., 2010; Nakagawa et al., 2010; Vedder, 1984], while the chimpanzees at Bossou experience long, extremely arid dry seasons [Takemoto, 2004]. Indeed, all three infants carried for long periods at Bossou died during the dry season [Biro et al., 2010; Matsuzawa, 1997]. Extreme conditions, whether cold or arid, may slow the natural rate of decomposition of deceased individuals [Haglund & Sorg, 1997], thus extending the periods over which dead infants can be carried. These patterns raise the intriguing possibility that differences between populations or species of primates in the duration of dead infant carrying may, in part, reflect intersite differences in climatic conditions. They also suggest researchers should be cautious about inferring a greater sense of loss or

attachment in species or populations where females sometimes carry dead infants for extended periods.

### GELADA BEHAVIOR TOWARD DYING INDIVIDUALS

Although long-term attachment to dead infants by mothers and others seems to be as multifaceted and nearly as enduring among geladas at Guassa as in chimpanzees at Bossou, the behaviors by conspecifics immediately before and after death in wild geladas may be “less compassionate” than in captive chimpanzees.

In April 2010, we witnessed a dependent infant (Tussock) die a day after its mother (Tesla) succumbed to illness following the recent rupture of a large parasitic swelling under her left arm. Although two nulliparous female groupmates provided assistance by carrying the 7-month old Tussock (extensive carrying of infants by females other than the mother is unusual among geladas) as

Tesla struggled to keep up with the rest of her group in the days before her death, these females and the rest of the group were very unlikely to have been nearby when Tesla and (a day later) Tussock drew their last breaths.

On the morning of her death (April 14, 2010), a frail, ragged Tesla remained behind with Tussock near their sleeping cliffs as other members of their group (and the rest of the gelada herd they were traveling with that day) left them to forage on the plateau hundreds of meters above the cliffs. Tesla and Tussock's groupmates peered intently back in their direction once during the morning before disappearing completely onto the plateau. Over the course of the day, Tesla, with Tussock in tow, managed to slowly move ~175 m along the edge of the cliff. That evening, Tesla's group returned to the same cliffs where they had slept the night before, showing no signs of searching for the missing mother-infant pair ~175 m away. The next morning, we found Tesla dead where we had left her the night before. Tussock remained alone that day, crying plaintively and rocking side-to-side beside her mother's lifeless body on the edge of the sleeping cliff. Tussock died that night, also presumably alone, and was found the next morning beside her dead mother.

Our observations of the events leading up to the solitary deaths of Tesla and Tussock stand in stark contrast to those from a recent report involving a captive adult female chimpanzee who died peacefully surrounded by attentive conspecific caretakers [Anderson et al., 2010]. It should be noted, however, that captive chimpanzees need not travel long distances for food, and thus have the option of maintaining long vigils near dying groupmates that may not be possible for their wild counterparts. Among wild chimpanzees, only the responses of several individuals to the accidental death of a group mate, after he fell and broke his neck, have been reported [Teleki, 1973]. In that instance, groupmates reacted with alarm, displaying and brushing past the dead individual repeatedly. Although they remained nearby for several hours, other group members never exhibited behaviors that could be regarded as "compassionate" toward the deceased individual [Teleki, 1973]. Clearly, more observations of natural deaths among wild chimpanzees and other nonhuman primates will be necessary before a truly scientific treatment of primate "thanatology," and a more informed understanding of the evolutionary roots of the social behaviors surrounding death in our own species, become possible.

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#### REFERENCES

- Anderson JR, Gillies A, Lock LC. 2010. *Pan* thanatology. *Current Biology* 20:R349–R351.
- Ashenafi ZT, Coulson T, Sillero-Zubiri, Leader-Williams N. 2005. Behaviour and ecology of the Ethiopian wolf (*Canis simensis*) in a human-dominated landscape outside protected areas. *Animal Conservation* 8:113–121.
- Bates LA, Poole JH, Byrne RW. 2008. Elephant cognition. *Current Biology* 18:R544–R546.
- Biro D, Humle T, Koops K, Souse C, Hayashi M, Matsuzawa T. 2010. Chimpanzee mothers at Bossou, Guinea carry the mummified remains of their dead infants. *Current Biology* 20:R351–R352.
- Bryant CD, editor. 2003. *Handbook of death and dying*. Thousand Oaks: Sage Publications, Inc.
- Counts DR, Counts DA, editors. 1991. *Coping with the final tragedy: cultural variation in dying and grieving*. Amityville, NY: Baywood Publishing Company, Inc. 326p.
- Davenport LC. 2010. Aid to a declining matriarch in the giant otter (*Pteronura brasiliensis*). *PLoS ONE* 5:e11385. DOI: 10.1371/journal.pone.0011385.
- Dobzhansky T, Boesiger E. 1983. *Human culture: a moment in evolution*. New York: Columbia University Press.
- Douglas-Hamilton I, Shalla S, Wittemyer G, Vollrath F. 2006. Behavioural reactions of elephants towards a dying and deceased matriarch. *Applied Animal Behaviour Science* 100:87–102.
- Engh AL, Beehner JC, Bergman TJ, Whitten PL, Hoffmeier RR, Seyfarth RM, Cheney DL. 2006. Behavioural and hormonal responses to predation in female chacma baboons (*Papio hamadryas ursinus*). *Proceedings of the Royal Society B* 273:707–712.
- Fashing PJ, Nguyen N, Fashing NJ. 2010. Behavior of geladas and other endemic wildlife during a desert locust outbreak at Guassa, Ethiopia: ecological and conservation implications. *Primates* 51:193–197.
- Haglund WD, Sorg MH, editors. 1997. *Forensic taphonomy: the postmortem fate of human remains*. Boca Raton: CRC Press.
- Holt BM, Formicola V. 2008. Hunters of the Ice Age: the biology of Upper Paleolithic people. *Yearbook of Physical Anthropology* 51:70–99.
- Kutscher AH, Carr AC, Kutscher LG, editors. 1987. *Principles of thanatology*. New York: Columbia University Press. 342p.
- Matsuzawa T. 1997. The death of an infant chimpanzee at Bossou, Guinea. *Pan African News* 4:1.
- Nakagawa N, Nakamichi M, Sugiura H, editors. 2010. *The Japanese macaques*. New York: Springer.
- Nakamichi M, Koyama N, Jolly A. 1996. Maternal responses to dead and dying infants in wild troops of ring-tailed lemurs at the Berenty reserve, Madagascar. *International Journal of Primatology* 17:505–523.

- Pearson M. 2003. The archeology of death and burial. Phoenix Mill: Sutton Publishing.
- Sugiyama Y, Kurita H, Matsui T, Kimoto S, Shimomura T. 2009. Carrying of dead infants by Japanese macaque (*Macaca fuscata*) mothers. *Anthropological Science* 117:113–119.
- Takemoto H. 2004. Seasonal change in terrestriality of chimpanzees in relation to microclimate in the tropical forest. *American Journal of Physical Anthropology* 124:81–92.
- Teleki G. 1973. Group responses to the accidental death of a chimpanzee in Gombe National Park, Tanzania. *Folia Primatologica* 20:81–94.
- Vedder A. 1984. Movement patterns of a group of free-ranging mountain gorillas (*Gorilla gorilla beringei*) and their relation to food availability. *American Journal of Primatology* 7:73–88.
- Warren Y, Williamson EA. 2004. Transport of dead infant mountain gorillas by mothers and unrelated females. *Zoo Biology* 23:375–378.
- Zeller A. 1991. The grieving process in non-human primates. In: Counts DR, Counts DA, editors. *Coping with the final tragedy: cultural variation in dying and grieving*. Amityville, NY: Baywood Publishing Company, Inc. p 5–26.