DOI 10.1515/mammalia-2011-0091 — Mammalia 2012; 76(4): 447–449

Short Note

Jinhong Luo, Guanjun Lu and Jiang Feng*

Diurnal capture reduces the colony size of *Hipposideros armiger* (Chiroptera: Hipposideridae)

Abstract: Although it is conjectured that diurnal capture may reduce the colony size of bats, little evidence is available. We monitored a maternity colony of cave-dwelling bats (*Hipposideros armiger*) both before and after casual diurnal disturbance and capture. Results from more than 40 days of monitoring after disturbance suggested that diurnal capture significantly reduced the colony size from more than 90 individuals to a few. Moreover, the trend for colony size after disturbance indicated that most bats may not return to the roost for the whole season. This study has implications for both bat researchers and wildlife managers.

Keywords: anthropogenic activity; cave; *Hipposideros armiger*; maternity; roost disturbance.

***Corresponding author: Jiang Feng,** Jilin Key Laboratory of Animal Resource Conservation and Utilization, Northeast Normal University, 5268 Renmin Street, Changchun 130024, China, e-mail: Fengj@nenu.edu.cn
Jinhong Luo: Jilin Key Laboratory of Animal Resource Conservation and Utilization, Northeast Normal University, 5268 Renmin Street, Changchun 130024, China
Guanjun Lu: Jilin Key Laboratory of Animal Resource Conservation and Utilization, Northeast Normal University, 5268 Renmin Street, Changchun 130024, China

Underground roosts such as caves play important roles as maternity, hibernating, mating, and aggregation sites for many bat species (Kunz 1982). However, roost disturbance due to a variety of anthropogenic activities has long threatened bats worldwide (Hutson et al. 2001). In spite of the continued conservation efforts from both scientific researchers and wildlife managers during the past 20–30 years, many bat species are still under threat (Altringham 2011). Cave bat conservation has even been listed as the conservation priority for some areas or countries (Kingston 2010).

Scientific evidence is crucially important in supporting conservation decision making in policy and practice (Pullin and Knight 2005). Specifically, lack of both short-term and long-term monitoring severely compromises our ability to practice evidence-based conservation in bats (Altringham 2011). Diurnal capture by both researchers and casual roost visitors, for example, has not been fully recognized as a potential threat to cave bats and little related monitoring of bat colony or population has been conducted. Here, we provide empirical evidence showing that colony size of bats could be dramatically reduced by diurnal capture and its negative effects on bats may last for several months.

We conducted this study at Bianfu Cave (31.63°N, 104.40°E) in Anchang town of Sichuan province, China, in June 2010 and April to June 2011. Bianfu Cave was located in a secondary forest, about 200 m away from the nearest residential area. It is a small cave with an entrance size of about 7 m^2, the smallest tunnel size of 1.2 m^2, and the minimum and maximum heights between ceiling and ground of 0.5 and 4 m, respectively. Bianfu Cave was used as a day roost mainly by *Hipposideros armiger* (Hodgson, 1835) and occasionally by several *Rhinolophus sinicus* (Andersen, 1905).

Hipposideros armiger is one of the largest species in the genus *Hipposideros*, with a forearm length ranging from 82 to 99 mm (Smith and Xie 2008). It is a common cave-dwelling species that feeds in open spaces in woodlands, gardens, and around trees (Bates and Harrison 1997). Studies on *H. armiger terasensis* showed that maternity colonies of this species may be sensitive to human disturbance and they tended to prefer roosts with little human disturbance (Ho and Lee 2003).

Bats were captured by a mist net set at the cave entrance during dusk emergence on June 7 and 8, 2010. Since female *Hipposideros armiger* were mid to late pregnant at the time, mist netting on June 8 was primarily aimed at capturing other bat species. As a result, once *H. armiger* was trapped, it was freed immediately. Pregnancy was determined by direct observation of the distended lower abdomen and swollen nipples or through palpation (Racey 1969, 2009). Capturing and handling of bats conformed to the guidelines for animal care and use established by the American Society of

Mammalogists (Gannon and Sikes 2007) and abided by the law of the People's Republic of China on Protection of Wildlife.

The colony size of *Hipposideros armiger* was assessed through evening emergence counts by one or two observers on June 6, 2010, and from April 27 to June 11, 2011, respectively. In 2011, we made 27 emergence counts, including three evenings before the roost disturbance. Bat counts started 20–30 min before the first bat emerged and ended when no bat was seen for 30 min. Initially, we counted the bats directly by eye and dim red light was used as darkness fell.

The roost was accidentally disturbed by three children who entered the roost and captured three individuals of *Hipposideros armiger* by hands covered with clothes in the afternoon on April 30, 2011. They stayed in the roost for about 10 min. The three bat individuals died afterward. We confirmed this event by talking to these children on May 2. To avoid further disturbance, the roost was closely watched by us and nobody including ourselves approached or captured bats since then in our study period.

On June 6, 2010, 92 individuals of *H. armiger* were recorded through evening emergence counts. On the following two evenings, 20 *H. armiger* and three *Rhinolophus sinicus* were captured with a mist net. As 8 of the 15 captured female *H. armiger* were pregnant, Bianfu Cave is a maternity roost of *H. armiger*. In 2011, data from three consecutive evenings before the roost disturbance indicated that there were more than 95 individuals of *H. armiger* (Figure 1). This result was consistent with that from 2010, although five or six more individuals were recorded. After the roost disturbance, however, the colony size was largely reduced to 2 to 29. The largest colony size after the disturbance occurred on May 10, 2011, which represented less than one third of the previous colony size. Moreover, the trend of the colony size after the disturbance indicated that most bats may not return to the roost for the whole season.

Our data indicate that a single capture of bats in the daytime has a strong enough negative effect to largely reduce the colony size of bats and the effect could last for several months. Our result is contrary to some evidence suggesting that disturbed bat colonies returned to their roosts within days. For example, a cavity-roosting species, *Nycteris grandis* (Peters, 1865), abandoned preferred roosts after a disturbance but returned several days later (Fenton et al. 1993). Although there is no conclusive explanation for this contrasting result, species differences and the related life-history stage, colony size, and roost traits such as roost type and size, may

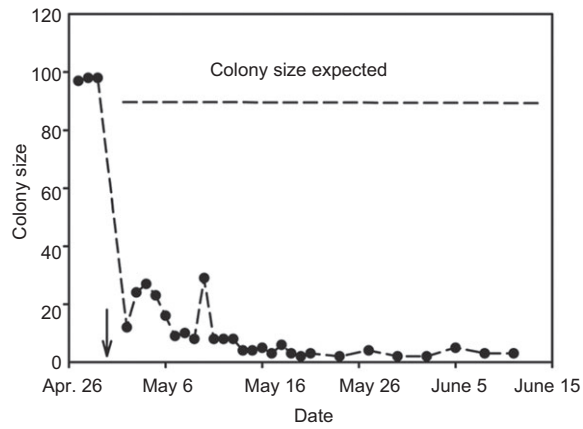

Figure 1 Colony size of *Hipposideros armiger* in Bianfu Cave, Sichuan Province, China, before and after casual diurnal capture in 2011.
The arrow indicates the date of casual diurnal capture, and the black dot indicates the recorded number of bat individuals for corresponding date.

be all responsible. However, it is least likely that our result was due to the natural roost switching in bats, although this occurs in many bat species (Fenton et al. 1994, Lewis 1995).

Considerable evidence suggests that roosts are limiting for many bat species, particularly for cave-dwelling animals (Pierson 1998). Once bats are forced to leave the preferred roosts, they need to find alternative shelters. These efforts, however, could be energetically costly (Lewis 1995). Moreover, temporary roosts may place bats in an unfavorable condition with higher physiological and ecological pressure if the historical roosts are the optimal choices. The constraints may be more severe during certain life-history stages such as pregnancy, lactation, and hibernation, when they are more sensitive to their roost environment (Hayes et al. 2009, Kunz et al. 2009). Consequently, roost switching due to human disturbance could be harmful to bats and thus may reduce their fitness.

Our results have implications for both bat researchers and wildlife managers. In the field, bat researchers should avoid direct capture of roosting bats from maternity colonies in the daytime, even when the pregnancy is not obvious. Wildlife managers, on the other hand, need to pay more attention to maternity colonies of bats in order to prevent them from disturbance by casual visitors.

Acknowledgements: We are grateful to Hong Xiao for his support in the field. We thank Professor M. Brock Fenton and the late Professor Elisabeth K.V. Kalko for sharing their perspectives with us. Special thanks go to Ying-Yi

Ho for spending a great amount of time on reading and carefully commenting on our earlier manuscript. Professor Paul A. Racey is acknowledged for native language editing and valuable comments as a reviewer. Funding for our fieldwork came from the National Natural Science Foundation of China (grant no. 31030011, 30870371, and 30900166).

Received September 9, 2011; accepted June 12, 2012; previously published online August 4, 2012

References

Altringham, J.D. 2011. Bats: from evolution to conservation. Oxford University Press, New York. pp. 239–240.

Bates, P.J.J. and D.L. Harrison. 1997. Bats of the Indian subcontinent. Harrison Zoological Museum, Sevenoaks, UK. pp. 98.

Fenton, M.B., I.L. Rautenbach, D. Chipese, M.B. Cumming, M.K. Musgrave, J.S. Taylor and T. Volpers. 1993. Variation in foraging behaviour, habitat use, and diet of large slit-faced bats (*Nycteris grandis*). Z. Säugetierk. 58: 65–74.

Fenton, M.B., I.L. Rautenbach, S.E. Smith, C.M. Swanepoel, J. Grosell and J. van Jaarsveld. 1994. Raptors and bats: threats and opportunities. Anim. Behav. 48: 9–18.

Gannon, W.L. and R.S. Sikes. 2007. Guidelines of the American Society of Mammalogists for the use of wild mammals in research. J. Mammal. 88: 809–823.

Hayes, J.P., H.K. Ober and R.E. Sherwin. 2009. Survey and monitoring of bats. In: (T.H. Kunz and S. Parsons, eds.) Ecological and behavioral methods for the study of bats. The Johns Hopkins University Press, Baltimore, MD. pp. 112–129.

Ho, Y. and L. Lee. 2003. Roost selection by Formosan leaf-nosed bats (*Hipposideros armiger terasensis*). Zool. Sci. 20: 1017–1024.

Hutson, A.M., S.P. Mickleburgh and P.A. Racey. 2001. Microchiropteran bats: global status survey and conservation action plan. IUCN, Gland, Switzerland. pp. 43–46.

Kingston, T. 2010. Research priorities for bat conservation in Southeast Asia: a consensus approach. Biodivers. Conserv. 19: 471–484.

Kunz, T.H. 1982. Roosting ecology of bats. In: (T.H. Kunz, ed.) Ecology of bats. Plenum Press, New York. pp. 1–55.

Kunz, T.H., R. Hodgkison and C.D. Weise. 2009. Methods of capturing and handling bats. In: (T.H. Kunz and S. Parsons, eds.) Ecological and behavioral methods for the study of bats. The Johns Hopkins University Press, Baltimore, MD. pp. 3–35.

Lewis, S.E. 1995. Roost fidelity of bats: a review. J. Mammal. 76: 481–496.

Pierson, E. 1998. Tall trees, deep holes, and scarred landscapes: conservation biology of North American bats. In: (T.H. Kunz and P.A. Racey, eds.) Bat biology and conservation. Smithsonian Institution Press, Washington, DC. pp. 309–325.

Pullin, A.S. and T.M. Knight. 2005. Assessing conservation management's evidence base: a survey of management-plan compilers in the United Kingdom and Australia. Conserv. Biol. 19: 1989–1996.

Racey, P.A. 1969. Diagnosis of pregnancy and experimental extension of gestation in the pipistrelle bat, *Pipistrellus pipistrellus*. J. Reprod. Fertil. 19: 465–474.

Racey, P.A. 2009. Reproductive assessment of bats. In: (T.H. Kunz and S. Parsons, eds.) Ecological and behavioral methods for the study of bats. The Johns Hopkins University Press, Baltimore, MD. pp. 249–264.

Smith, A.T. and Y. Xie. 2008. A guide to the mammals of China. Princeton University Press, Princeton, MA. pp. 346.