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Nursing Period, Behavior Development, and Growth Pattern of a Newborn Formosan Pangolin (*Manis pentadactyla pentadactyla*) in the Wild

Nick Ching-Min Sun[1], Jephte Sompud[2], and Kurtis Jai-Chyi Pei[3]

Abstract

The Formosan pangolin mainly inhabits the lowland forest in Taiwan. Biological information on pangolins is limited due to their solitary behavior. This study reports the first field record of the behavior development and growth pattern of a newborn male Formosan pangolin during the entire nursing period in the wild. The methods used in this study were radio-tagging and camera-trapping. Data collection for this study was conducted from November 2014 until May 2015. The nursing period was 157 days. The infant started to exit the nursing burrow alone at 11 weeks old, with significant soil scraping and licking behaviors. The duration and distance of the exploring were both extended considerably after 15 weeks old. All exploring behaviors that were recorded occurred after the mother had left the burrow. The total body length of the infant pangolin growth was at a relative constant rate of 1.2 cm/week during the nursing period, which was faster than the only record from a hand-reared individual (0.7 cm/week). This study presents a useful method to monitor the maternal behaviors and infant growth pattern for the Formosan pangolin under natural conditions.

Keywords

camera-trapping, infant growth rate, pangolin, radio-tracking, southeastern Taiwan

Introduction

The Formosan pangolin (*Manis pentadactyla pentadactyla*) is a subspecies of the Chinese pangolin (Allen, 1906; Schlitter, 1993; Wu, Ma, Tang, Chen, & Liu, 2002) that mainly inhabits the lowland forest of Taiwan (Chao, 1989). However, recent cytogenetic analysis could not confirm the previous morphological differentiation among the subspecies (Wu et al., 2007); therefore, in this article, we used the Formosan pangolin to refer to the Chinese pangolin population on Taiwan. The biological information of Chinese pangolin is understudied. Moreover, it is ''critically endangered'' due to poaching and illegal trade (International Union for Conservation of Nature, 2017). One of the greatest challenges to acquiring biological information on the wild Chinese pangolins is their solitary behavior that makes it difficult to observe and study.

The newborn total body length of the Chinese pangolin has been reported to range from 18.5 cm to 23.2 cm (Chao, Chen, Yeh, & Fang, 1993; Heath & Vanderlip, 1998; Wu, 1998; Zhang et al., 2016). However, the behavioral development and growth of the newborn pangolin has never been studied or observed under natural conditions; even captive observation has been limited (Chan, 2009; Wang, Lin, & Chan, 2012) due to survival abilities within captivity (Chao et al., 1993; Chin et al., 2011; Yang et al., 2001; Zhang et al., 2016). The growth rate,

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in terms of total body length, of a hand-reared Formosan pangolin, was reported to be about 0.7 cm/week (Wang et al., 2012). This observation, made by Wang et al. (2012), however, may not be representative of the wild pangolin within its natural environment as the diet and habitat varied to conditions in the wild.

This study reports the first field record of the growth (total body length) of a newborn male Formosan pangolin during the entire period of its maternal care based on a series of videos taken by camera traps of a radio-tagged adult female. This information contributes to the species not only fills an important knowledge gap but also provides valuable figures that can be useful in both in situ and ex situ conservation.

Methods

Ethics Statement

Ethics approval was granted by the laboratory animal center, National Pingtung University of Science and Technology. Pangolins were captured under the license with permission granted by the Taiwan Forestry Bureau (permit numbers 1011701139 and 1031700176) as required by the Wildlife Conservation Act, 2013. Anesthesia and medical treatment were done with guidelines (see Khatri-Chhetri, Sun, Wu, & Pei, 2015, for a detailed procedure). It is part of the ''Pangolin biology and ecology project'' conducted by the Institute of Wildlife Conservation, National Pingtung University of Science and Technology.

Study Site

The study site was located within the southern part of Coastal Mountain Range, Taitung County, Taiwan (22°90′ N, 121°18′ E). The ground elevations range from 100 m to 700 m. The vegetation landscape consisted of secondary forests, bamboo forests, orchards, grasslands, tree plantations, and farmland.

Radio Telemetry Monitoring for the Female Parent

A female pangolin (LF28) was caught and radio-tagged at its native habitat in October 2012, when it was a subadult with body weight of 1.85 kg, and was monitored until June 2016. Except during the nursing period, LF28 was recaptured approximately every 2 to 3 months. The radio transmitter was replaced periodically to ensure the continuity of monitoring. The radio transmitters used during this period included ATS R2020 (12 g) and R2030 (24 g) (Advanced Telemetry Systems, Inc, Isanti, MN) following the growth of LF28, with the active mode of 16 h on/8 h off. Radio transmitters were attached on the scale of the tail near the hip with small screws and bolts (Sun & Pei, 2015). The activity signals and locations of LF28 were monitored using a telemetry receiver (TR4; Telonics) with a directional H-antenna (RA-2AK or RA-23 K). The signal monitoring was conducted once a day for 7 days consecutively and for 2 separate weeks per month. We continually checked LF28's position for the duration of 14 days and longer when necessary.

Delivery Determination

A single individual Formosan pangolin uses up to several dozens of resting burrows within its home range and usually frequently changes the resting sites every 1 to 3 days (Lin, 2011). LF28 was found returning to the same resting burrow since early November 2014 based on daily position checks. LF28 did not leave the burrow to forage between December 1 and 3 and resumed her daily foraging routine after December 4, 2014. LF28 was recaptured when leaving the burrow on December 6, 2014. Based on evidence from the camera trapping footage, it was verified that it was lactating. Due to this information, the inferential conclusion is that LF28 gave birth approximately on December 1, 2014.

Behaviors and Growth Rate of the Infant

Two camera traps (Reconyx UltraFire model WR6 and XR6) were set in front of the observed burrow on December 10 to monitor the pangolin activity near the entrance. These camera traps were programmed to take a 30-s video whenever an animal was detected and a 3-s lag between two consecutive videos, if the animal was still present. The video recording in the evening was assisted with built-in LED lights. These camera traps were relocated whenever LF28 and its newborn moved to another burrow during the entire nursing period.

A pangolin mother typically carries their infant on its rump when traveling (Chan, 2009; Heath, 1992). We used the tail length (30 cm) of LF28 as a reference to estimate the total body length of the newborn while being carried (Figure 1). Because we used the filming function of the camera trap, it was always possible to take the measurement when the infant was on the full or nearly full stretch posture on the mother's back. It is important to note that there is potential for inaccuracy within our method, such as margins of error in measurements. Therefore, we only measured to the nearest centimeter. However, when compared with the margin of error caused by resistance of a stressed animal during handling when using band tape, the potential error in our method should be acceptable.

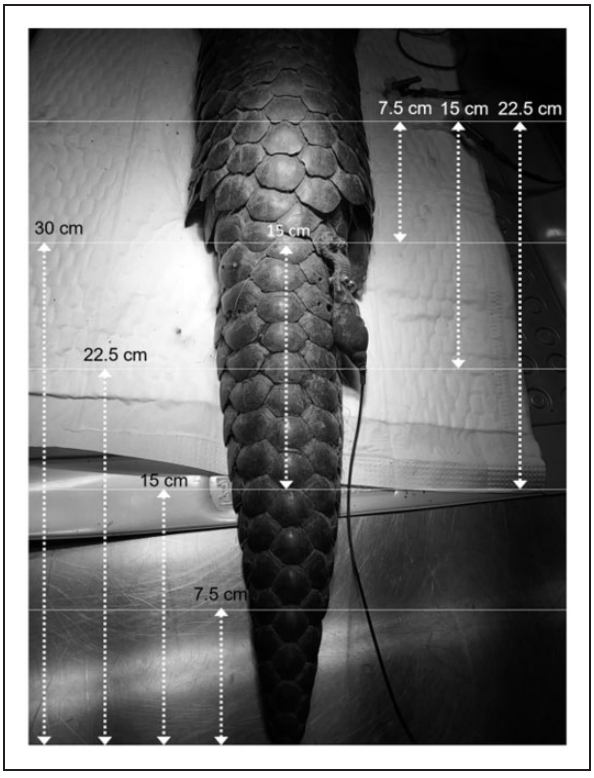

Figure 1. The tail length (30 cm) of a female Formosan pangolin (*Manis pentadactyla pentadactyla*) (LF28) as a reference for estimating the total body length of the newborn.

Results

Based on the data retrieved from the camera traps, LF28 had permanently left the young alone in the burrow on evening of May 6, 2015. The pup also left the burrow independently on May 8. Subsequent camera and radio monitoring was continued for LF28. It was observed that LF28 used three different resting burrows without the young between May 7 and 13. In addition, the baby was also not beside LF28 based on radio-tracking monitoring. Hence, confirming that LF28 and the pup had already become independent of each other. The nursing period was determined to be 157 days, approximately 22 to 23 weeks, from December 1, 2014, to May 6, 2015. Camera-trap monitoring was continued on the last burrow used by the pup, but no return was recorded and the camera traps were removed on May 20. The sex of pup was confirmed by the indication of the male genitalia on camera.

Twelve images of LF28 with the infant on its rump were taken with an interval of 3 to 27 days (Figure 2). The first image of the infant was taken on December 29 when it was approximately 1 month old. The total body length of the pup was estimated to be 25 cm during the initial recording and increased to 47 cm on May 6 morning right before it became permanently independent from LF28. The pup grew at a relative constant rate of 1.2 cm/week during this period (Figure 3).

During the entire nursing period, we also obtained an additional 29 video recordings of the infant alone. These video recordings revealed the behavioral data of the male pup. The first image of the pup was taken at 8 weeks old, showing the pup was moving near the entrance with good balance. Between 8 and 10 weeks old, one recording was taken per week. During those periods, the footage revealed that the pup peered outside of the burrow. This particular behavior lasted for about 0.5 to 2 min each time. The pup began to leave the nursing burrow alone when it was 11 weeks old. Exploration of the area was within 1 m from the entrance with significant soil sniffing, scraping, and licking behaviors. The time spent outside the burrow also increased to more than 25 min at this stage. After 15 weeks old, much longer duration and distance were spent by the pup exploring outside the burrow. The last video was recorded at 23 weeks old, it spent 130 min, mainly outside of the camera range, outside the burrow. The pup would always leave the burrow to explore independently after the mother had left for foraging.

Discussion

Our observation corresponds with the inference by Wang (2007) that the nursing period for the Formosan pangolin is approximately 6 months. The first time the pup was recorded leaving the nursing burrow on the mother's rump was at nearly 1 month old, which was also comparative to the 34 days observed in captivity (Chan, 2009). Therefore, despite only containing one sample, information presented from this study could still be representative.

Our records indicate that the pup began to spend a longer duration and distance exploring outside the nursing burrow at 15 weeks old. These data may indicate that the pup began to independently forage and wean around that age. The pup was carried by the mother only when changing burrow. We never recorded the mother carrying the pup on its back leaving the burrow and returning to the same burrow after foraging. The growth rate derived from our result (1.2 cm/week) was clearly faster than the 0.7 cm/week increment in a hand-raring baby reported by Wang et al. (2012), which suggested the artificial food and environment might not be suitable enough to support the infant's growth.

Implications for Conservation

Our long-term observation confirms that the method and position of the transmitter attachment will neither hinder

Figure 2. Four images of the pangolin pup carried by LF28 during different intervals. The total body length of the baby was estimated according to the comparison of the female's tail length.

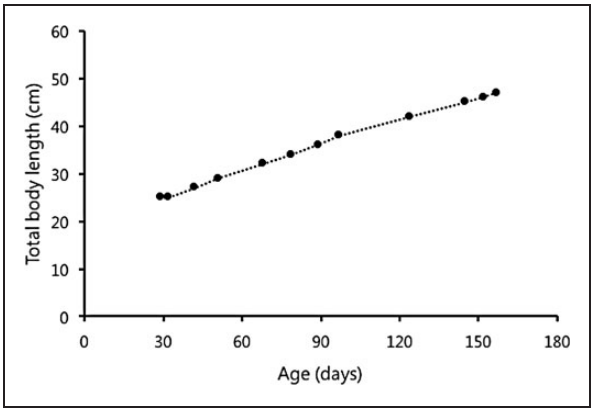

Figure 3. The total body length growth for a newborn male Formosan pangolin (*Manis pentadactyla pentadactyla*) during the nursing period based on photos taken by camera traps. Total body lengths were estimated using the mother's tail length as a reference.

the mating nor maternal behavior during the nursing period. Moreover, the LED light from the camera trap did not appear to affect the pangolin behavior. This article presents a useful method, with the combination of field techniques, to closely monitor and study the pangolin maternal behavior, infant development, and infant growth under natural conditions. An increase in sample size and utilization of more camera traps with a broader coverage should generate more data, which may not be possible to collect under captive conditions. Results from this study may also provide a set of useful references for pangolin rehabilitation or rescue facilities.

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Declaration of Conflicting Interests

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