Birth Processes and Related Behaviors of Yunnan Snub-nosed Monkeys in Baimaxueshan Nature Reserve

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ABSTRACT

Birth processes and related behaviors are the crucial events in mammalian reproduction. However, detailed reports of birth processes and related behaviors in wild nonhuman primates in their natural habitats are rare. Here, we document our observations of birth processes and related behaviors via scan sampling and focal animal samples during the birth of two infant Yunnan snub-nosed monkeys (Rhinopithecus bieti) in 2017. One of the infants was born during diurnal to a multiparous female, while the other one was a nocturnal birth to a primiparous female. Actual parturition lasted only 7 min for diurnal birth. During the parturition process, the mother received what could be described as assistance in delivery from the other females and resident male within one male unit. During each of the two births, the one-male unit’s resident male patrolled the area to keeping it secure. After birth, other members of the unit showed intense interest in the neonate. Adult females are more skilled and efficient in handling infants than subadult females. Our results will serve to advance our understanding of this important life history event in nonhuman primates.

INTRODUCTION

Birth processes and related behaviors are the crucial events in mammalian reproduction, and these behaviors including in parturition posture, duration time, assistant behavior and newborn infant care (Chism et al., 1983). Therefore, the behaviors surrounding the birthing process are expected to be under strong selective pressure. Understanding birth processes and related behaviors of primate parturition can help to illuminate the evolution in humans and non-human primates (Yao et al., 2012; Nguyen et al., 2017).

Detailed reports of birth in wild non-human primates in their natural habitats are rare, possibly because even most diurnal primates often give birth in seclusion at night (Nguyen et al., 2017; Jolly, 1972). So far, two main evolutionary explanations have been advanced for nocturnal birth: females may reduce the chance of being left behind if their group moves on, and females may...
understand birth for this endangered primate. (2) summarize the whole birth-related behaviors; and (3) of other group members to the infant and the mother. We births of Yunnan snub-nosed monkeys and the reactions 2020a, b). Here we report the parturition behaviors of two behavior of wild group (Li et al, 2016), and a Sichuan snub-nosed monkey (R. roxellana) (Li et al, 2010a).

Yunnan snub-nosed monkeys (Rhinopithecus bieti) live in the eastern Himalayan highlands, bounded by the upper Yangtze River and Mekong Rivers (Xia et al, 2020a; Huang et al., 2021). R. bieti is an endangered species of Asian colobine endemic to China, inhabiting high altitude mountain forests (Xia et al., 2020b), and the population of wild R. bieti has increased from more than 2,000 in 1994 to more than 3,000 in 2017 (Xia et al., 2020a). R. bieti social groups are characterized by a multilevel society, which are composed of many one-male units (OMUs) and at least one all-male unit (AMU) (Xia et al., 2020a). Previous studies have focused on the demography, ecology and sexual behavior of wild group (Li et al., 2010b; Xia et al., 2016, 2020a, b). Here we report the parturition behaviors of two births of Yunnan snub-nosed monkeys and the reactions of other group members to the infant and the mother. We aim to (1) describe of the complete parturition process; (2) summarize the whole birth-related behaviors; and (3) understand birth for this endangered primate.

MATERIALS AND METHODS

Study site and species

A continuous study of the behavior and ecology of R. bieti is ongoing from 2010 to 2018 in Baimaxueshan Nature Reserve, Yunnan Province, China (Xia et al., 2020a, b). This study’s focal group lives at Xiangguqing (27°37′N, 99°22′E), which includes multiple habitat types: mixed coniferous and deciduous broadleaf forest, subalpine fir forest, montane sclerophyllous oak forest, subtropical evergreen broadleaf forest, and pine forest (Xia et al., 2020a). The focal group is a stable habituated group (ca 56-64 individuals in 2017), which was composed of nine one-male units (OMUs, average individual number was 5.7±3.3) and one all-male unit (AMU, individual number was 6) (Xia et al., 2020b). All group members were individually recognized using distinctive physical characteristics such as body size, hair pattern, scars, facial features, and pelage color and named by 2010 (Xia et al., 2020c).

During of this study, we observed two birth-related behavior. The first, a diurnal birth on February 24, 2017. The newborn male monkey, which was named QJ, was this group’s first birth in 2017. His mother, LX, had her first baby on May 7, 2016, who died the following day on May 8, 2016. The second, nocturnal birth occurred before 7:00 am on March 15, 2017. The diurnal birth occurred in the male HD’s OMU, and the nocturnal birth occurred in the male XS’s OMU (Table I).

The parturition site is located at 27°38′48.24″ N, 99°21′52.84″ E at 2783 m above sea level. The average temperature was 2.75°C, and rainfall was 5 mm on February 24, 2017. The tree of Tsuga dumosa in which diurnal birth occurred is beside a narrow ravine. Because of its location, we were able to observe the process of parturition from the opposite side (ca 20 m) of the ravine with few obstructions. There are main branches on the trunk of the tree with diameter approximately 30-40 cm, which can ensure safety for the monkeys. LX give birth on high branches, which are 40 m above the ground.

Table I. The composition of two focal one-male units during the 2017 birth season.

| OMU leader | Multiparous female | Primiparous female | Pregnant female | Subadult female | Infant |
|------------|--------------------|--------------------|----------------|----------------|-------|
| HD         | LX                 | CF                 | ED             |                | QJ    |
|            | XH                 |                    |                |                | LJ    |
|            | LY                 |                    |                |                | LXi   |
|            | ML                 |                    |                |                | LG    |
| XS         | BM                 | EY                 | EB             |                |       |
|            |                    |                    |                |                |       |

Data collection

The entire delivery process occurred in three stages for diurnal birth. The first stage, prepartum, began when the female assumed a uterine contraction posture and ended when the vertex of the infant was visible at the vaginal orifice (Turner et al., 2010). The second stage, parturition,
The birth processes and related behaviors data were recorded via scan sampling and focal animal samples. We recorded birth related behavior and the spatial distribution of the whole OMU individuals through scan sampling (Altmann, 1974). Quantitative descriptive data on diurnal parturition were drawn from focal animal samples. Meanwhile, we used binoculars (OLYMPUS 10 × 42, EXWP I), a stopwatch (Tianfu, PC2810) and a digital camera (Canon, DS126271, 55-250 mm) to record the overall process.

**RESULTS**

**Diurnal birth**

**Prepartum stage**

Individuals of HD’s OMU remained on a tree near the feeding site. LX was anxious on the ground after reserve staff fed the monkeys lichens at 9:00. Other nearby individuals were feeding or playing together and paid no particular attention to her. LX’s amniotic sac ruptured at 9:45. LX appeared restless, moved away from her OMU and climbed up a tree. At the same time, HD sat with LX and groomed her. At 14:00, HD went to the birth tree alone and scanned the area (Table II). Thirty seconds later, LX and the rest of the unit followed in a tight pack. LX moved frequently at 14:35 and could not stop scratching herself. HD groomed LX for 242 seconds. LX was surrounded by XH and ML, two other females in the unit, and one infant at 14:55 (Fig. 1). HD remained vigilant. At 14:58 LX changed her body position constantly, twisting or raising her rump (Table II). All members of this unit were nervous and vocalized.

**Parturition stage**

It was difficult to observe this period clearly because LX was surrounded by the other females and infants. At 14:59, LX looked uncomfortable and was pushing the baby out. By 15:04, the infant’s head was entirely exposed, but still covered by a white viscous membrane. The birth was complete within 1 min.

**Postpartum stage**

The newborn, QJ, was immediately embraced by the other females of the OMU. It was too far away from us to recognize which females were involved. They licked QJ extensively, trying to examine and oral exploration the infant. The umbilical cord and placenta were still attached to the neonate’s body. HD approached QJ, and LX successfully retrieved the baby from the other group members at 15:10. She severed the umbilical cord quickly, but did not ingest the placenta. The whole process lasted 10 min.

**Post-birth behavior**

At 15:30, the female XH carried QJ tightly, went down to the ground, then ascended to a branch 5 m high. In total, XH carried QJ for 36 min. During this period, LX engaged in many familiar behaviors (approaching, following, contact sitting, proximity), parental behaviors (examination, oral exploration, kidnapping) and hostile
behaviors (threat, escape, vigilance, warning, attack). Other females also approached her, followed her, stayed in proximity, and kidnapped the infant. At 16:08, LX held QJ in one arm while she ate. Four adult females and two infants showed intense interest in QJ. Twenty min later, LX left the feeding site carrying QJ. Then, XH kidnapped, nursed and kissed QJ, and groomed him for 29 s. LX held QJ for 11 min. The mother, LX, approached XH, followed her, sat in contact with her, embraced her from behind, and smelled her infant while it was in XH’s arms. At 16:40 a primiparous female, ML, took QJ successfully and groomed him for 236 s (Table III). CF, XH and LX all stayed within 5 m of the infant. 3 min later, LX kidnapped QJ and left. Although we could identify the baby’s sex, we could only see the umbilical cord briefly. At 16:42, LX went to the feeding site and ate again. XH embraced the infant and groomed it for about 26 s. Then, CF groomed QJ for 75 s while two other individuals 1 m away showed intense interest in QJ. LX successfully reclaimed her baby at 17:10.

Nocturnal birth

This was a nocturnal birth in XS’s OMU. Before giving birth, several changes were observed in LK of the mother. LK’s vulva got redder, the vaginal orifice became black, and her breasts became engorged with plump nipples (Fig. 2a-f). She moved on the ground more cautiously than usual. The unit’s resident male, XS, was aggressive and displayed frequently on March 14, 2017, more than sum total in the past five days. All members within unit except for one sub-adult female spent more time huddling the day before the birth.

We first observed the neonate with binoculars at 7:00 am. All females within unit showed intense interest in the infant. LK, the mother, remained alert all day. At 9:00 am, we were able to observe them closely. The neonate’s eyes were opening, and the umbilical cord was about 20 cm long. The infant was too weak to grasp LK well, so she held it with both hands (Fig. 2h). LK embraced the infant against her chest, then licked its hands, head, and body while kissing, smelling ceaselessly, and nursing the infant for 127 s.

| Stage (total time) | Start time | Behavioral observations | Duration |
|--------------------|------------|-------------------------|----------|
| Prepartum (328 min) | 9:30 | LX’s abdomen rose and fell | <15 min |
| 9:45 | Amniotic fluid came out of the vagina. LX was anxious and HD was grooming LX | 290 min |
| 14:35 | LX started scratching herself and calling weakly | 15 min |
| 14:50 | HD was grooming LX | 3 min |
| 14:55 | LX was surrounded by two females and one infant within 1 m of her. HD remained vigilant | 4 min |
| 14:58 | LX raised her rump | 1 min |
| Parturition (7 min) | 14:59 | LX was surrounded by the members of her unit and began to scream. HD remained vigilant | < 5 min |
| 15:04 | The infant’s head was completely exposed | ≤1 min |
| 15:04-15:05 | The infant, QJ, was born | ≤1 min |
| Postpartum (15 min) | 15:05 | QJ was immediately embraced by other females of the unit and licked extensively. The umbilical cord and placenta were still attached to the neonate’s body | <5 min |
| 15:10 | LX embraced QJ. She severed the umbilical cord but didn’t ingest the placenta | <10 min |

Table III. The duration and number of times of birth-related behavior in XS’s OMU.

| Female | Embrace (sec) | Kidnap | Oral exploration | Smell | Sit in contact | Lick (sec) | Groom infant (sec) | Groom LK (sec) | Hold tail |
|--------|---------------|--------|------------------|-------|---------------|-----------|-------------------|----------------|-----------|
| LK     | 29            | 4      | 29               | 22    | 31            | 723       | 0                 | 0              | 0         |
| EB     | 0             | 62     | 3                | 5     | 4             | 0         | 544               | 126            | 1         |
| EY     | 480           | 37     | 9                | 7     | 8             | 0         | 90                | 297            | 1         |
| BM     | 133           | 13     | 1                | 3     | 5             | 0         | 0                 | 0              | 0         |
Fig. 2. Changes in LK prior to giving birth on March 15, 2017. (a) The vulva started to become red on February 25, 2017. (b) The vulva was redder, with a raised pattern, on February 26, 2017. (c) The vulva was bright red and protruded when LK sat on branch on March 8, 2017. (d) Transparent fluid was visible dripping from the vulva at 15:02 on March 14, 2017. (e) The vaginal orifice was black and wet at 16:02 on March 14, 2017, but she had yet to show discomfort. As the OMU went to feed, LK moved on the ground cautiously. (f) The engorged breast, with protruding nipple. (g) The vulva, covered with blood after giving birth. (h) LK embracing the infant with both hands in the early morning.

During this day, the sub-adult female EB was threatened by LK nine times and tried to embrace the infant but was unsuccessful. A pregnant female, EY, successfully kidnapped the infant at 9:42 after trying 12 times. LK followed EY the entire time and tried to retrieve her infant 23 times while EY had it. About 8 min later, LK finally retrieved her infant, groomed it for 50 s and nursed it for 186 s. At 9:58, EB sat opposite to LK, gently held the infant’s head with her left hand. During this period, EB was oral exploring and smelling the infant and tried to take it 8 times. The multiparous female BM kidnapped the infant successfully 2 times while displaying less parental and familiar behavior. Compared with XH, who was multiparous, primiparous LK seemed inexperienced in holding her infant. Many times, we observed the infant sitting on the ground where it couldn’t nurse. Furthermore, LK did not immediately pick up her infant when she was sucking.

**DISCUSSION**

**Parturition duration time**

We recorded a total labor duration of 350 min, but actual parturition lasted only 7 min for LX’s diurnal birth. The parturition duration reported here is inconsistent with other primates. Such as, the parturition duration time of the Sichuan snub-nosed monkey (*R. roxellana*) was 4 min and 10 sec (Yang *et al.*, 2016), the toque macaque (*M. sinica*) was 55 min (Raineyke and Dittus, 1989), the capped langur (*T. pileatus*) was 43 min (Kumar *et al.*, 2005), the white-headed langur (*T. leuccephalus*) was 6 min and 53 sec (Yao *et al.*, 2012), and the red howler (*A. seniculus*) was 2 min (Sekulic, 1982). We think that parturition duration time is closely related to the environment.

**Parturition female’s behavior**

Studying on parturition female’s behavior have an important significance on understanding birth-related behaviors (Yao *et al.*, 2012; Nguyen *et al.*, 2017). QJ was born at 15:05, and the mother resumed eating food within an hour. The second infant was born shortly before 7:00 on March 15, 2017, because blood was still evident on the infant’s head. We observed that the mother was sitting on the ground eating lichens with her baby in her arms at 9:57. Some researchers proposed that diurnal births allow the mother to start feeding as soon after giving birth as possible (Peker *et al.*, 2009).

In this study, the placenta was left on the birth tree (Fig.1-1). Possible explanations for why the placenta was not consumed include: (1) Quality of life in this group has been improved by provisioning, reducing nutritional stress (Xia *et al.*, 2020a). This is supported by the observation that in this same group, a female gave birth for two consecutive years, and both infants survived. In the wild, *R. bieti* typically only gives birth in two consecutive years when an infant die in its first year (Xia *et al.*, 2020b). (2) The new mother was disturbed by other females after giving birth. Immediately after being born, QJ was embraced by other females and kidnapped for 10 min while the umbilical cord and placenta were still attached to the infant’s body. There might not have been time for LX to ingest the placenta. (3) The presence of domesticated animals and tourists might have been disruptive to the birth process. During the day
of giving birth, February 24th, 2017, about 2 cows and 12 pigs fed near the monkey groups. Additionally, three tourists took pictures with a tripod and moved among the monkeys. The presence of tourists can have negative impacts on animals, especially when close contact occurs (Xia et al., 2016; Lott and McCoy, 1995; Treves and Brandon, 2005; Mann and Suts, 1999).

Parturition assistant behavior

Female assistance

The birth mother can get direct or indirect assistance from other unit members (Turner et al., 2010). This is especially important for primiparous females. When the pregnant female went into labor, she was surrounded by the other females from her OMU and received what could possibly be described as birth assistance. Females in labor receiving birth assistance from multiparous females has been reported (Starin, 1988; Ding et al., 2013; Peker et al., 2009; Duboscq et al., 2008; Douglas, 2014; Deluycker, 2014). This has the potential to increase the newborn infant’s chances of survival, especially when the mother is primiparous. Although there are few cases of direct assistance from other individuals during birth, parturition in front of other social group members has been reported (Alouatta palliata; Macaca fuscata; Nasalis larvatus; Trachypithecus pileatus; T. leucocephalus; Alouatta piliata; Alouatta palliata; Macaca fuscata; Nasalis larvatus; Trachypithecus pileatus; T. leucocephalus; Alouatta piliata; Alouatta palliata; Macaca fuscata; Nasalis larvatus; Trachypithecus pileatus; T. leucocephalus) (Yao et al., 2012; Kumar et al., 2005; Turner et al., 2010; Gorzitze, 1996; Dias, 2005).

The newborn was embraced by the other females in unit and licked extensively. In both birthing events reported here, there were many parental and familiar behaviors displayed towards the infant (Li et al., 2013). The same phenomenon has been observed in the Sichuan snub-nosed monkey, R. roxellana (Yang et al., 2016). Adult females, including the pregnant ones, showed more interest in the newborn than the unit’s sub-adult female. Adult females are more skilled and efficient in handling infants than sub-adult females. Females who are pregnant for the first time may take advantage of the opportunity to learn about infants from another birth.

Resident male assistance

Before the female gave birth, resident male became more aggressive. The resident male remained vigilant from beginning to end while she was in labor. The unit male’s role may be to provide support to the mother as well as to keep the area secure. Yunnan snub-nosed monkeys have a multi-level social structure, with several OMUs and AMUs coming together to form large groups of several hundred monkeys (Li et al., 2014). Social bonds have many evolutionary benefits, but they may be particularly important during birth (Turner et al., 2010).

CONCLUSIONS

In summary, the parturition duration is inconsistent with primates. Diurnal births allow the mother to start feeding as soon after giving birth as possible. The birth mother can get direct or indirect assistance from other members within unit. Adult females are more skillful and efficient in handling infants than sub-adult females. Our results will serve to advance our understanding of this important life history event in nonhuman primates.

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Field study permissions

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Statement of conflicts of interest

The authors have declared no conflict of interests.

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