



Slow loris (*Nycticebus borneanus*) consumption by a wild Bornean orangutan (*Pongo pygmaeus wurmbii*)

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Abstract

Vertebrate predation and consumption by wild Bornean orangutans (*Pongo pygmaeus* spp.) is rare. In contrast to recorded observations of slow loris consumption by Sumatran orangutans (*Pongo abelii*), no cases of this have been previously published for Bornean orangutans in the wild. In 2017, we observed the capture and consumption of a slow loris (*Nycticebus borneanus*) by an adult unflanged male Bornean orangutan at Tuanan Orangutan Research Station, which is located in the Kapuas region of Central Kalimantan. The unflanged male was together with an adult female and her 3.5-year-old offspring throughout the event. However, despite the mother and her offspring watching the male closely and occasionally begging while he consumed the loris, he resisted all food-taking attempts. This study reports, to the best of our knowledge, the first documented case of slow loris predation and consumption by a Bornean orangutan, and thus provides an important data point for understanding primate predation on other primate species.

Keywords Vertebrate predation · Meat-eating · *Nycticebus borneanus* · *Pongo pygmaeus wurmbii*

Introduction

Vertebrate predation and consumption is widespread among non-human primates and has been documented across a large number of species (Butynski 1982; Fedigan 1990; Gilby et al. 2017; Hardus et al. 2012; Heymann et al. 2000; Hill and Dunbar 1998; Ichino and Rambeloarivony 2011; Souza et al. 1997; Stanford 1995; Uehara 1997). However, the catching and consumption of primates by other primate

species is rarer, and has been documented for far fewer species, including chimpanzees (Gilby and Wawrzyniak 2018; Watts 2020), orangutans (Hardus et al. 2012), and baboons (Devore and Washburn 1963). Orangutans are by preference frugivorous (Knott 1998a; Morrogh-Bernard et al. 2009; Russon et al. 2009; Vogel et al. 2008) and vertebrate predation and consumption has rarely been observed in them. The majority of cases of meat-eating in orangutans have been reported for Sumatran orangutans (*Pongo abelii*) (Hardus et al. 2012; Sugardjito and Nurhuda 1981; Utami and van Hooft 1997; van Schaik et al. 2003), with only four previous cases reported for Bornean orangutans (*Pongo pygmaeus* spp.) (see Table 1).

Even rarer are cases of orangutans consuming other species of primates. The consumption of slow lorises (*Nycticebus coucang*) by Sumatran orangutans has been observed, at least 15 times, at two sites, the Ketambe Research Station area (Hardus et al. 2012; Utami and van Hooft 1997) and Suaq Balimbing (van Schaik et al. 2003, 2009), both of which are located in the Gunung Leuser National Park, Aceh Province. Thus, the consumption of slow lorises has been considered a cultural variant within these two *P. abelii* populations (van Schaik et al. 2003). Slow lorises are nocturnal, arboreal, semi-gregarious primates that are also

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Table 1 Previously reported cases of vertebrate consumption by Bornean orangutans

Location	Duration of observations	Age class/sex	Prey	Reference
Tanjung Puting NP	N/A	Flanged male	Young squirrel	Morrogh-Bernard et al. (2014)
Gunung Palung NP	50,000 h	Juvenile female	Tree rat	Knott (1998b, 1999)
Sabangau	16,000 h (2003–2013)	Flanged male	Adult squirrel ^a	Buckley et al. (2015)
Tuanan	73,312 h (2003–2017)	Adolescent female	Young mouse	Unpublished data

The consumption of birds' eggs from nests has also occasionally been seen in several orangutan populations in Borneo and Sumatra (Russon et al. 2009)

NP National Park, N/A not assessed

^aAdult horse-tailed squirrel (*Sundasciurus hippurus*; scientific names of prey items are only given where provided), reported as most likely a carcass

venomous (Nekaris 2014; Rode-Margono et al. 2014; Wiens 2002). A mix of saliva and venom from the brachial gland in the upper arm is transferred when a slow loris bites, and causes anaphylactic shock in humans and sometimes death in conspecifics (reviewed in Nekaris et al. 2013). However, the orangutans (*P. abelii*) that were observed consuming the lorises (*N. coucang*) in Sumatra were not observed being bit or visibly injured during the observed predation events (Hardus et al. 2012; Utami and van Hooff 1997). Despite several long-term studies on Bornean orangutans, to our knowledge, there are no published records of their predation on slow lorises, although one recent study documented two brief interactions between Bornean orangutans and slow lorises in Sabangau Forest, Central Kalimantan (Morrogh-Bernard et al. 2014). However, because there were no signs of interest or aggressive behavior by the orangutans, it was proposed that this behavior represented play or non-aggressive exploration rather than predation (Morrogh-Bernard et al. 2014). Likewise, observations of predation on slow lorises by any species appear to be quite rare (Wiens and Zitzmann 1999). Here, we describe, to the best of our knowledge, the first case of slow loris predation and consumption by a Bornean orangutan.

Methods

The Tuanan Orangutan Research Station (TORS) is located in the Kapuas, province of Central Kalimantan (2°09'S, 114°26'E; Fig. 1). The study area is a peat swamp forest that was previously used as a forest concession in the 1980s and for a peatland project in 1997. Since 2003, the area has been protected, with very low levels of logging along its borders. The research area is about 1.5 km from the banks of the Kapuas river and lies between two tributaries of the Kapuas: the Daha river and the Bengkirai river. The forest canopy is generally 15–25 m high and is characterized by low overall fruit productivity that ranges from 1–14% of trees fruiting at a given time, with an average of about 4.3% (van Schaik et al. 2005; Vogel

et al. 2009, 2017). The primate species other than Bornean orangutans (*Pongo pygmaeus wurmbii*) and slow lorises (*Nycticebus borneanus*) found in TORS include red langurs (*Presbytis rubicunda*), white-bearded gibbons (*Hylobates albibarbis*), Bornean tarsiers (*Cephalopachus bancanus borneanus*), long-tailed macaques (*Macaca fascicularis*) and pig-tailed macaques (*Macaca nemestrina*).

Focal data were collected for a total of 73,312 h focal-follow hours between July 2003 and December 2017 on more than 100 independent Bornean orangutans: females, flanged males, unflanged males, and immatures ranging independently from their mothers [for methods, see van Schaik (1999) and Morrogh-Bernard et al. (2002)]. Typically, during a focal follow, one focal animal is followed from nest to nest each day by a pair of observers when possible, although simultaneous nest to nest focal follows of different individuals on the same day may occur. During focal sampling, all observed occurrences of 'unusual' behaviors in the context of feeding, display, vocalizations, nest-building, social interactions, predation, etc., are recorded, either per event or through presence/absence sampling during 2-min sampling periods. In addition, photos and videos are recorded and viewed to confirm identification and behaviors. Overall, the Tuanan orangutan diet is composed of 61% fruit, 14% young leaves, 8% flowers, 5% insects, 5% non-woody herbaceous vegetation, 4% inner bark, and 3% mature leaves (Vogel et al. 2014, 2008, 2017). Vertebrate predation by Tuanan orangutans is quite rare, with only two events (including the case reported here) recorded during the 73,312 focal-follow hours between July 2003 and December 2017. The other documented event was that of an independent subadult who ate infant mice from a nest (Table 1).

Results

This first observation of predation on and consumption of a slow loris by a Bornean orangutan was recorded at TORS in December 2017 (Supplementary Material, video 1). On

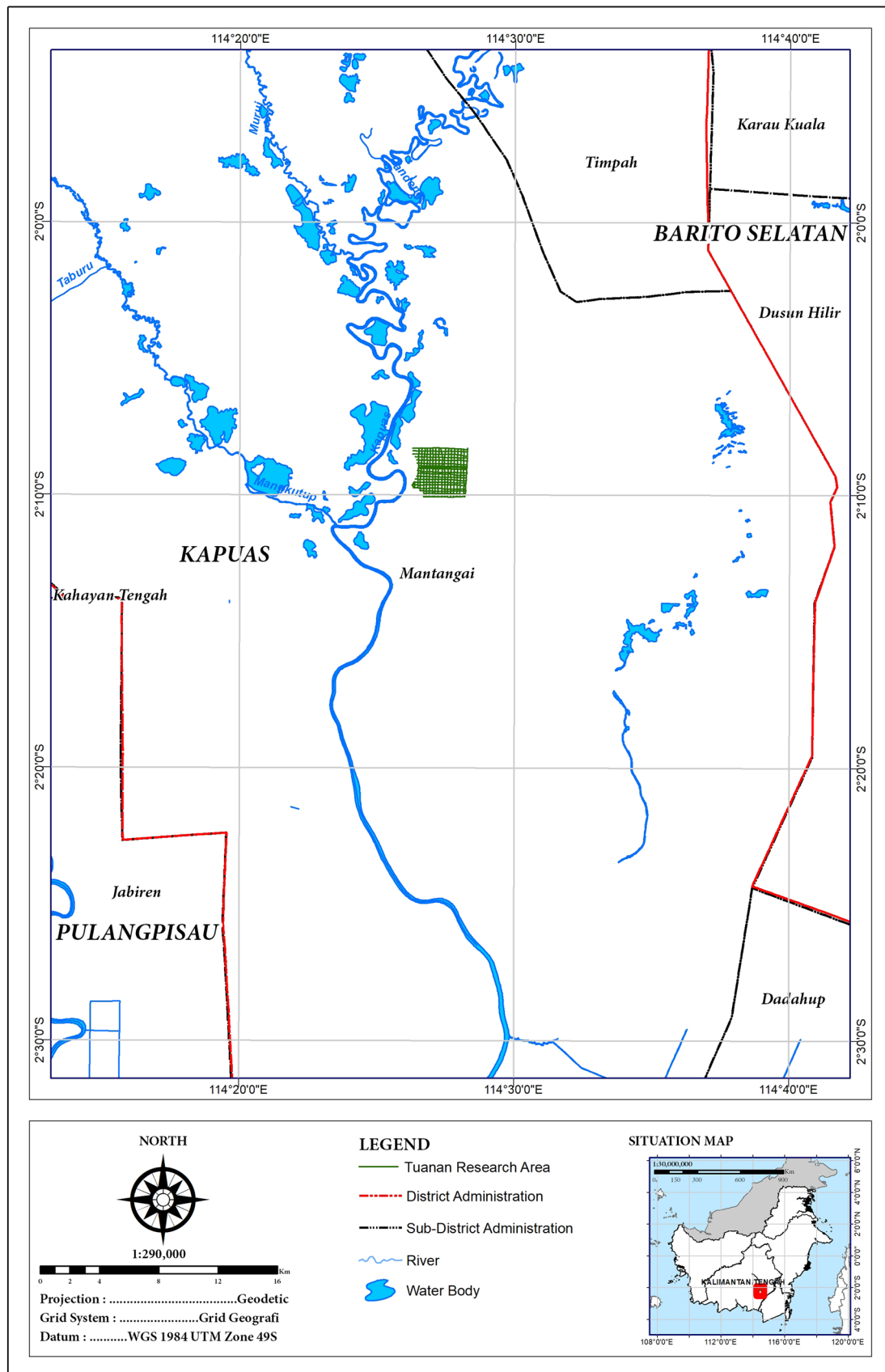


Fig. 1 Map of the location of Tuanan Orangutan Research Station and research area grid

27 December 2017, K. P. M. and an assistant were conducting a focal follow of a well-habituated mother (Kerry) with her 3.5-year-old offspring (Ketambe), who had been accompanied by a habituated unflanged male, Molong, since the previous day. Kerry and her offspring were the focal animals of that day and Molong was included in the data collection as he was considered to be in a social interaction (also referred to as a party) with Kerry. At the time of this encounter, Kerry had been followed regularly since 2003 and Molong since 2015.

Chronology of the orangutan predation event on the slow loris

At 1346 hours, Molong was 5 m from Kerry and Ketambe in a tree when he suddenly moved further away from Kerry and went down to the ground. It was assumed at the time that Molong was avoiding another male, since long call vocalizations had been heard (Lameira and Wich 2008) earlier from approximately 150 m away. However, a few moments later, Molong was observed chasing a slow loris (*Nycticebus borneanus*) on the ground. The observers did not see the loris fall from the tree and did not know why it was on the ground, as lorises are arboreal primates (Nekaris 2014). Molong moved quickly on the ground for less than a minute, and then climbed back into the tree while scanning the ground. He then returned to the ground and made a grumph vocalization (Hardus et al. 2009) while chasing the loris. After chasing the loris for 10–15 m on the ground, Molong climbed up a tree to a height of 2–5 m and then returned to the ground again. Molong repeated this action by going up a tree one more time, to a height of 5–10 m, and then quickly returning to the ground. In total, Molong chased the loris over a distance of 20–30 m before he caught it.

When Molong climbed again into a tree, to a height of 2–5 m, the slow loris was observed to be 1 m away from

him on a smaller branch. At 1355 hours, Molong swatted the slow loris with his hand so that it fell onto another branch below him. Molong descended from his branch, broke off the branch that the loris was clinging to, and brought the branch higher into the tree while holding it outwards and almost vertically, so that the slow loris could not easily move off the branch.

Molong then sat on a branch at a height of about 5–10 m, took the slow loris from the branch that he was holding, and killed it by biting the nape of its neck. This caused the slow loris to scream for about a minute until its vocalizations ceased, at which point it was no longer moving and presumed dead. Initially, Molong held the slow loris with his feet, but when he had killed it and began to eat it, he used both hands. During the entire chase and predation encounter, Kerry and her son Ketambe rested in a tree at slightly less than 50 m away from Molong.

Once the loris was dead, Molong consumed the head first. The observers could hear the loud sound of the skull cracking when Molong ate the head; he then appeared to suck at the throat and then the entire body of the slow loris (see Fig. 2a). Molong then ate the feet and hands, and then broke the legs from the rest of the body. He held the unconsumed limbs of the slow loris with his left foot. During the observations, both flesh and bones of the slow loris were consumed by Molong, but he was also observed dropping some bones, including the femur.

The distance between Molong and Kerry was less than 50 m when he first killed the slow loris, but after the sound of Molong cracking the skull of the slow loris was heard by the observers, Kerry and Ketambe moved towards him. Ten minutes later, Kerry and Ketambe moved within 2 m of Molong, and watched him feeding on the loris. Within two minutes, they approached him further while he was eating, and both watched him closely as he continued to consume the loris (Fig. 2b). While they were sitting within contact,

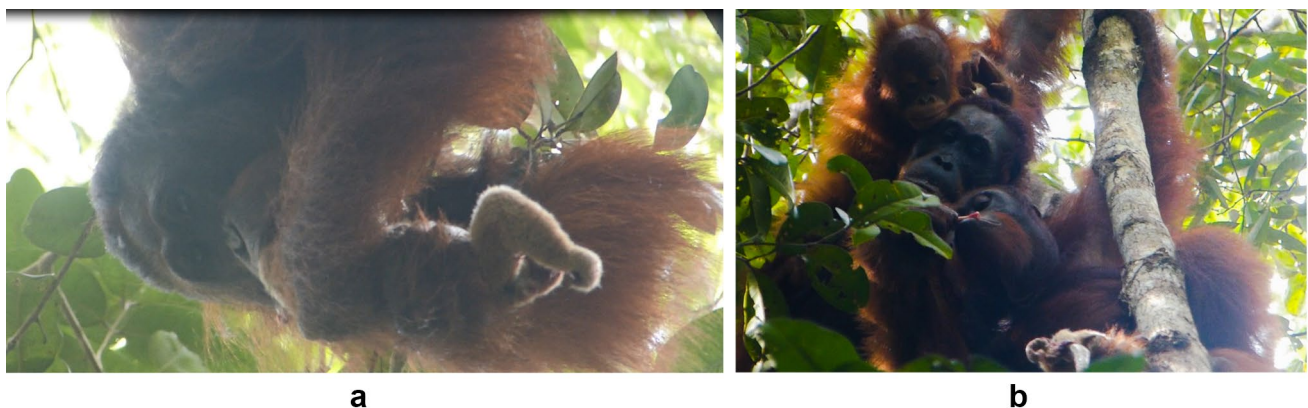


Fig. 2 **a** Unflanged male orangutan (Molong) consuming the slow loris. **b** Molong feeding on the slow loris while the adult female, Kerry, and her son, Ketambe, watch him within close proximity

Kerry touched Molong's hand repeatedly, but he ignored her. Kerry and Molong were sitting so close that their heads were touching, yet there was no direct conflict between them over the loris. Ketambe watched (from less than 1-m distance) Molong closely while he consumed the slow loris, and pulled Molong's arm hair several times (possibly as a begging gesture). After 20 min, Kerry pulled Molong's hand towards her and licked his palm, but Molong pulled back his hand. Kerry attempted to take pieces of the slow loris several times by reaching towards Molong's hand, but Molong did not allow her to take any scraps. Occasionally, Molong appeared to present the loris remains on his outstretched hand to Kerry, but whenever she tried to take a piece, he did not release the loris.

After 40 min of watching Molong closely and making attempts to obtain some of the slow loris remains without any success, Kerry moved to a nearby tree to feed on fruit, while still watching Molong. While Kerry moved further away, Molong followed her while holding the remains of the slow loris with his feet. He did not share the loris meat and kept an average distance of 5 m from Kerry for 2.5 h after he caught the loris. Molong briefly fed on *Elaeocarpus mastersii* fruit in between feeding bouts on the slow loris, while holding the remains of the slow loris with his feet. The research team continued to follow the focal animal, Kerry, while trying to also observe Molong, who maintained possession of the loris remains. The observations ended when it began to get dark and Kerry made her nest. By that point, Molong had moved more than 50 m from Kerry and Ketambe and could not be located again by the research team.

Since TORS was established, in 2003, there have only been a few recorded observations of mammal predation and consumption by orangutans, i.e., of infant squirrels and a nest of young mice in 2009 (Table 1). However, slow lorises were rarely seen by the researchers who observed adult and independent orangutans during the day for 73,312 h of focal observations prior to 27 December 2017, and there was only one additional recorded encounter between a focal orangutan and a slow loris. In that case, the slow loris fell out of the tree and was not pursued by the focal animal. Thus, the rate of encounter in our database is extremely low (2.73×10^{-5} events h^{-1}).

Discussion

Vertebrate consumption by chimpanzees, a species that has received notable attention due to its high rates of predation, has been linked to periods of preferred fruit abundance, which supports the nutrient surplus hypothesis (Gilby et al. 2006; Mitani and Watts 2001; Watts and Mitani 2002). On the day of the observed slow loris predation event at Tuanan, the orangutans Molong, Kerry, and Ketambe were observed

feeding on the fruit (i.e., of *Diospyros pseudomalabarica*, *Willughbeia* sp., *Leucomphalos callicarpus*, *Mezzettia* sp., *Elaeocarpus mastersii*, *Alseodaphne elmeri*, and *Dyera lowii*) and young leaves (of *Leucomphalos callicarpus* and *Xanthophyllum ecarinatum*) of several species before Molong caught and consumed the slow loris. As fruit availability was then in the medium range [cf. Vogel et al. (2017) for details of measurement], it seems unlikely that Molong was motivated to consume meat to compensate for a nutritional shortfall due to seasonal fruit scarcity, but instead took advantage of a sudden opportunity to catch a slow loris. Thus, as has been suggested for Sumatran orangutans, vertebrate predation and consumption appears to be rare and opportunistic in Bornean orangutans (Hardus et al. 2012). Solitary eastern chimpanzees have also been observed to hunt opportunistically for prey mammals, such as duikers (Uehara 1997; Watts and Mitani 2002). It is important to note that eight of the 12 known cases of slow loris consumption by orangutans in Sumatra took place during periods of low fruit availability (the three other recorded cases in the archives were not dated), suggesting that meat consumption may provide caloric and macronutrient, particularly protein, benefits during episodes of reduced fruit intake (Hardus et al. 2012).

The observation of a Bornean orangutan catching and consuming a slow loris described here is similar to those reported for Sumatran orangutan populations, including discovery (i.e., the hunting was opportunistic) and consumption (i.e., there was no active sharing by the hunter, the slow lorises were killed by a bite to the neck/skull area, and the head was consumed first, followed by the limbs). In Sumatra, peering and co-feeding between the mother and her offspring was observed in Ketambe (Hardus et al. 2012) and Suaq, but when there was transfer of meat, it was always after begging and through tolerated taking of the prey, and not through active sharing. The case reported in the present study, however, is unique in two ways: the male orangutan broke off the small branch that the loris was clinging to, and held the branch upright while carrying it to another tree, prior to killing and consuming the loris; the male orangutan had been in a social party with the female and her offspring since the previous day. In all but one of the cases observed at other sites, the orangutans, both male and female, were alone (or with dependent offspring) (Hardus et al. 2012). In the one case when there was a consort partner, in Suaq Balimbing (South Aceh), however, no meat sharing was observed between the consort partners (C. P. van Schaik, personal communication).

The consumption of slow lorises by orangutans has been well documented for at least two sites in north-western Sumatra—Ketambe (Southeast Aceh; lowland forest) and Suaq Balimbing (South Aceh; peat swamp forest)—both of which are in Gunung Leuser National Park, and about

100 km from one another. We can now add one additional observation to these, for Bornean orangutans in Tuanan, which is the first observed case of the consumption of a slow loris, or any other primate, by a Bornean orangutan. The only prior documented interactions between a Bornean orangutan and a slow loris took place in Sabangau and were interpreted as being more exploratory and playful rather than potential predation attempts (Morrogh-Bernard et al. 2014). Even though the distance between Sabangau and Tuanan is similar to that between the Sumatran sites, these former sites are separated by two wide rivers (the Kapuas and the Kahayan), making it very unlikely that slow loris hunting behavior has transferred between these two populations. However, like one of the interactions described for the Sabangau site (Morrogh-Bernard et al. 2014), in the interaction described in the present study, the loris did not defend itself against the orangutan and instead clung to a branch. We propose that, while orangutans most likely have little experience with slow lorises, at least some of them do recognize slow lorises as a potential food resource. This potential lack of experience may be a result of the density of slow lorises at Tuanan being low, as indicated by the low rate of human encounters with them during focal animal follows and searches for orangutans. Thus, orangutans may simply not encounter lorises at Tuanan very often, although systematic population density estimates of lorises have yet to be conducted at this site. Likewise, little is known about the behavioral ecology of *Nycticebus borneanus*, and studies of this species in peatland habitats are needed. Thus, the low incidence of loris predation and consumption by orangutans in most Bornean study sites may be a consequence of low loris density, resulting in a lack of opportunity and experience of the orangutans to prey on them.

Since male orangutans disperse over large areas (Arora et al. 2012; Nietlisbach et al. 2012), and we know that the male Molong did not grow up within the TORS area, he may have had earlier exposure to the effective handling of a loris in his natal range. However, the rare opportunity for a orangutan to witness a successful catch if slow loris density is similarly low across the study area, and the relatively low rate of association of an orangutan with conspecifics (Kunz et al. 2021), make it unlikely that catching slow lorises will spread widely through social learning in this population (van Schaik et al. 2003).

In conclusion, we describe the first predation and consumption event of a wild Bornean orangutan on a slow loris, which was recorded after over 73,000 h of observations of wild orangutans at TORS. This study demonstrates that (1) slow loris, and vertebrate predation in general, by orangutans is rare and most likely opportunistic at this site; and (2) long-term field data are often required to capture this type of predation event in species that are rarely observed to hunt for vertebrate prey.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10329-021-00960-4>.

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Declarations

Research involving human and animal rights As a strictly observational study on wild animals, there was no interaction with the study animals in any way. The research complied with protocols approved by the institutional animal care committee (IACUC) of Rutgers, The State University of New Jersey (IACUC no. TR202000055), and adhered to the legal requirements of Indonesia.

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