Chapter 19
Exudates and Animal Prey Characterize Slow Loris (*Nycticebus pygmaeus, N. coucang* and *N. javanicus*) Diet in Captivity and After Release into the Wild

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Abstract We present dietary data for individuals of three species of slow loris rescued from the pet trade: *Nycticebus pygmaeus* released and radio-tracked in Vietnam and *N. coucang* and *N. javanicus* held in captivity in Indonesia. Contrary to popular belief that slow lorises are frugivores, our data support recent studies that slow lorises are one of few primates specialized for regular extractive gouging of plant exudates, and capable of consuming insect prey containing secondary compounds. These behaviors are present in juveniles as young as 4 months. This specialized diet should be considered when maintaining captive individuals, and when planning reintroduction programs.

Resume Nous présentons des données sur le régime alimentaire de trois espèces de loris lents, obtenues sur des individus vendus sur les marchés locaux: *Nycticebus pygmaeus*, relâchés et radio-pistés au Vietnam, et captifs *N. coucang* et *N. javanicus* en Indonésie. Contrairement à la croyance populaire qui voit ces animaux comme frugivores, nos donnés indiquent que les loris lents sont parmi les rares primates spécialisés dans l'extraction d'exudats, et capables de consummer des insectes contenant des produits toxiques. Ces comportements sont déjà observés chez les juvéniles de quatre mois. Ce régime alimentaire spécialisé devrait être pris en considération dans les élevages captifs, et les plans de réintroduction.

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Introduction

Slow lorises (Lorisidae: *Nycticebus*) are nocturnal primates ranging throughout Southeast Asia. All five *Nycticebus* species have recently been discovered to feed regularly on exudates that they obtain through active gouging (*N. bengalensis*, Swapna et al. 2010; *N. coucang*, Wiens et al. 2006; *N. javanicus*, Nekaris et al. 2010; *N. menagensis*, Nekaris and Munds 2010 and *N. pygmaeus*, Starr et al. 2011). These same studies reveal that nectar, insects (including those containing secondary toxic compounds) and fruit also form part of their diets.

These new findings have not yet been applied to the dietary regimes of captive slow lorises, which have classically been modeled on that of the mainly frugivorous potto (*Perodicticus*) (Charles-Dominique 1977; Fitch-Snyder et al. 2001), a genus that can be up to six times heavier than the smallest slow lorises (Nekaris and Bearder 2007). In captivity, slow lorises are usually maintained on fruit and vegetables, with some insects (Fitch-Snyder et al. 2001). Opportunities to access gum are usually presented only through enrichment devices (Craig and Reed 2003), and zoo keepers report that slow lorises can cause considerable damage to the wood in their enclosures (Streicher 2004). Inappropriate captive diets may be linked to dental disease, obesity and low reproductive output (Streicher 2004). Furthermore, no data are available as to how diet develops ontogenetically in slow lorises, although youngsters seem to learn about food resources directly from their parents, either through active (visual) or passive (olfactory) observation (Wiens and Zitzmann 2003; Nekaris et al. 2010).

An understanding of the feeding behavior of slow lorises is crucial, as they are amongst the most common primates in the Southeast Asian pet trade (Nekaris and Nijman 2007). To improve their suitability as pets, many slow lorises have their anterior incisors and canines removed by traders (Nekaris and Munds 2010). Juvenile lorises are prevalent in the trade, and both adults and juveniles may be confiscated many miles from their capture localities and released into areas with unfamiliar food resources. If animals survive transport to one of South-east Asia's many rescue centers, it is common practice to release them directly into the wild without a period of adjustment (Collins and Nekaris 2008). Knowledge of how rescued slow lorises select their captive diet, whether all age classes gouge, and what they eat when released is hitherto lacking. To address these issues, we present data on the diet of three slow loris species (*N. pygmaeus, N. coucang* and *N. javanicus*) confiscated from the pet trade.

Methods

Released Slow Lorises: Vietnam

Streicher collected dietary data from four reintroduced *N. pygmaeus* individuals which had been held in captivity for several months at the Endangered Primate Rescue Center (EPRC), Cuc Phuong, Vietnam. All animals were captured as adults, so all had previous experience of wild food sources. Full details of their release are

described in Streicher and Nadler (2003). The individuals were equipped with radio transmitters. Before dusk, an observer arrived at the sleeping site and observed *N. pygameus* from a distance of 5–15 m from the beginning of the active period for a few minutes to 2 h over 163 days. Each animal was radio tracked for 4–6 weeks from the date of release. Data were collected *ad libitum* (Altman 1974).

Captive Slow Lorises: Sumatra

The other authors collected data from 2 April to 17 June 2007 at Pusat Penyelamatan Satwa (PPS), Lampung, Sumatra on twelve *N. coucang* (two adults and ten juveniles) and one adult *N. javanicus*. The *N. coucang* had been rescued from the pet trade 2 weeks prior to the study, and the *N. javanicus* had been at PPS for 3 months. By the third week, all juveniles ate solid food. The outdoor enclosure was comprised of two neighboring chambers (2 m × 2 m × 2 m), with *N. javanicus* in one and *N. coucang* in the second. It had an open floor with natural ground and foliage and was thickly furnished with natural branches at all levels. Slow lorises were fed six times nightly. In addition to insects and reptiles that entered the enclosure naturally, 23 types of food were offered (Table 19.1). We recorded all dietary selections and

Table 19.1 Food items presented to *N. javanicus* and *N. coucang*, and their reactions to these items: ++ instantly accepted; + accepted with hesitation; −− refused

Food type	*N. javanicus*	*N. coucang*
Fruits		
Duku	++	++
Banana	++	++
Ripe kiwi	++	++
Orange	+	++
Green grape	−−	+
Red grape	+	−−
Guava	−−	+
Corn	−−	−−
Raisin	−−	−−
Avocado	−−	−−
Animals		
Moths	++	++
Crickets	++	++
Yellow-vented bulbul	++	++
Mealworms	+	+
Millipede	++	−−
Chicken eggs (raw)	++	−−
Quail eggs (raw)	−−	++
Cooked chicken	−−	−−
Ants	−−	−−
Other		
Honey	−−	+
Yoghurt	−−	−−
Peanuts	−−	−−
Baby formula	+	+

modeled food tests after Hladik (1979). We recorded observations nightly from 19:00 to 05:00 over 153 h.

Results

Released Slow Lorises

Streicher recorded 27 feeding bouts by solitary *N. pygmaeus*. Eleven observations (40%) involved insect prey, including Hymenoptera and Hemiptera. Insect feeding occurred at heights <10 m. *Nycticebus pygmaeus* fed on gum eight times (30%) and on unidentifiable plant exudates eight times (30%); seven of these bouts occurred at heights over 8 m. Feeding on fruit was never observed.

Nycticebus pygmaeus searched for animal prey by moving slowly along branches with their noses near the substrate. They caught insects with one or both hands, clinging with both legs to the branch or standing bipedally. Pygmy lorises licked some smaller insects, including ants, off branches. Larger insects were eaten head first, the wings were dropped and other parts were disposed of by fierce head shaking. Head shaking also followed when an *N. pygmaeus* was bitten by its prey. Hunting in general was a rapid event. Only when a pygmy loris found a large insect or a number of insects in the same place did it spend several minutes feeding (e.g. the devouring of a large cricket required 20 min).

Whilst feeding on gum, pygmy lorises remained stationary while intensely licking a single trunk or branch for 1–20 min. They consumed exudates from *Spondias axillaris* (Anacardiaceae), *Sapindus* sp. (Sapindaceae), *Vernicia montana* (Euphorbiaceae) and *Saraca dives* (Fabaceae). When animals licked the branches of *S. dives*, no sounds were audible, suggesting the food sources were on the surface. For all other species, gum scraping was accompanied by intense sounds of scratching and breaking bark. Animals fed with the body orthograde, clinging with all four extremities to the tree. One pygmy loris returned to the same site several times.

In full blossom *S. dives* carried large bundles of orange flowers. Pygmy lorises inspected these intensively and probably consumed the nectar. Of the few observations of wild pygmy lorises at Cuc Phuong National Park, two were made in *S. dives* in bloom. (Roberton, personal communication)

Captive Slow Lorises

Results of food tests are presented in Table 19.1. Both *N. javanicus* and *N. coucang* consumed animal prey eagerly. Slow lorises caught prey by stalking it and rapidly lunging forward to grab it with one or two hands. They caught yellow-vented bulbuls (*Pycnonotus goiavier*) within 30–50 s, instantly killed them by biting the neck

and consumed all parts, including the bones and beak. Four juveniles grouped together to catch one bird that escaped but was swiftly killed by the adult female, who then shared it with them. Interestingly, although *N. coucang* rejected ants as food, they allowed them to crawl onto their hands, feet and limbs and shook or rubbed them off.

Nycticebus javanicus and *N. coucang* accepted fruit, especially duku (*Lansium domesticum*) and banana (*Musa* sp.). Fruit was consumed slowly, and even if instantly accepted, animals only ate small pieces, returning to it throughout the night. Sharing of fruit and animal prey occurred with no aggression.

Although no exudates could be derived from the timber of their enclosures or from fresh branches that were placed there daily, both species of all age classes gouged and chewed daily at a rate of 2.9 times per hour (see also Nekaris et al. 2010). Gouging was accompanied by audible bark breaking and could be heard even when animals entered dense foliage. Gouging resulted in deep holes measuring on average 2.5-cm diameter and 0.6-cm deep in the substrate (Fig. 19.1).

Discussion

Nycticebus has previously been assumed to be largely frugivorous (Chivers and Hladik 1980). Our study contributes to the growing volume of literature that fruits form only part of slow loris diets. Released *N. pygmaeus* did not consume any fruit during the observation period. Before their release at EPRC, *N. pygmaeus* (350–600 g) chose invertebrates over other food items and mostly rejected fruit, boiled eggs and vegetables (Streicher 2004). In the case of the larger *N. javanicus* (650–1,000 g) and *N. coucang* (600–750 g), some fruits were consumed, but animal prey was always preferred. These differences could be a result of physiological requirements. Hladik (1979) postulated that strepsirhines in this size range must utilize a variety of food sources, since they are too large to be able to maintain themselves merely on insects, which they consumed with far more enthusiasm and familiarity in our study.

Based on its sympatry with *N. bengalensis* and on morphological characteristics, [AU1] Ratajszczak (1998) and Ravosa (1998) suggested that *N. pygmaeus* is insectivorous. Although Wiens et al. (2006) viewed insects as unimportant to *N. coucang*, invertebrates including ants were nevertheless present in >90% of feces they analysed, including up to 20 ants in a single sample. The closely related slender loris is mainly faunivorous, and its capture mode is identical to that observed in slow lorises (Nekaris and Rasmussen 2003). All slow lorises in our study captured insects single handedly or bimanually with stereotyped movements typical for prosimians and specifically adapted to catch rapidly moving or flying insects (see also Hladik 1979; Nekaris and Rasmussen 2003). Feeding similarities between slender and slow lorises extend to the consumption of noxious prey including Hymenoptera, usually avoided by other strepsirhines (Hladik 1979). Although our captive slow lorises did not consume ants, it is possible they were engaging in passive "anting". Common in

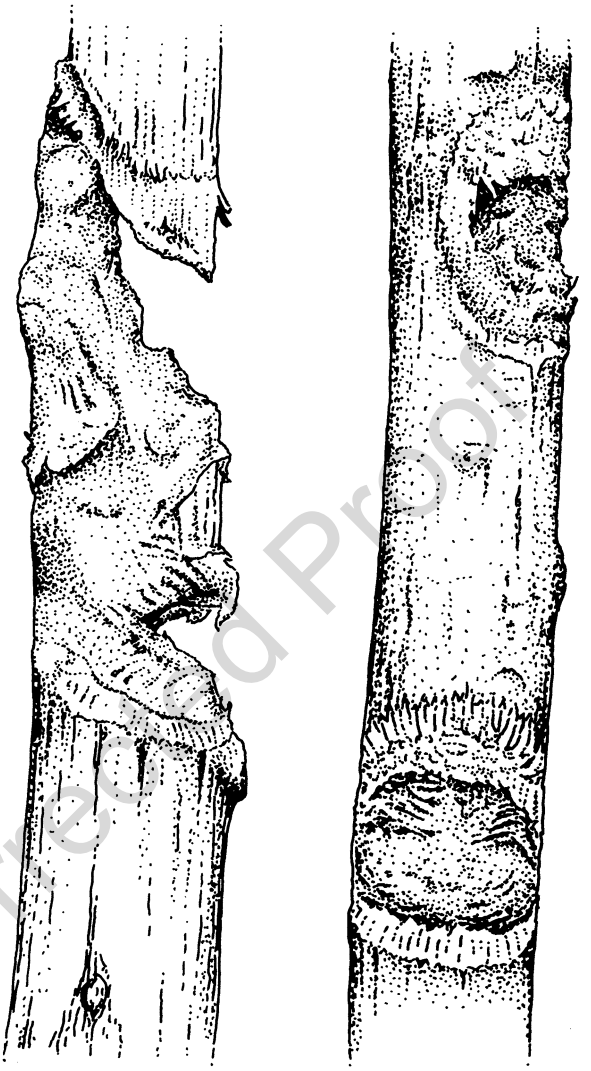

Fig. 19.1 Examples of branches gouged by *N. coucang*, showing the typical gnawing pattern for this genus (drawing by H. Schulze)

158 birds and some monkeys (Weldon 2004), several species of *Loris* and *Nycticebus*
159 have now been observed to allow ants to crawl over their limbs (Kumara et al. 2005)
160 and even to rub ants into their fur before consuming them (Nekaris personal obser-
161 vation). One use of secondary compounds may be to keep the body free of ticks.
162 Indeed, no loris in the Sumatra study had any ectoparasites, and of a sample of 51
163 *N. pygmaeus* studied at EPRC, only one animal was infested with lice (Streicher
164 2004). How lorises use the secondary compounds sequestered from their noxious
165 prey deserves further study.

Gum and plant exudates, extracted through active gouging, were also essential foods for the slow lorises observed in this study. Exudates were the foods most frequently consumed by *N. pygmaeus*. Captive wild-caught Sumatran *N. coucang* began "practising" gouging behavior from 4 months of age; the fact that the branches did not contain gum supports the interpretation of gouging as a stereotyped behavior and implies that exudate consumption in the wild begins at an early age (Hladik 1979). Active stimulation of exudate flow by gouging trees has previously been documented for some callitrichines, *Cebuella* and *Callithrix* (Coimbra-Filho and Mittermeier 1978) and the fork-marked lemur, *Phaner (furcifer) pallescens* (Petter et al. 1971). Stimulating exudate flow by scraping gum at the same location every night maintains a renewable food supply. Gum contains high concentrations of carbohydrates (Bearder and Martin 1980; Hladik 1979) and some strepsirhines, such as the lesser bushbaby (*Galago moholi*) and the thick-tailed bushbaby (*Otolemur crassicaudatus*), are able to subsist on gum alone when other foods are scarce (Bearder 1987). Being available all year round, gum is a reliable food, and consumption of exudates has now been observed year round for three slow loris species (Nekaris et al. 2010). Consequently, when considering a slow loris reintroduction project, sites containing gum-producing trees should be chosen, and only slow lorises with teeth should be reintroduced.

Nycticebus pygmaeus in this study foraged alone, whereas *N. coucang* shared food peacefully. However, *N. pygmaeus* housed together at Cuc Phuong Rescue Centre also engaged in food sharing. Captive slow lorises are normally held alone or in pairs, mainly due to fear of fighting (Fitch-Snyder et al. 2001). Knowing that some slow lorises can be housed together without aggression is important for captive management, especially as numbers of animals confiscated from the pet trade are increasing. Providing ample live prey and gouging opportunities may facilitate social grouping.

Slow lorises clearly show numerous morphological and physiological adaptations for processing animal prey and harvesting and consuming plant exudates. The myth that these animals are frugivores should at last be quashed for the sake of their health in captivity and for designing reintroduction programs.

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