

# Metadata of the chapter that will be visualized online

Series Title	Developments in Primatology: Progress and Prospects	
Chapter Title	Using Facial Markings to Unmask Diversity: The Slow Lorises (Primates: Lorisidae: <i>Nycticebus</i> spp.) of Indonesia	
Chapter SubTitle		
Copyright Year	2010	
Copyright Holder	Springer Science+Business Media, LLC	
Corresponding Author	Family Name	<b>Nekaris</b>
	Particle	
	Given Name	<b>K. A. I.</b>
	Suffix	
	Division	Nocturnal Primate Research Group
	Organization	School of Social Sciences and Law, Oxford Brookes University
	Address	OX3 0BP, Oxford, UK
	Email	anekaris@brookes.ac.uk
Author	Family Name	<b>Munds</b>
	Particle	
	Given Name	<b>Rachel</b>
	Suffix	
	Division	Nocturnal Primate Research Group
	Organization	School of Social Sciences and Law, Oxford Brookes University
	Address	OX3 0BP, Oxford, UK
	Email	
Abstract	<p>The slow lorises (<i>Nycticebus</i>) are the only strepsirrhine primates found in Indonesia (Nekaris and Bearder 2007). In addition to features such as a toothcomb and moist nose, these small nocturnal primates were given their name based on their trademark steady, stealthy, and fluid locomotion. Morphologically incapable of leaping (Sellers 1996), slow lorises rather slither through the treetops, and if startled, they may freeze or even cover their face, resulting in one of their many Indonesian names, <i>malu malu</i> or “the shy one” (Supriatna and Wahyono 2000). Alternatively, they can fleetingly but silently escape, resulting in the name <i>buah angin</i> or “wind monkey” in Acehnese (Nekaris and Nijman 2007a). One of two genera of nocturnal primates found in Indonesia (the other being <i>Tarsius</i>), slow lorises are a unique part of Indonesian primate communities, and are widely spread on at least 27 of Indonesia’s islands, including Borneo, Sumatra, and Java (Table 22.1) (Nijman and Nekaris in review). Despite this, studies of Indonesian slow lorises are in their infancy.</p>	

# Chapter 22 1

## Using Facial Markings to Unmask Diversity: 2

### The Slow Lorises (Primates: Lorisidae: 3

#### *Nycticebus* spp.) of Indonesia 4

K.A.I. Nekaris and Rachel Munds 5

### Introduction 6

The slow lorises (*Nycticebus*) are the only strepsirrhine primates found in Indonesia (Nekaris and Bearder 2007). In addition to features such as a toothcomb and moist nose, these small nocturnal primates were given their name based on their trademark steady, stealthy, and fluid locomotion. Morphologically incapable of leaping (Sellers 1996), slow lorises rather slither through the treetops, and if startled, they may freeze or even cover their face, resulting in one of their many Indonesian names, *malu malu* or “the shy one” (Supriatna and Wahyono 2000). Alternatively, they can fleetingly but silently escape, resulting in the name *buah angin* or “wind monkey” in Acehnese (Nekaris and Nijman 2007a). One of two genera of nocturnal primates found in Indonesia (the other being *Tarsius*), slow lorises are a unique part of Indonesian primate communities, and are widely spread on at least 27 of Indonesia’s islands, including Borneo, Sumatra, and Java (Table 22.1) (Nijman and Nekaris in review). Despite this, studies of Indonesian slow lorises are in their infancy. 7-19

Lack of studies of slow lorises seems to have derived not only from their nocturnal habits but also from a belief that slow lorises were unspesiose and common, resulting in a conservation status of Least Concern (Meijaard et al. 2005). These beliefs are being upturned, making studies of the behavior and taxonomy of slow lorises imperative to their conservation. Indonesia is notable for its loris diversity, with at least three taxa (*N. coucang*, *N. javanicus*, *N. menagensis*) recognized on genetic and morphological bases (Roos 2003; Chen et al. 2006; Groves and Maryanto 2008); all are considered Vulnerable or Endangered (IUCN 2009). 20-27

Habitat loss is a serious threat to all Indonesia’s primates, and slow lorises are no exception. Owing to the paucity of population data from the ground, Thorn et al. (2009) used ecological niche modeling to elucidate the current conservation status 28-30

---

K.A.I. Nekaris (✉) and R. Munds  
 Nocturnal Primate Research Group, School of Social Sciences and Law,  
 Oxford Brookes University, Oxford, OX3 0BP, UK  
 e-mail: anekaris@brookes.ac.uk

S. Gursky-Doyen and J. Supriatna (eds.), *Indonesian Primates*, Developments in Primatology: Progress and Prospects, DOI 10.1007/978-1-4419-1560-3\_22,  
 © Springer Science+Business Media, LLC 2010

K.A.I. Nekaris and R. Munds

t1.1 **Table 22.1** Taxonomy, body weight range (from unpublished records and museum labels), conser-  
 t1.2 vation status and distribution of Indonesian slow lorises

t1.3	t1.4	t1.5	t1.6	t1.7	t1.8	t1.9	t1.10	t1.11	t1.12
Species	Common name	Body weight (grams)	Conservation status	Distribution					
<i>N. coucang</i>	greater or Sunda slow loris	480–710	VU A2cd	Sumatra, Bunguran, Riau archipelago, Tebingtinggi					
<i>N. javanicus</i>	Javan slow loris	565–900	EN A2cd	Java, Panaitan					
<i>N. menagensis</i>	Philippine or Bornean slow loris	265–325	VU A2cd	Banggi Bangka, Belitung, Borneo; Karimata; Labuan; Sulu archipelago					

31 of Indonesian lorises by predicting the likely remaining loris habitats throughout  
 32 Sumatra, Java, and Borneo. They found that Javan lorises, in particular, are threatened  
 33 with habitat loss, followed closely behind by Sumatran lorises.

34 Trade, too, has been highlighted for many years as a factor seriously underpin-  
 35 ning the ability of many Indonesia's primates to persist (Nijman 2005, 2009). The  
 36 omnipresence of slow lorises as amongst the most common protected mammals in  
 37 Indonesia's many bird markets (Shepherd et al. 2004) has also been a factor used [AU1]  
 38 by researchers to suggest that they are plentiful in the wild (Meijaard et al. 2005).  
 39 Detailed studies from other parts of Asia, and new data emerging from Indonesia  
 40 itself, suggest, however, that it is more the inability of a loris to escape from expert  
 41 hunters combined with the opportunity for easy financial reward that leads to abun-  
 42 dance in markets (Ratajszczak 1998; Collins and Nekaris 2008). The stark impact  
 43 of pet trade on Javan slow lorises has led to their inclusion on Conservation  
 44 International's biennial list of the "Top 25 Most Endangered Primates" (Nekaris  
 45 et al. in press). Although we still know little about Indonesian loris life history,  
 46 parameters of closely related species are slow even among the primates (Rasmussen  
 47 and Izard 1988), with a gestation period of about 6 months (Fitch-Snyder and  
 48 Ehrlich 2003); combined with typical litters of one or two infants that require 3–6  
 49 months for weaning, their extremely slow life history does not lend well to this  
 50 level of off-take.

51 The large number of animals coming through pet markets has had the side effect  
 52 of offering scientists a glimpse of Indonesian loris diversity (Nekaris and Jaffe 2007).  
 53 Earlier taxonomists recognized greater diversity in the Sundaland region (Osman Hill  
 54 1953), and ongoing research is investigating the validity of previously proposed taxa  
 55 (Ravosa 1998; Nekaris and Jaffe 2007; Groves and Maryanto 2008). In recent times,  
 56 numerous cryptic species have been revealed amongst other nocturnal primates (e.g.,  
 57 galagos – Bearder 1999; tarsiers – Merker and Groves 2006; lemurs – Thalmann and  
 58 Geissmann 2005); it would be unsurprising to find hitherto unappreciated diversity  
 59 amongst slow lorises (Groves 1971, 1998; Schwartz and Beutel 1995).

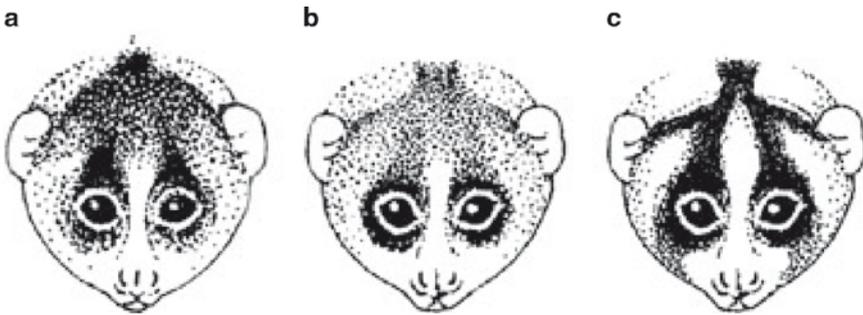
## 22 Using Facial Markings to Unmask Diversity

In this chapter, we had two aims. In the first half, we review studies of the behavior and ecology of wild Indonesian slow lorises. Understanding the behavior and ecology of lorises hinges upon resolving their taxonomic diversity (Chen et al. 2006). Variation in external characters, including facial masks, has improved our knowledge in discerning species within many nocturnal primates (Musser and Dagasto 1987; Ford 1994; Bearder 1999; Rasoloarison et al. 2000; Defler 2003). Several factors have been implicated as selecting for species-specific “facial masks”: species-specific recognition devices (Bearder et al. 1995), individual recognition within species (Barash 1974) and predator deterrents (Newman et al. 2005). Nekaris and Jaffe (2007) showed facial masks distinguished Indonesian loris species, but they did not specifically define characters of the mask. Furthermore, the animals they examined were from trade and thus their localities were not known. In this chapter, we further explore the utility of the facial mask to determine loris taxa, based on a sample of living lorises and museum specimens measured from known localities. In particular, we examine if any characters statistically distinguish the three recognized species, and if the face mask provides any evidence for further diversity.

## Methods

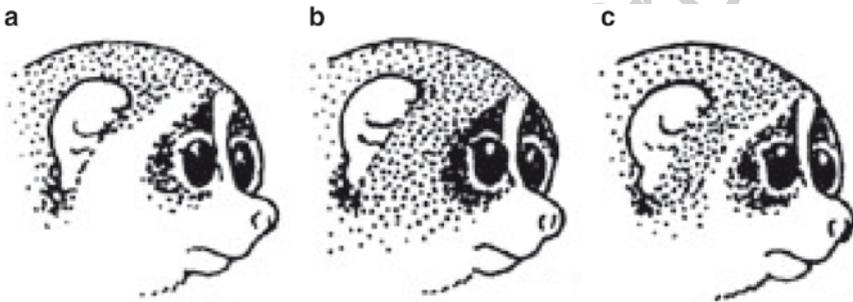
For the behavioral overview, we compiled data on wild Indonesian slow lorises from the literature and report novel data from our own observations, summarized by taxon. We examined the facemasks of Indonesian slow lorises from photographs and museum specimens from known localities, either given by field workers or taken from museum tags. We used SPSS v.14.0 for the analysis, applying appropriate nonparametric and descriptive statistics. We coded each face mask for 12 discrete characters; measures were either presence/absence on an ordinal scale. Characters fell into four general groups: circumocular eye patch characters ( $n=6$ ), ear characters ( $n=2$ ), nose skin color ( $n=1$ ), and crown characters ( $n=3$ ). These are patch top distinctly pointed, rounded, or diffused into crown; patch middle (midline of eye) barely visible around the edge of the eye, a distinct band around the eye, or broad extending to cheek; patch bottom ended as a small line just below the eye, as a wider band on top of the zygomatic, or as a broad band below the zygomatic; presence/absence of an additional distinct black rim around the eye; width and shape of the interocular stripe (narrow or wide; rectangle, hourglass, diamond) (Fig. 22.1); the size of the preauricular hair that differed in color from the circumocular patch (narrow/absent, medium, wide, Fig. 22.2); ears were naked, distinctly furred but pressed to the head (appearing hidden), distinctly furred but erect on the head, or furred with additional tufts; nasal skin color – pink, black, or pink/black mix; crown patch small with distinct pointed forks, large with rounded forks, or diffuse; and the general color of the crown and facial markings – brownish, blackish, reddish, or yellowish.

K.A.I. Nekaris and R. Munds



**Fig. 22.1** Characteristics of the loris facial mask: (a) shows a mask with an hourglass interocular stripe, where the top of the patch is rounded into a large crown with rounded forks. (b) shows a mask with a rectangular interocular stripe, with diffuse patches and crown, and black rim around the eye. (c) shows a diamond-shaped interocular stripe, with distinct pointed forks leading to a small crown; eye patch extends beneath the zygomatic

[AU2]  
[AU3]



**Fig. 22.2** The width of differently colored preauricular hair: (a) wide, (b) narrow/absent, (c) medium

## 100 Results

### 101 *Studies from the Wild*

#### 102 *N. coucang*

103 Also found in peninsular Malaysia, Thailand, and Singapore, in Indonesia, *N. coucang*  
 104 is restricted to the island of Sumatra and some smaller islands. Presence of a brown  
 105 and a red variant on Sumatra may ultimately require taxonomic revision (see below).  
 106 Nekaris and Nijman (2007a) spent several weeks conducting surveys of the red  
 107 variant of this taxon in Aceh, Sumatra. Of five sites surveyed, lorises were found at  
 108 two sites within the Ulu Masen forest complex: SP Limon and Jantho. At SP  
 109 Limon, in 13.8 km of transects, the only evidence for lorises was a decaying animal  
 110 found on a path. Residents described the recent removal by a specialist loris dealer

## 22 Using Facial Markings to Unmask Diversity

of a large number of lorises from the area in conjunction with deforestation of a large area of forest for agriculture, perhaps explaining the paucity of encounters. The Jantho site was a two-day walk from human settlements, and yielded an encounter rate of 0.39 lorises/km, with 22 km covered. The average distance of lorises from the line was 7.5 m. Animals were patchily distributed, with areas of high concentration, followed by 1–5 km without a single loris sighting.

Pairs of lorises, or lorises separated by less than 30 m, were encountered five times. Three of these included a mother and her male infant. The infant was seen “parked”, as well as being carried ventrally by its mother. He was caught and measured; weighing 115 g, his age was determined to be about 3 months old (Zimmermann 1989), suggesting birth in February. Animals emitted a high-pitched whistle, which was heard only three times over five nights. Habitat analysis of the area of high loris density revealed that median tree height was 8 m, with most sightings of lorises occurring at 5 m, on trees that averaged 10.2 cm DBH. Lorises were seen to catch unidentified insects three times, and were also seen to consume the bland fruit of *ranuk dong*, a tree belonging to the Piperaceae (Nekaris and Nijman 2007a). In the nearby Gunung Leuser ecosystem, *N. coucang* is also known to be a prey item of Sumatran orangutans (*Pongo abelii*) (van Schaik et al. 2003). Wild-born animals measured at the Schmutzer Primate Center had an average neck circumference of 145 mm ( $\pm$ sd 10.1,  $n=9$ ), a figure important for future radio-collar studies.

In southern Sumatra in Lampung Province, seven wild-born brown lorises, only recently caught and confiscated, were observed in captivity for two months before being reintroduced to the wild (Collins and Nekaris 2008). Although captive lorises accepted fruit (particularly the native duku – *Lansium domesticum*), they preferred insects and live birds (yellow-vented bulbuls, *Pycnonotus goiavier*), the latter of which was shared with other lorises (Streicher et al. in review). They also gouged the timber of their enclosure 441 times, favoring *senгон* (Fabacea: *Paraserianthes falcataria*) (Nekaris et al. in press). Animals regularly emitted affiliative calls (“krik”) (c.f. Schulze and Meier 1995), and also counter-called to with a loud call strongly reminiscent of a crow’s caw. Lorises allogroomed, played, and fed together, the behaviors that continued after their release. Upon release, animals moved quickly on small branches and maintained group cohesion for the single night during which observations were made (Collins and Nekaris 2008). Wild-born animals had an average neck circumference of 146 mm ( $\pm$ sd 14.9,  $n=16$ ).

*Nycticebus coucang* was the subject, too, of a long-term study in peninsular Malaysia. Although the Malaysian form may in fact be a distinct species, we summarize key aspects of its behavior and ecology. In a study lasting more than two years, Wiens et al. (2006) found that nectar and gum comprised more than 70% of the diet, with fruit and insects playing a limited role. Indeed, lorises seem to have a number of morphological specializations for exudativory (Nekaris et al. in press). One to three animals interacted in overlapping home ranges ranging from about 10 to 25 ha in size, and social sleeping occurred. The general social organization was uni-male, uni-female (Wiens and Zitzmann 2003). Mating, however, was promiscuous with multiple males pursuing a single estrous female (Elliot and Elliot 1967; Wiens 2002), a behavior seen also in slender lorises (Nekaris 2003).

156 *N. javanicus*

157 Supriatna and Wahyono (2000) provided the first opportunistic observations of  
158 Javan slow lorises. They found them in primary and secondary forest, bamboo forest,  
159 mangrove forest, and plantations, with a preference for chocolate plantations. They  
160 observed slow lorises consuming fruit, lizards, eggs, and chocolate seeds. Nijman  
161 and van Balen (1998) confirmed presence of lorises in the Dieng Mountains.  
162 Surveys in Gunung Gede Pangrango National Park, West Java, revealed low densities  
163 of lorises, with encounter rates ranging from 0.02 to 0.20 animals/km (Arisona,  
164 pers. comm.; Nekaris et al. 2008). Another survey in the nearby Mt. Salak National  
165 Park found few lorises (0.03 animals/km), and only in areas where human distur-  
166 bance was minimal (Collins 2007; Munds et al. 2008). Lorises were encountered  
167 alone or in pairs, and occurred at heights from 1.5 to 9.5 m.

168 A pilot study by Winarti (2008) revealed further aspects of the ecology of Javan  
169 lorises. In Ciamis and Tasikmalaya regencies, West Java, she found that lorises  
170 were able to persist in mixed-crop home gardens with high levels of human distur-  
171 bance. They did not use nest holes, but slept curled into a ball on branches in tangles  
172 of rope bamboo; multiple animal sleeping groups were observed. She observed  
173 them actively gouging gum from Fabaceae: *Albizia*. They moved at heights of  
174 3–22 m, and were also observed crossing open spaces on the ground in their dis-  
175 turbed habitat. Wild-born animals measured at the Schmutzer Primate Center had  
176 an average neck circumference of 136 mm ( $\pm$ sd 12.1,  $n=6$ ).

177 *N. menagensis*

178 *Nycticebus menagensis* is the least studied of Indonesia's lorises. In 1971, seeking this  
179 species in Kinabalu National Park, Sabah, Jenkins (1971) described it as present, but  
180 rarely seen. A first attempt to study this species in more detail at the Sabangau  
181 National Park, Central Kalimantan, yielded only 12 sightings in 75 days (Nekaris  
182 et al. 2008). The median distance of a loris from the transect line was about 13 m and  
183 all were seen at heights of 15–20 m in the trees. Lorises were encountered singly,  
184 mother and offspring, or in adult trios. Of two trios spotted, both were on fruiting  
185 trees: *Calophyllum hosei* and *Syzygium cf. nigricans*. Another survey at Wehea, East  
186 Kalimantan yielded similar results, with only one loris encountered in more than  
187 30 km (0.02 animals/km). This animal was seen at 30 m height (Munds et al. 2008).  
188 Other attempts to find *N. menagensis* have proved equally futile. In 46,000 trap nights  
189 in Kinabalu National Park, Wells et al. (2004) caught only one animal, albeit thrice.  
190 Duckworth (1997) was unable to record loris presence in Similajau National Park,  
191 Sarawak after 77 h of nocturnal walks. Baker (2008 pers. comm.) was able to locate  
192 only three lorises (one pair and one single adult) at Danum Valley Research Station,  
193 Sabah, during more than 60 h of night walks. In her on-going study in the Lower  
194 Kinabatangan Wildlife Sanctuary (LKWS), Sabah, Malaysia, Munds has found  
195 *N. menagensis* to be in relatively low densities. The primary study site, Danau Girang

## 22 Using Facial Markings to Unmask Diversity

Field Centre, is a riparian secondary forest within the LKWS. Of 35 night surveys, 196  
 only three lorises have been spotted, on average at 20 m height. All were alone and 197  
 traveling between two trees by lianas or vines. All lorises were sighted at least 100 m 198  
 away from any of the major rivers that surround the field centre. One loris, spotted at 199  
 5:30 a.m., moved along a branch toward a 15 m high thicket of vines and leaves. The 200  
 sighting may indicate that such thickets provide sleeping sites for Bornean lorises. On 201  
 the basis of its craniodental morphology, Ravosa (1998) proposed that this species 202  
 might be more insectivorous than its congeners. 203

### Facial Masks 204

We collected data from 106 individual lorises *N. coucang* (brown),  $n=16$ ; *N.* 205  
*coucang* (red),  $n=16$ ; *N. menagensis* (Borneo and offlying islands, Sulu archipelago), 206  
 $n=29$ ; *N. menagensis* (Bangka),  $n=3$ ; *N. javanicus* (short-furred form),  $n=26$ ; *N.* 207  
*javanicus* (long-furred form,  $n=16$ ). Table 22.2 summarizes 12 characters of the 208  
 facial masks, all of which were significantly different among taxa. Certain charac- 209  
 teristics always distinguish the three species (Fig. 22.3). For example, *N. coucang* 210  
 has medium width preauricular hair, *N. menagensis* always has circumocular 211  
 patches that end just below the eye, and *N. javanicus* always has a diamond interoc- 212  
 ular stripe. 213

Other features are suggestive of additional species or subspecies. Sumatran 214  
*N. coucang* occurs in two color phases: red and brown. The red form is further dis- 215  
 tinguished by significant presence of rounded forks leading to a distinctly shaped 216  
 crown, and a dark rim around the eye. Figure 22.4 reveals that the majority of red 217  
 specimens in our sample are restricted to Northern Sumatra, with brown specimens 218  
 restricted to the southern 2/3 of the island. Although similar to other *N. menagensis* 219  
 in our sample in many respects, facemask color, width of preauricular hair, and 220  
 furred ears give lorises from Bangka a strikingly distinct appearance. Other than 221  
 their long-silky fur, the only characters distinguishing the long-furred Javan lorises 222  
 from those with short fur were a tendency for black facial markings and a pink nose. 223  
 Figure 22.4 reveals substantial overlap between these two forms; the current analy- 224  
 sis, however, does not allow for altitude to be taken into account. 225

### Discussion 226

Here, we have reviewed the handful of data available to us on Indonesian lorises in 227  
 the wild. We reaffirm earlier work showing that lorises occur in sparse numbers 228  
 in their natural habitat (Nekaris et al. 2008). Indeed, Indonesian lorises appear to 229  
 occur at even lower densities than mainland *Nycticebus* (Duckworth 1997). 230  
 This rarity combined with high volume in the pet trade highlight the conservation 231

K.A.I. Nekaris and R. Munds

**Table 22.2** Percent that each character was present among the individuals in our sample; all characters were statistically significantly different ( $p < 0.001$ ) when tested with a chi-square cross tabulation, even when *menagensis* from Bangka was removed from the sample

Character	<i>coucang</i> (brown) <i>n</i> = 16	<i>coucang</i> (red) <i>n</i> = 16	<i>menagensis</i> <i>n</i> = 29	<i>menagensis</i> (Bangka) <i>n</i> = 3	<i>javanicus</i> (short fur) <i>n</i> = 26	<i>javanicus</i> (long fur) <i>n</i> = 16
<i>Circumocular patch</i>						
Top	P: 94%	P: 6%	D: 100%	P: 100%	P: 100%	P: 100%
	R: 6%	R: 94%				
Middle	B: 94%	B: 94%	N: 100%	N: 100%	B: 100%	B: 100%
	N: 6%	N: 6%				
Bottom	AZ: 94%	AZ: 94%	UE: 100%	UE: 100%	UZ: 100%	UZ: 100%
	UE: 6%	UE: 6%				
Rim	A: 94%	P: 100%	A: 10%	P: 100%	A: 100%	A: 100%
	P: 6%		P: 90%			
<i>Interocular stripe</i>						
Width	N: 100%	N: 100%	N: 100%	N: 100%	W: 100%	W: 100%
Shape	H: 75%	H: 94%	R: 67%	H: 33%	D: 100%	D: 100%
	R: 25%	R: 6%		R: 67%		
Nose color	P: 25%	B: 6%	P: 45%	B: 100%	P: 27%	P: 94%
	M: 75%	M: 94%	B: 21%	M: 73%	M: 73%	M: 6%
			M: 35%			
<i>Ear characters</i>						
Preauricular hair	M: 94%	M: 100%	N: 31%	M: 100%	W: 100%	W: 100%
	W: 6%		M: 69%			
Ears furred?	F: 100%	F: 94%	H: 100%	F: 100%	T: 100%	T: 100%
		T: 6%				
<i>Crown</i>						
Shape	RF: 100%	DF: 6%	DF: 7%	DF: 43%	DF: 100%	DF: 100%
		RF: 94%	D: 93%	RF: 33%		
				D: 26%		
Forks	D: 100%	D: 100%	B: 100%	D: 100%	D: 100%	D: 100%
Color	R: 25%	R: 100%	R: 14%	R: 100%	R: 12%	R: 6%
	Br: 75%		Br: 3%		Br: 85%	Br: 6%
			Y: 83%		Bl: 4%	Bl: 88%

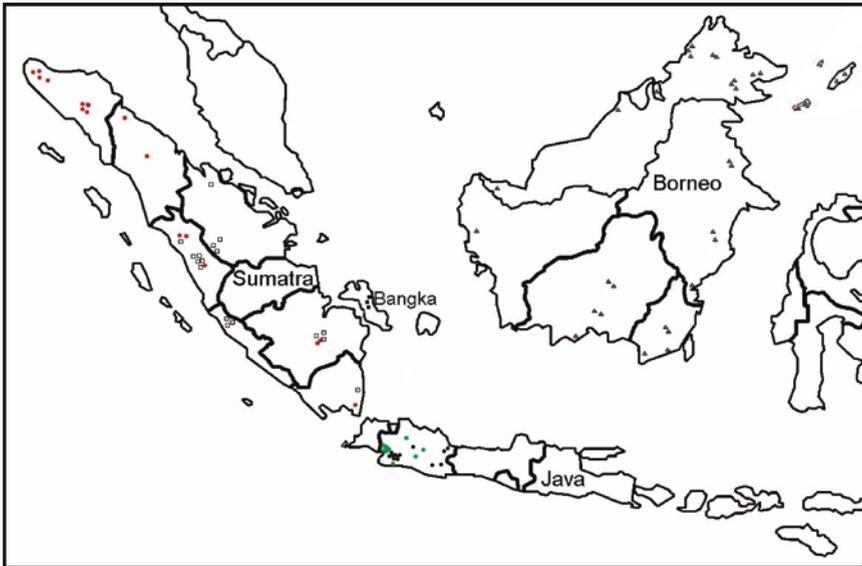
Top – *P* pointed, *R* rounded, *D* diffuse; Middle – *B* broad, *N* Narrow; Bottom – *UE* under eye, *AZ* above zygomatic, *UZ* under zygomatic; Rim – *P* present, *A* absent; Width – *N* narrow, *W* wide; Shape – *H* hourglass, *R* rectangle, *D* diamond; Nose color – *P* pink, *B* black, *M* mixed; Preauricular hair – *N* narrow, *M* medium, *W* wide; Ears – *H* hidden, *F* furred, *T* tufted; Shape – *DF* distinct forked, *RF* rounded forked, *D* diffuse; Forks – *D* distinct, *B* blended; Color – *R* red, *Br* brown, *Y* yellow, *Bl* black.

plight faced by lorises. In Indonesia, lorises are protected under Decree of Agriculture Ministry No. 66 of 1973, the Government Regulation No. 7 of 1999 concerning the Protection of Wild Flora and Fauna and Act No. 5 of 1999 concerning Biodiversity Conservation (Streicher et al. 2008). Furthermore, Indonesia supported the 2007 up-listing of *Nycticebus* to CITES I (Nekaris and Nijman 2007b). Despite this protection, enforcement is challenging, and penalties issued in the rare instances when lorises are confiscated are meager (Shepherd et al. 2005).

## 22 Using Facial Markings to Unmask Diversity



**Fig. 22.3** Face masks of six subspecies used in this study, showing distinctive characters of each taxon. Clockwise from upper left – *N. coucang* (brown), *N. coucang* (red), *N. javanicus* (long-furred form), *N. menagensis* (Bangka form; museum specimen), *N. menagensis* (Borneo), *N. javanicus* (short-furred form)



**Fig. 22.2** Map of slow loris distribution in Sundaland showing points for species with known localities used in this analysis. In Sumatra, the dark spots demarcate the red form, with open squares indicating brown form localities. In Java, the darker points are the short-furred form, with the lighter points representing the long-furred form. Triangles indicate *N. menagensis*, with the Bangka form denoted with dark squares

239 Our literature review also shows that quantitative data are sorely lacking on their  
240 diet, ranging patterns, social behavior, and habitat preferences. These data are vital to  
241 managing lorises in the wild, determining reintroduction programs, as well as to  
242 improve captive management (Fitch-Snyder and Schulze 2001). Fitch-Snyder et al.  
243 (2008) outline extensive guidelines on keeping lorises in captivity, and Streicher et al.  
244 (2008) provide details on following IUCN protocol for reintroducing wild animals.  
245 All of these authors reiterate, however, the fundamental importance of understanding  
246 loris taxonomy. Currently, the reintroduction of the wrong species into the wrong area  
247 only increases taxonomic and conservation havoc (Schulze and Groves 2004).

248 Our data on facial mask characteristics solidify support for classification of  
249 Indonesian lorises into at least three species. Based on craniometric evidence,  
250 Ravosa (1998) and Groves and Maryanto (2008) found that *N. javanicus* was highly  
251 distinguishable by several characters, including its larger size. Pelage differences  
252 have been noted before (Groves 1998), and our study yields quantifiable evidence  
253 that *N. javanicus* is easily distinguished from other Indonesian lorises by its facial  
254 mask. Nekaris and Jaffe (2007) pointed out two forms may be present on Java, with  
255 a key feature being significantly longer fur length. Our study only slightly distin-  
256 guished a long-coated form from Java. Whether or not it can be classified as a dis-  
257 tinct taxon remains to be seen. Data on altitudinal variation are sorely needed;

## 22 Using Facial Markings to Unmask Diversity

it may follow a coat pattern under the influence of similar ecological factors as those dictating variation in ebony langurs (*Trachypithecus auratus*) (Nijman 2000).

Long considered a subspecies of *N. coucang*, two independent genetic studies have distinguished *N. menagensis* as a taxon (Roos 2003; Chen et al. 2007). In our analyses, pelage characters also clearly distinguished Bornean lorises from their congeners. Lorises from Bangka are clearly united with *N. menagensis* by distinctive cranial morphology, including the persistent absence of the second upper incisor (Groves 1971; Groves and Maryanto 2008). Unique facial characters and striking pelage warrant additional review of the taxonomy of these lorises.

Although Sumatran lorises shared a number of traits distinguishing *N. coucang* from *N. menagensis* and *N. javanicus*, our analysis points toward a red form found throughout Sumatra and a brown one restricted to the southern two-thirds. Northern Sumatra is known as a faunal transition area. Certain species, including tapirs (*Tapirus indicus*), agile gibbons (*Hylobates agilis*) and banded langurs (*Presbytis melalophos*), are only found south of this boundary. It might be reasonable to assume that similar selective pressures may have resulted in two taxa of slow loris. In the case of nocturnal mammals, where morphology is only a small part of the story in distinguishing cryptic species (Bearder et al. 1995), genetic studies and more current locality data from the wild are required to elucidate Sumatran loris taxonomy.

Another area to explore is why these facial characters are so distinct. Bearder (1999) showed that galago species can be easily discriminated by a suite of facial characters and suggested that face masks may be part of complex system of species recognition. Face masks clearly aid in individual recognition; in the field, both galagos and slender lorises can identify individuals by vision from a distance of 20–50 m away (Bearder et al. 2006). A striking face mask may also serve as a form of aposematism to make a species look larger or threatening (Newman et al. 2005). This hypothesis would be particularly interesting to test for slow lorises; appearing larger would be a valuable antipredator benefit to these otherwise slow and relatively helpless primates (Nekaris et al. 2007). Although still an area under study, the purportedly toxic bite of slow lorises has even been known to kill humans (Hagey et al. 2007); aposematic face masks could also serve as a warning to potential predators.

In conclusion, we clearly have much to learn about Indonesia's lorises. Long thought to be common, conservation of these primates is of utmost importance, as is an understanding of the complex biology of these unique strepsirrhines.

**Acknowledgments** We thank S. Gursky and J. Supriatna for inviting us to contribute to this volume. We are grateful to the following individuals for access to and help with their zoological collections: H. van Grouw (Naturalis Leiden), D. Hill and P. Jenkins (Natural History Museum London), W. Stanley (Field Museum of Natural History Chicago), A. Rol and V. Nijman (Zoological Museum Amsterdam), and M. Nowak-Kemp (Natural History Museum Oxford). Others who have and are continuing to assist with this project include: J. Ariosona, S. Bearder, M. Bruford, B. Goossens, F. den Haas, F. Jalil, A. Knight, K. L. Sanchez, and I. Winarti. H. Schulze provided the loris figures, and the map was adapted from one produced by J. Thorn. We thank K. Wells for the photo of the ever elusive *N. menagensis*. C. Groves, H. Schulze, and V. Nijman provided valuable comments on the manuscript. Funding was provided by the Systematics Research Fund of the Linnaean Society, Primate Conservation Inc, International Animal Rescue Indonesia, the Royal Society, and Oxford Brookes University Research Strategy Fund. This

K.A.I. Nekaris and R. Munds

304 research received support from the SYNTHESYS Project, which is financed by European  
305 Community Research Infrastructure Action under the FP6 "Structuring the European Research  
306 Area" Programme (NL-TAF-3491).

## 307 References

- 308 Bearder SK (1999) Physical and social diversity among nocturnal primates: a new view based on  
309 long term research. *Primates* 40:267–282
- 310 Bearder SK, Honess PE, Ambrose L (1995) Species diversity among galagos with special refer-  
311 ence to mate recognition. In: Alterman L, Doyle G, Izard MK (eds) *Creatures of the dark: the*  
312 *nocturnal prosimians*. Plenum, New York, pp 331–352
- 313 Bearder SK, Nekaris KAI, Curtis DJ (2006) A re-evaluation of the role of vision in the activity  
314 and communication of nocturnal primates. *Folia Primatol* 77(1–2):50–71
- 315 Barash DP (1974) Neighbor recognition in two 'solitary' carnivores: the raccoon (*Procyon lotor*)  
316 and the red fox (*Vulpes fulva*). *Science* 185(4153):794–496
- 317 Chen JH, Pan D, Groves CP (2006) Molecular phylogeny of *Nycticebus* inferred from mitochon-  
318 drial genes. *Int J Primatol* 27(4):1187–1200
- 319 Collins R (2007) Preliminary study of behaviour and population densities of *Nycticebus coucang* and  
320 *N. javanicus* in Sumatra and Java, Indonesia. MSc Thesis, Oxford Brookes University, Oxford
- 321 Collins R, Nekaris KAI (2008) Release of greater slow lorises, confiscated from the pet trade, to  
322 Batutegi Protected Forest, Sumatra, Indonesia. In: Soorae PS (ed) *Global re-introduction per-*  
323 *spectives*. IUCN Reintroduction Specialist Group, Abu Dhabi, pp 192–195
- 324 Defler TR (2003) Primate of Colombia. Conservation International, Bogota, Colombia
- 325 Duckworth JW (1997) Mammals in Similajau National Park, Sarawak, in 1995. *Sarawak Mus J*  
326 51:171–192
- 327 Elliot O, Elliot M (1967) Field notes on the slow loris. *Malaya J Mammal* 48:497–498
- 328 Fitch-Snyder H, Ehrlich A (2003) Mother-infant interactions in slow lorises (*Nycticebus benga-*  
329 *lensis*) and pygmy lorises (*Nycticebus pygmaeus*). *Folia Primatol* 74(5–6):259–271
- 330 Fitch-Snyder H, Schulze H (2001) Husbandry manual for Asian Lorises (*Nycticebus* and *Loris*).  
331 Center for Reproduction of Endangered Species (CRES) Zoological Society of San Diego, San  
332 Diego
- 333 Fitch-Snyder H, Schulze H, Streicher U (2008) Enclosure design for captive slow and pygmy  
334 lorises. In: Shekelle M, Maryanto I, Groves C, Schulze H, Fitch-Snyder H (eds) *Primates of*  
335 *the oriental night*. LIPI, Jakarta, pp 123–135
- 336 Ford SM (1994) Taxonomy and distribution of the owl monkey. In: Baer JF, Weller RE, Kakoma  
337 I (eds) *Aotus: the owl monkey*. Academic, San Diego, pp 1–57
- 338 Groves CP (1971) Systematics of the genus *Nycticebus*. In: Biegert J, Leutenegger W (eds)  
339 *Taxonomy, anatomy, and reproduction, vol 1, Proceedings of the third international congress*  
340 *of primatology*. S Karger, Basel, pp 44–53
- 341 Groves CP (1998) Systematics of tarsiers and lorises. *Primates* 39:13–27
- 342 Groves CP, Maryanto I (2008) Craniometry of slow lorises (genus *Nycticebus*) of insular Southeast  
343 Asia. In: Shekelle M, Maryanto I, Groves C, Schulze H, Fitch-Snyder H (eds) *Primates of the*  
344 *oriental night*. LIPI, Jakarta, pp 115–122
- 345 Hagey LR, Fry BG, Fitch-Snyder H (2007) Talking defensively, a dual use for the brachial gland  
346 exudate of slow and pygmy lorises. In: Gursky SL, Nekaris KAI (eds) *Primate anti-predator*  
347 *strategies*. Springer, New York, pp 253–272
- 348 IUCN (2009) IUCN red list of threatened species. Version 2009.1. [www.iucnredlist.org](http://www.iucnredlist.org). Accessed  
349 07 June 2009
- 350 Jenkins DV (1971) Animal life of Kinabalu National Park. *Malay Nat J* 24:177–183
- 351 Meijaard E, Sheil D, Nasi R (2005) Life after logging: reconciling wildlife conservation and pro-  
352 duction forestry in Indonesian Borneo. CIFOR and UNESCO, Bogor

## 22 Using Facial Markings to Unmask Diversity

- Merker S, Groves C (2006) *Tarsius lariang*: a new primate species from western central Sulawesi. Int J Primatol 27(2):465–485 353  
354
- Munds RA, Collins R, Nijman V, Nekaris KAI (2008) Abundance estimates of three slow loris taxa in Sumatra (*N. coucang*), Java (*N. javanicus*) and Borneo (*N. menagensis*). Primate Eye 96:902 355  
356
- Musser GG, Dagasto M (1987) The identity of *Tarsius pumilus*, a pygmy species endemic to the montane mossy forests of central Sulawesi. Am Mus Novit 2867:1–53 357  
358
- Nekaris KAI (2003) Observations on mating, birthing and parental care in three taxa of slender loris in India and Sri Lanka (*Loris tardigradus* and *Loris lydekkerianus*). Folia Primatol 74:312–336 359  
360  
361
- Nekaris KAI, Bearder SK (2007) The strepsirrhine primates of Asia and Mainland Africa: diversity shrouded in darkness. In: Campbell C, Fuentes A, MacKinnon K, Panger M, Bearder SK (eds) Primates in Perspective. Oxford University Press, Oxford, pp 24–45 362  
363  
364
- Nekaris KAI, Jaffe S (2007) Unexpected diversity of slow lorises (*Nycticebus* spp.) in the Javan pet trade: implications for slow loris taxonomy. Contrib Zool 76:187–196 365  
366
- Nekaris KAI, Nijman V (2007a) Survey on the abundance and conservation of Sumatran slow lorises (*Nycticebus coucang hilleri*) in Aceh, Northern Sumatra. In: Proceeding of the European Federation of Primatology, Prague, Charles University, Prague, p 47 367  
368  
369
- Nekaris KAI, Nijman V (2007b) CITES proposal highlights rarity of Asian nocturnal primates (Lorisidae: *Nycticebus*). Folia Primatol 78(4):211–214 370  
371
- Nekaris KAI, Blackham GV, Nijman V (2008) Implications of low encounter rates in five nocturnal species (*Nycticebus* spp.). Biodivers Conserv 17(4):733–747 372  
373
- Nekaris KAI, Pimley ER, Ablard K (2007) Anti-predator behaviour of lorises and pottos. In: Gursky SL, Nekaris KAI (eds) Primate anti-predator strategies. Springer, New York, pp 220–238 374  
375
- [AU4] Nekaris KAI, Collins RL, Starr C, Navarro-Montes A (in press-a). Comparative ecology of exudate feeding by Asian slow lorises (*Nycticebus*). In: Nash L, Burrows A (eds) The evolution of exudativory. Springer, New York 376  
377  
378
- Nekaris KAI, Sanchez KL, Thorn J, Winarti I, Nijman V (in press-b). Primates in peril: the world's top 25 most endangered primates 2008–2010 – Javan slow loris. Primate Conserv 379  
380
- Newman C, Buesching CD, Wolff JO (2005) The function of facial masks in “midguild” carnivores. Oikos 108(3):623–633 381  
382
- Nijman V (2009) An assessment of trade in orang-utans and gibbons on Sumatra, Indonesia. Traffic Southeast Asia, Petaling Jaya 383  
384
- Nijman V (2005) Hanging in the balance: an assessment of trade in orang-utans and gibbons on Kalimantan, Indonesia. Traffic Southeast Asia, Petaling Jaya 385  
386
- Nijman V (2000) Geographic distribution of ebony leaf monkey *Trachypithecus auratus* (E. Geoffroy Saint-Hilaire, 1812) (Mammalia: Primates: Cercopithecidae). Contrib Zool 69(3):157–177 387  
388  
389
- [AU5] Nijman V, Nekaris KAI (in review) Distribution patterns of slow lorises and tarsiers in insular Southeast Asia – interspecific competition or something else. Int J Primatol 390  
391
- Nijman V, van Balen S (1998) A faunal survey of the Dieng mountains, Central Java, Indonesia: distribution and conservation of endemic primate taxa. Oryx 32:145–156 392  
393
- Osman Hill WC (1953) Primates. Comparative anatomy and taxonomy. I. Strepsirhini. Edinburgh University Press, Edinburgh 394  
395
- Rasoloarison RM, Goodman SM, Ganzhorn JU (2000) Taxonomic revision of mouse lemurs (*Microcebus*) in the western portions of Madagascar. Int J Primatol 21(6):963–1019 396  
397
- Rasmussen DT, Izard MK (1988) Scaling of growth and life-history traits relative to body size, brain size and metabolic rate in lorises and galagos (Lorisidae, Primates). Am J Phys Anthropol 75:357–367 398  
399  
400
- Ratajszczak R (1998) Taxonomy, distribution and status of the lesser slow loris *Nycticebus pygmaeus* and their implications for captive management. Folia Primatol 69:171–174 401  
402
- Ravosa MJ (1998) Cranial allometry and geographic variation in slow lorises (*Nycticebus*). Am J Primatol 45:225–243 403  
404
- Roos C (2003) Molekulare Phylogenie der Halbaffen, Schlankaffen, und Gibbons. Unpubl. Ph.D Thesis, Technische Universität München 405  
406

K.A.I. Nekaris and R. Munds

- 407 Schulze H, Groves CP (2004) Asian lorises: taxonomic problems caused by illegal trade. In:  
408 Nadler T, Streicher U, Thang Long H (eds) Conservation of primates in Vietnam. Frankfurt  
409 Zoological Society, Frankfurt, pp 33–36
- 410 Schulze H, Meier B (1995) Behaviour of captive *Loris tardigradus nordicus*: a qualitative descrip-  
411 tion including some information about morphological bases of behavior. In: Alterman L,  
412 Doyle G, Izard MK (eds) Creatures of the dark: the nocturnal prosimians. Plenum Publishing,  
413 New York, pp 171–192
- 414 Schwartz JH, Beutel JC (1995) Species diversity in lorises: a preliminary analysis of *Arctocebus*,  
415 *Perodicticus* and *Nycticebus*. In: Alterman L, Doyle G, Izard MK (eds) Creatures of the dark:  
416 the nocturnal Prosimians. Plenum Publishing, New York, pp 171–192
- 417 Sellers W (1996) A biomechanical investigation into the absence of leaping in the locomotor  
418 repertoire of the slender loris (*Loris tardigradus*). *Folia Primatol* 67:1–14
- 419 Shepherd CR, Sukumaran J, Wich SA (2005) Open season: an analysis of the pet trade in Medan,  
420 North Sumatra, 1997–2001. TRAFFIC Southeast Asia, Kuala Lumpur
- 421 Streicher U, Schulze H, Fitch-Snyder H (2008) Confiscation, rehabilitation and placement of slow  
422 lorises – recommendations to improve the handling of confiscated slow lorises *Nycticebus*  
423 *couang*. In: Shekelle M, Maryanto I, Groves C, Schulze H, Fitch-Snyder H (eds) Primates of  
424 the oriental night. LIPI, Jakarta, pp 137–145
- 425 Streicher U, Collins R, Navarro-Montes A, Nekaris KAI (in review). Observations on the feeding  
426 preferences of slow lorises (*Nycticebus pygmaeus*, *N. javanicus*, *N. couang*) rescued from the  
427 trade. In: Masters J, Crompton R, Genin F (eds.) Leaping ahead. New York: Springer.
- 428 Supriatna J, Wahyono EH (2000) Panduan lapangan primata Indonesia. Yayasan Obor Indonesia,  
429 Jakarta, p 332
- 430 Thalmann U, Geissmann T (2005) New species of woolly lemur *Avahi* (Primates: Lemuriformes)  
431 in Bemaraha (central western Madagascar). *Am J Primatol* 67(3):371–376
- 432 Thorn JS, Nijman V, Smith D, Nekaris KAI (2009) Ecological niche modelling as a technique for  
433 assessing threats and setting conservation priorities for Asian slow lorises (Primates: *Nycticebus*).  
434 *Divers Distrib* 15(2):289–298
- 435 van Schaik CP, Ancrenaz M, Borgen G (2003) Orang-utan cultures and the evolution of material  
436 culture. *Science* 299:102–105
- 437 Wells K, Pfeiffer M, Lakim MB (2004) Use of arboreal and terrestrial space by a small mammal  
438 community in a tropical rain forest in Borneo. *Malaysia J Biog* 31:641–652
- 439 Wiens F (2002) Behavior and ecology of wild slow lorises (*Nycticebus couang*): social organisation,  
440 infant care system and diet. Dissertation, Bayreuth University
- 441 Wiens F, Zitzmann A (2003) Social structure of the solitary slow loris *Nycticebus couang*  
442 (*Lorisidae*). *J Zool* 261(1):35–46
- 443 Wiens F, Zitzmann A, Hussein NA (2006) Fast food for slow lorises: is low metabolism related to  
444 secondary compounds in high-energy plant diet? *J Mammal* 87(4):790–798
- 445 Winarti I (2008) Field research on Javan slow loris' population in Sukakarta Ciamis and  
446 Kawungsari Tasikmalaya, West Java, Indonesia. Report to IAR Indonesia. Ciapus, Bogor,  
447 Indonesia, p 7
- 448 Zimmermann E (1989) Reproduction, physical growth and behavioural development in slow loris  
449 (*Nycticebus couang*, *Lorisidae*). *Hum Evol* 4(2–3):171–179

# Author Queries

Chapter No.: 22      0001106645

Queries	Details Required	Author's Response
AU1	"Shepherd et al. 2004 and Chen et al. 2007" are cited in text but not given in the reference list. Please provide details in the list or delete the citations from the text.	
AU2	Figures 1–4 are renumbered.	
	Figure 2 changed to 1	
	Figure 3 changed to 2	
	Figure 4 changed to 3	
	Figure 1 changed to 4	
	Please amend the changes.	
AU3	Figures 1–4 have been renumbered. Original sequence was 2, 3, 4, 1. Please check.	
AU4	Please update the references "Nekaris et al. in press-a and b" and also update the citations.	
AU5	Please update the references "Nijman and Nekaris in review" and "Streicher et al. in review" and also update the citations.	