Original Article

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Group Structure and Physical Characteristics of Simakobu Monkeys *(Simias concolor)* on the Mentawai Island of Siberut, Indonesia

Susilo Hadi[a–c] Thomas Ziegler[a] J. Keith Hodges[a]

[a]Department of Reproductive Biology, German Primate Centre, [b]Department of Conservation Biology, Centre for Nature Conservation, Georg August University, Göttingen, Germany; [c]Faculty of Biology, Gadjah Mada University, Jogjakarta, Indonesia

Key Words
Social organization · Physical characteristics · Mating system · Sexual dimorphism · *Simias concolor* · Reproductive seasonality

Abstract

We present data on group structure and physical characteristics from free-ranging *Simias concolor*. Mean group size (n = 3) was 8.7 ± 1.1 individuals with an average adult male:female sex ratio of 1:3. All individuals were sexed and allocated into three categories (infants, juveniles plus subadults and adults) on the basis of their physical development. Within age categories, head-body lengths ranged from 19.6 to 25, 34 to 44 and 42 to 53 cm. Corresponding body weights ranged from 0.5 to 0.9, 2.35 to 4.4 and 5.2 to 7.85 kg, respectively; on average adult males were 13% larger and 23% heavier than adult females. Results indicate that for *S. concolor* living in undisturbed habitat (i) group sizes are larger than previously reported and (ii) polygyny is the most likely mating system. Both results support an earlier proposal that group size and social organization in Simakobu monkey are related to the degree of habitat disturbance.

Introduction

Having been separated from the Sunda shelf for more than 500,000 years, the four main islands comprising the Mentawai archipelago (Siberut, Sipora, North and South Pagai) [Verstappen, 1975, 1980] possess an unusual degree of biological diversity and species endemism. Of 16 mammal species found nowhere else, 5 are pri-

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Dr. Thomas Ziegler, Dept. of Reproductive Biology
German Primate Centre
Kellnerweg 4, DE–37077 Göttingen (Germany)
Tel. +49 551 3851 141, Fax +49 551 3851 288
E-Mail tziegl@dpz.eu

mates, all of which are officially listed as threatened (vulnerable, endangered or critically endangered) [Eudey et al., 2000]. One of these, the pig-tailed langur *(Simias concolor)*, locally known as Simakobu, is listed as one of the World's 25 Most Endangered Primates [Mittermeier et al., 2007]. Like most other areas in Sundaland, loss of suitable forest habitat through commercial logging and other non-sustainable land use practices is the main factor threatening populations of all the Mentawai primates, including Simakobu.

Despite the urgent need for scientifically based conservation measures for this species, basic information on the biology of the pig-tailed langur is very limited. Even data on group size and composition, as reported in studies conducted in the 1970s and 1980s [Tilson, 1977; Watanabe, 1981; Kawamura and Megantara, 1986] are contradictory and there is still no consensus on adult sex ratio and mating system of this species. For example, the monogamous mating system proposed for *S. concolor* by Tilson [1977] does not accord with the significant morphological differences between the sexes reported from field observations by Tenaza and Fuentes [1995]. Furthermore, the only data on physical characteristics of the species derive from studies on relatively few specimens kept in museum collections [Napier, 1985] and direct measurements of animals living in the wild have never been recorded. Concerning pelage, *Simias* is asexually dichromatic [Chasen and Kloss, 1927], with the majority of animals having a greyish-black fur colour and less than one third of individuals being creamy-buff with brown [Tilson, 1977].

Despite widespread habitat destruction throughout most of the Mentawai Islands, Northern Siberut still possesses areas of relatively undisturbed rainforest cover and recent census data for the Peleonan forest [Waltert et al., 2008] indicate that *S. concolor* occurs in densities of up to 53.1 individuals/km^2, considerably higher than estimates reported for other locations. Although hunting pressure in North Siberut is thought to be relatively low, and local inhabitants have traditionally shown considerable respect for their natural habitat and its resources, primates are still killed as an occasional source of animal protein. As part of our field research and conservation programme in Northern Siberut (SCP; www.siberut-island.org), which relies heavily on the support of and close interaction with local inhabitants, the opportunity arose for one of our team to passively attend a rare (1–2 per year) ceremonial hunt of *S. concolor*. In the course of this, three groups were hunted down and the majority of individuals were killed. Here we present data on size and composition of these groups as well as physical characteristics of most of the individuals killed by the local hunters.

Materials and Methods

The data presented here were collected in the Loh Bajou bay region of NE Siberut (0°55′46.41″S and 98°53′17.98″E), which forms part of a largely undisturbed forested area (outside the 5,000 ha of forest protected by SCP), stretching between the village of Politcioman, next to the Sigep river in the West, and the village of Loh Bajou in the East (fig. 1). The habitat can be described as an undisturbed peat swamp forest, dominated by the tree species *Terminalia phellocarpa, Elaeocarpus* sp. and *Alstonia angustiloba* Miq. All local traffic between the villages is restricted to boats going along the NE coast or a 12-km track along the beach.

The ceremonial hunt took place in the 3rd week of December 2006, during which three Simakobu groups were encountered. For two of these groups, comprising 8 and 10 individuals,

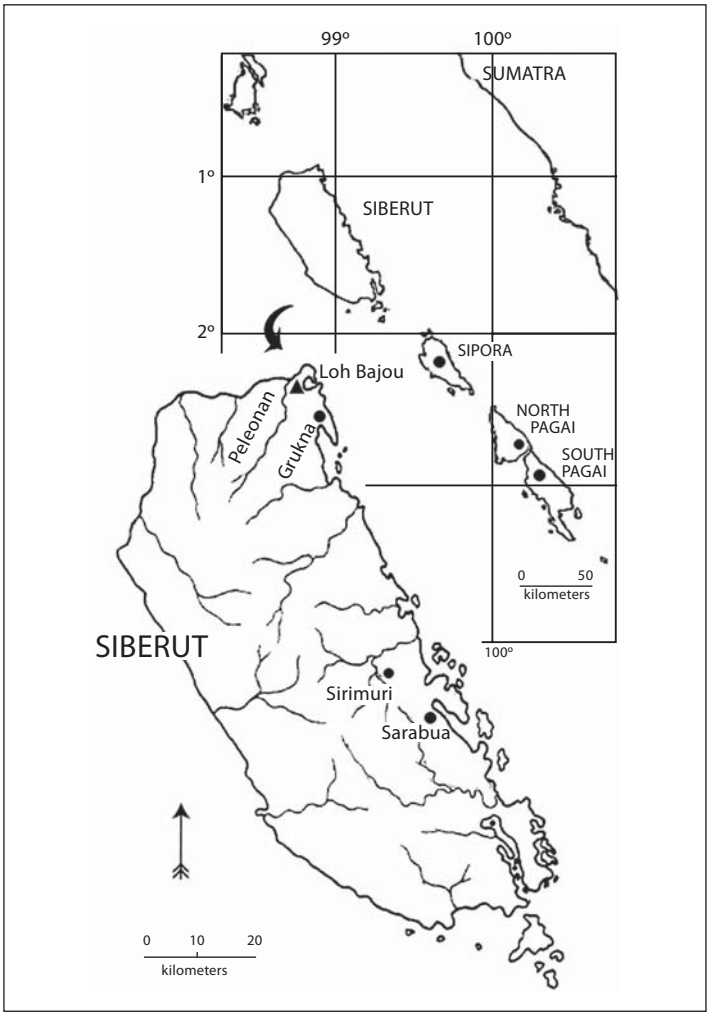

Fig. 1. Map of Mentawai islands/Siberut, depicting the site of the present study at Loh Bajou (triangle) on Siberut and the sites of previous studies by Tenaza and Fuentes [1995] in North and South Pagai; Kawamura and Megantara [1986] on Sipora; Watanabe [1981] in Sarabua and Grukna Tilson [1977] at Sirimuri (circles on Siberut island).

respectively, all but 1 member were killed. Data on sex, age class and measurements of body weight and crown-rump length were collected within 1 h by the first author. A third group was followed and its size determined, but culling was called off after the sighting of an individual with white (creamy buff) fur, the hunting of which is prohibited by a religious taboo. Data on sex, age class and reproductive status were collected, but were incomplete (table 1), whereas for this third group, physical measurements of culled individuals were not possible at all.

After sexing of individuals in the first two groups (18 in total), animals were allocated to three age categories: infant, juvenile plus subadult and adult, according to their physical development (body size, reproductive status, parity, dental development). Additionally, measures of

Table 1. Group composition and individual measurements of head-body length and body weight in *S. concolor*

	Sex (age category)	Length cm	Weight kg	Remarks
Group I				
1	male (adult)	53	7.85	
2	male (infant <1 week)	19.6	0.5	
3	female (adult)	50	6.95	
4	female (adult)	45	6.3	
5	female (infant 1–2 weeks)	21.7	0.55	
6	female (adult)	44	5.55	
7	female (infant 2 weeks)	24.5	0.7	
8	female (adult)	42	5.2	
Group II				
1	male (adult)	51	7.65	
2	male (juvenile)	39	3.75	
3	male (subadult)	44	4.4	
4	male (fetus II/4)	13.6	0.18	
5	female (adult-pregnant)	47	7.0	with fetus-placenta 7.3 kg
6	female (subadult)	41	4.25	
7	female (juvenile)	34	2.35	
8	female (adult)	48	6.75	
9	female (infant <1 month)	25	0.9	
10	female (infant <1 month)	24	0.7	
11	female (adult)	–	–	survived
Group III				
1	male (adult)	–	–	
2	male (subadult)	–	–	
3	male (juvenile)	–	–	
4	female (adult-pregnant)	–	–	fetus 60% smaller than the one listed as II/4
5	female (adult-pregnant)	–	–	fetus 20% smaller than the one listed as II/4
6	female (adult)	–	–	
7	sex? (infant)	–	–	survived
8	sex? (subadult, white fur)	–	–	survived

the head-body length (using hand-held tape measure) and body weight (using a portable digital balance) of these individuals were taken and the species-specific relationship between these parameters was analysed using a least-squares regression. Being genetically predisposed and unaffected by seasonal changes, head-body length was used as the independent variable. Differences in physical characteristics between adult males and adult females were analysed using the Student's t test. The results were compared to data obtained from the only other comparable study by Tenaza and Fuentes [1995], which is based on measurements of museum specimens.

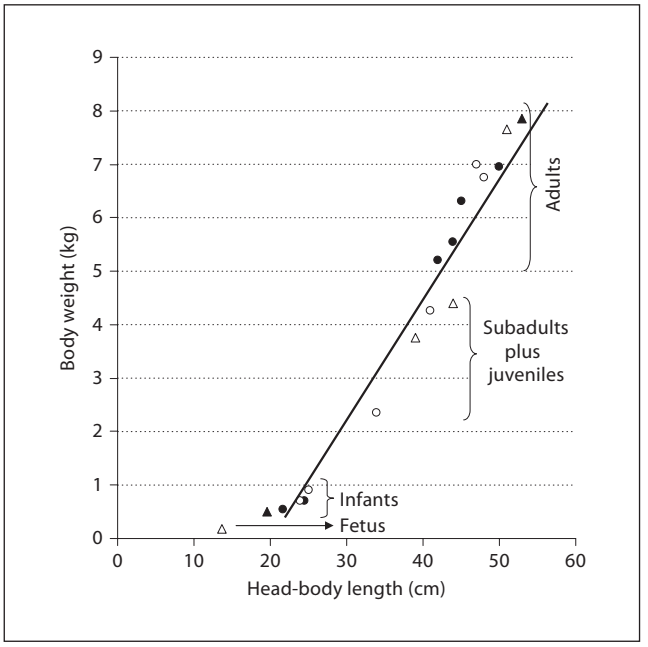

Fig. 2. Relationship of physical characteristics (head-body length in centimeters and body weight in kilograms) across age categories of Simakobu monkeys. ▲ = Male, ● = female group I; △ = male, ○ = female group II.

Results

Sizes and composition of the three groups are shown in table 1. Individual group sizes were 8, 10 (without fetus) and 8 (mean group size was 8.7 ± 1.1 individuals). The adult male:female sex ratio was on average 0.3 and similar in all groups (either 3 or 4 females per adult male). In each group only 1 adult male was present (tables 1, 3). Of the 9 adult females killed, 3 were pregnant and 4 were accompanied by infants less than 1 month old. Within the three age categories infant, juvenile plus subadult and adult (sexes combined), head-body lengths ranged from 19.6 to 25, 34 to 44 and 42 to 53 cm, respectively. Corresponding body weight ranges were 0.5–0.9, 2.35–4.4 and 5.2–7.85 kg (table 1, fig. 2). Head-body lengths and body weights showed significant differences between adult males and adult females. As shown in table 2, adult males were 13% ($p < 0.05$) larger and 23% ($p < 0.05$) heavier than adult females. Our data for wild animals compare well with those for museum specimens as published by Tenaza and Fuentes [1995]. Based on measurements of 3 infants less than 2 weeks of age, we propose a neonatal body weight of 450–500 g and a head-body length of about 20 cm (table 1). According to our physical measurements the relationship between head-body length and body weight for this species (fig. 2; sexes combined, n = 17) follows the equation $y = 0.24x - 4.91$ ($R^2 = 0.962$).

Table 2. Comparison of head-body length and body weight measurements in adult male and female Simakobu monkeys

Measurement	Male		Female		Statistics[1]		Sources
	mean	range	mean	range	t	p	
Head-body length, cm	52 ± 0.14 (n = 2)	51.0–53.0	46.0 ± 2.9 (n = 6)	42.0–50.0	3.38	<0.05	this study
	53.11 ± 2.61 (n = 8)	48.0–57.1	47.61 ± 1.38 (n = 12)	46.0–50.0	5.82	<0.001	Tenaza and Fuentes [1995]
Body weight kg	7.75 ± 0.14 (n = 2)	7.65–7.85	6.29 ± 0.76 (n = 6)	5.2–7.0	3.20	<0.05	this study
	8.8 ± 0.2 (n = 2)	8.6–8.9	6.8 ± 0.5 (n = 3)	6.2–7.1	4.18	<0.05	Tenaza and Fuentes [1995]

[1] Student's t test (two-tailed).

Discussion

The present study provides an important contribution to the limited dataset for *S. concolor*, one of the 25 most endangered primates worldwide [Mittermeier et al., 2007]. The data, collected in an undisturbed swamp forest of North Siberut, indicate a mean group size (8.7 individuals) higher than that reported previously from various locations throughout the Mentawai archipelago (table 3). Interestingly the present figure for group size is most similar to that reported by Watanabe [1981], based on a total of 23 groups encountered (mean group size: 7.1 individuals). In his publication, Watanabe [1981] notes that large groups of Simakobu can only be found in the North of Siberut island and that local people often see relatively large groups of this langur species in inaccessible swamp forest areas. The present study confirms these earlier observations on group size and, since our own study was carried out in a peat swamp forest region, it also provides further support that peat swamp forest represents an important habitat for *S. concolor* [see also: Quinten, 2008]. These findings, together with the high abundance of *S. concolor* in the adjacent (mixed) primary rainforest of North Siberut (53.1 individuals/km^2) shown by Waltert et al. [2008], indicate a relatively high carrying capacity of both habitats, situated in the northern periphery of the distribution range of *S. concolor*. The comparatively low level of forest degradation in this region combined with the relatively low hunting pressure exerted on *S. concolor* by the locals living in this area most likely explain the abundance of these primates in the Peleonan forest and emphasise the conservation significance of this region for this critically endangered species.

Consideration of our data together with those from earlier studies also allows us to comment on group composition and mating system in this species. One of the first scientific publications on *S. concolor* describes the mating system as monogamous and therefore unique among Asian colobines [Tilson, 1977]. These initial observations, however, were made on non-habituated groups, living in a disturbed secondary forest near Sirimuri, where hunting pressure was relatively high. Based on

Table 3. Comparison of present data on mean group size, group size ranges and observed sex ratios with previous studies

Parameter	N. Siberut Loh Bajou[1] (n = 3)	S. Siberut Sirimuri[2] (n = 15)	S. Siberut Sarabua[3] (n = 7)	N. Siberut Grukna[3] (n = 23)	Sipora[4] (n = 2)	Pagai[5] (n = 20)
Group size	8.7 ± 1.1	3.5 ± 1.1	3.0 ± 1.0	7.1 ± 6.4	3.0 ± 0.0	4.1 ± 2.1
Range	8–11	2–5	2–5	2–20	3	2–7
Adult M:F ratio	1:3	1:1	1:1	1:2	1:2	1:1.8
Proportion of groups observed with						
1 adult M, 1 adult F	–	100%	100%	39%	–	45%
1 adult M, >1 adult F	100%	–	–	61%	100%	55%

Sources: [1] This study (2006); [2] Tilson [1977]; [3] Watanabe [1981]; [4] Kawamura and Megantara [1986]; [5] Tenaza and Fuentes [1995].

counts during relatively short sightings, group sizes reported ranged from 2 to 5 individuals. Some years later, Watanabe [1981] studied *S. concolor* at two different sites on Siberut, at one of which he observed much larger single-male/multi-female groups near Grukna, in a relatively undisturbed area. Subsequently, Tenaza and Fuentes [1995] proposed the revised term 'monandrous' (i.e. 1 adult male and 1 or more adult females) to describe the mating system of *S. concolor*, and since then the species has been considered to be organized into both monogamously and polygynously breeding groups. However, Watanabe [1981] was the first to propose that in the absence of large predators on the Mentawai Islands, group size and composition in Simakobu monkeys is strongly influenced by human hunting pressure. In contrast to the earlier studies conducted in disturbed or secondary forests, where relatively high hunting pressure existed [Tilson, 1977; Kawamura and Megantara, 1986; Tenaza and Fuentes, 1995], our study in an undisturbed swamp forest found only 1-male/multi-female groups of Simakobu monkeys.

This result is not only in line with the findings of Watanabe [1981], but is also supported by our own long-term observation of an all-male band of *S. concolor* near our field station in northern Siberut – a phenomenon, not yet described for *S. concolor*, but to be expected as a consequence of a heavily biased sex ratio in polygynous groups [see also Watanabe, 1981; Kawamura and Megantara, 1986]. An additional indication contradicting a monogamous mating system in this species is the significant sexual dimorphism found in this species on the basis of museum specimens [Tenaza and Fuentes, 1995] and direct measurements from the present study (table 2). Thus, combining all available evidence, we propose that the mating system of Simakobu monkeys be reassigned as polygynous. Furthermore, we consider the local occurrence of 1-adult male/1-adult female units as an unusual social organization caused by increased human hunting pressure in combination with the degradation of the natural habitat of these langurs due to commercial logging and the conversion of primary forest into agricultural fields.

The conservation significance of local hunting of *S. concolor* and its effect on the overall population size of the species is difficult to assess. Historically, hunting for food probably had a low impact, especially in the light of the traditional animistic religion of the Mentawaians, in which all creatures of the forest possess a soul and are considered valuable. Currently, however, with much less forest habitat available and a more widespread use of non-sustainable land use practices, the additional impact of hunting may, at least locally, represent a more serious threat to already vulnerable populations of the species than previously envisaged.

Although our data are limited, certain inferences on postnatal development and reproductive seasonality can also be made. Based on its size and the presence of visible remains of the umbilical cord (1.5 cm in length with dry blood on the tip), the youngest infant of group I can be assumed to have been born a few (2–3) days prior to the hunting event. Its body weight and head-body length are therefore likely to fit closely to those of newborn Simakobu monkeys. The other infants of the same group were estimated to be 1–2 and about 2 weeks of age, being 50 and 200 g heavier than the newborn. As referred from their physical measurements (table 1) and information from the local hunters, both infants found in group II were no older than about 1 month. These data suggest a growth rate for newborn Simakobu infants of approximately 1.5 cm and 0.15 kg per week and provide the first information of this nature for the species.

Based on their estimated age, infants were most probably born in the first and second week of December and the third or fourth week of November 2006. The mature fetus found in group II would most probably have been born in the second half of January 2007, and the 2 other fetuses (found in group III) from which exact measurements could not be collected were estimated to have reached 80 and 40% of the size of the mature embryo (13.6 cm/0.18 kg), giving a prospected time of birth around late February to April [Kirkwood, 1885; Tarantal and Hendrickx, 1988; Martin and MacLarnon, 1988, 1990; Ross, 1991]. Since Tilson [1977] reported births in June/July, collectively the data indicate that the period during which births occur extends from at least November to July. Thus, in contrast to the earlier suggestion of a restricted birth season for Simakobu monkeys [Tilson, 1977], we propose that only a weakly seasonal, if not an aseasonal pattern of reproduction can be expected for this species.

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