NICHE SEPARATION IN SYMPATRIC LION-TAILED MACAQUE (*MACACA SILENUS*) AND NILGIRI LANGUR (*PRESBYTIS JOHNII*) IN AN INDIAN TROPICAL RAIN FOREST.

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Key words: Lion-tailed macaques, Nilgiri langurs, sympatricity, food specialization, vertical stratification, Western Ghats

Abstract

The study was carried out on one group each of lion-tailed macaques and Nilgiri langurs living as sympatric groups in a rainforest in Anaimalai Hills, Western Ghats, south India. Whereas the lion-tailed macaques were found to be frugivorous/insectivorous, the Nilgiri langurs were primarily folivorous. Fruit was the only shared component in the diet of the two species. The lion-tailed macaques occupied a higher substratum than the Nilgiri langurs not only for their routine activities, but also for overall feeding and fruit feeding. The presence of lion-tailed macaques resulted in further lowering the feeding substratum and increased passivity in Nilgiri langurs. Food specialization and vertical stratification differentiate the niches of these two sympatric species.

Introduction

The lion-tailed macaque (*Macaca silenus*) is an endangered species and the Nilgiri langur (*Presbytis johnii*) is a threatened species. Both of these species inhabit the forests of Western Ghats in southern India. Although, the Nilgiri langur may be found in wet, moist as well as relatively dry forests, the lion-tailed macaque is restricted only to the rain forest (SINGH et al., 1997b). However, in those patches of rain forest which are relatively large (100 hectares or more), the lion-tailed macaque and the Nilgiri langur are often found to be sympatric (KUMAR et al., 1995; SINGH et al., 1997a).

Although a number of studies have now been reported on the ecology and behavior of lion-tailed macaque(KUMAR, 1987; KURUP and KUMAR, 1993; SINGH et al., 1998) as well as of Nilgiri langur (POIRIER, 1968a,b; UMAPATHY and PRABHAKAR, 1996), no information has as yet been reported on the sympatric groups of these two species. The information on the behavior of the sympatric groups is essential for two reasons: (a) The species could form an **interspecific association** in absence of interspersed individuals, a **mixed species** association with interspersed individuals but without physical interactions, or a **polyspecific association** with individuals of the two species socially interacting (BURTON and CHAN, 1996). When two species compete for limited resources, the study of sympatric species can provide us an insight into the adaptive processes leading to niche selection wherein the climate, the forest, and the competing species are held constant (FLEAGLE, 1988). (b) In the case of endangered sympatric species, the information on feeding substratum, food items, and activity patterns etc. may help design scientifically sound conservation and management strategies.

As far as the differential resource utilization by sympatric primate species is concerned, one of the most notable and systematic works has been by TERBORGH (1983). Terborgh pointed out that the differential exploitation of fruit resources can be achieved either through 'preemption' i.e. by utilizing the resources at earlier stages of ripeness, or through 'interference', i.e. by driving off a less assertive species by a more aggressive or larger size species. However, utilization of insect or other small prey resource may be achieved through 'exploitation'. Citing the theoretical frame developed by MACARTHUR and PIANKA (1966), and CHARNOV (1976), Terborgh concluded that optimal foraging on small prey should be achieved through specialization on patch type whereby the utilization by one species would effectively reduce the prey capture rate of the others.

The present paper deals with the resource utilization and niche separation in sympatric groups of lion-tailed macaque and Nilgiri langur.

Study Area, Subjects and Methods

Study Area

The study was carried out in a 2.73 sq. Km patch of rain forest called Andiparai Shola in the middle of Indira Gandhi Wildlife Sanctuary, Anaimalai Hills, Tamil Nadu, India. The forest is located at approximately 770 0' E and 100 23' N. The habitat types and the distribution of four species of primates in this wildlife Sanctuary are described elsewhere in detail (SINGH et al., 1997a,b).

Fig. 1.: Lion tailed macaques use more often a higher substratum than Nilgiri langurs. (Photo: W. Kaumanns)

Subjects

The subjects for this study included one group each of lion-tailed macaques (N=23) and Nilgiri langur (N=13). Although the sole lion-tailed macaque group ranged in the entire forest patch, the home range of the Nilgiri langur group was limited to a small part of the forest at Shola Kurku. However, the forest was inhabited by 12 more groups of Nilgiri langurs. As a result, the home range of the lion-tailed macaque group overlapped the home ranges of 13 groups of Nilgiri langurs and the lion-tailed macaques were almost always in the vicinity of one or the other group of Nilgiri langurs. Our intensive study group of Nilgiri langur at Shola Kurku had the highest frequency of encounters with the lion-tailed group as compared to the other groups of Nilgiri langurs.

The forest is frequently visited by mammalian predators including tiger (*Panthera tigris*), leopard (*Panthera pardus*) and dhole (*Cuon alpinus*), and the non-predatory mammals such as elephant (*Elephas maximus*), sambar (*Cervus unicolor*), barking deer (*Muntiacus muntjak*), bear (*Melursus ursinus*) etc. The arboreal competitors to primates include several species of squirrels, most conspicuous of them being the Malabar giant squirrel (*Ratufa indica*), and a large variety of birds.

Fig. 2: A very important key stone species *Cullenia exharillata* is used by both primate species.
(Photo: W. Kaumanns)

Methods

The study includes the data collected between August 1994 and March 1996. The data were collected through 'scan sampling'. A scan was taken every 10 minutes on one animal per age-sex class. During a scan, the information was recorded on Date, Time, Identity of the animal, Weather condition, Place (Tree or Ground), Location in the home range, Height of the tree, Height of the animal, Activity (Passivity, Movement, Feeding, Social, Self-directed), and Food item eaten. Ad libitum notes were maintained on the plant species used by the study animals. The seasons in this paper are described as Dry (December-May), and wet (June-November. A total of 10404 and 12060 scans were made on the lion-tailed macaques and the Nilgiri langurs respectively. Most of the data analysis was made using Z test for binomial proportions (GIBBONS, 1971). The data given in the tables however represent percentages of behaviors. The canopy for analysis was divided into lower (below 5 meters), middle (between 5 and 15 meters) and higher (above 15 meters). Different periods of the day were divided into morning (upto 10 a.m.), midday (between 10 a.m. and 2 p.m.) and afternoon (2 p.m. onwards).

Results

Tree Height

Table 1 presents the data for the frequency in trees of various heights by the two species. Although both of the species are almost totally arboreal, the statistical analysis revealed that the two species significantly differ in their use of trees of various heights. Whereas the lion-tailed macaques are mostly seen in taller trees (Mean 17.5 meters), the Nilgiri langurs are mostly found in trees of medium and lower height (Mean 12.2 meters). Similar difference was also observed between the two species during the dry and the wet seasons. A significant seasonal variation revealed that the lion-tailed macaque make less use trees of medium height during the wet season as compared with the dry season. On the other hand, the use of less than 5 meters and more than 15 meters trees increases significantly during the wet season. The Nilgiri langurs show a pattern of seasonal variation opposite to that of lion-tailed macaques. During the wet season, the langurs make significantly more use of medium height trees and less use of taller trees.

Table 1: Percent frequency in trees of various heights (meters).

		< 5	**5-15**	**> 15**	**Scans**
	M. silenus	4.18	30.65	65.17	10404
	P. johnii	15.61	53.23	31.16	12060
	Z	28.09	34.10	50.93	
	p	0.01	0.01	0.01	
Dry season	*M. silenus*	2.70	33.71	63.59	6639
	P.johnii	15.44	49.53	35.02	7207
	Z	25.76	18.85	33.60	
	p	0.01	0.01	0.01	
Wet season	*M. silenus*	6.76	25.13	67.58	3785
	P. johnii	15.87	58.69	25.45	4853
	Z	12.97	31.18	39.15	
	p	0.01	0.01	0.01	

		< 5	**5-15**	**> 15**	**Scans**
M. silenus	Dry vs Wet				
	Z	9.99	9.15	4.11	
	p	0.01	0.01	0.01	
P. johnii	Dry vs Wet				
	Z	0.63	9.88	11.13	
	p	NS	0.01	0.01	

Animal Height

The data and the analysis presented in Table 2 reveal that the two species differ significantly in their presence at various heights. Whereas the lion-tailed macaques are mostly found in the middle and the higher canopy (Mean 14.7 meters), the Nilgiri langurs are in the middle and the lower canopy (Mean 9.6 meters). Similar difference was also observed between the two species during the dry and the wet seasons. Both species also showed a significant seasonal variation for canopy use. The lion-tailed macaques make significantly more use of lower and upper canopy during the wet season as compared with the dry season. On the other hand, the Nilgiri langurs make significantly lesser use of upper canopy during the wet season.

Table 2: Percent frequency of animal at various heights (meters).

		< 5	**5-15**	**> 15**	**Scans**
	M. silenus	7.27	53.99	38.74	10404
	P. johnii	24.78	61.33	13.88	12060
	Z	35.13	11.11	42.69	
	p	0.01	0.01	0.01	
Dry season	*M. silenus*	5.74	56.91	37.36	6639
	P.johnii	23.07	59.72	17.21	7207
	Z	28.73	3.36	26.72	
	p	0.01	0.01	0.01	
Wet season	*M. silenus*	9.91	48.59	40.98	3785
	P. johnii	27.34	63.71	8.94	4853
	Z	20.21	14.09	35.11	
	p	0.01	0.01	0.01	
M. silenus	Dry vs Wet				
	Z	7.89	8.19	3.65	
	p	0.01	0.01	0.01	
P. *johnii*	Dry vs Wet				
	Z	5.32	4.42	12.87	
	p	0.01	0.01	0.01	

Food Items

The data and analysis presented in Table 3 reveal a highly significant difference in the two species with respect to their food items. The lion-tailed macaques show a high frequency of feeding on fruits (59.46 %) and insects (17.98 %). On the other hand, the Nilgiri langurs show a 57.31 per cent frequency of feeding on leaf. However, langurs also showed 18.93 % frequency of feeding on fruits. Therefore, fruit is the only common food item between the two species. A similar pattern of difference between the two species for feeding on leaf, insect and fruit was also observed during dry and wet seasons. A significant seasonal variation in the case of lion-tailed macaques for their feeding revealed that this species consumes more fruit and less insects during the wet season as compared with the dry season. Likewise, a significant seasonal variation in feeding by the Nilgiri langur revealed that the langur feed less on fruits and other items and more on leaf during the wet season as compared with the dry season.

Table 3: Percent frequency of feeding on different food items.

		Leaf	**Insect**	**Fruit**	**Others**	**Scans**
	M. silenus	1.96	17.98	59.46	20.60	3214
	P. johnii	57.31	0	18.93	23.76	3961
	Z	49.77	-	35.34	3.19	
	p	0.01	-	0.01	0.01	
Dry season	*M. silenus*	1.33	23.65	55.18	19.84	2182
	P. *johnii*	53.94	0	20.23	25.82	2447
	Z	39.32	-	24.63	4.83	
	p	0.01	-	0.01	0.01	
Wet season	*M. silenus*	3.29	6.01	68.50	22.19	1032
	P. johnii	62.79	0	16.85	20.42	1513
	Z	30.26	-	26.39	1.07	
	p	0.01	-	0.01	NS	
M. silenus	Dry vs Wet					
	Z	3.75	12.16	7.19	1.54	
	p	0.01	0.01	0.01	NS	
P. johnii	Dry vs Wet					
	Z	5.42	-	2.63	3.88	
	p	0.01	-	0.01	0.01	

Plant Species

Table 4 presents the list of the plant species most commonly used by the two primate species in the study area. Although, there are many plant species that are exclusively used by each species, there are several plants which are used by both of the animal species primarily for fruit.

Table 4: List of plant species most commonly used by *M. silenus* and *P. johnii*.

M. silenus **alone**	***P. johnii*** **alone**	**Both animal species**
Knema attennuata	*Thraulococcus erectus*	*Piper brachystachyum*
Myristica beddomei	*Clerodendrum infortunatum*	*Calamus* sp.
Xanthophyllam sp.	*Mallotus albus*	*Cullenia exharillata*
Smilax zeylanica	*Actinodaphne bourdillonii*	*Pygeum wightianum*
Flacourtia montana	*Cinnamomum iners*	*Macaranga peltata*
Ficus infectoria	*Ligustrum perrottetii*	*Grewia disparma*
Acronychia laurifolia	Apodytes beddomei	*Psychotria thwaitesii*
	Eugenia mooniana	*Rubus gardnerianus*
	Croton lacciferus	*Mesua ferea*
	Psychotria anamallayna	*Syzigium cumini*
	Eleocarpus tuberculatius	*Eleocarpus munronii*
		Antidesma menasu
		Maesa indica
		Nephalium longana
		Villebrunea integrifolia
		Meogyne pannosa

Feeding Substratum

In order to find out the differences in feeding substratum by the two species, the analysis was also made for their overall feeding height (Table 5a) as well as for fruit feeding height (Table 5b). The two species significantly differ in the above parameters. Both for overall and for fruit feeding, the lion-tailed macaques use a higher substratum than the Nilgiri langurs.

Table 5: Percent frequency of feeding height (meters).

	< 5	**5-15**	**> 15**	**Scans**
(a) Overall feeding height				
M. silenus	5.76	48.88	45.36	3214
P. johnii	36.73	51.68	11.59	3961
Z	31.07	2.36	32.15	
p	0.01	0.05	0.01	
(b) Fruit feeding height				
M. silenus	4.76	47.83	47.41	1911
P. johnii	26.74	55.75	17.51	748
Z	16.32	3.67	14.21	
p	0.01	0.01	0.01	

Feeding Schedules

Table 6 presents the data on the frequency of feeding at different times of the day. Whereas the lion-tailed macaques show a significantly higher frequency than the Nilgiri langurs of feeding during the midday period, the langurs show a comparatively higher frequency during the afternoon period.

Table 6: Percent frequency of feeding at different periods (hours).

	0600-1000	**1000-1400**	**1400-1800**	**Scans**
M. silenus	19.13	47.85	33.01	3214
P. johnii	17.75	42.44	39.81	3961
Z	1.51	4.59	5.94	
p	NS	0.01	0.01	

Activity

The data and analysis presented in Table 7 reveal that the two species significantly differ in their percent frequency for all activities except social behavior. Whereas the Nilgiri langurs show a significantly higher frequency of passivity, eating and self-directed behaviors as compared with the lion-tailed macaques, the lion-tailed macaques show a relatively higher frequency of movement.

Table 7: Percent frequency of various activities.

	Passive	**Move**	**Eat**	**Social behavior**	**Self-directed**	**Scans**
M. silenus	17.61	43.59	30.95	5.79	3.06	10404
P. johnii	34.04	21.84	32.91	5.89	5.32	12060
Z	27.86	34.87	3.14	0.32	12.68	
p	0.01	0.01	0.01	NS	0.01	

Behavior of Nilgiri langurs during presence and absence of lion-tailed macaques

The lion-tailed macaques are almost always in the vicinity of one or another group of Nilgiri langurs throughout their range, the same is not true in the case of Nilgiri langurs. The data presented in Table 8(a) reveal that the Nilgiri langur left the upper canopy in the presence of lion-tailed macaques. The data shown in Table 8(b) reveal a significant difference in feeding height during presence and absence of lion-tailed macaques. Whenever the lion-tailed macaques appeared in the area occupied by langurs, the langurs went considerably down to the lower substratum (which also often included the bushes) to feed.

Table 9 presents the data and analysis for major activities of langurs during the presence and absence of lion-tailed macaques. The presence of lion-tailed macaques resulted in a significant increase in passivity and a significant decrease in movement by the Nilgiri langurs.

Table 8: Percent frequency of animal height and feeding height (meters) in *P. johnii* during presence and absence of *M. silenus*.

	< 15	**15-45**	**> 45**	**Scans**
(a) Animal height				
LTM present	27.53	64.47	8.00	425
LTM absent	24.80	61.29	13.91	11951
Z	1.28	1.32	3.48	
P	NS	NS	0.01	
(b) Feeding height				
LTM present	47.14	51.43	1.43	140
LTM absent	35.87	52.28	11.85	3875
Z	2.72	0.20	3.86	
p	0.01	NS	0.01	

Table 9: Precent frequently of various activities in *P. johnii* during and absence of *M. silenus*.

	Passive	**Move**	**Eat**	**Social behavior**	**Self-directed**	**Scans**
M. silenus	17.61	43.59	30.95	5.79	3.06	10404
P. johnii	34.04	21.84	32.91	5.89	5.32	12060
Z	27.86	34.87	3.14	0.32	12.68	
p	0.01	0.01	0.01	NS	0.01	

Discussion

In the narrow strip of Western Ghats south of Coorg, the lion-tailed macaques and the Nilgiri langurs are often found sympatric. Following conclusions can be drawn from the data presented in this paper:

- The lion-tailed macaques usually remain at a higher substratum than the Nilgiri langurs.
- Whereas the lion-tailed macaques are frugivorous/insectivorous, the Nilgiri langurs are primarily folivorous. However, the langurs also eat some amount of fruit which makes the two species minor competitors.
- The feeding substratum used, both overall as well as for feeding on fruits, is higher for lion-tailed macaques than for Nilgiri langurs.
- The presence of lion-tailed macaques results in a shift of activity, including feeding, by Nilgiri langurs to a still lower substratum.
- The feeding schedules of the two species during midday and afternoon periods differ.
- The Nilgiri langurs are more 'passive' than the lion-tailed macaques, and their passivity still increases when the lion-tailed macaques are present in the area.

In other words, it can be stated that these two sympatric species of primates specialize on different food sources, and when there is some resource competition, there is a clear vertical stratification between them. The two species, therefore, can be said to have different niches. The data on seasonal variations in 'animal height' suggested that during the dry season the lion-tailed macaques make comparatively lesser use of middle canopy, a pattern just opposite to Nilgiri langurs. During the dry season, there is a relative shortage of resources, and it is during this season that niche separation becomes more pronounced. Since the langurs not only shift their feeding to a further lower substratum and increase their passivity in the presence of lion-tailed macaques, the lion-tailed macaque appears to be the dominant species of the two. This fact was further corroborated by our general observations that whenever the lion-tailed macaques entered the area occupied by langurs, the langurs avoided them and moved away in more than 75 per cent of such encounters (unpublished information).

Several studies in the past indicate that sympatric primate species separate their niches in the canopy through stratigraphic separation (GAUTIER-HION, 1978; MACKINNON and MACKINNON, 1980). UNGAR (1995) reported that in sympatric long-tailed macaques, white-handed gibbons, orangutans and Thomas' langurs, the niche separation was caused not only by the food preferences but also by the feeding height differences. The results of the present study clearly correspond with the above observation.

If, sympatric primate species show ecological and social segregation (CROCKET and WILSON, 1980; FOODEN, 1982; RODMAN, 1991), they become polyspecific associations. RICHARD (1985) concludes that the reasons for the coexistence of primate species may include predator-avoidance, ability to locate food, gain in feeding efficiency, social commensalism/parasitism, and increase in insect capture rates. Several other hypotheses proposed to explain polyspecific associations (STRUHSAKER, 1981; WASER, 1982; GAUTIER-HION, 1988; BOINSKI, 1989; NORCONK, 1990) emphasize costs and benefits of sympatricity. The lion-tailed macaques and Nilgiri langurs can be said to be polyspecific because they are sympatric, but they do not form a 'community' since they hardly ever 'move together'. However, we have observed several instances of simultaneous alarm calls given by the two species to avian and terrestrial predators (unpublished information). Although none of the species appeared to actively initiate an association, the Nilgiri langurs, most of the times, benefited from lion-tailed macaques. In this part of the rainforest, *Cullenia exharillata* is one of the most predominant tree species. The seeds of this fruit constitute a major item in the food of lion-tailed macaques, but they are also consumed by the Nilgiri langurs. This fruit not only has a rather hard outer case, it is also very spiny. The lion-tailed macaques can easily open up this fruit with their long and piercing teeth but it is not possible for langurs to open. If an opened fruit falls from the hands of a lion-tailed macaque, the animal never climbs down the tree to pick it up, and rather goes for another fruit. Such opened up and fallen *Cullenia* fruits are most of the times picked up by Nilgiri langurs and the seeds are eaten by them. Since Cullenia constitutes not only a major food item, it is also a highly preferred food. The langurs, therefore, clearly benefit from the presence of lion-tailed macaques inspite of the fact that they are often displaced by the macaques.

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References

BOINSKI, S.: Why don't *Saimiri oerstedii* and *Cebus capucinus* form mixed-species groups? Int. J. Primatol. (1989) 10: 103-114.

BURTON, F.D. and CHAN, L.: Behavior of mixed species groups of macaques. In: FA, J.E. and LINDBURG, D.G. (eds.): Evolution and Ecology of Macaque Societies. Cambridge: Cambridge University Press (1996): 389-412.

CHARNOV, E.L.: Optimal foraging: the marginal value theorem. Theor. Popul. Biol. (1976) 9: 129-136.

CROCKET, C.M. and WILSON, W.L. The ecological separation of *Macaca nemestrina* and *M. fascicularis* in Sumatra. In: LINDBURGH, D.G. (ed.): The Macaques: Studies in Ecology, Behavior and Evolution. New York: Van Nostrand Reinhold (1980): 148-181.

FLEAGLE, J.G.: Primate Adaptation and Evolution. San Diego: Academic Press Inc. (1988).

FOODEN, J.: Ecogeographic segregation of macaque species. Primates (1982) 23: 574-579.

GAUTIER-HION, A.: Food niches and coexistence in sympatric primates in Gabon. In: CHIVERS, D.J. and HERBERT, J. (eds.): Recent Advances in Primatology Vol. 1. London: Academic Press (1978): 269-286.

GAUTIER-HION, A.: Polyspecific associations among forest guenons: ecological, behavioral and evolutionary aspects. In: GAUTIER-HION, A., BOURLIERE, F., GAUTIER, J.P. and KINGDON, J. (eds.): A Primate Radiation: Evolutionary Biology of African Guenons. Cambridge: Cambridge University Press (1988): 452-476.

GIBBONS, J.D.: Nonparametric Statistical Inference. New York: McGraw Hill (1971).

KUMAR, A.: The Ecology and Population Dynamics of the Lion-tailed Macaque (*Macaca silenus*) in South India. Ph.D. Thesis, University of Cambridge (1987).

KUMAR, A., UMAPATHY, G. and PRABHAKAR, A.: A study on the management and conservation of the small mammals in fragmented rainforests of Western Ghats, south India: A preliminary report. Primate Conserv. (1995) 65: 53-58.

KURUP, G.U. and KUMAR, A.: Time budget and activity patterns of lion-tailed macaque (*Macaca silenus*). Int. J. Primatol. (1993) 14: 27-39.

MACARTHUR, R.H. and PIANKA, E.: On optimal use of a patchy environment. Amer. Natural. (1966) 100: 603-609.

MACKINNON, J.R. and MACKINNON, K.S.: Niche differentiation in a primate community. In: CHIVERS, D. (ed.): Malayan Forest Primates: Ten Years Study in Tropical Rainforest. New York: Plenum Press (1980): 167-190.

NORCONK, M.A.: Mechanisms promoting stability in mixed *Saguinus mystax* and *S. fuscicollis* troops. Amer. J. Primatol. (1990) 21: 159-170.

POIRIER, F.E.: Analysis of a Nilgiri langur (*Presbytis johnii*) home range change. Primates (1968a) 9: 20-43.

POIRIER, F.E.: Nilgiri langur (*Presbytis johnii*) territorial behavior. Primates (1968b) 9: 351-364.

RICHARD, A.F.: Primates in Nature. New York: W.h. Freeman (1985).

RODMAN, P.S.: Structural differentiation in microhabitats of sympatric *Macaca fascicularis* and *M. nemestrina* in East Kalimantan, Indonesia. Int. J. Primatol. (1991) 12: 357-375.

SINGH, M., SINGH, M., KUMAR, M.A., KUMARA, H.N. and D'SOUZA, L.: Distribution and research potential of non-human primates in the Aliyar-Valparai sector of Indira Gandhi Wildlife Sanctuary, Tamil Nadu, India. Trop. Biodiv. (1997a) 4: 197-208.

SINGH, ME., SINGH, MR., KUMARA, H.N., KUMAR, M.A. and D'SOUZA, L.: Inter-and intra-specific associations of non-human primates in Anaimalai Hills, south India. Mammalia (1997b) t61, n01: 17-28.

SINGH, M., SINGH, M., KUMAR, M.A., KUMARA, H.N., D'SOUZA, L. and ANATHA KRISHNA SHARMA, B.A.: Behavior of lion-tailed macaque (*Macaca silenus*) in vulnerable and relatively secure habitats in rainforest of Western Ghats, India. Tigerpaper(1998) 5(4): 16-25.

STRUHSAKER, T.T.: Polyspecific associations among tropical rain-forest primates. Zeit. Fur Tierpsychol. (1981) 57: 268-304.

TERBORGH, J.: Five New World Primates. Princeton: Princeton University Press (1983).

UNGAR, P.S.: Feeding height and niche separation in sympatric Sumatran monkeys and apes. Folia Primatol. (1996) 67: 163-168.

WASER, P.M.: Primate polyspecific associations: do they occur by chance? Animal Behav. (1982) 30: 1-8.

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