however, find a commercial trade in pets in Bolivia and Peru. We observed many young primates in captivity in all three countries. The following is a list of the species kept in captivity by individuals: saddle-back tamarin (*Saguinus fuscicollis*), red-bellied tamarin (*S. labiatus*), Spix's black-mantled tamarin (*S. nigricollis*), Andean titi monkey (*Callicebus oenanthe*), squirrel monkey (*Saimiri* sp.), white-fronted capuchin (*Cebus albifrons*), brown capuchin (*Cebus apella*), red howler (*Alouatta sara*), woolly monkey (*Lagothrix lagotricha*), Peruvian spider monkey (*Ateles chamek*) and white-bellied spider monkey (*Ateles belzebuth*). Most were kept in appallingly small cages or tied at the waist on a short leash. Young tapirs were also kept as pets, as were many species of birds, especially parrots and macaws.

The hunting pressure for meat and pets appears to be high in all three countries. No primates bigger than titis were seen in our surveys except at field sites where primatologists were studying and protecting them. More conservation education is needed in all three countries. In Peru, people only had one name for "monkey" and did not discriminate between species, nor realize that some were endemic to their region.

In the lowlands of Bolivia there is still extensive forest, except along the roads. But Brazil nut extractors have cut trails throughout the forest and many hunters are now using this trail system. This may be preferable, however, to colonists who slash and burn the forest to grow crops and cattle.

The lowland region of Ecuador has a great deal of protected forest on the map. However, the indigenous inhabitants are allowed to hunt all they want in these forests, and many have newly acquired shotguns. Some of these forests also have oil reserves under them, and there is a great deal of pressure to extract this oil whether it lies in a protected area or not. The oil companies build roads which will later be used by colonists, and the forest will inevitably disappear as a result.

Conclusion

This survey for titi monkeys found that the distributions in northern Bolivia and northern Ecuador are not consistent with the distributions described by Van Roosmalen *et al.* (2002). Rather, our observations are consistent with what is reported for the distribution of *C. brunneus* by Anderson (1997) and Hershkovitz (1990) in Bolivia. In Ecuador we found *C. lucifer*, not *C. medemi*, which is consistent with Hershkovitz (1990, Fig. 44) and Groves (2001, p. 177). More surveys are needed in these regions to determine the exact distributions of *Callicebus*. The distribution of *C. oenanthe* in Peru was consistent with Van Roosmalen *et al.* (2002).

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SOCIAL SPACING IN A BACHELOR GROUP OF CAPTIVE WOOLLY MONKEYS (*LAGOTHRIX LAGOTRICHA*)

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Introduction

In the wild, woolly monkeys (*Lagothrix lagotricha*) form social groups with several adult males and females. Recent evidence (Nishimura, 1999) has indicated that males stay in the natal group and females emigrate. This suggests that in the formation of natural groups adult males are tolerant of each other, having a common developmental experience, long periods of familiarity, and the possibility of shared kinship. Nishimura (1994, 1997) reported that even though these males have had much in common and many years together, it is extremely rare for them to form feeding aggregates that are exclusively male.

Stevenson (1998) also found that close association among adult males is rare. He studied spacing in a different group of woolly monkeys in Tinigua National Park in Colombia, in the same region as Nishimura. In Stevenson's study, adult males were never observed within 2 m of each other. Of all age/sex categories, adult males and subadult females were most often at distances greater than 5 m from the other animals. The subadult females were likely to move between groups, and this distance may be a precursor to emigration, but the adult males appeared to be stable members of the group. Stevenson reported that adult males were the most

Table 1. Summary of distinguishing characteristics of a woolly bachelor group.

Study animal #[1]	ID	Mother's #[1]	Date of birth	Date moved from Louisville	Location of move	Date returned
132	MO	116	8 Jan 1988	5 Mar 1990	Lowry	12 Oct 1995
135	JA	115	17 Feb 1989	29 Oct 1992	St. Paul	19 Apr 1998
138	WI	116	26 Oct 1989	29 Oct 1992	St. Paul	19 Apr 1998
141	BR[2]	116	2 Nov 1991	28 Dec 1995	St. Paul	19 Apr 1998
143	LY	114	7 Mar 1992	28 Dec 1995	St. Paul	19 Apr 1998
144	JE	115	13 Jun 1992	-	-	-

[1] Studbook numbers from 1998 North American Regional Studbook.
[2] Subject BR died between the summers of 1998 and 2001.

aggressive age/sex class. He suggested that avoidance of conflict, competition for resources, and a lower predation risk may contribute to adult males maintaining greater social distances. In wild groups, adult male tolerance of each other may depend on sufficient space for the individuals to avoid or minimize close encounters.

In contrast to social grouping in the wild, captive-breeding groups have usually been maintained with a single adult male. Aggression among adult males has been the primary reason for this practice. Although there are no published reports, there have been cases where adult male aggression has resulted in the death of one of the animals, even when the males were siblings. Maintaining captive groups with one adult male generates a surplus of males, which have been placed in bachelor groups. With the limited space available in zoo exhibits, this has the potential for creating an unnatural concentration of males and forcing close association among them.

We studied the formation of a six-member bachelor group in order to characterize their adjustment in social distance three years later. A group of four monkeys was merged with a pair of animals. Each group had been together for at least two years prior to being merged into the study group. On the basis of spacing studies in the wild, we expected the captive males to maintain substantial social distance within the limitations of the enclosure, allowing for a relatively peaceful accommodation to their new social arrangements. We also predicted that individuals housed together before the present group was formed would be likely to continue their close association throughout the study period.

Methods

Study Site and Subjects

Six adult male woolly monkeys (*Lagothrix lagotricha poeppigii*) were studied during the summers of 1998 and 2001 at the Louisville Zoo (Louisville, Kentucky, USA). All were paternal siblings, and some were full siblings, as shown in Table 1. Their ages ranged from six to 10 years in 1998. Only the youngest had been at the Louisville Zoo since birth. Table 1 shows placement of the animals at other zoological parks. The death of BR during the course of the study had no apparent relationship to the grouping of the animals.

The Louisville exhibit comprised two connected rooms inside a building (floor space approximately 40 m²) with two ramps leading to the larger of two outdoor islands (combined island area of approximately 100 m²). All areas had ropes, cargo nets, trees, and/or elevated platforms for arboreal activity. The islands were surrounded by a wet moat and connected by ropes and a log. In May of 1998, the four animals from St. Paul were placed in the exhibit with MO and JE. Partial separation of the two groups was maintained as various combinations of animals were allowed access to each other during a six-month period of gradual introductions. By November of 1998, all of the monkeys were allowed to move freely within the exhibit, except when access was restricted for cleaning or inclement weather.

Procedure

Two observers performed 241 instantaneous focal observations during the summer of 1998 (18 June through 31 July), over the course of 136.7 observer-hours at the exhibit. In the summer of 2001, a single observer recorded 277 observations (11 June through 26 July), during 109.5 hours at the exhibit. Focal observations lasted for 15 minutes, during which the behavior of the focal animal and the proximity of other animals were recorded from scans every 30 seconds. Proximity was scored in mutually exclusive categories of contact: within reach, nearest, or alone (no other monkey on the island or in the stall area with the focal). Mutually exclusive categories of behavior included feeding (consuming or handling food), resting (stationary and not standing), and other (for example, play, groom, aggression, locomotion, stationary alert). Our preliminary observations revealed that with the exception of locomotion and stationary alert, these "other" behaviors were rare. We used Radio Shack Model 100 handheld computers and The Observer 2.0 (Noldus Technology Services) software for the focal observations. All instances of screaming and chest-rubbing were recorded in *ad libitum* notes throughout the time an observer was at the exhibit.

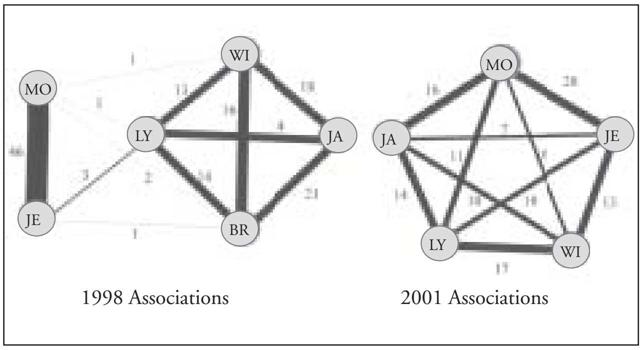
Using the proximity results, we calculated an association index (AI) similar to Nishimura's feeding association index (Nishimura, 1997). AI represented the percentage of the scans in which a pair of monkeys was nearest to each other based on their total scans when they were in proximity to any monkey. We used the Spread of Participation Index (SPI; Dickens, 1955; Shepherdson *et al.*, 1993) to quantify the degree to which an individual's associations were spread among the group. Participation in chest-rubbing was also evaluated with the SPI. This index ranges in value from 0 to 1.0. In this paper we have reported SPI as 1-SPI so that the higher number represents a more even spread of participation.

Results

From 1998 to 2001, there was a dramatic decline in the mean proportion of days on which an animal screamed (mean for 1998 = 0.10; mean for 2001 = 0.04; paired t(4) = 3.52, p = 0.02). The mean proportion of days on which an animal chest-rubbed also declined from 1998 to 2001 (mean for 1998 = 0.36; mean for 2001 = 0.18; paired t(4) = 3.71, p = 0.02). In 1998, participation in chest-rubbing was spread quite evenly among the animals (1-SPI = 0.85). In 2001, three of the animals did almost all of the chest-rubbing (1-SPI = 0.64).

Proximity measures also changed over the three years of the study. Contact between animals was rare in 1998 (< 3% of 7230 scans) and in 2001 (< 1% of 8310 scans). The next level of proximity that we measured was an estimate of how often these animals were within reach of another animal and not in contact. This measure declined from 12% of the scans in 1998 to 3% in 2001. A proportion test applied to the frequencies of within-reach scans yielded a statistically significant decline (z = 8.37; p < 0.001). The low incidence of animals within reach or in contact precluded more detailed statistical analysis of these measures. There was no change in the time that an animal spent alone. We also recorded the frequency and identity of the nearest monkey when no animal was within reach or in contact. In 1998, 72% of the scans included a nearest animal while 82% were recorded in 2001.

Figure 1 shows the sociograms constructed with the AI for each year and each animal. The grouping in 1998 largely reflects the maintenance of the previous living constraints while the animals were being introduced. The 2001 sociogram illustrates the accommodation of the animals after 2.5 years of unrestrained grouping by the keepers (from November 1998 to July 2001). The AI for monkey pairings in 2001 was significantly correlated with the 1998 AI (r(9) = 0.64, p = 0.04), but not with genetic relatedness or total time together. To evaluate the change in the distribution of associations, we calculated SPI for each animal in each year based on the frequency of their being nearest to each other. In Figure 2, we have expressed this as 1-SPI so that a high score represents a more even spread of association among the animals. The mean 1-SPI increased significantly from 1998 to 2001 in all behavioral categories: feeding (paired t(4) = 3.84, p = 0.02), resting (t(4) = 5.00, p = 0.008), and other behaviors (t(4) = 4.83, p = 0.009).



1998 Associations

2001 Associations

Figure 1. Sociograms for 1998 and 2001. The values represent the AI (see text) for each possible pairing of the animals.

Discussion

As expected from the behavior of wild woolly monkeys (Nishimura, 1994, 1997; Stevenson, 1998), the bachelor group spent very little time in contact or within reach. Our assessment of the nearest animals when none was within reach revealed a more even distribution of proximity in 2001 than in 1998. The correlation between the 1998 and 2001 AIs illustrates the persistence of the earlier bonding of the animals. We expected this result based on the apparent long-term association of adult males in wild populations (Nishimura, 1994, 1997). Kinship could be a factor in the adjustment of these animals. All were related at the level of paternal siblings and some were full siblings. Degree of relatedness did not predict final association as reflected in the nearest-neighbor AIs, but the correlation approached statistical significance. A better test of the role of kinship would include animals with a wider range of relatedness and a larger sample.

Applying the SPI to nearest-neighbor associations revealed a more even spread of associations among the individuals

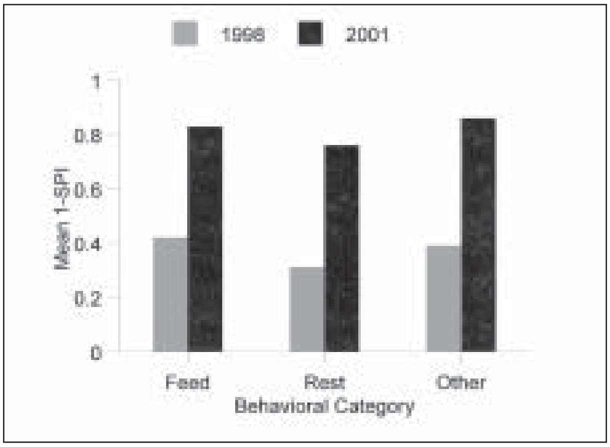


Figure 2. Mean 1-SPI showing increasing spread of association among the animals from 1998 to 2001 as they engaged in the three types of behavior. Higher values of 1-SPI indicate a more even spread of associations among the animals in the group.

after three years together. This more equitable spread of associations was consistent across the three categories of behavior, indicating that it was not limited to the feeding context, which is likely to force close association.

The sociograms and the SPIs show that the adult males are capable of adapting to the presence of relatively unfamiliar males. This has not yet been reported in wild populations. Perhaps the tendency of adult males to maintain social distance provides the basis for accommodation when additional adults are introduced. Our results suggest that two components of this social adjustment include maintenance of a minimal social distance and increasing tolerance of other individuals at that minimal distance.

The scream and chest-rubbing results suggest that the accommodation achieved by this group was stable and peaceful. The change in the rate of screaming and chest-rubbing over the three years of the study indicates a reduction in tension. In earlier studies of a breeding group in this exhibit, we found scream interactions to be a measure of social tension that could be used to characterize the social hierarchy of the group (White *et al.*, 1988; Stearns *et al.*, 1988). These earlier studies yielded a scream rate of 0.12 screams/hour/animal, which is slightly lower than the rate for the present bachelor group in 1998. By 2001 the bachelor group's social accommodation resulted in a dramatically reduced scream rate. In fact, the incidence of screaming was insufficient for us to use it to construct a social hierarchy.

Chest-rubbing is common in captive woolly monkeys, but its function is unknown. From our earlier studies of a breeding group (White *et al.*, 2000), we found chest-rubbing was exhibited by adult monkeys and most often by males. We were not surprised to find a high incidence of chest-rubbing in the present study when the bachelor group was formed. Whether its role is spacing among groups of monkeys, or as a displacement activity, we would have predicted that a group of adult males would exhibit a high frequency of this behavior. However, an unexpected result was the marked decline to a rate similar to our studies of the breeding group (0.05 chest-rubs/hour/animal). Nearly all of the chest-rubbing in the breeding group was done by the adult male (White *et al.*, 2000) and it is interesting that the present all-male group had a similar rate of chest-rubbing after three years. Participation in chest-rubbing was distributed more widely when the bachelor group was first put together in 1998. The broad participation at the point of disruption of the group is similar to the increased involvement of females in chest-rubbing in the breeding group when the adult male died (White *et al.*, 2000). Disturbance of the social group appears to produce wider participation in chest-rubbing. An increase when group relationships are altered is consistent with a displacement function for this behavior in captivity. It may be appropriate to conclude from our captive studies that the frequency and participation in chest-rubbing reflects the level of disruption of the group. Our results suggest similar behavioral spacing mechanisms may be operating in captivity and the wild. Further study of group formation and social dynamics is likely to improve the management of this species and may contribute to the understanding of the high sensitivity of *Lagothrix* to fragmentation of its habitat.

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