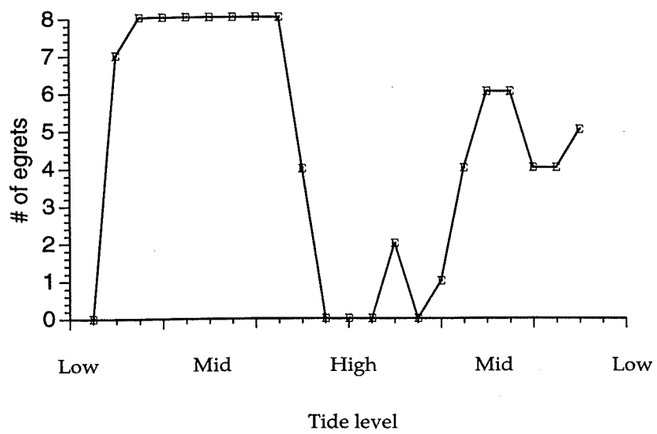


Fig. 1. The number of egrets present at single point counts at the mouth of the Rio Sirena, Corcovado National Park, Costa Rica in relation to tidal level (n = 22 observations over 11 hours).

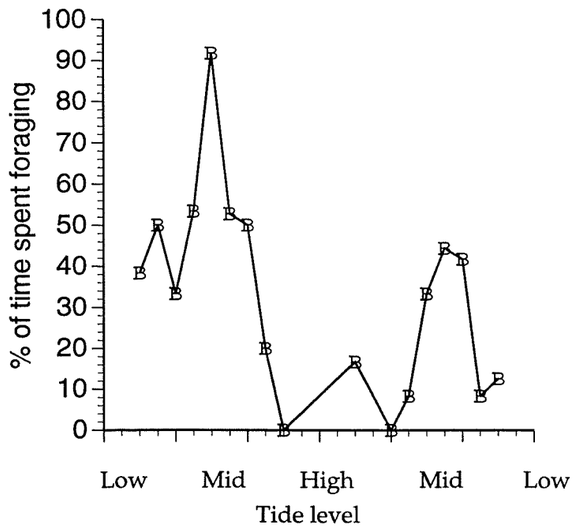


Fig 2. The mean percent of time spenf foraging as a function of tide level (n=17).





# COSTS AND BENEFITS OF FORAGING SUB-GROUP SIZE IN *ATELES GEOFFROYI*, THE SPIDER MONKEY

CHRIS I. DUMS, JOSEPH W. GILBERTSON, EMILY B. SOHN, AND JAMES P. ZAK

*Abstract.* Spider monkeys, *Ateles geoffroyi*, forage in groups of different sizes based upon food resource levels . In groups of smaller sizes, there are more resources available per individual at feeding time, but fewer individuals to notice potential predators. We tested the costs of foraging alone, and found that solitary monkeys were more vigilant and foraged less than monkeys within groups. Costs and benefits of different foraging sub-group size seem to be influencing foraging behavior and group dynamics of spider monkeys. Approximately 25 % of the foraging sub-groups we encountered were made up of a solitary individual. Our results suggest that optimal sub-group size is two individuals, but they do not elucidate why some monkeys would forage alone.

*Key words* : Ateles geoffroyi, *costs and benefits, foraging, group size, spider monkeys*

## INTRODUCTION

Spider monkeys, *Ateles geoffroyi*, have a flexible pattern of social organization in which foraging subgroup size is extremely variable. The size and composition of a subgroup can change several times per day (Klein 1972), and is directly related to food distribution (Chapman 1990).

Past studies have examined the relationship between individual fitness and the size of the foraging group. When group size is too low, animals may have a greater risk of being preyed upon and/or suffer lower feeding rates as more time needs to be spent scanning for predators (Hoogland 1979, as cited in Chapman 1990). When group size increases, competition for food may increase (Janzen 1986). High-ranking individuals may experience less severe food competition than low-ranking individuals as a result of an increase in subgroup size, and therefore, the size of the optimal or stable subgroup will be smaller for a subordinate than for a dominant individual (Giraldeau 1988). In fact, dominant individuals benefit from increased group size, as they have access to the best food resources, and spend little time in vigilance (Chapman 1990).

There are costs and benefits to foraging in small groups. As group size decreases, there will be more food resources available to individuals in that group, but these individuals must spend a greater proportion of time scanning for potential predators. We predicted that these costs will be observed in the behavior of spider monkeys and that solitary foraging non-dominant individuals will spend a greater proportion of time being vigilant and a smaller proportion of time feeding than non-dominant individuals in groups. We chose to focus on non-dominant animals because dominant animals are seldom solitary (Chapman and Lefebvre 1990). In addition, when non-dominant individuals occur in groups, they are adversely affected by increased group size, particularly because their access to high quality food resources is limited (Chapman and Lefebvre 1990).

## METHODS

We conducted our study on 4-5 February 1997 along the trail systems near the Estación Biológica Sirena in Corcovado National Park, Costa Rica. The trails passed through both primary and secondary forest.

Each of us walked along separate trails, and upon sighting one or more spider monkeys, we chose one focal individual to observe. We recorded group size, and time spent by the focal individual in one of four behavioral categories: foraging, vigilance, traveling, and resting. Vigilance was defined as actively watching, and/or displaying aggression towards intruders (i.e., us). In choosing a focal individual we picked that monkey of which we had the clearest view. We attempted to choose non-dominant adult monkeys by avoiding the largest individuals. Each focal individual was watched for as long as possible, up to a maximum of 20 min.

To quantify behavioral differences among different sized troops, we classified the monkey groups into four size categories: solitary, pairs, three to five, and six or more. We also compared the behavior of solitary individuals versus individuals in groups of two or more. We analyzed individual monkey behaviors as a percentage of total time observed for that individual.

Because lengths of focal samples were variable, the mean percent time for each behavior was weighted in an ANOVA by the individuals' observation time. A total of 40 focal individuals were observed.

## RESULTS

Solitary individuals spent a larger proportion of their time being vigilant than did individuals in groups (1-way ANOVA, F=4.37, df=35, P=0.05; Fig. 1). In contrast, although the difference was not statistically significant, solitary monkeys tended to spend a smaller proportion of their time feeding than did individuals within groups (1-way ANOVA, F=1.64, df=35, P=0.21; Fig. 1). There was no difference between solitary and group individuals in time spent resting (1-way ANOVA, F=0.12, df=35, P=0.73) or in time spent traveling (1-way ANOVA, F=0.35, df=35, P=0.56).

In comparing behaviors among the four group categories, no differences existed in proportions of time spent feeding (1 way ANOVA, F=1.24, df=3, P=0.31), in vigilance (1 way ANOVA, F=1.47, df=3, P=0.24), in resting (1 way ANOVA, F=1.55, df=3, P=.22), or in traveling (1 way ANOVA, F=0.22, df=3, P=0.88). However, trends show increasing feeding and decreasing vigilance among individuals in the larger groups as opposed to solitary individuals (Fig. 2).

## DISCUSSION

Individual spider monkeys that foraged alone spent a greater proportion of time being vigilant, and less time feeding, than those foraging in groups. This finding supports the assumption that individuals in smaller groups will forage less and be more vigilant than those in larger groups. During our study we found that only single individuals devoted less time to foraging than to vigilance. Members of groups with two or more individuals had a marked increase in proportion feeding time, and a decrease in proportion of vigilance time.

It has been shown that most foraging subgroups of spider monkeys contain two individuals (Freese 1976). This suggests that a group size of two individuals may optimize feeding time for individuals, while at the same time reducing the limitations that predator vigilance and inter-specific foraging competition place on foraging time. Our data helps explain Freese's assertion that spider monkeys forage primarily in groups of two. Paired individuals presumably split the task of predator vigilance. This allows both individuals a larger proportion of their time to feed. Our data shows that individuals in groups of six to 20 were able to spend approximately the same percentage of time feeding and in vigilance as individuals in pairs. However, it is likely that these individuals in larger groups had lower access to food. On the two days we sampled, 25% of our sub-groups had one individual, 25% had two individuals, and the remaining 50% were made up of three or more individuals.

The fission-fusion group dynamics of *Ateles geoffroyi* potentially benefits the individuals of a troop in a variety of ways. Our observations suggest that there are differences in foraging efficiency with groups of different sizes. The question remains, why do some individuals forage alone? Perhaps dominance, age, sex, or reproductive status of the individual are other causal factors in foraging dynamics.

## LITERATURE CITED


Chapman, C.A. and L. Lefebvre 1990. Manipulating foraging group size: spider monkey food calls at fruiting trees. *Anim. Behav.* 39: 891-986.

Chapman, C. A. 1990. Ecological constraints on group size in three species of neotropical primates. *Folia Primatol.* 55: 1-9.

Freese, C. 1976. Censusing *Alouatta palliata, Ateles geoffroyi,* and *Cebus capucinus* in the Costa Rican dry forest. National Academy of Sciences, Washington D.C. (As cited in Janzen, 1983).

Giraldeau, L. 1988. The stable group and the determinants of foraging group size. Pp 33-35 *The Ecology Of Social Behavior* C.H. Slobodchikoff Ed. Academic Press, New York. (As cited in Chapman 1990).

Hoogland , J. L. 1979. The effect of colony size on individual alertness of prairie dogs. *(Sciuridea: Cynomys* spp.). Anim. Behav. 27: 394-407. (As cited in Chapman 1990).

Janson, C. H. 1986. Ecological and social consequences of food competition in brown capuchin monkeys, Ph.D. thesis, University of Washington, Seattle. (As cited in Chapman 1990).

Janzen, D. H. 1983. *Costa Rican Natural History.* Daniel H. Janzen Ed. University of Chicago Press, Chicago, IL. pp.

Klein, L. L. 1972. The ecology and social organization of the spider monkey, *Ateles belzebuth.* Ph.D.thesis, University of California, Berkeley. (As cited in Chapman 1990).






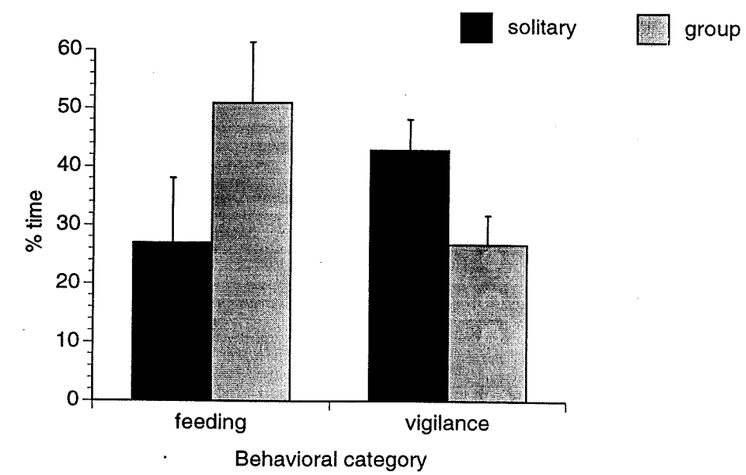


Fig. 1. Percentage (mean ± S.E.) of time spent foraging and in vigilance by solitary spider monkeys (n=9) and focal individuals in spider monkey foraging sub-groups. (n=31)

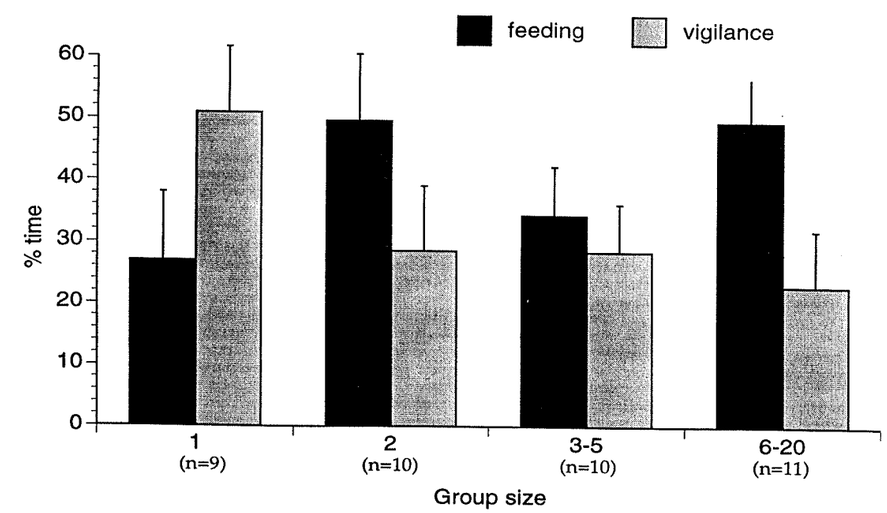


Fig. 2. Relative frequency (mean ± S.E.) of individual spider monkey behavior as a function of group size.