



Niche Separation in Peruvian Primates

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Sympatric primate species coexist in the same habitat because they utilize different niches, either in terms of location in the canopy or the food that they consume. Due to abundant food supply and habitat complexity, the Amazon rainforest sustains large numbers of sympatric primate species. For example, red howler monkeys, *Alouatta seniculus*, are commonly found in sympatric association with other primates such as capuchins, *Cebus* spp, squirrel monkeys, *Saimiri* spp., and tamarins, *Saguinus* spp., (Peres, 1993). *Alouatta seniculus* are typically found in groups to 10-20 individuals and are found throughout South America (Di Fiore *et al.*, 2010). They are diurnal, folivorous-frugivorous primates that have a specially adapted digestive system which allows them to digest mature leaves (Di Fiore *et al.*, 2010). They reside in numerous forest habitats, although they usually prefer areas overlooking river banks. *Alouatta seniculus* are generally found in the upper canopy, only visiting the lower for feeding (Palacios & Rodriguez, 2001). However, when in association with other species, *Alouatta seniculus* prefer even higher strata in the canopy (Peres, 1993).

The South American squirrel monkey, *Saimiri boliviensis* (previously classified as *Saimiri sciureus*), is found throughout South America and can live in large groups of up to 500 individuals although groups of 20-50 are more common (Jack, 2010). They are diurnal, frugivore-insectivores with insects accounting for up to 80% of their diet (Stone, 2007). Across their range, capuchin monkeys (*Cebus* spp) and squirrel monkeys (*Saimiri* spp) are found in semi-permanent foraging groups (Pinheiro *et al.*, 2011; Levi *et al.*, 2013). This is particularly surprising as capuchins have been observed to eat other monkey species which are a similar size to squirrel monkeys, yet very few agonistic encounters have been observed between groups of squirrel and capuchin monkeys in a field study of their associations (Pinheiro *et al.*, 2011). Squirrel monkeys may benefit from these associations as they pick up dropped fruit opened by the capuchins which would not otherwise be available (Peres, 1993). Tufted capuchins occupy a wide range of forest habitats and have a varied diet that includes fruits, insects, leaves, nectar, nuts, and pith, the relative proportions of which in the diet vary considerably with the seasons (Jack, 2010).

Saddleback tamarins, *Saguinus fuscicollis*, reside in primary and secondary forests of Bolivia, Brazil, Colombia, Ecuador, and Peru generally in the lower canopy (Digby *et al.*, 2010). They are typically found in groups of 2 to 20 individuals (Digby *et al.*, 2010). *Saguinus fuscicollis* are primarily frugivorous, with trichromatic colour vision that enables them to select ripe fruits (Jack, 2010). Insects, nectar and exudates in the form of gums supplement the diet (Heyman *et al.*, 2000).

The Peruvian Amazon provides many ecological niches and consequently contains multiple primate species. However, anthropogenic disturbance is a widespread problem throughout the Amazon, and as such, the availability of certain habitats is decreasing. Understanding niche separation of Amazonian primates will greatly benefit primate conservation by identifying those species most at risk. The Pacaya Samiria National Reserve is home to 12 different primate species distributed across three major forest habitat types: uplands (terra firma), seasonally-flooded forest (varzea), and palm swamp (aguajale). This site therefore provides an excellent location to investigate niche separation between sympatric primate species.

Methods

Study Site

Research will be conducted in the Lower Yarapa River in the buffer zones of the Pacaya-Samiria National Reserve and the Tamshiyacu-Tahuayo Regional Community Reserve and surrounding forest of the Lower Yarapa River Valley in the Loreto region of the Peruvian Amazon. Situated deep in the rainforests of the western Amazon basin, the Loreto region is a truly exceptional wilderness area teems with aquatic and terrestrial wildlife. Community-based conservation dominates the landscape of Loreto with large community-based reserves, community co-managed reserves and indigenous territories covering 98,800 km². The project will provide research to support the positive community-based conservation trajectory that we currently see in Loreto and study how threats can be minimized and monitored. The major habitat type in this region is the low-lying flooded forests (varzea), which can be further divided into different subcategories of varzea based on the extent to which the forest floods, with levees flooding only during the very peak of rainy season and palm swamp remaining flooded all year round. However, Tamshiyacu-Tahuayo also contains vitally important terra firma forest that does not flood and provides a constant supply of fruit year round.

Data Collection

Behavioural observations will be conducted daily starting at 6.30am 12pm and then again from 2pm until 5pm. Three teams will enter the forest each day, each one will collect data on a different species, namely red howler monkeys (*Alouatta seniculus*), Peruvian squirrel monkeys (*Samiri boliviensis peruviansis*): previously classified as *Saimiri sciureus*), tufted capuchins (also known as brown capuchins: *Cebus apella*) and saddleback tamarins (*Saguinus fuscicollis*). Once a group of the target species has been found, efforts will be made to stay with the same group for the duration of the data collection period. The GPS location of the group will be recorded throughout the day to assess home and day range. Upon locating a group, the number or individuals and age-sex classification of each will be recorded. The presence of other primates will also be recorded, noting the species present, the number of individuals, and where possible, the age-sex composition of the group.

Information will be collected using instantaneous scan samples (Altmann, 1974) at 3-minute intervals noting the time, species present, and the behaviour of each individual in view (see Table 1). When feeding, the type of food (mature leaves, young leaves, fruit, flowers, seeds, insects and gums), and corresponding plant species will be recorded where known. Where plants cannot be identified in the field, photographs and samples will be taken for later identification. For each sample, the habitat type and weather conditions will be recorded, and when interspecies associations are observed, the relative height of each species in the canopy relative to the other will be recorded.

Table 1: Behavioural Ethogram

Behaviour	Definition
Feed	Pulling food sources towards the body using hands and mastication of food while food item is in hand or mouth.
Move	The changing of positions within a tree or movement between trees by any mode of locomotion
Rest	Inactivity in a sitting, standing or laying position
Social	All interactions between two or more individuals. Interactions may be affiliative and include behaviours such as social grooming and playing or may be agonistic and include all types of aggression (threats, chases, lunges, strikes and bites) manipulation fur of another individual with hands and / or mouth
Vigilant	Stationary position with head raised, scanning the surroundings and looking into the distance
Other	Includes all subcategories not assigned

Out of View	Monkey is out of view during scan
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Another form of niche separation relates to the different habitats within the forest that each primate species occupies namely terra firma forest (broadleaf rainforest with abundant food supply year round, varzea forest (seasonally flooded with peaks of fruit production during the onset of rainy season) and palm swamp (permanently flooded forest close to the river edge with palm fruit and abundant insect life). The habitat type in which the primates are located will be recorded with every behavioural scan. These data may then be used to investigate habitat preferences of each species, but also to investigate variation in activity budgets in relation to habitat type.

As we do not have individual IDs for the primates, scan samples record the behaviour of each individual in view in a sweeping movement from the left to the right of the group, only recording behaviours of individuals that could be seen in the exact instant of the sample. The percentage of scans that each species spent feeding, moving, resting, social and vigilant will be calculated for each habitat type for each morning and afternoon observation period per day and used as a data point for analyses (providing a minimum of two data points per day of data collection with the exact amount determined by the number of habitat types used). Although this method can over inflate the sample size, this over inflation applies equally to each species collection and as all statistical analyses is aimed at comparing differences in behaviour across species, the results of such analyses will not be biased. Mean percentage of scans spent feeding, moving, resting, social and vigilant will be compared across species and across habitat types.

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