



Patterns of Hand use in Golden Langur (*Trachypithecus geei*) during feeding in a fragmented habitat of Western Assam, India.

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Abstract

Golden Langurs *Trachypithecus geei* are selective feeders and feed on variety of food plants throughout its life time. Handling and procuring of the food items by Golden Langurs have been observed in field, while they are feeding on different food items in Kakoijana Reserve forest, Assam. It has been observed that depending upon the food item the langurs used different techniques for eating them. Out of 6833 observations, it was recognized that they used six different techniques for handling the food item. The techniques include Pluck and hold with left hand (PLR) collecting and holding the item in left hand and then eat from hands, Pluck and hold with right hand (PHR) collecting and holding the item in right hand and then eat from hands, Pluck and feeding with right hand (PFR) collecting and feeding the item with right hand, Pluck and feeding with left hand (PFL) collecting and feeding the item with left hand, Both hand (BH) feeding collecting and holding the item in both hands and then eat from hands, Bending and Towing methods, when foods are collected directly from the food plant either towing the plant towards them or bending itself towards the food plant. For a leafy food item Golden Langurs pluck the leaf and eats by hand and sometimes they pluck a handful of leaves and put directly to mouth. In cases of small fruits like *Syzygium cummi*, they collect the fruits either with right or left hand one by one with fingers and put them into mouth. Our data show that there is individual variation in hand preferences for feeding among the Golden Langurs.

Keywords: Golden Langur, Fragmented habitat, feeding techniques, Hand use.

1. Introduction:

Of all activities in which animals engage, perhaps the most important are finding and consuming food. Faced with the complex scenery of a tropical rainforest, the environment in which most primate species live, primate individual uses its senses, edibility of the fruit by their size, shape, colour, smell, texture and taste to identify its food plants (Dominy *et al.* 2001) and use hands either left or right hand or both hands in different ways to processes the food items and consume the food in very effective and efficient manner. The Golden Langur, *Trachypithecus geei* (Khajuria 1956) is an endemic and endangered colobine monkey with a very restricted range being confined to western Assam in India and Bhutan only (Khajuria 1956). Golden Langur is generally foliovorous and young leaves are major

components in its diet followed by mature leaves, fruits, shoot, seeds and flowers.

The Golden Langur always moved in compact groups for feeding. When the food plants have good crop, almost all the members of the troop sit scattered on their branches and eat the fruits. In certain cases, members of the troop consumed food from different plants at a time; especially during summer months. On arriving at a feeding tree, there was a good deal of commotion for a few minutes until the individuals adjusted distances between them, so as to feed comfortably. They emitted many 'kheek' 'kheek' sounds and contact calls and moved up and down before starting feeding. The male langur actively defended the territory of the feeding site. Golden Langurs are selective feeders and feed on variety of

food plants throughout its life time. Thus, the varied food species selection enables the species to colonize a wide range of vegetation types from Tropical evergreen forests to Sal dominated forests. Primates use their hands as very important 'tools' for many activities (Goodall 1986). The hands are primarily employed in different sorts of locomotor functions. Furthermore, the manipulation of food items using hands by primates is of great importance. Hence, we investigate the

manipulations made by Golden Langur while foraging on different food items and identify various foraging techniques used by them.

2. Study area

Kakoijana Reserve Forest (hereafter referred as 'KRF') is located between 26° 24' N-latitude and 90° 36.5'E longitude with a total area of 17.201 square kms in Bongaigaon District of Western Assam, India (Fig.1). The region has a tropical monsoon climate



Fig. 1: Google map of Study area, Kakoijana Reserve Forest, Western Assam marked with an arrow.

receiving an annual average rainfall of about 100cm with max and min temperature of 36 °C and 10 °C respectively. Altitudinal variation of KRF ranges between 35 meter and 60 meter above sea level. KRF is bounded on East by the river Aie and on west by river Kujia with its tributaries. Remaining sides of KRF have paddy fields. Vegetation type of Kakoijana Reserve Forest is semi evergreen to mix deciduous with a wide range of floral and faunal diversity, hence it was declared as reserve forest for biodiversity conservation.

3. Methods

Procuring and handling of the food items by Golden Langurs have been observed in the field while they were foraging on different plants. Golden Langurs were observed from a distance of 7-10m with a 8" x40" binocular. A minimum distance of 15 m was maintained. All individuals in a single group were observed for 10- minute continuously using focal animal sampling method (Altmann, 1974) and each individual was sampled and then repeated. The Langurs were

observed on feeding various food items including leaves, leaf petiole, flowers, figs, fruits, etc., in different plants across days and seasons. The left over plant parts and pilferage of food items were collected to assess the scar marks and also to identify the food plant species. All observations were made by an observer, who dictated behavior and a recorder who scribed and measured the durations of behaviours using a stopwatch.

4. Results

A total of (n=6833) observations were done to record the feeding techniques of Golden Langurs in a fragmented habitat of Assam. The following foraging techniques were documented.

4.1 Pluck holding

Golden Langurs generally pluck the food items like leaf, which may be a single leaf (e.g. leaf of *Gmelina arborea*) or clump of leaves (e.g. leaves of *Albizia procera*) and put the items directly to mouth after plucking or hold in either hands and eat them. In this method they use one hand for

processing food and another hand for support. This type of technique is further classified on the basis of hands used for feeding as follows:

- a) Pluck and hold with left hand (PLR) method: In this case, they collect and hold the item in



- left hand and then eat from hands (Fig 2 a).
b) Pluck and hold with right hand (PHR) method: In this case, they collect and hold the item in right hand and then eat from hands (Fig. 2 b).



Fig. 2: Various food handling techniques of Golden Langur

- a. Golden Langur feeding on leaf petiole of (*Hevea brasiliensis*) using Pluck and hold with left hand (PHL) method
b. Golden Langur feeding on mature leaves of *Holarrahena antidysentrica* using Pluck and hold with right hand (PHR) method,

4.2 Pluck feeding

In some cases, Golden Langurs pluck the food items like leaf or small fruits, which may be a single leaf (e.g. leaf of *Shorea robusta*) or fruits of *Syzygium cumini* and *Dillenia pentagyna* and put the items directly to mouth either with left or right hand after plucking. On the basis of hand using, this type of technique is further classified as follows :

- a) Pluck and feeding with right hand (PFR) method: In this case, they collect the item with right hand and then eat directly.
b) Pluck and feeding with left hand (PFL) method: In this case, they collect the item with left hand and then eat directly.

4.3 Both hand (BH) feeding method

In case of fruit (e.g. *Mangifera indica*), shoots



Fig. c : Gloden Langur feeding on fruits of *Bauhinia varaeigata* using Both hand (BH) method. *Ficus* without plucking it, directly taking from the branch

of *Bamusa tulda* or flower (e.g *Bombyx cebia*), Golden Langurs hold the items with right hand/ left hand or both and then eat with an average bout ranging from 8 to 12 minutes (Fig 2 c).

4.4 Direct Feeding (DF)

When foods are procured directly from the food plant either towing the plant towards them or bending itself towards the food plant, we termed it as Direct feeding which can be classified further as:

- a) Bending: Occasionally, Golden Langurs bend themselves toward the branch of food plants and either collects the food item from trees using hand and eats or they eat directly from the branches with mouth (Fig 2 d).

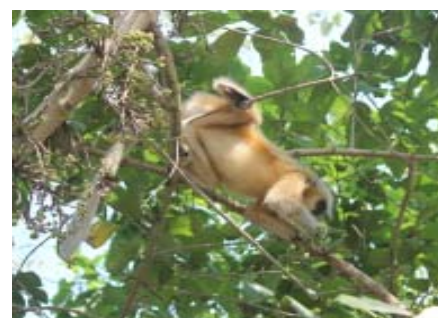


Fig. d : Golden Langur feeding on *Ficus* bending itself towards the branch using Bending method

- b) Towing: During a rainy or hot mid day, Golden Langurs have been observed to tow the branch of food plants (e.g. *Ficus hispida*, *Hevea brasiliensis*, etc.) close to them and either pick with their lips or pluck with fingers and eat (Fig 2 e).



Fig. e : Golden Langur feeding on young leaves of *Wrightia tomentosa* using towing method in the a fragmented habitat of Assam.

Of the 6833 Observations, Golden Langurs were recorded to use Pluck and hold with right hand (PHR) technique most of the time (41.6%) followed by Pluck and feeding with right hand (PFR) technique (29.1%). The other foraging techniques were used less than 10%

each. The Bending or Towing i.e. Direct feeding (DF) method contributed 9.8%, Both hand (BH) feeding method with 9.3%, Pluck and feeding with left hand (PFL) method with 8.2% and Pluck and hold with left hand (PHL) method with 2.0% (Table 1).

Table 1: The number and percentage of occasions the Golden Langur, *Trachypithecus geei* used different foraging techniques while foraging on different food items in a Fragmented habitat of Western Assam. The priority of the techniques is given as rank in the last column.

Foraging techniques	Number of occasions	%	Rank
Pluck and hold with right hand (PHR)	2843	41.7	1
Pluck and feeding with right hand (PFR)	1989	29.1	2
Direct Feeding (DF)	669	9.8	3
Both hand (BH) feeding	634	9.3	4
Pluck and feeding with left hand (PFL)	559	8.2	5
Pluck and hold with left hand (PHL)	131	1.9	6
	6825	100	

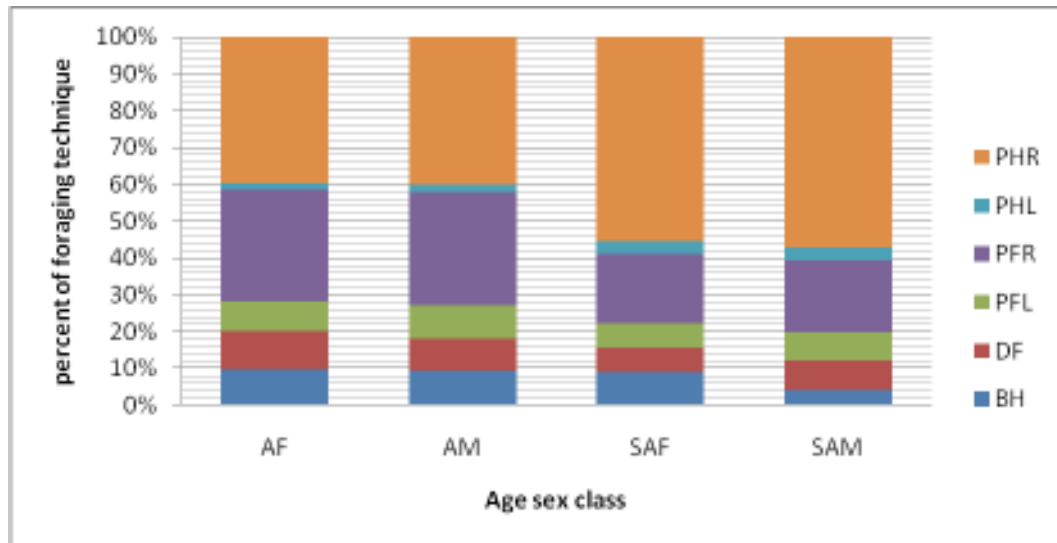


Fig. 1: Percentage of foraging techniques used by different age sex class of Golden Langur, *Trachypithecus geei* in a fragmented habitat of Western Assam.

Age-sex differences in utilization of different foraging techniques

The percent of foraging techniques used by different age sex classes of Golden Langur is shown in figure-1. Golden Langur showed variation in foraging techniques with respect to age and sex. It has been seen that the sub adults followed by the adults used significantly the PHR technique. Adult female used PHR technique (39.70%) followed by PFR technique (30%). Adult male used PHR technique (40%) followed by PFR (30%). Sub adult female used PHR technique (55%) followed by PFR technique (18%) and Sub adult male used PHR technique (57%) followed by PFR technique (19%) respectively. Other techniques used by all ages sex classes is less than or equal to 10%. Regardless of age-sex classes, we found significant differences in using different foraging techniques across the age-sex classes in different season ($F_{2,104.35} = 104.35$, $DF=15$, $P=0.00$).

Golden Langurs forage mainly on the top or middle strata but depending on the weather conditions (rainy/sunny) and habitat characteristics (canopy continuity) they sometimes come to the ground and forage. It has been observed that with variation of food items, the techniques of eating them also vary. For a leafy food item Golden Langurs pluck the leaf and eats by hand and sometimes they pluck a handful of leaves and put directly to mouth. In cases of small fruits like *Syzygium cumni*, they collect the fruits either with right or left hand one by one with fingers and put them into mouth. Figs of *Ficus hispida* are eaten directly from trees.

Larger fruits are held in hands and then eaten.

Feeding pattern of leaves

The method of handling of larger leaves like that of figs and *Tectona grandis* were different from smaller ones. These leaves were pulled manually off the branch one at a time and then treated individually. But the twig of small leaves were stripped with the incisors and consumed as a whole. Only rarely the Langur consumed complete leaves. In most cases only parts of the leaves were preferred, others discarded. For example, in the case of *Lantana Camera* they took flowers and leaves together and discarded after taking a bite. When they took older leaves of *Tectona grandis*, they consumed petiole of the leaf and dropped out the remaining parts. At least one third of all food materials were found dropped and wasted by the Langur troops. This was also observed by Poirier (1968) in case of Nilgiri Langurs (*Trachypithecus johnii*). While eating the whole leaf (eg. Sal leaf), the Langur held the leaf in one hand, rolled the leaf together, and then took a bite from the rolled leaf, until it is finished completely or fell down.

5. Discussion

In this study, we described feeding techniques used by Golden Langur with respect to hand preferences. Over the period of study, it has been observed that Golden Langurs used both hands for collecting food as well as feeding. Numerous studies provide evidence that non-human primates exhibited

hand preferences for a variety of tasks (Ward and Hopkins, 1993). The extent of such hand preferences, however, is variable both between and within species (McGrew and Marchant, 1997). For example, captive chimpanzees (*Pan troglodytes*) exhibited a consistent population-level right-hand preference across a variety of different tasks (Hopkins, 1996). Feeding which did not include manipulation, i.e. mostly feeding on leaves had an overall significant right hand preference (Riyas and Meena, 2015). Three monkeys had a left hand preference and one had a right hand preference in study by (Mittra *et al.*, 1997) Further, Hopkins (1995) argued that bimanual hand use can be divided into two distinct categories: coordinated and uncoordinated. An uncoordinated bimanual action occurs when both hands perform actions independently of each other, while a coordinated bimanual action is described as instances during which both hands work together to achieve a unitary goal, such as food procurement. It is well established that the animals use different foraging techniques on various food items to make the foraging more profitable (e.g. Nagarajan *et al.*, 2015). Therefore, the Golden Langur would have used these techniques to make the foraging more profitable. Also our results indicated that Golden Langurs showed a stronger preference of right hand use during foraging followed by left hand and both hands. Gorillas exhibited a significant population-level right-handedness for the bimanual actions (Adrien M *et al.*, 2009). In addition, it may be a significant condition that Golden Langurs expressed a significant hand preference for supporting

itself on a branch during feeding, an uncoordinated bimanual task. In the terminal branches the necessity to hold branches by the right hand probably becomes a priority over using it for feeding. (Riyas and Meena, 2015). Endogenous differences between species in the use of the forelimb(s) during feeding could explain the observed findings on hand preference. For example, both mountain gorillas, and to a lesser extent lowland gorillas, feed while seated and use their hands in a coordinated manner (Byrne & Byrne, 1991; Parnell, 2001; Remis, 1999). In contrast, orangutans, and to a lesser extent chimpanzees, forage in the trees with one hand while posturally supporting themselves with the opposite hand (Peters, 2005). In terms of bimanual feeding, studies indicate that chimpanzees and gorillas are right handed but only under conditions where the hands are involved in the independent actions of holding and feeding (Hopkins & de Waal, 1995). When one of the hands is involved in either postural or forelimb substrate support, no population-level handedness is evident in both wild and captive apes (Hopkins & de Waal, 1995; Marchant & McGrew, 1996). Injury and death due to a fall provide a significant pressure on arboreal animals to constantly maintain a state of balance in the canopy (Fleagle, 1998). Thus, one would expect arboreal species to evolve morphological and/or behavioral adaptations in response to this pressure. In other words, the dominant hand, used for reaching for food when stability was not an issue, may at times be better suited for supporting the individual when it is situated in precarious positions within the canopy.

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