

Habitat Utilization and Feeding Biology of Himalayan Grey Langur (*Semnopithecus entellus ajex*) in Machiara National Park, Azad Kashmir, Pakistan

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Abstract: Habitat utilization and feeding biology of Himalayan Grey Langur (*Semnopithecus entellus ajex*) were studied from April, 2006 to April, 2007 in Machiara National Park, Azad Kashmir (Pakistan). The results showed that in the winter season the most preferred habitat of the langurs was the moist temperate coniferous forests interspersed with deciduous trees, while in the summer season they preferred to migrate into the sub-Alpine scrub forests at higher altitudes. Langurs were folivorous in feeding habit, recorded as consuming more than 49 plant species (27 in summer and 22 in winter) in the study area. The mature leaves (36.12%) were preferred over the young leaves (27.27%) while other food components comprised of fruits (17.00%), roots (9.45%), barks (6.69%), flowers (2.19%) and stems (1.28%) of various plant species.

Key words: Himalayan Grey Langur; Habitat; Food biology; Machiara National Park

喜马拉雅灰叶猴栖息地利用和食性生物学研究

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摘要: 我们于 2006 年 4 月至 2007 年 4 月在巴基斯坦克什米尔地区马希亚拉国家公园 (Machiara National Park) 对喜马拉雅灰叶猴 (*Semnopithecus entellus ajex*) 的栖息地利用和食性生物学进行研究。结果表明, 冬天, 叶猴首选的栖息地多为温暖湿润的针叶林和落叶林混交地区; 夏天, 它们则迁移至高海拔的亚高山灌木丛林里。喜马拉雅灰叶猴主要以植物的叶子为食, 研究期间在该地区共发现 49 种被采食过的植物 (夏季 27 种, 冬季 22 种)。通过观察它们的所有食物, 发现老叶 (36.12%) 比嫩叶 (27.27%) 更受欢迎, 随后依次为果实 17.00%、树根 9.45%、树皮 6.69%、花 2.19% 和根茎 1.28%。

关键词: 喜马拉雅灰叶猴; 栖息地; 食性生物学; 马希亚拉国家公园

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The Grey Langur or Hanuman Langur (*Semnopithecus entellus*) is large-sized and most widely distributed animal species of the 19 non-human primate species, found in the Indian subcontinent (Roonwal & Mohnot, 1977). Himalayan Grey Langur (*S. entellus ajex*) belongs to the family Cercopithecidae and sub family Colobinae, which includes all the old-world monkeys with

folivorous feeding habit (Roberts, 1997; Thorington & Anderson, 1984).

Himalayan Grey Langur is found in Himachal Pradesh, India (Great Himalayan National Park, Kallatop-Khajjiar and Manali Wildlife sanctuaries) and State of Jammu Kashmir (Kistwar National Park), Nepal (Lang Tang National Park of Central Province) (Walker

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& Molur, 2004). In Pakistan, these langurs are confined to Azad Kashmir and District Mansehra, Pallas Kohistan, Bankad Dubair and Pattan (Roberts, 1997). In Azad Kashmir, these beautiful monkeys are distributed in Neelum Valley (Machiara National Park and Salkhala

Game Reserve), Jehlum Valley (Moji Game Reserve and surroundings), and Hillan and Phalla game reserves in District Bagh (Ahmed, 1999; Baig, 2004; Dar, 2006) (Fig. 1).

The Langurs are ecologically very adoptable to a

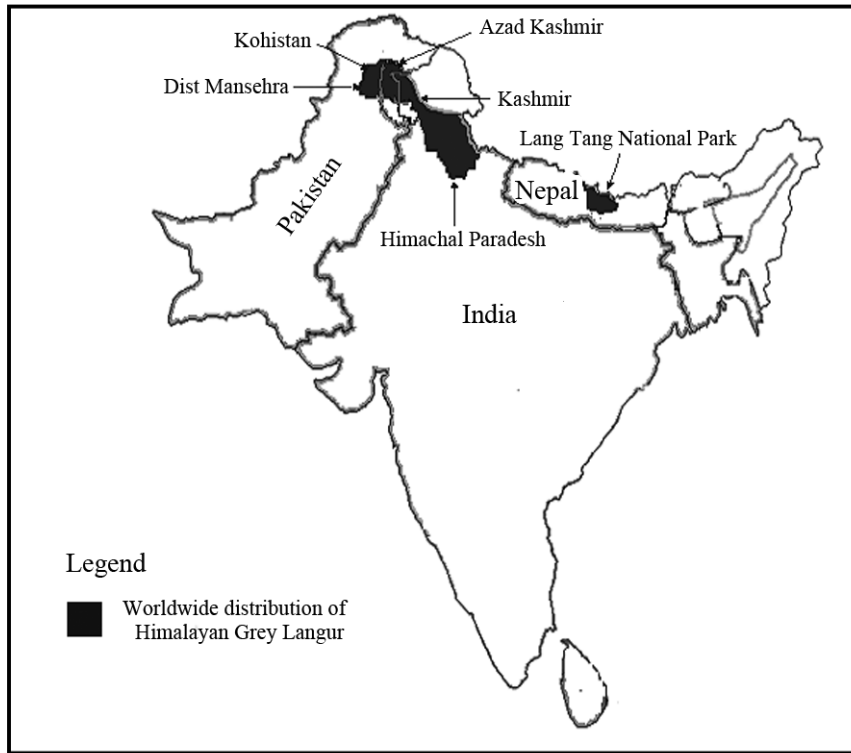


Fig. 1 Worldwide distribution of Himalayan Grey Langurs (*Semnopithecus entellus ajax*)

variety of habitats, including quite dry savannah and tropical rain forests. They inhabit between 2200-4000 m asl (above sea level) in the subtropical, tropical moist temperate, alpine, coniferous, broadleaved forests and scrublands (Nowak, 1999; Hilton & Taylor, 2000; Roberts, 1997). They are arboreal and diurnal species and prefer to jump from tree to tree through the branches when foraging but some may become accustomed to living close to the human settlements (Tritsch, 2001).

The Himalayan Langurs are mainly folivorous species, but also consume fruits, flowers, cultivated crops, seeds with high levels of the toxins, like, strychnine (*Strychnos non-vomica*) and distasteful vegetation avoided by other creatures. The animal is exclusively herbivorous, feeding mainly on young leaf buds, shoots and other vegetations (Roberts, 1997) but observations in the open scrub forests of Jodhpur reveal that the insects may also constitute a regular part of their diet and that insectivory is particularly prevalent in the monsoon months of July-September (Srivastava, 1991).

Moore (1985) in a study of langur all-male bands also observed five episodes of active insect predation.

All the primate taxa including langurs in the South Asia are under severe threats. The major and common threats through out the region are the habitat loss and degradation through human encroachment, overgrazing, building roads through forests, lopping, deforestation, agriculture, fire, unavailability of food, predation by carnivores (leopards and tigers) and attack of several viral and bacterial diseases. Present and future threats are mainly due to agriculture and development practices (Biswas & Sankar, 2002; Bagchi et al, 2003; Nandi et al, 2003; Nowak, 1999). The species does not raid the crops, therefore, it does not invite the anger of local villagers but the living conditions for such a leaf eating species are very harsh in the long winter season at these altitudes (Roberts, 1997).

Although habitat of these langurs is stable in the area, but is predicted future decline by 10% during the next 10 years due to forest clearance for agriculture and

encroachments. There has already been a decrease in habitat quality due to such alterations (Hilton & Taylor, 2000).

Langurs are endangered because of an encroaching human expansion (Nowak, 1999). The International Union for the Conservation of Nature and Natural Resources (IUCN) in 2000 classified the '*Semnopithecus entellus ajax*' as Lower Risk; near threatened and now due to improved information and taxonomic revision [CRB1ab(iii,v) +2 ab (iii,v) ver.3.1 (2001)], this subspecies was reassessed in 2004 and is now regarded as "Critically Endangered" (IUCN, 2006). According to Roberts (1997), this monkey was very rare in Pakistan, and excluding Azad Kashmir, its total population was estimated to be less than 200 individuals. In Azad Kashmir however, its population is better as compare to Pakistan and according to an estimate there are more than 500 individuals in Azad Kashmir (Dar, 2006).

Above-mentioned facts reveal that the animal is highly important with the conservation point of view as its population is restricted to a very small area and is continuously declining throughout the range. Moreover, the habitat conditions and availability of food for this species were never studied and remain unclear throughout its distribution range in Pakistan and Azad Kashmir. Therefore, a proper study of this critically endangered species with special reference to the assessment of the existing habitat and available food for this species in Machiara National Park Azad Kashmir is highly demanded. The present study is a step to address these issues for future management and conservation of this species.

1 Materials and Methods

1.1 Study Area

Machiara National Park (MNP) lies at 34° 31' N latitude and 73° 37' E longitude, covering an area of about 135.35 km² (33450 acres), and between 2000 m to 4733 m above the sea level. The Park is located at a distance of about 35 km from Muzaffarabad (the capital city of Azad State of Jammu and Kashmir, Pakistan). On its northern side it is bounded by Neelum Valley while the Kaghan Valley (North West Frontier Province, Pakistan) surrounds it from the western side. Along the Southern periphery of the Machiara National Park, there are 30 villages comprising 7635 households with 52792 persons (Fig. 2). The region is influenced by the

southwest monsoon. The average annual temperature ranges between 13 °C and 27 °C with the extremity between -2 to 46. Generally the spring (February to April) and monsoon (July to August) are the raining seasons of the year.

MNP is a true representative of Himalayan Mixed Forest-Rangeland Ecosystem. It comprises of Himalayan moist temperate forests, Himalayan dry coniferous forests, sub-alpine scrub forest and alpine pastures. The park is very rich in biodiversity and provides habitat to hundreds of important animals, birds and plant species, including rare and globally significant wildlife species of Snow leopard (*Uncia uncia*), Musk deer (*Moschus chrysogaster*), Western Horned-tragopan (*Tragopan melanocephalus*), Cheer pheasant (*Catreus wallichii*), Lammergeier (*Gypaetus barbatus*) and the Himalayan Griffon vulture (*Gyps himalayensis*). Trees such as fir (*Abies pindrow*), spruce (*Picea smithiana*), deodar (*Cedrus deodara*), blue pine (*Pinus wallichiana*) and barmi (*Taxus wallichiana*) dominate the floral cover. Among the broad-leaved species, Bankhor (*Aesculus indica*) and Kalakat (*Prunus cornutus*) are important. Barmi (*Taxus wallichiana*), a globally threatened species, occurs in good number in MNP and is therefore, protected under CITES (Beig, 2004; Hassan, 2004).

1.2 Methods

Three "focal groups" of the langurs were selected and assigned names. These focal groups included two bisexual troops {one uni-male bisexual (UMBS) and one multimale bisexual (MMBS)} and one all-male band (AMB).

For the assessment of habitat, vegetation type including grasses (annual or perennial herbaceous plants with hollow and jointed stems), herbs (annual or perennial angiospermic plants with small and soft stems), shrubs (woody plants with many stems rising from the ground and trees (with single woody stem), topography and dominant plant species were recorded. Data on feeding behaviour were collected using focal and scan sampling techniques in which the activities of visible animals were recorded throughout the day from dawn to dusk following Altman (1974) and Chhangani & Mohnot (2004). Data were collected for 72 hours per month for each of the focal troops (UMBS, MMBS and AMB) for three consecutive days in a month. One day prior to the commencement of data collection, the trees on which the focal group roosted were located. This strategy facilitated to start observation next day before the group would

leave its sleeping trees early in the morning. While scanning the feeding activities of the animals, the record of plant species and plant part eaten was noted. Unidentifiable plant samples were collected and labeled for afterward identification. Much of the information was obtained by the examination of the signs they left behind.

These include partially eaten flowers, fruits, roots and leaves. For this purpose identified animals were followed from dawn to dusk, and types and numbers of food items brought into the mouth were recorded for each minute of observation. To supplement the field data, a number of knowledgeable local people was also interviewed.

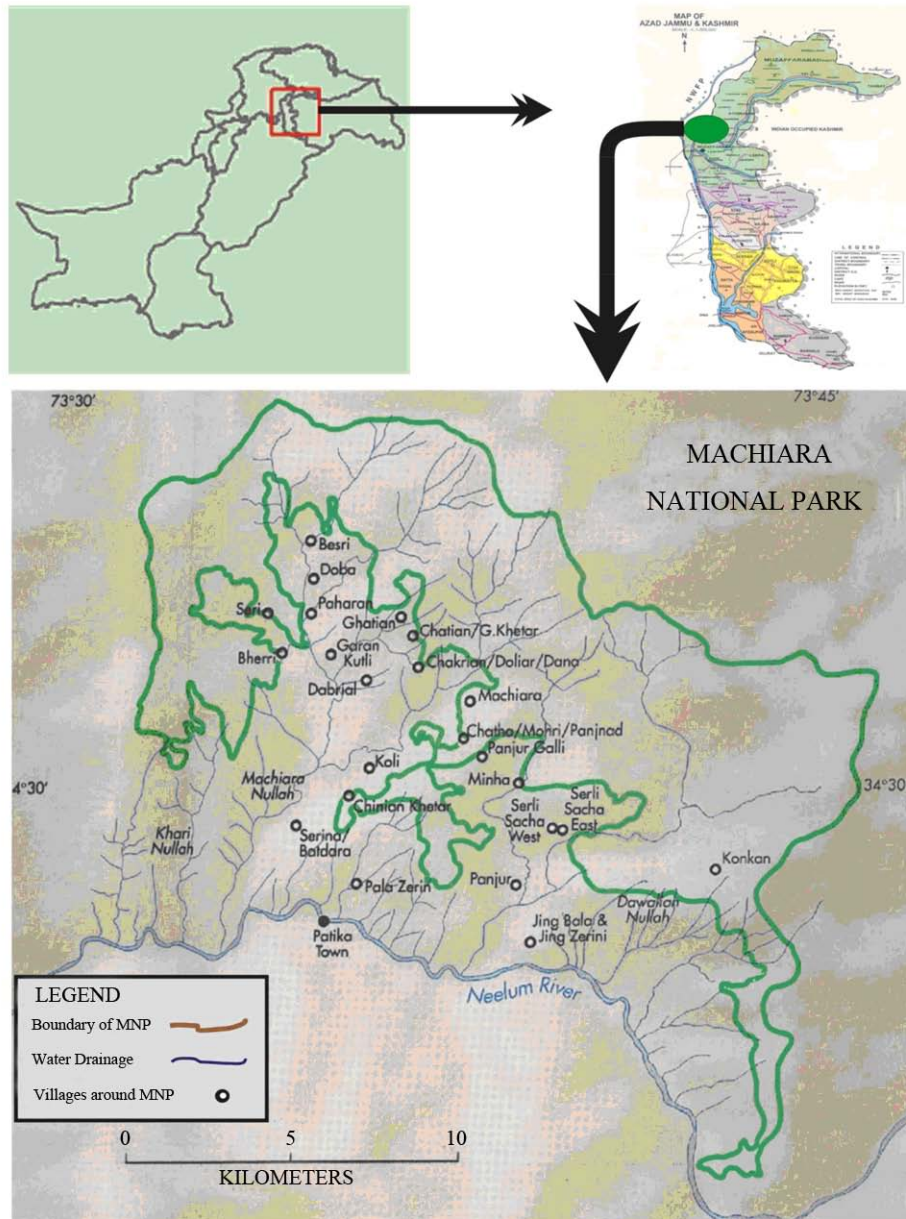


Fig. 2 Location map of the study area (Machiara National Park)

2 Results

2.1 Habitat utilization

In Machiara National Park langurs were usually found in the moist temperate coniferous habitats with mixed deciduous forests. However during the summer

season they migrated upwards into the subalpine scrub forests and in some localities (Ganja Mountains) even further into the alpine zone. In most of the habitats, they preferred moist temperate forests with dominant deciduous vegetations. They have never been observed penetrating into the cultivated areas in or around the

villages, however they were observed many times in the cultivated fields inside the forest areas during the winter. It was also observed that the langurs sometimes overlapped the habitats of rhesus monkeys during the winter months and they were never observed together in the summer since during these months the rhesus monkeys are usually found in the vicinity of the cultivated areas while the langurs were found penetrating into the high altitudinal areas mostly overlapping the habitats of musk deer in subalpine scrub forests. Most of the langur troops were found in the areas where adequate water was available. The habitat preferences of the three focal groups of langurs with the dominant vegetations and seasonal variations are given below.

‘UMBS’ troop was found around Kole Daber-Silade-Purana Chhanj-Thora (Forest Compartment No. 9A) localities on the South-Western aspect, the hilly area with about 60% slop. During the winter season this troop was mostly confined to the moist temperate coniferous forests mixed with deciduous trees, dominated with *Quercus incana*, *Viburnum nervosum* and *Achillea millefolium* at about 2250-2700 m above sea level (asl) (Tab. 1, Tab. 2). However, during the summer months this troop penetrated into the subalpine scrub forests dominated by *Juniperus communis* and *Salix denticulate* up to 3800 m asl. The area was disturbed during the summer season by the livestock and human population and usually remained undisturbed in winter. The other important animals found in the area were black bear, leopards, martens, musk deer, gorals, tragopans, monals and koklass (Tab. 1).

The second focal troop ‘MMBS’ was confined to Domailan, Reveri and Kuthial (Forest Compartment No.

9b) areas situating on the South-Western aspect of the Ganja Mountain ranges with more than 60% slop. The troop remained confined to the moist temperate coniferous forests mixed with deciduous trees dominated with *Aesculus indica* in the western aspect while with *Quercus incana* on the southern and northern aspects at about 2000-2500 m asl. Among the shrubs and herbs *Indigofera heterantha*, *Viburnum nervosum* and *Valeriana jatamansi* were the dominant species of langur’s habitat (Tab. 1). Like the UMBS, this troop also moved upwards into the subalpine scrub forests dominated by *Juniperus communis*, *Salix flabellaris* and *Salix denticulate* in the summer months. Water sources were sufficiently available throughout the area. The disturbance remained during the most part of the year, reaching at the peak in the summer when livestock grazing and human settlements were at maximum (Tab. 1). The dominant plant species (Tab. 3) and the important animals in the area were black bear, leopards, musk deer, yellow throated martens, gorals, tragopans, monals, chukors and koklass.

The third focal group was an all-male band nominated as ‘AMB’ found in Jhugian-Danna Magri (Forest Compartment No.15 a & b) localities between 1790-3000 m asl. The area comprised of high cliffs of more than 60% slops. The band remained confined in the moist and dry temperate coniferous forests mixed with deciduous trees. *Pinus wallichiana* was the dominant tree species in the area while among the shrubs and herbs *Phytolacca letbenia* and *Viola odorata* were recorded as the dominant species (Tab. 4). The area was disturbed during the summer season by the

Tab. 1 Habitat utilization by focal langur troops and all male bands in Machiara National Park during 2006-2007

Sr. #	Name of troop/ band	Name of locality	Aspect	Slop (%)	Habitat type	Land use	Dominant Vegetations			Associated animals
							Dominant trees	Dominant shrubs	Dominant herbs	
1	UMBS	Sila Da-Prana Chanj-Thora	SW	60	Moist temp. mixed coniferous Forests, sub al-pine scrubs	Pasture, Forests	<i>Quercus incana</i>	<i>Viburnum nervosum</i>	<i>Achillea millefolium</i>	Black bear, leopard, Tragopan, Koklass, Monal, Monk-eyes Musk deer
2	MMBS	Thora-Khuthiali-Domallan	NW	60	Moist temp. mixed coniferous Forest, sub alpine scrubs	Pasture, Forests	<i>Aesculus indica</i>	<i>Indigofera heterantha</i>	<i>Valeriana jatamansi</i>	Black bear, leopard, Gor-al, Tragopan, Koklass, Mon-al, Monkeys,

Sr. #	Name of troop/ band	Name of locality	Aspect	Slop (%)	Habitat type	Land use	Dominant Vegetations			Associated animals
							Dominant trees	Dominant shrubs	Dominant herbs	
										Musk deer
3	AMB	Jhugian-Danna magri	NE	70	Moist and dry temperate mixed forests	Agricultural lands, forests	<i>Pinus wallichiana</i>	<i>Phytolacca letbenia</i>	<i>Viola odorata</i>	Black bear, leopard, Kokl-ass, Monal, Monkeys

UMBS: uni-male bisexual troop, MMBS: multi-male bisexual troop, AMB:all-male band. NE: North East, NW:North West, SW: SouthWest.

Tab. 2 List of important vegetation found in the habitat of troop UMBS

Trees	Shrubs	Herbs
<i>Quercus incana</i>	<i>Jasminum humile</i>	<i>Adiantum incisum</i>
<i>Abies pindrow</i>	<i>Plectranthus rugosus</i>	<i>Androsace rotundifolia</i>
<i>Aesculus indica</i>	<i>Rubus ulmifolium</i>	<i>Valeriana jatamansii</i>
<i>Betula utilis</i>	<i>Viscum album</i>	<i>Potentilla gerardiana</i>
<i>Picea smithiana</i>	<i>Sorbaria tomentosa</i>	<i>Rheum emodi</i>
<i>Juglans regia</i>	<i>Rubus ellipticus</i>	<i>Mentha longifolia</i>
<i>Pinus wallichiana</i>	<i>Viburnum foetens</i>	<i>Iris hookeriana</i>
<i>Prunus cornuta</i>	<i>Viburnum nervosum</i>	<i>Poa annua</i>
<i>Taxus wallichiana</i>	<i>Indigofera heterantha</i>	<i>Podophyllum emodi</i>
<i>Celtis australis</i>	<i>Salix denticulata</i>	<i>Thlipsis arvensis</i>
<i>Grewia tenax</i>	<i>Salix flabellaris</i>	<i>Polygonum amplexicaulis</i>
	<i>Rhodendron hypenanthum</i>	<i>Geranium nepalens</i>
	<i>Juniperus communis</i>	<i>Thymus serpyllum</i>
	<i>Indigofera linifolia</i>	<i>Plantago lanceolata</i>
	<i>Vitis vinifera</i>	<i>Cymbopogan matini</i>
	<i>Berberis aristidae</i>	<i>Solanum nigrum</i>
	<i>Berberis lycium</i>	<i>Podophyllum emodi</i>
		<i>Dryopteris stewartii</i>
		<i>Dryopteris ramosa</i>
		<i>Skimmia laureola</i>
		<i>Malva spp.</i>
		<i>Asphodelus tenuifolius</i>
		<i>Geranium wallichianum</i>
		<i>Ziziphus jujube</i>
		<i>Solanum tuberosum</i>
		<i>Urtica dioica</i>
		<i>Achillea millefolium</i>

Tab. 3 List of important vegetation found in the habitat of troop MMBS

Trees	Shrubs	Herbs
<i>Quercus incana</i>	<i>Jasminum humile</i>	<i>Adiantum incisum</i>
<i>Abies pindrow</i>	<i>Plectranthus rugosus</i>	<i>Androsace rotundifolia</i>
<i>Aesculus indica</i>	<i>Rubus ulmifolium</i>	<i>Valeriana jatamansii</i>
<i>Betula utilis</i>	<i>Viscum album</i>	<i>Potentilla gerardiana</i>
<i>Picea smithiana</i>	<i>Sorbaria tomentosa</i>	<i>Rheum emodi</i>
<i>Juglans regia</i>	<i>Rubus ellipticus</i>	<i>Mentha longifolia</i>
<i>Pinus wallichiana</i>	<i>Viburnum foetens</i>	<i>Iris hookeriana</i>
<i>Prunus cornuta</i>	<i>Viburnum nervosum</i>	<i>Poa annua</i>
<i>Taxus wallichiana</i>	<i>Indigofera heterantha</i>	<i>Podophyllum emodi</i>
<i>Celtis australis</i>	<i>Salix denticulata</i>	<i>Thlipsis arvensis</i>
<i>Grewia tenax</i>	<i>Salix flabellaris</i>	<i>Polygonum amplexicaulis</i>
<i>Diospyros lotus</i>	<i>Rhodendron hypenanthum</i>	<i>Geranium nepalens</i>
	<i>Juniperus communis</i>	<i>Thymus serpyllum</i>
	<i>Deutzia staminea</i>	<i>Cymbopogan matini</i>
	<i>Parratiopsis jacquemantiana</i>	<i>Fragaria nubicola</i>
	<i>Ribes alpestre</i>	<i>Plantago major</i>
	<i>Elaeagnus spp.</i>	<i>Impatiens edgeworthii</i>
	<i>Rosa burnonii</i>	<i>Euphorbia spp.</i>
	<i>Jurinea dolomiaea</i>	<i>Datura stramonium</i>

<i>Indigofera linifolia</i>	<i>Solanum nigrum</i>
<i>Ziziphus mauritiana</i>	<i>Dryopteris stewartii</i>
<i>Skimmia laureola</i>	<i>Dryopteris ramose</i>
<i>Rosa moschata</i>	<i>Lavatera spp.</i>
<i>Ziziphus nummularia</i>	<i>Podophyllum emodi</i>
<i>Ziziphus mauritiana</i>	<i>Bistorta spp.</i>
<i>Ziziphus jujube</i>	<i>Polygonum alpinum</i>
	<i>Malva spp</i>
	<i>Asphodelus tenuifolius</i>
	<i>Cymbopogon martini</i>
	<i>Geranium wallichianum</i>
	<i>Phaseolus aconitifolius</i>
	<i>Solanum tuberosum</i>

livestock grazing, human settlements and agricultural activities, which resulted temporarily in the seasonal movements of the band (Tab. 1). The important animals found in the area were black bear, leopards, martens, monals and koklass.

2.2 Sleeping sites

During the study of the home ranges and habitats of the focal troops and the all-male band, the sleeping sites and tree species used for the roosting were also observed in each habitat. At the end of the day all the individuals

would gather around the sleeping sites and on the onset of darkness they would climb up the trees for the sleeping purpose. All focal groups used 2-11 large and small trees of various species for the roosting within their home ranges (Tab. 5).

The study troop (UMBS) mostly used eight sleeping sites, where in they mostly roosted on the 3-7 trees of *Betula utilis* and *Quercus incana* in three sites during the summer season while *Aesculus indica*, *Abies pindrow* and *Juglans regia* were used at the five roosting sites

Tab. 4 List of important vegetation found in the habitat of troop AMB

Trees	Shrubs	Herbs
<i>Pinus wallichiana</i>	<i>Strobilanthus urticifolius</i>	<i>Adiantum incisum</i>
<i>Abies pindrow</i>	<i>Plectranthus rugosus</i>	<i>Androsace rotundifolia</i>
<i>Aesculus indica</i>	<i>Rubus ulmifolium</i>	<i>Potentilla gerardiana</i>
<i>Juglans regia</i>	<i>Viscum album</i>	<i>Cotoneaster affinis</i>
<i>Picea smithiana</i>	<i>Sorbaria tomentosa</i>	<i>Mentha longifolia</i>
<i>Prunus cornuta</i>	<i>Sambucus wightiana</i>	<i>Poa annua</i>
<i>Celtis australis</i>	<i>Phytolacca latbenia</i>	<i>Trifolium repens</i>
<i>Cedres deodara</i>	<i>Viburnum nervosum</i>	<i>Arisaema jacquemontii</i>
<i>Diospyros lotus</i>	<i>Indigofera heterantha</i>	<i>Polygonum amplexicaulis</i>
	<i>Desmodium elegans</i>	<i>Geranium nepalens</i>
	<i>Phytolacca letbenia</i>	<i>Onychium contiguum</i>
		<i>Plantago major</i>
		<i>Dryopteris stewartii</i>
		<i>Cymbopogon matini</i>
		<i>Viola odorata</i>

Tab. 5 Sleeping Sites and Tree species used by the focal troops of langurs during 2006-2007

Name of the group	Sleeping sites	Numbers of tree used for roosting	Plant species used for roosting	
UMBS	summer	A	3	<i>Betula utilis</i> , <i>Quercus incana</i>
		B	7	<i>Betula utilis</i> , <i>Quercus incana</i>
		C	5	<i>Betula utilis</i> , <i>Quercus incana</i>
	winter	A	2	<i>Quercus incana</i>
		B	3	<i>Aesculus indica</i> , <i>Abies pindrow</i>
MMBS	summer	C	3	<i>Abies pindrow</i> , <i>Picea smithiana</i>
		D	5	<i>Aesculus indica</i> , <i>Juglans regia</i> , <i>Abies pindrow</i>
		E	2	<i>Juglans regia</i>
		A	11	<i>Abies pindrow</i>
	B	6	<i>Quercus incana</i> , <i>Abies pindrow</i>	
	C	8	<i>Abies pindrow</i>	
	D	6	<i>Aesculus indica</i> , <i>Abies pindrow</i>	

winter	A	7	<i>Aesculus indica</i>
	B	4	<i>Aesculus indica, Abies pindrow</i>
	C	6	<i>Aesculus indica</i>
summer	A	1	<i>Abies pindrow</i>
	B	2	<i>Picea smithiana, Abies pindrow</i>
	C	2	<i>Picea smithiana, Abies pindrow</i>
	D	2	<i>Abies pindrow, Pinus wallichiana</i>
	E	2	<i>Pinus wallichiana, Aesculus indica</i>
winter	A	2	<i>Aesculus indica, Abies pindrow</i>
	B	2	<i>Cedres deodara</i>
	C	2	<i>Aesculus indica, Cedres deodara</i>
	D	2	<i>Juglans regia</i>

during the winter (Tab. 5). The second bisexual focal troop (MMBS) used seven sleeping sites, of those four were used in summer, where they used mostly the 6-11 trees of *Quercus incana* and *Abies pindrow* while three sites were used in winter on *Aesculus indica* and *Abies pindrow*. The langurs of all-male band used 9 roosting sites, of which 5 were used in summer, preferring mostly the *Abies pindrow* as the roosting tree. During winter 4 sites were selected, where in *Pinus wallichiana*, *Cedres deodara* and *Aesculus indica* were used for their roosting (Tab. 5).

It was observed that the sleeping sites were usually changed due to the disturbance by the predators and human beings. The langurs of focal troops also shifted their sleeping sites due to the disturbances by the all-male bands.

2.3 Food and feeding behaviour

In Machiara National Park, langurs mostly used a combination of fruits, buds, leaves, stems, barks, roots and flowers and were also observed eating insects.

Langurs of study troops were observed consuming plant parts of over 49 species (Tab. 6), found naturally in their habitat except three species (*Phaseolus aconitifolius*, *Solanum tuberosum*, *Diospyros lotus*) which were cultivated by the human beings near the summer residences. During the monsoon months of July-September and also in November they were frequently observed consuming insect larvae. Langurs fed on natural food available in their home ranges the year round. The monthly number of plant species consumed from dawn to dusk fluctuated during the year (Fig. 3).

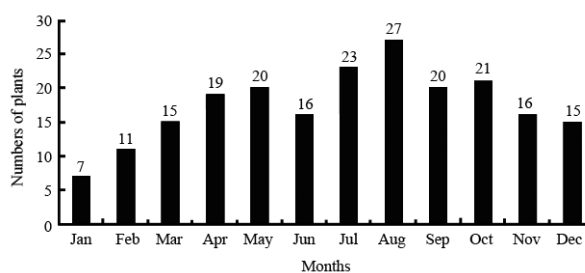


Fig. 3 Number of plant species consumed by langurs in different months of the year 2006-2007

The number of plant species and parts consumed varied considerably in different months. In monsoon they consumed a large number of plant species as compared to other months suggesting relationship between the monthly distribution of the number of plant species consumed by langurs and rainfall (Fig. 3).

It shows that during the dry season, the number of species constituting langur food goes down and with the onset of rains the plant taxa increase manifolds reaching to a maximum during August (Fig. 3). The plant species consumed by the langurs during summer and winter of 2006-2007 and average percentages of total feeding time per day (rate of consumption) is given in Tab. 6.

During summer, 37 plant species were consumed by the langurs of the focal troops. Of these *Betula utilis*, *Polygonum alpinum*, *Skimmia laureola*, *Juniperus communis*, *Rheum emodi*, *Ribes alpestre*, *Quercus incana*, *Jurinea dolomiaea* and *Prunus cornuta* constitute major share of langur's diet. These species together accounted for about 55% of total time spent by langurs on feeding. The remaining 29 plant species accounted for about 45% of feeding time (Fig. 4). Similarly six species *Aesculus indica*, *Quercus incana*, *Prunus cornuta*, *Abies pindrow*, *Viburnum nervosum* and *Ziziphus jujube* constituted more than 70 % of langur's diet during the winter season (Fig. 5). These fifteen plant species accounted for 62.76% of the total yearly diet of the three focal troops. Among these species, *Aesculus indica* (14.44 %) followed by *Quercus incana* (13.83 %) *Prunus cornuta* (5.66 %) and *Betula utilis* (5.28 %) were most commonly used.

Overall, the *Aesculus indica* was the major part of the langur's diet while the *Phaseolus aconitifolius* was consumed in least quantity. Many plant species which were infrequently eaten showed strong seasonal variation. About 37 species were consumed during summer, whereas only 22 species were consumed during cold

months from October to March (Fig. 4,5). It showed remarkable seasonal variation not only in their availability but also in their consumption. *Aesculus indica* (26.34%) constituted the major portion of the langur diet during the winter while *Betula utilis* (10.56%) was used in summer (Fig. 4,5). Langurs of troop MMBS were also observed eating insects like termites (*Zootermopsis* spp), body lice (*Pediculus* spp) picked up from the bodies of the other individuals during grooming, stick insects and other insect larvae.

The annual distributions of parts of plants utilized

by langurs of troop MMBS showed the percentages of total feeding time that langurs spent on major food types like, mature leaves, young leaves, fruits (generally unripe but occasionally ripe), roots, flowers (both buds and open), stem, bark etc. (Tab. 7). The mature leaves (36.12%) were preferred to young leaves (27.27%). Fruit eating accounted for 17.00% of the total feeding time. Consumption of roots accounted for about 9.45%, barks for about 6.69% and remaining items such as flower and stem consumption was calculated to be 2.19 % and 1.28% respectively (Tab. 7).

Tab. 6 Names of the plants consumed and the rate of consumption by the focal troops of the langurs during 2006-2007

Sr. #	Name of plant consumed	Local Name	Type	Summer			Winter		
				Parts consumed	Average time (minute) spent in feeding/Day	Rate of consumption	Parts consumed	Average time (minute) spent in feeding/day	Rate of consumption
1	<i>Abies pindrow</i>	Rewar	tree	shoots	6.06	1.16	shoots, seeds	17.68	4.85
2	<i>Pinus wallichiana</i>	Kail	tree				shoots, seeds	13.22	3.62
3	<i>Taxus wallichiana</i>	Bermi	tree	leaves	5.23	1.00	shoots	9.91	2.72
4	<i>Picea smithiana</i>	Kachhal	tree				shoots	4.56	1.25
5	<i>Cedrus deodara</i>	Diar	tree				Seed, shoots	6.44	1.77
6	<i>Aesculus indica</i>	Bankhor	tree	buds, flowers	13.26	2.54	Buds,barks, fruit	96.07	26.34
7	<i>Prunus cornuta</i>	Parth	tree	buds, fruit	23.45	4.48	Buds	24.98	6.85
8	<i>Quercus incana</i>	Reen	tree	buds	21.36	4.09	Buds, fruit	85.99	23.58
9	<i>Grewia tenax</i>	Damanr	tree	leaves, fruits	5.41	1.03			
10	<i>Parratiopsis jacquementiana</i>	Pashoor	tree	buds, shoots	5.26	1.01			
11	<i>Diospyros lotus</i>	Amlook	tree				Fruit	3.25	0.89
12	<i>Celtis australis</i>	Batkararh	tree				Fruit	6.57	1.80
13	<i>Viburnum nervosum</i>	Guchh	shrub	buds, fruit	17.52	3.35	Buds	16.05	4.40
14	<i>Ziziphus jujube</i>	Ber	shrub				Roots	15.11	4.14
15	<i>Ziziphus nummularia</i>	Beri	shrub				Roots,buds	13.36	3.66
16	<i>Rubus</i> spp.	Garachha	shrub	leaves	6.57	1.26			
17	<i>Salix denticulata</i>	Biara	shrub	buds	13.52	2.59			
18	<i>Ribes alpestre</i>	Kag dakh	shrub	fruit	23.67	4.53			
19	<i>Elaeagnus</i> spp.	Kankoli	shrub	fruit	17.56	3.36			
20	<i>Rosa burnonii</i>	Kuruch/phl war	shrub	fruit	14.05	2.69			
21	<i>Jurinea dolomiaea</i>		shrub	roots	31.96	6.11			
22	<i>Betula utilis</i>	Burz	shrub	barks, young shoots	55.23	10.56			
23	<i>Datura stramonium</i>	Tatura	shrub	fruit	8.54	1.63			
24	<i>Indigofera linifolia</i>	Kainthi	shrub	fruit, buds	6.65	1.27			
25	<i>Vitis vinifera</i>	Dahk	shrub	fruits	4.68	0.90			
26	<i>Ziziphus mauritiana</i>	Sinjli	shrub	leaves	7.6	1.45	Roots buds	10.56	2.90
27	<i>Skimmia laureola</i>	Nera	shrub	young shoots	35.63	6.81			
28	<i>Juniperus communis</i>	Metheri	shrub	buds	28.8	5.51			
29	<i>Rosa moschata</i>	Garachha	shrub	buds, fruit	11.97	2.29			
30	<i>Berberis aristidae</i>	Sumbal	shrub	flowers, fruit	5.06	0.97			
31	<i>Impatiens edgeworthii</i>	Bantil	herb	fruit	17.37	3.32			
32	<i>Euphorbia</i> spp.	Hervi	herb	leaves, fruits	9.02	1.73			
33	<i>Solanum nigrum</i>	Kachmach	herb	fruits	7.12	1.36			

34	<i>Dryopteris stewartii</i>	Kunji	herb	roots,leaves	3.58	0.68	Roots	9.33	2.56
35	<i>Dryopteris ramose</i>	Nanoor	herb	young shoots, leaves	5.07	0.97			
36	<i>Lavatera</i> spp.	Dag sonchal	herb	fruits, leaves	3.11	0.59			
37	<i>Podophyllum emodi</i>	Ban khakhri	herb	fruits, flowers, stems	3.0	0.57			
38	<i>Bistorta</i> spp.	Maslonrh	herb	roots, flowers, roots	11.26	2.15	Roots, young leaves	4.99	1.37

(to be continued)

(continued)

Sr. #	Name of plant consumed	Local Name	Type	Summer		Winter		Rate of consumption	Rate of consumption
				Parts consumed	Average time (minute) spent in feeding/Day	Parts consumed	Average time (minute) spent in feeding/day		
40	<i>Polygonum alpinum</i>	Chukroon	herb	leaves	41.21				
41	<i>Asphodelus tenuifolius</i>	Jangli piaz	herb	flowers, leaves	3.9				
42	<i>Malva</i> spp.	Sonchal	herb	fruit	3.06				
43	<i>Cymbopogon martini</i>	Gogoon	herb				Roots	12.04	3.30
44	<i>Geranium wallichianum</i>	Ratan jog	herb				Roots	3.59	0.98
45	<i>Plantago major</i>	Chamchi Patter	herb	seeds	4.82				
46	<i>Fragaria nubicola</i>	Meva	herb	fruit	16.85				
47	<i>Phaseolus aconitifolius</i>	Moth	herb				Fruit	1.00	0.27
48	<i>Solanum tuberosum</i>	Aloo	herb				Stem	2.04	0.56
49	<i>Polygonum</i> spp.	Masloonr	herb				Roots	5.32	1.46

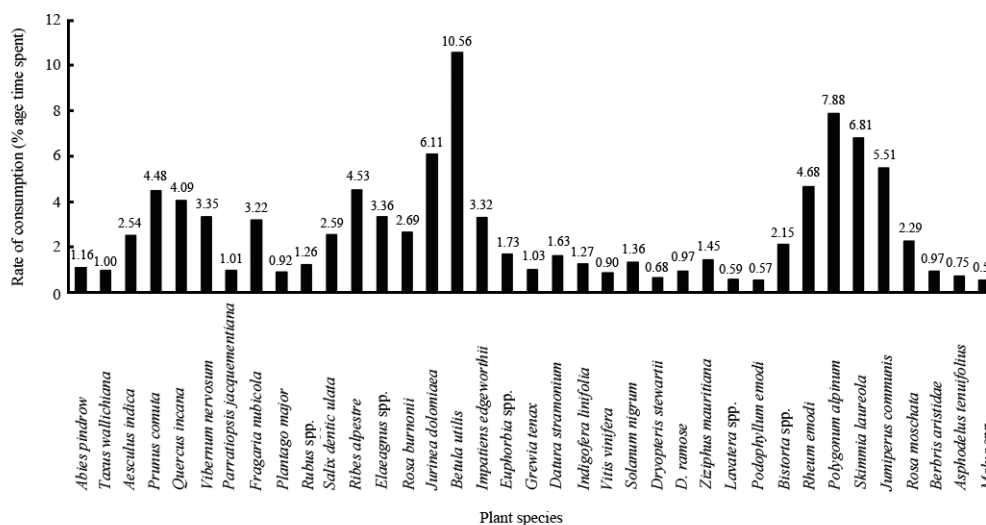


Fig. 4 Rate of consumption (% age time spent) for different plant species by langurs in MNP during summer 2006-2007

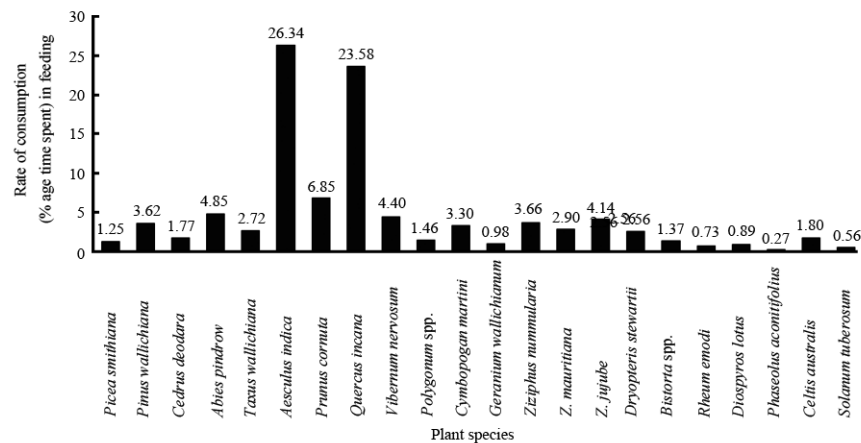


Fig. 5 Rate of consumption (% age time spent) for different plant species by langurs in MNP during winter 2006-2007

Tab. 7 Percentage time spent in different plant parts used by langurs in MNP during the year 2006-2007

Mature leaves	36.12
Young leaves, shoots, buds	27.27
Fruits	17.00
Flowers	2.19
Stem	1.28
Bark	6.69
Roots	9.45

3 Discussion

3.1 Habitat utilization

The langurs are forest dwelling animals, ecologically adaptable to a variety of habitats, including quite dry savannah as well as tropical rain forests. This is an arboreal and diurnal species. In the study area, they are distributed in moist and dry coniferous forests mixed with deciduous trees and subalpine scrubs between 1700-4000 m asl. Nowak (1999), Hilton and Taylor (2000) and Roberts (1997) also reported that the species inhabited between 2200-4000 m asl in the subtropical, tropical moist temperate, alpine, coniferous, broadleaved forests, including scrublands.

3.2 Food and feeding behaviour

The contemplation for food and feeding behaviour is essential for the understanding of a species and its ecological adaptation to the environment. Like the other animals the search of food is a crucial part of the langur's lives as they are vital for the maintenance and reproduction of the animals.

Grey Langurs are mainly classified as folivorous species, as they have sacculated stomachs, specialized

for the digestion of leaves (Amerasinghe et al, 1971). They have been observed feeding mainly on the leaves and other parts of the plants in the study area. Roberts (1997) stated that langurs are exclusively herbivorous, feeding mainly on young leaf buds, shoots and other vegetations but observations in the open scrub forests of Jodhpur reveal that the insects may also constitute a regular part of their diet and that insectivory is particularly prevalent in the monsoon months of July-September (Srivastava, 1991). Thus, most of the studies suggest that the classification of langurs as folivorous species seems to be a narrow concept because langurs may consume many types of provisioned food in various habitats in India (Rajpurohit, 2005).

Present study showed that about 49 plant species were consumed by the langurs during the study period. In many previous studies at various habitats they are reported to consume 36-87 species (Rahman, 1973; Starin, 1973; Yoshiba, 1967; Ripley, 1970; Haldik & Haldik, 1972; Mohnot, 1974).

It has been observed during the present study that the langurs ingest 36.12 % mature leaves, 27.27 % young leaves, 17.00 % fruits, 2.19 % flowers, 1.28 % stems and 9.45 % bark of the plants. Rajpurohit (2005) observed during one year an average of 6 % leaves, 23 % fruits and 7 % flowers. Among the leaves, about two thirds (38.5 %) of total feeding time were devoted to mature leaves and about 27.5 % on young leaves. Similarly, the average yearly diet of langurs reported by Rahman (1973) consisted of 85.4 % leaves. Yoshiba (1967) observed that langurs spent 94.6 % of their feeding time on leaves, 1.7 % on fruits and 1.2 % on flowers. In other studies by Ripley (1970), Haldik and Haldik (1972), the langurs consumed about 71.9-83.7 % of leaves, 7.9-12.5 % of

fruits and 7.9-6.8 % of flowers. Stanford (1991) reported that Capped langurs (*Presbytis pileata*) in Madhupur National Park in north-central Bangladesh also consumed 42 % mature leaves of their annual diet. Thus from the above studies it can be concluded that the langurs almost consumed more leaves (about 85 %) and are exclusively herbivorous. This large amount of leaves consumed by the langurs is due to several physiological and behavioural adaptations. This helps them to survive on their relatively un-nutritional diet through most of the day and gain energy by steady foraging for long periods of time that involves little movement (Rajpurohit, 2005). Similarly flowers are particularly important source of food during flowering seasons which may also aid animals through a vulnerable stage of life (Daubenmire, 1971).

During the present study langurs were observed consuming insects in several episodes. Moore (1985) has also reported that langurs preyed and consumed insect pupae and eggs of birds during several observations. He concluded that the insect-eating by langurs was best explained by an energy/nutrient maximization model,

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rather than as a consequence of any special characteristic of meat itself. Insectivory in langurs is also reported by Srivastava (1991) and Rajpurohit (2005) in the Jodhpur langur population.

4 Conclusions

In Machiara National Park, langurs mostly inhabit in the moist temperate coniferous forests mixed with deciduous trees. The langurs are folivorous animals and during the study they were observed consuming more than 49 plant species. Of those *Betula utilis*, *Polygonum alpinum*, *Skimmia laureola*, *Juniperus communis*, *Rheum emodi*, *Ribes alpestre*, *Quercus incana*, *Jurinea dolomiaea* and *Prunus cornuta* constitute the major share of langur's diet in summer while *Aesculus indica*, *Quercus incana*, *Prunus cornuta*, *Abies pindrow*, *Viburnum nervosum* and *Ziziphus jujube* during winter. In Machiara National Park, langurs preferred mature leaves as compared to the other parts of the plants and the availability of the food plant is sufficient for the existing langur population in the area.

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