Effects of sterilization on social organization and behaviour of free-ranging rhesus macaque (*Macaca mulatta*)

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CERTIFICATE

This is to certify that **Ms. Abhilasha S. Fulzele** of Sálim Ali Centre for Ornithology and Natural History (SACON) has carried out an original research work titled, '**Effects of sterilization on social organization and behaviour of free-ranging rhesus macaque (*Macaca mulatta*)**' in partial fulfilment of the M.Sc. (Ornithology & Conservation Biology) degree of Saurashtra University, Rajkot. This investigation was carried out under my supervision from December 2019 to August 2020. I also certify that this research work has not been submitted for any other degree to any university.

Date: 27th August, 2020
Place: Coimbatore

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SUMMARY

Non-human primates are frequently at conflict with humans due to their adaptability towards human-modified environments. Rhesus macaques (*Macaca mulatta*) co-occur with humans throughout the North and Central parts of India. In the past two decades, there has been a significant increase in the intolerance towards macaques as they are continuously forced to share space with humans. Using birth control to limit population growth is believed to be an ethical alternative to culling. Hence, owing to the human-macaque conflict in Himachal Pradesh, the State Government and Forest Department of the state initiated the 'Monkey Sterilization Programme'. The study was conducted to understand and assess the consequences of long-term sterilization on the macaques' social organization and in turn, on their behavior. Field work for sampling was carried out from December 2019 to March 2020. To address the set objectives, a 12-day survey was pursued within a radius of 31 km of a Monkey Sterilization Centre at Una, Himachal Pradesh, to understand the social organization of rhesus macaques in the study area. An ethological study was carried out with a group of 21 individuals of rhesus macaque to understand their behavior. The results indicate that the mean group size of rhesus macaque in Una was $12.27 \pm 10.24_{SD}$, is relatively smaller when compared to other sites e.g., North India (41.9), Central India (41.9), Bangladesh (urban) (41.3) and Bangladesh (rural) (30.2), where there was no sterilization of individuals done. Also, the size of the group in the population was much smaller (~51% of groups). The result also signifies that the number of females in the population was more but immatures were in less numbers, and less immature ratio (1:0.6) to the adults indeed a result of successful sterilisation program executed by the Himachal Pradesh Forest Department. The significant variation in all the age-sex ratios observed between the groups indicates the destabilised grouping of rhesus macaque in the study area. The results of the behavior study indicate that the pattern of time spent by the study group was on par with time activity patterns at various locations as observed at Bangladesh and Cayo Santiago. Social network analysis reveals that the pattern of grooming observed, it can be deduced that there is a stability in the group and familiarity between the individuals within the group. However, comparative data on the control population without any sterilised individuals and have relatively unaltered population is essential to substantiate these findings. This alternative of sterilization can eventuate in a humane (than the option of culling) process to regulate the population of rhesus macaque in Himachal Pradesh.

INTRODUCTION

1.1. BACKGROUND

There has been a substantial antipathy towards wild animals universally due to the ever-increasing conflict between humans and wildlife (Dickman, 2012). Amongst them non-human primates are frequently at conflict with humans due to their adaptability towards human-modified environments (Dickman, 2012).

There are a multitude of reasons that drive human-primate conflicts. Drivers of human primate conflicts include economic costs, such as damage due to crop raiding and livestock depredation (Dickman, 2012). Physical visibility due to large body size or group size contributes significantly toward conflict. Likewise, cultural visibility due to 'hyperawareness' of potential risks posed by the remarkable presence of the species also acts as drivers (Dickman, 2010). Economic conditions of a particular landscape may lead to human-wildlife conflicts as poverty can lead to 'compounding vulnerability' (Naughton-Treves, 1997; Dickman, 2012). Cultural norms and expectations can reduce antagonism and act as drivers of conflicts in different parts of the world (Dickman, 2012). Occasionally, social tensions such as economic disparity among the rural and urban populations aggravate conflict with the primates (Naughton-Treves & Treves, 2005; Dickman, 2012). Also, individuals frequently dread animals due to an overstated interpretation of endangerment (Dickman, 2012). Often conflicts are also intensified due to lack of knowledge about species ecology (Dickman, 2012). Anthropomorphism of primates can also act as a driver of conflicts (Dickman, 2012). Conflict mitigation measures undertaken in the wake of above-mentioned domains can be short-term methods that involve traditional deterrents and disturbances, whereas measures such as electric fencing, land use planning, research, and community conservation can be long-term methods (Hockings, 2007). Due to the complex and divergent conflicts between humans and non-human primates, it is obligatory to act on these conflicts at disparate temporal and spatial scales. The acumen and flexibility of some primates can make traditional and sophisticated disturbance devices unsuccessful in the long-term in mitigating the conflict (Jones-Engel *et al*, 2011).

The genus *Macaca* constitutes about 23 species of Old-World monkeys (Fooden, 1976). They belong to the sub-family Cercopithecinae (Gray, 1821). Macaques have the greatest geographical distribution of all non-human primates, across Asia, Southern Europe, and North Africa. They are peculiarly successful at exploiting various environs where they can be commensal or conflicting (Dickman, 2012).

Rhesus macaques (*Macaca mulatta*) are the most expansive species among macaques and show a strong propensity to be commensal with humans (Priston & McLennan, 2013). Nevertheless, in numerous regards, it is a classic ‘weed’ species (Richard *et al*, 1989). Thus, rhesus macaque is placed under the ‘Least Concern’ category in IUCN Red-list (Singh *et al.,* 2020).

Rhesus macaques have adapted to live in temples, at roadsides and canals, in parks, railway stations, university campuses, in villages, towns, and cities (Devi & Saikia, 2008; Imam & Yahya, 2002; Mathur & Manohar, 1990; Medhi *et al.*, 2007; Southwick *et al.*, 1961, 2005). Under the Indian Wildlife Protection Act, 1972, rhesus macaques are placed in ‘Schedule II (part I)’ (Anon, 2007). Southwick and Siddiqi (1988) showed a decline of rhesus macaque population of North Central India over a period of 28 years from 1959 to 1986. They assigned the genesis of this decline to the increasing agricultural pressure, loss of macaque habitat, less protection for rhesus macaques and a striking level of trappings for export for biomedical research. In the late 1970s, when the green revolution in India was at its peak, agricultural production escalated. Therefore, the rhesus macaque population began to flourish. This became more prominent after 1978 when India laid an embargo on the export of rhesus macaque. The study showed that in 1985-1986 there was a 53% recovery in the number of rhesus groups, and a 129% recovery in total macaques from their low points in 1977-1978 (Southwick & Siddiqi, 1988). Southwick *et al.* (2005) indicated that India’s rhesus population showed signs of recovery which started posing significant implications towards their conflict with humans. This was aggravated by the augmentation of agriculture and deforestation leading to loss of habitat for rhesus macaques (Southwick & Siddiqi, 2011).

In India, macaques are believed to be the representatives of ‘Lord Hanuman’ and are worshipped, protected and provisioned by the people. However, Saraswat *et al.* (2015) documented the development of intolerance towards rhesus macaque in the last two decades. The study also highlighted ambiguity in people’s attitudes, despite the religious significance of the species. Several mitigation strategies such as translocations, monetary compensations for crop damage by rhesus macaques, and so forth have been adapted by the forest departments of several states in India. Himachal Pradesh adopted a distinctive way of conflict mitigation measures.

1.2. RATIONALE OF THE STUDY

Himachal Pradesh is a northern Indian state in the Himalayas. Rhesus macaques occupy a range of habitats from forests of lower altitude to as high as 3000 m asl also in the state (Bishop *et al.,* 1981). Rhesus macaques can be largely found in the central, eastern, and western regions of the state of Himachal Pradesh, but are uncommon in the northern divisions (Singh *et al.,* 2016). The human-macaque conflict in the state is almost a century old (Rattan, 2011). The annual economic loss in the year 2003-2004 was estimated to be $50 million USD in the state (Rattan, 2011).

The first known population estimation of rhesus macaques in Himachal Pradesh was done in 1977 by the Zoological Survey of India. The later estimated population was 19,500 macaques (Southwick & Lindberg, 1986). In 1980 the forest rhesus macaque population was reported to be between 60,000 and 70,000 for the entire state of Himachal Pradesh (Dolhinow & Lindburg 1980). After almost a decade, Pirta *et al.,* (1997) reported an estimate of 2,05,274 macaques. In 2004, Himachal Pradesh Forest Department carried out a state-level and estimated the population to be around 3,17,512 individuals following the total count method. The 2013 census, done by the forest department which gives an estimate of 2,26,086 individuals. The population estimate of rhesus macaque in Himachal Pradesh was 2,07,614 individuals in 2015 (Singh *et al.,* 2016).

Increased intolerance and ambiguity in religious beliefs of the people of Himachal Pradesh has been observed in past two decades due to various conflict issues such as crop-raiding, stealing, snatching, and mobbing of humans by these animals (Chauhan & Pirta, 2010). Owing to the human-macaque conflict, the State Government and Forest Department of Himachal Pradesh initiated the 'Monkey Sterilization Program'. Under the program, Monkey Sterilization Centers (MSC) were established in Himachal Pradesh in 2006. They have eight fully functioning centers across the state. Males are geld via thermo-cauteric coagulative vasectomy. Females are tubectomised via endoscopic thermo-cauteric tubectomy. The total number of individuals sterilized until 2018 was 1,40,882 individuals (Source: Himachal Pradesh Forest Department). The population trend in rhesus macaque has since shown a decline (Singh *et al.,* 2016). The sterilization program has been running for more than a decade, yet, the long-term implications of the program on the species' social organization and in turn on their social behavior are poorly understood.

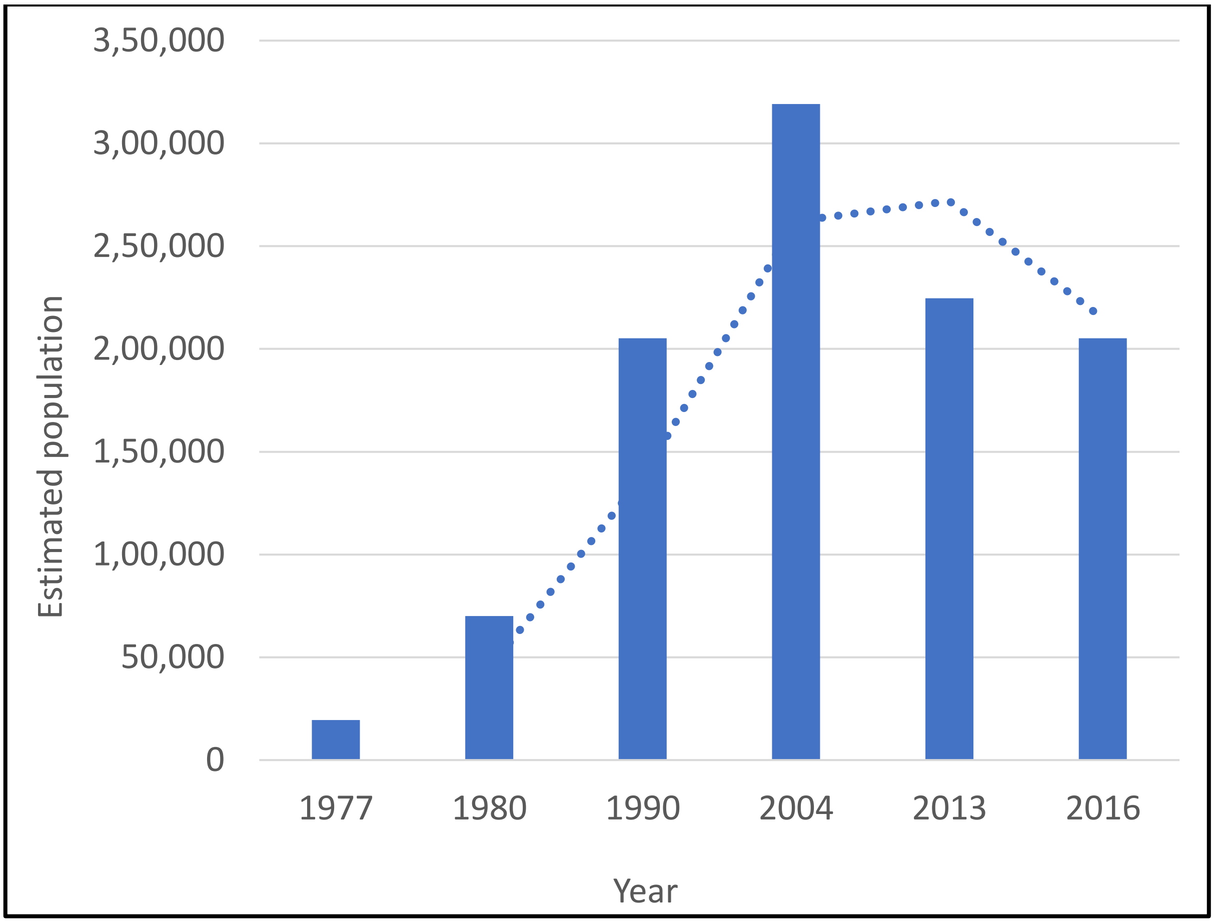


Figure 1. The population trend of rhesus macaque (*Macaca mulatta*) in Himachal Pradesh between 1977 and 2016.

Large scale sterilization and to some extent translocations of rhesus macaque in Himachal Pradesh gave an opportunity to study various aspects of their population and behavioral ecology. Studying their social organization and social behavior wherein they are subjected to sterilization would help in testing the efficacy of the program, thus, the present study was taken up with the following hypothesis.

1.3. RESEARCH HYPOTHESIS

Hypothesis I: Sterilization of adults and release of individuals in distorted age-sex ratios may lead to altered ratios in the population leading to a greater number of mature individuals than immature ones. In other circumstances, the sterilization may not be mediating population control of the species.

Hypothesis II: Skewed group composition may influence the activity pattern and social behavior of rhesus macaques. Contrastingly, group composition may not influence the activity pattern or behavior.

The above-mentioned hypothesis was tested by answering the question: How does sterilization affect the social organization and their behaviour of free-ranging rhesus macaque?

To answer the aforementioned question the following objectives were undertaken and worked upon.

1.4. OBJECTIVES

1. Study the social organization of population of rhesus macaques having sterilized individuals.

2. Study the behavior of a social group of rhesus macaque from the sterilised population.

Study period: December 2019 to March 2020

1.5. REVIEW OF LITERATURE

1.5.1. Social Organisation

The role of group size and composition on behavior in social systems is indubitable. Furthermore, the role of density and large groups, increased life expectancy, overlapping reproductive periods, male-female composition, small-sample fluctuations and dispersal are crucial in defining behavioral activities in social animals (Altmann & Altmann, 1979). It has been observed in primates housed in unnatural social groups that they display anomalous behaviors such as self-mutilation, self-clasping, masturbation, re-ingestion, regurgitation, coprophagy (eating of faeces), stereotypic pacing and an inability to breed (Mallapur, 2008). In Japanese macaques (*Macaca fuscata*) it has been reported that when there is mate scarcity, the females fiercely compete, and high-ranking females are often more successful in mating than sub-ordinate females (Rendall & Taylor, 1991). In the same study, the lowest ranking female who was the male's long-term grooming partner was rarely preferred as a mate and was observed to exhibit auto-erotic stimulation and homosexual behaviors that were attributed to the dominant female's monopolization of the male (Rendall & Taylor, 1991). Differences in behavior due to skewed sex-ratios have been observed in commensal Olive baboons (*Papio Anubis*) in Africa where 50% of the dominant males died due to tuberculosis which led the remaining subordinate males to groom one another (Sapolsky & Share, 2004). Multiple studies in captivity and in the field suggest that the degree at which macaque mothers encourage independence in their infants and tolerate their interaction with others depends on the presence or absence of particular classes of individuals (Berman, 1980; Holley & Simpson, 1981; Fairbanks & McGuire, 1987; Silk 1991).

1.5.2. Social behavior

Social behavior of the rhesus macaque groups play a major role in the survival and fitness of an individual (Krebs & Davies, 2009). In 1975, Clancy and McBride in their study on "The Isolation Syndrome in Childhood" put forth a novel diagnostic category for human children to describe "a pattern of behavior which occurs when children are in certain situations or have certain primary disorders such as separation of mother and child, the deprivation syndrome, mental deficiency and infantile autism". The isolation syndrome has also been observed in anthropoid primates. Several studies on laboratory-raised rhesus macaques indicate that complete social isolation during infancy impairs behavioral development (Harlow & Harlow, 1966; Sackett & Ruppenthal, 1976). Sackett (1973) mentions four points to describe 'isolation syndrome' in rhesus macaques as follows, (a) deviant personal behaviors such as body rocking, self-clutching, bizarre postures, repetitive stereotyped locomotion, and self-directed aggression; (b) low levels of exploration, and withdrawal from a novel or complex inanimate stimulation; (c) almost total absence of social interaction; and (d) abnormal adult sexual and maternal behavior. These characteristics were found in rhesus macaques reared in social isolation, separated from the mother and other groups members. "Stereotypy is associated with a state of cognitive inflexibility and social and sensory isolation in humans and monkeys" (Ridley & Baker, 1982). It can be regarded as an outcome of negligence to utilize sensory input to regulate behavior (Ridley & Baker, 1982). One of the most common stereotypic behaviors in macaques is self-injury. In laboratory rhesus macaques caged in isolation, the occurrence of self-biting can be as high as 14% (Jorgensen *et al.,* 1998). This "behavioral pathology" (Erwin, 1979) can be recognized by observing macaques that frequently bite their own body parts and show signs of severe excitation such as threatening, trembling, head jerking, and piloerection (Reinhardt, 1999; Tinklepaugh, 1928). It is possible that the modification of the normal conceptive stages (cycling-gestating-lactating) and the prolonged absence of new offspring could potentially affect the behavior and social dynamics of females on a long-term basis in the sterilized population (Coleman *et al.,* 2011).

1.5.3. Translocations

Translocation can be defined as the release in a new location of one or more free-ranging animals that come from anywhere other than the place in which they are released. There are certain dangers associated with translocation for the animals such as the increased risk of mortality due to injuries sustained during capture, disease and psychological stress leading to depressed immune functions (Jones & Finn, 1999). Aguilar-Cucurachi *et al.*, (2010) found that there is an increase in fecal corticosterone during translocations. They also reported that females showed higher levels of corticosterone than males throughout. Their findings provide preliminary evidence for physiological stress in Mantled Howlers (*Alouatta palliata*) during translocation which may have implications for decisions concerning translocations for other primate species. Stress may result in lower disease resistance and lead to the production of unhealthy individuals in an otherwise healthy population (Caldecott & Kavanagh, 1983). Like in the case of most places in Himachal Pradesh, if the species that is to be translocated is already present in the releasing environment then it may have effects on the carrying capacity of the area and pose a very real threat of creating ecological imbalance. Another ramification of translocation can be the elimination of other species, for instance, avifauna, as some primates including rhesus macaques, may predate on eggs or nestlings (Caldecott & Kavanagh, 1983). In over-populated places like India, where the primary occupation is agriculture, translocations of conflict species only shifts the problem, does not solve it.

2. STUDY AREA

I selected Una, a district in Himachal Pradesh as it has one of the oldest sterilization centres and has contributed in the sterilization of a large number of macaques (Fig. 2). The density of macaques was 0.34 with an average group size of 31 individuals in the study area (Singh *et al.,* 2016).

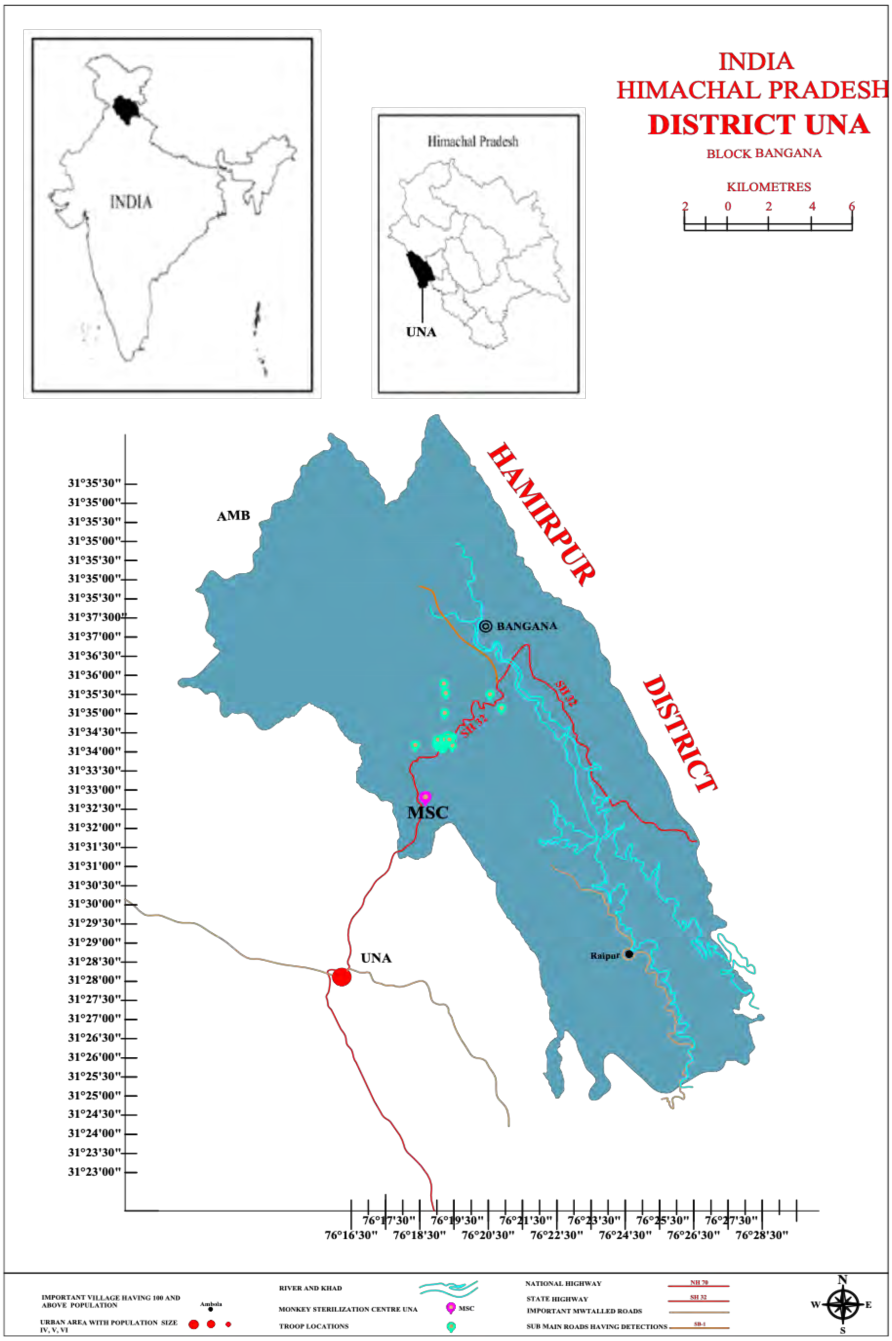


Figure 2: The location of Una district, Himachal Pradesh, and location of study group of rhesus macaque

Una lies in the South-Western side of Himachal Pradesh at an altitude of 350 m to 1200 m (Fig. 3). The average annual temperature was 23.6°C and the annual precipitation was ~1100 mm. Una district extends up to 1540 km^2 with a forest area of 185 Km^2, the cultivated area of 430 km^2, barren and uncultivable land of 226.7 km^2(Government of Himachal Pradesh; https://hpuna.nic.in/). Swan is the major river flowing through Una. Monkey Sterilization Centre, Boul (Latitude: 31°32′43″N, Longitude: 76°18′28″E) located within the Una district. Situated at the foothills of Shivaliks, Una has a variety of Conifers such as *Pinus wallichina*, *Pinus roxburghii* and *Cedrus deoda*`.

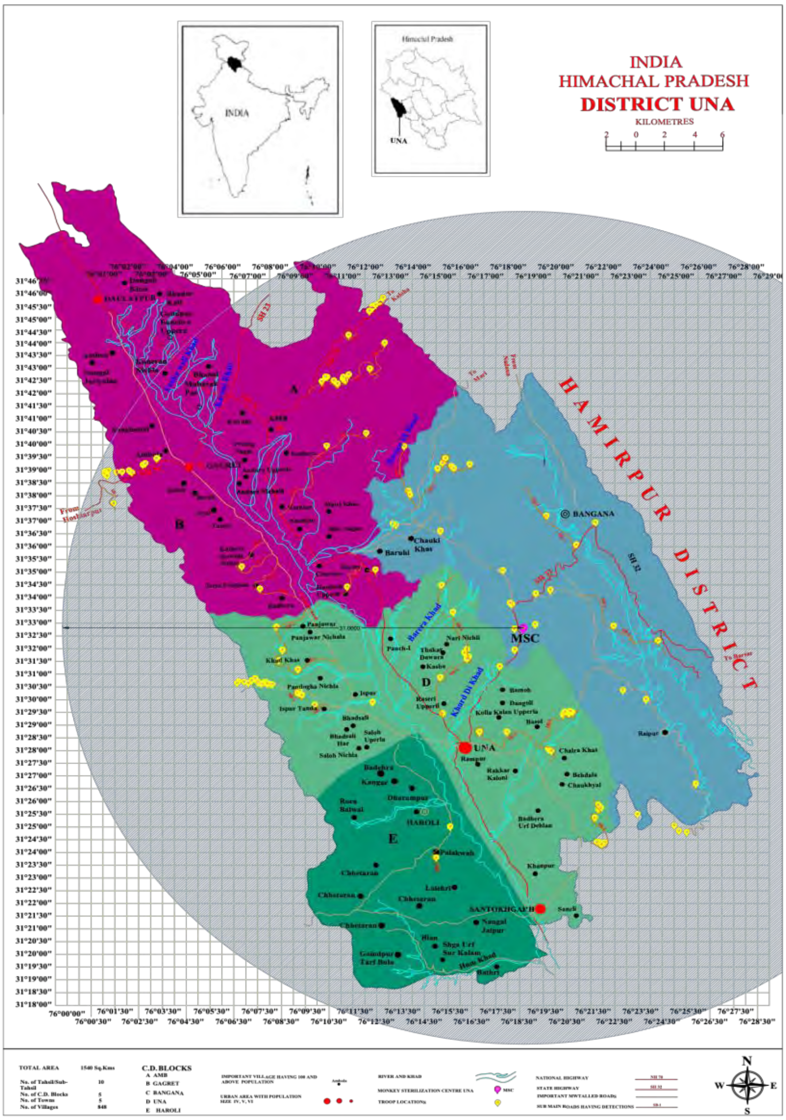


Figure 3: The area surveyed for the rhesus macaque in the district of Una, Himachal Pradesh

3. FIELD AND ANALYTICAL METHODS

3.1 SOCIAL ORGANIZATION OF RHESUS MACAQUES:

The Monkey Sterilization Centre at Boul, Una was selected as the center location of the study. As I came to know from the forest department that macaques within 50 to 70 km radius from each sterilisation centre were attempted to capture and sterilise. Thus, an area of about 31 km radius from the Monkey Sterilization Center at Boul was considered as the study site to assess the social organisation of the macaques. I considered 29 roads including National Highways, State Highways, important metal roads, and kuccha roads, which were pooled and considered under six road sectors for sampling. I used all existing roads and trails within this area and collected the data on social organization of all the detected rhesus macaques.

The data on the social organization of rhesus macaque was collected for 12 days. The trails/ roads were covered by a moped between 0700 and 1800 hrs between December 2019 and January 2020. During the survey, once the macaque was detected, the data on geocoordinates of the location and age-sex of the individuals were recorded. I considered the detections within 500 m as the same group and more than 500 m as separate groups. Further, if the survey was done on the first day, then on consecutive days, any individual/group located beyond 500 m of the first group was identified as a separate group. The road length of each route was measured using Google Earth Pro 7.3.

3.2 ACTIVITY PATTERN AND SOCIAL BEHAVIOR:

Using the information from data on social organization, one group with a few sterilized individuals was selected, which was located about 10 km from Una. The group was located in the small patch of forest but having a winding road and adjoining to Gowshala (protective shelters for cows). The group is partially provisioned on roadsides and also often visits the Gowshala. The study group comprised of 2 adult males (A, CK), 15 adult females (SB, TW, EA, ASAB, BILLI, OC, CH2, KKF, KKCM, KDCM, DP, KB, LB, TPC, KUB), 2 sub-adult males (LANG, KKM), one female juvenile (JUV), and one female infant (INF). Each individual was identified based on natural markings and distinctive morphology. The data on these individuals were collected From January to March 2020. The data on activity was collected using scan and behaviour was collected using focal animal sampling (Altmann, 1974). The group was followed from 0600 hrs to 1800 hrs. During the observations of the group, scan sampling was done for 5 minutes at an interval of 30 minutes. Focal animal sampling was done between the two-scan periods.

3.2.1 Activity pattern using scan sampling (Altmann, 1974)

During the scan period, all visible individuals were scanned and their activities were recorded. For each scan, time, individual ID, age-sex, substrate, and activity of the individual were recorded (Table 1).

Table 1. Ethogram for scan sampling and description of substrate used by the study group

BEHAVIOR	**CODE**	**DESCRIPTION**
Resting	RE	Focus animal is asleep or is not engaging in other behaviors or has eyes closed and appears to be asleep.
Movement	MO	Moving from one place to another. e.g., running, jumping, hopping.
Feeding	FE	Food and water consumption.
Foraging	FO	Search widely for food or provisions. Touching, playing with, moving, licking, biting etc. an object.
Agonistic interactions	AG	Include, attack (ATT), dominant mount (DM) and threat (THR).
Groom	GR	Animal is grooming another or the animal is being groomed.
Other social activities	SOC	Include play (PL), vigilance (VIG) and huddle (HUD).
SUBSTRATE	**CODE**	**DESCRIPTION**
Vegetation	VEG	Trees, stumps and shrubs.
Ground	G	Ground and rock.
Cliff	CL	Cliffs, hills and hillocks.
Construction	CON	Bridge (BR), building (BU), platform (PF), pole, wall, tin shades (TIN)

If they are feeding then food item, and if they are in social interaction then the type of interaction with the ID of the other individual was recorded using the scan sheet. The geocoordinates of the group location were recorded for every 30 min. The visual estimation of the spatial distance between two individuals on two diagonal directions in a group was recorded for every 30 minutes.

3.2.2 Social behavior using focal animal sampling (Altmann, 1974)

The selected individual in the group was followed for 5 minutes and the data on assorted behavior was recorded using the focal animal sampling. The individuals were sorted for the data collection to cover even data on all the individuals and also representing all the time slabs of the day. During this, the time spent on each behavior was recorded (Table 2). The precaution was taken such that two successive individuals will differ in their age or sex to avoid immediate resampling of the same individual. Dyadic interactions if any, amongst individuals were recorded with an individual's identity. Interactions of a focal animal with humans were noted.

Table 2. Ethogram for macaque activity and behaviour considered for recording during the focal animal sampling

BEHAVIOR	CODE	DESCRIPTION
Grooming	GR	Grooming Focus animal is grooming another.
Groomed	GRD	Focus animal is being groomed
Feeding	FE	Searching for food, eating food.
Explore	EXP	Touching, picking, mouthing, biting or visually examining physical elements of the environment in a non-ritualized manner.
Play	PL	Non-aggressive, non-maintenance affiliative interaction with cohorts may include mouthing, chasing, tumbling, wrestling etc.
Locomotion	LOCO	Movement from one place to another. e.g., running, jumping, hopping.
Rest	RE	Focus animal is asleep or is not engaging in other behaviors or has eyes closed and appears to be asleep.
Threat	THR	Open mouth threatening.
Attack	ATT	aggressive behavior in which a forceful assault is made.
Manipulation	MAN	Touching, playing with, moving, licking, biting etc. an object.
Dominant mount	DM	Sexual mount where the animal holds the top position.
Submissive mount	SM	Sexual mount where the animal holds the bottom position.
Vigilance	VIG	Focus animal is looking up, down, to the side, with or without head movement.
Huddle	HUD	Crowd together; nestle closely.
Cradle	CR	Hold gently and protectively
Contact with Infant	CI	Focus animal, which may be the mother or another individual, inspecting, playing with, grooming, nursing, hugging etc. an infant
Suckling	SKL	Feed from the breast or teat or feed by sucking the breast or teat.
Stereotypic behaviour	SB	Self-biting, Pacing, rocking, pulling out hair, head tossing, saluting, eye rubbing etc.

The selected group of rhesus macaque was followed for 25 days and collected 2222 scan samples and 629 focal samples (Table 3).

Table 3. Number of scan samples and focal samples on individuals of the study group

ANIMAL	AGE-SEX OF THE ANIMAL	SCAN	FOCAL
A	AM	140	41
ASAB	AF	121	26
BILLI	AF	87	22
CH2	AF	113	31
CK	AM	77	31
DP	AF	110	36
EA	AF	141	20
INF	INF	146	24
JUVI	JUV	139	34
KB	AF	122	30
KDCM	AF	109	33
KKCM	AF	120	33
KKF	AF	88	25
KKM	SAM	20	8
KUB	AF	132	39
LANG	SAM	65	35
LB	AF	76	34
OC	AF	111	35
SB	AF	77	27
TPC	AF	112	31
TW	AF	116	35
		2222	**629**

3.4 DATA ANALYSIS

I considered every road sector as independent transect, and pooled all independent detections. I calculated the number of groups and total individuals encountered per km. I considered different group size classes and counted the number of detections with specified group size class and plotted to check the group size distribution pattern. I provided different age-sex individuals for each road sectors. I calculated the age-sex ratios as number of females per adult male, number of immatures (sum of sub-adults, juveniles and infants) per adult (sum of adult males and females), and number of immatures per adult female for each detection of macaque. I tested the variability of ratios across the detections or groups using student's 't' test (Zar, 1999) in the SPSS statistical software (SPSS, 2011). I tested the relationship between the age, sex individuals, and group size using person correlation also using SPSS statistical software (SPSS, 2011).

I plotted the data from scan samples against time and individual activities. I calculated percent activities from the frequencies against the time in Microsoft Excel 2016. I compared the percent time spent on different activities by the group using chi-square test (Zar, 1999) to project the overall activity pattern using IBM SPSS 21. The pattern of percent time spent on different activities by the macaque at different timings of the day was done using Friedman test. The Friedman test is a non-parametric statistical test used here to detect differences in treatments across multiple test attempts. I also tested the pattern of time spent on different activities across the different timings of the day using tests for proportions. Using the focal animal sample data, the percent time spent on assorted (grooming) behaviour was calculated between the individuals using Microsoft Excel 2016.

Social network analysis is defined as the process of investigating social structures through the use of networks and graphs (Otte *et al*., 2002). Social network analysis is used to understand information about direct relationships, it aids in determining individual patterns with respect to the individual as well as group characteristics. Its strength lies in standardizing mathematical methods for calculating metrices of sociality across levels (Makagon *et al.,* 2012). To visualize the distribution of grooming activity in the current study group, I performed a social network analysis of allogrooming using UCINET version 6 (Borgatti *et al*., 2002) software and calculated the following measures:

Degree Centrality: It can be defined as the structural measure of network activity. The patterns of relations in a group can be studied by social network analysis (Fleisher, 2006). There will be a balance between grooming and being groomed (Fleisher, 2006). Nodes are measured in terms of degree or nodes that are connected to it. An indegree is the number of nodes adjacent to a node whereas outdegree is the number of nodes adjacent from it (Fleisher, 2006). In the current study, indegree is the number of grooms received by a focal animal while on the contrary outdegree is the number of grooms given by a focal animal. Using the normalized values for indegree (nIndegree) and outdegree (nOutdegree), the graph was plotted. Normalization was done for comparability of the in- and out-degree values. To assess whether the amount of grooming received (nOutdegree) was related to grooming given (nIndegree), I performed a Pearson's correlations test for each sex class in adults (Zar, 1999).

Eigenvector centrality is used to evaluate the influence of a node in a social network. In other words, it shows the influence of each individual in the group structure. In the current study, eigenvector centrality was used to determine the impact of an individual on the general grooming pattern in the study group. Based on these values, the sociogram was created using UCINET 6 NetDraw version 2.170 (Borgatti 2002).

4. RESULTS

4.1 SOCIAL ORGANIZATION OF RHESUS MACAQUES

A total of 111 detections of rhesus macaque consisting of 1362 individuals on 275.06 km around Una was recorded. The mean group size was $12.27 \pm 10.24_{SD}$. The average number of detections (groups) and individuals encountered was 0.64 and 10.55 per km respectively (Table 4). Of the 111 detections of the rhesus macaque, 51.4 % of the detections had less than 10 individuals in the group, 33.3% of them had group size between 11 and 20, 15.3% of the groups had more than 20 individuals (Fig. 4).

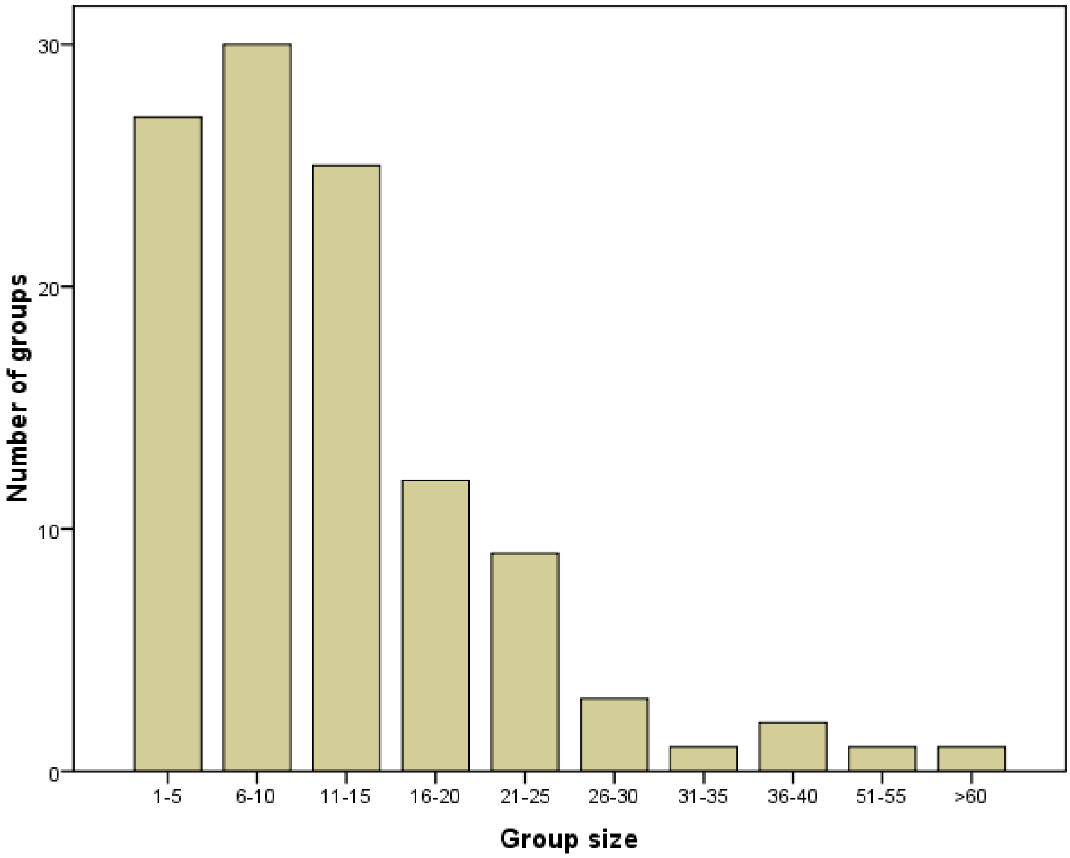


Figure 4. Number of rhesus macaque groups in different group size classes in Una, Himachal Pradesh

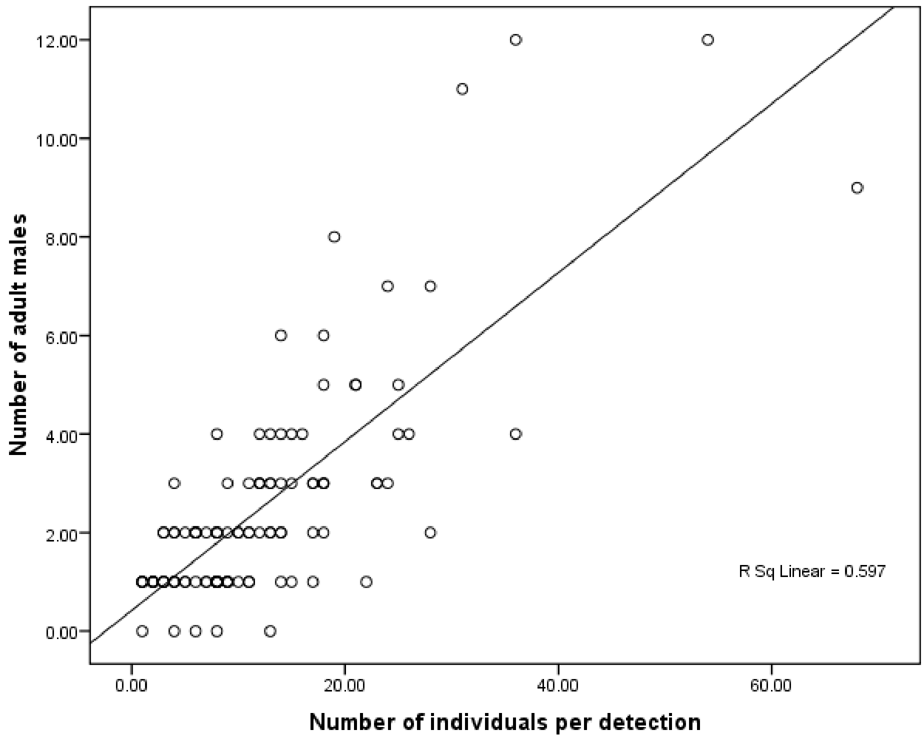
The recorded 1362 individuals included 280 adult males with an average of $9.66 \pm 12.45_{SD}$ males per group, 658 adult females with an average of $22.69 \pm 24.36_{SD}$ females per group, 90 sub-adult males with an average $03.46 \pm 4.93_{SD}$ per group, 153 juveniles with an average of $5.28 \pm 9.55_{SD}$ juveniles per group and 181 infants with an average of $06.24 \pm 7.55_{SD}$ infants per group. Percentage of adults (total adult males (20.56%) and adult females (48.31%)) was 68.87% and percentage of immatures (total sub-adult males, juveniles, and infants) was 31.13%.

Table 4. The social organization of rhesus macaque groups within 31 km radius from the MSC with each row representing the data of each road. (AM : adult male ; AF : adult female ; SAM : sub adult male ; JUV : juvenile ; INF : infant)

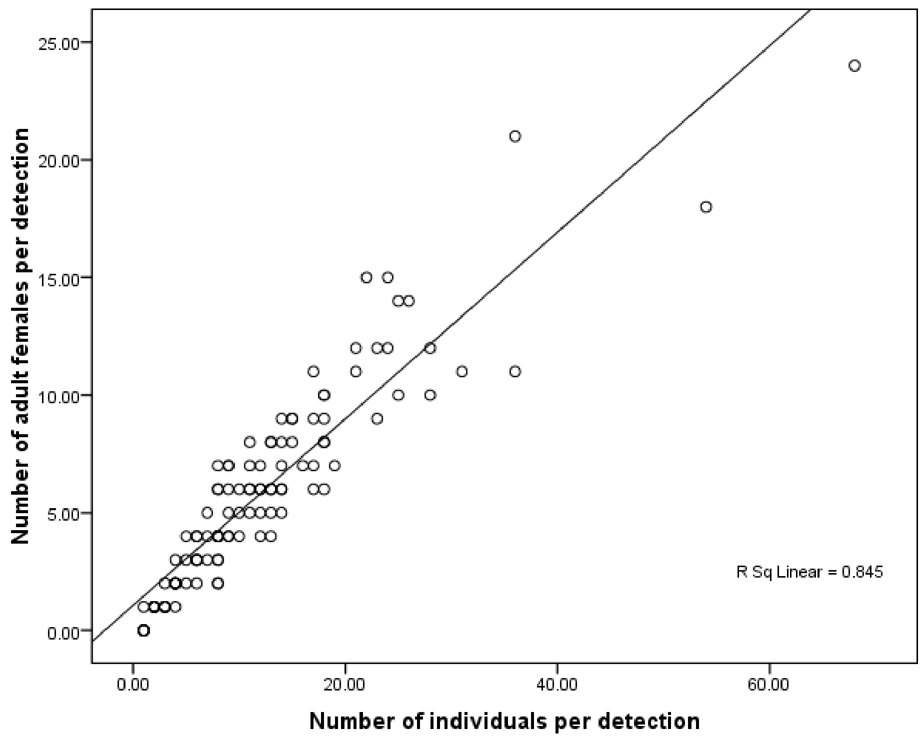
NO.	SECTOR NAME	ROAD NAME	ROAD LENGTH (IN KMS)	NO. OF DETECTIONS (DETECTIONS/ KM)	NO. OF INDIVIDUALS (INDIVIDUALS/ KM)	AM	AF	SAM	JUV	INF
1	SH25-A Santokhgarh to Una	Una-Jaijon	21.74	1 (0.05)	7 (0.32)	2	5	0	0	0
		Una-Jaijon sub main (Palakwah)	1	1 (1)	3 (3.00)	2	1	0	0	0
2	West of SH25-B Una towards Amb	Hoshiarpur-Una	19.98	12 (0.6)	273 (13.66)	64	114	22	49	24
		Hoshiarpur-Una Sub main (Upper Ispur)	0.68	2 (2.94)	19 (27.94)	3	12	1	0	3
		Hoshiarpur-Una Sub main 2 (Upper Ispur)	0.68	1 (1.47)	8 (11.76)	1	3	0	1	3
		Old Cricket Ground to Tanjawar	9.82	4 (0.41)	32 (3.26)	7	19	3	0	3
		Tatehra road to Prachin Shiv Mandir road oel	3.01	1 (0.33)	1 (0.33)	1				
		Badhera-Loharli	7.82	2 (0.25)	16 (2.05)	1	9	2	0	4
3	East of SH25-C Una towards Amb	Lambedara da Mohalla-Bher-SH25	1.5	1 (0.67)	5 (3.33)	1	3		0	1
		Baruhi Chowki road-Khurwain Road-Lander Landiya-Lander Tikkari	12.51	5 (0.4)	62 (4.96)	18	32	2	3	7
		SH25-Lath-E-Dargah	2.44	1 (0.41)	14 (5.74)	1	7		4	2
		Chatter-Talmera	10.48	6 (0.57)	48 (4.58)	10	28	1	2	7
		Thatal Road-Chak Sarai-Muchilya Road	13.71	2 (0.14)	9 (0.66)	3	4		1	1
4	NH70-A Hoshiarpur to Gagret	Hoshiarpur-Gagret road	8.05	9 (1.12)	86 (10.68)	15	54	8	4	5
		Hoshiarpur-Gagret road- Sub Main	4.6	1 (0.22)	18 (3.91)	3	6	2	2	5
5	NH70-B Amb to Kaloha	NH70 Amb-kaloha	16.17	5 (0.31)	54 (3.34)	10	26	7	9	2
		Lahad Village road	0.69	1 (1.45)	9 (13.04)	2	5		0	2
		Mairi-Dhauli dhar road	9.17	10 (1.09)	114 (12.43)	15	48	7	16	28
		Naloha-sub road-Mata Kamakhya Temple	2.85	1 (0.35)	6 (2.11)	1	4		0	1
6	SH32 Una to Bangana	Una to Jogipanga	15.8	4 (0.25)	38 (2.41)	11	21	1	3	2
		Jogipanga - Chehru	24.08	3 (0.12)	93 (3.86)	12	39	13	11	18
		Tamlet - Baba Balkrupi Mandir	8.77	1 (0.11)	13 (1.48)	2	6	3	1	1
		Jol - Khurwain Road	10.39	3 (0.29)	29 (2.79)	9	13	4	2	1
		Malahati Basoli-Shiv Mandir Chattara	8.68	4 (0.46)	48 (5.53)	10	24		6	7
		Jogipanga-Paned towards Badgar	8.8	2 (0.23)	8 (0.91)	3	4			1
		Pirnigaha Road	3.69	5 (1.35)	74 (20.05)	14	43	2	7	8
		Jogipanga-Mandi-Raipur road	21.35	7 (0.33)	91 (4.26)	15	43	4	11	19
		SB5-Sub jail-Bhabour Sahib Bharmoti Road	5.78	8 (1.38)	88 (15.22)	20	41	3	8	16
		Takka Road-Baba RudruRoad	20.82	8 (0.38)	96 (4.61)	24	44	5	13	10

Table 5. Age-Sex ratios of rhesus macaques on different road sectors in Una, Himachal Pradesh (AM : adult male ; AD : adult ; AF : adult female ; IMM : immature ; INF : infant)

Road name	**AM:AF**	**AD:IMM**	**AF:INF**	**AF:IMM**
1.Una-Jaijon	1:2.5	1:00	1:00	1:00
2. Una-Jaijon sub main (Palakwah)	1:0.5	1:00	1:00	1:00
3. Hoshiarpur-Una	1:1.7	1:0.5	1:0.2	1:0.8
4. Hoshiarpur-Una Sub main (Upper Ispur)	1:4.0	1:0.2	1:0.2	1:0.3
5. Hoshiarpur-Una Sub main 2 (Upper Ispur)	1:3.0	1:1.0	1:1.0	1:1.3
6.Old Cricket Ground to Tanjawar	1:2.7	1:0.2	1:0.2	1:0.3
7.Tatehra road to Prachin Shiv Mandir road oel	1:00	1:00	1:00	1:00
8. Badhera-Loharli	1:9.0	1:0.6	1:0.4	1:0.7
9. Lambedara da Mohalla-Bher-SH25	1:3.0	1:0.2	1:0.3	1:0.3
10. Baruhi Chowki road-Khurwain Road-Lander Landiya	1:1.7	1:0.2	1:0.2	1:0.4
11.SH25-Lath-E-Dargah	1:7.0	1:0.7	1:0.3	1:0.9
12. Chatter-Talmera	1:2.8	1:0.2	1:0.2	1:0.4
13. Thatal Road-Chak Sarai-Muchilya Road	1:1.3	1:0.2	1:0.2	1:0.5
14. Hoshiarpur-Gagret road	1:3.6	1:0.2	1:0.1	1:0.3
15.Hoshiarpur-Gagret road- Sub Main	1:2.0	1:1.0	1:0.8	1:1.5
16.NH70 Amb-kaloha	1:2.6	1:0.5	1:0.1	1:0.7
17.Lahad Village road	1:2.5	1:0.2	1:0.4	1:0.4
18.Mairi-Dhauli dhar road	1:3.2	1:0.8	1:0.6	1:1.1
19. Naloha-sub road-Mata Kamakhya Temple	1:4.0	1:0.2	1:0.25	1:0.2
20.Una to Jogipanga	1:1.9	1:0.19	1:0.1	1:0.3
21.Jogipanga - Chehru	1:3.2	1:0.82	1:0.46	1:1.1
22. Tamlet - Baba Balkrupi Mandir	1:3.0	1:0.63	1:0.17	1:0.8
23. Jol - Khurwain Road	1:1.4	1:0.32	1:0.08	1:0.5
24. Malahati Basoli-Shiv Mandir Chattara	1:2.4	1:0.38	1:0.29	1:0.5
25. Jogipanga-Paned towards Badgar	1:1.3	1:0.14	1:0.25	1:0.2
26. Pirnigaha Road	1:3.0	1:0.3	1:0.19	1:0.4
27. Jogipanga-Mandi-Raipur road	1:2.8	1:0.59	1:0.44	1:0.8
28.SB5-Sub jail-Bhabour Sahib Bharmoti Road	1:2.0	1:0.44	1:0.39	1:0.7
29. Una Takka Road-Baba Rudru Road	1:1.8	1:0.41	1:0.23	1:0.6
Total	1:2.3	1:0.45	1:0.28	1:0.6

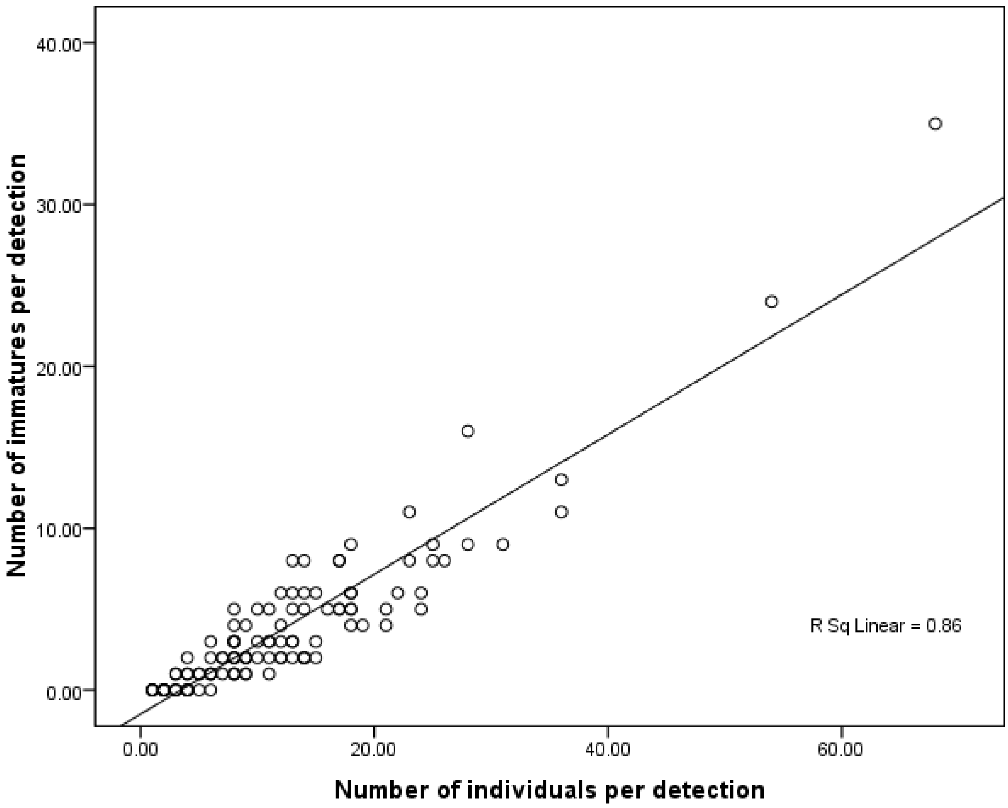


a



b

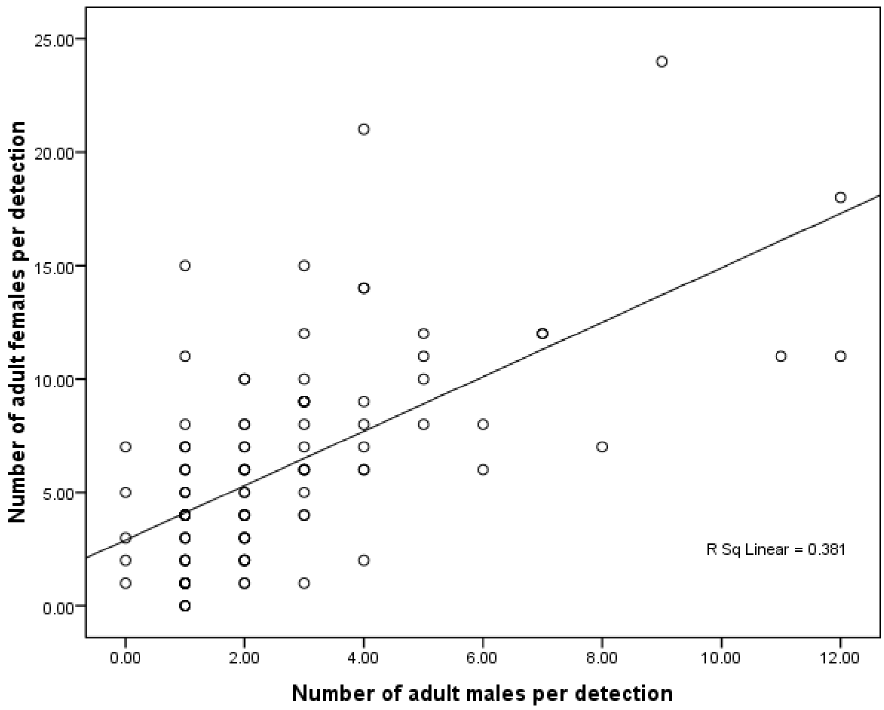
Figure 5a, & b. Different age sex individuals against number of individuals per detection of rhesus macaque around Una, Himachal Pradesh: a). adult males, and b). adult females



c

Figure 5c. Different age sex individuals against number of individuals per detection of rhesus macaque around Una, Himachal Pradesh: c). immatures.

With increase in the group size, increase in the number of adult males (r_p = 0.773, df = 111, $p < 0.001$), adult females (r_p = 0.919, df = 111, $p < 0.001$) and immatures (r_p = 0.928, df = 111, $p < 0.001$) were found significant. The R square value for adult male, adult female and immature against the total number of detections was 0.60, 0.85 and 0.86 (Figure 5. a, b, c). Similarly, the relationship between adult males and adult females (r_p = 0.617, df = 111, $p < 0.001$; R square = 0.38), adults and immatures (r_p = 0.777, df = 111, $p < 0.001$; R square = 0.60), adult females and immatures (r_p = 0.756, df = 111, $p < 0.001$; R square = 0.57), and adult females and infants (r_p = 0.718, df = 111, $p < 0.001$; R square = 0.51) were observed positive and significant (Figure 6. a, b, c, d).



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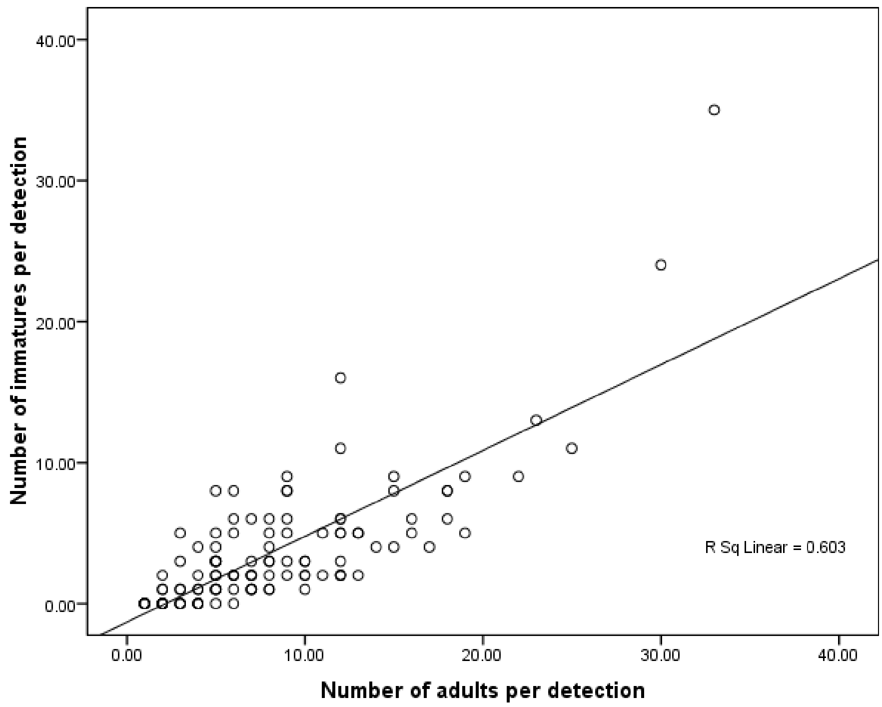
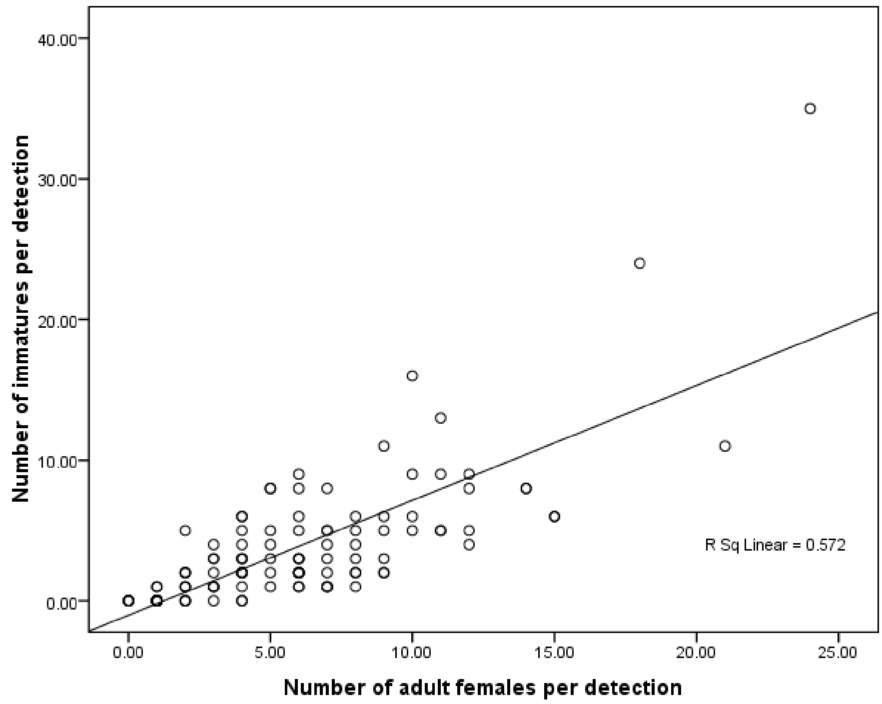


b

Figure 6 a & b. The relationship between different age and sex individuals of rhesus macaque in Una, Himachal Pradesh: a). adult male and adult female, and b). adults and immature



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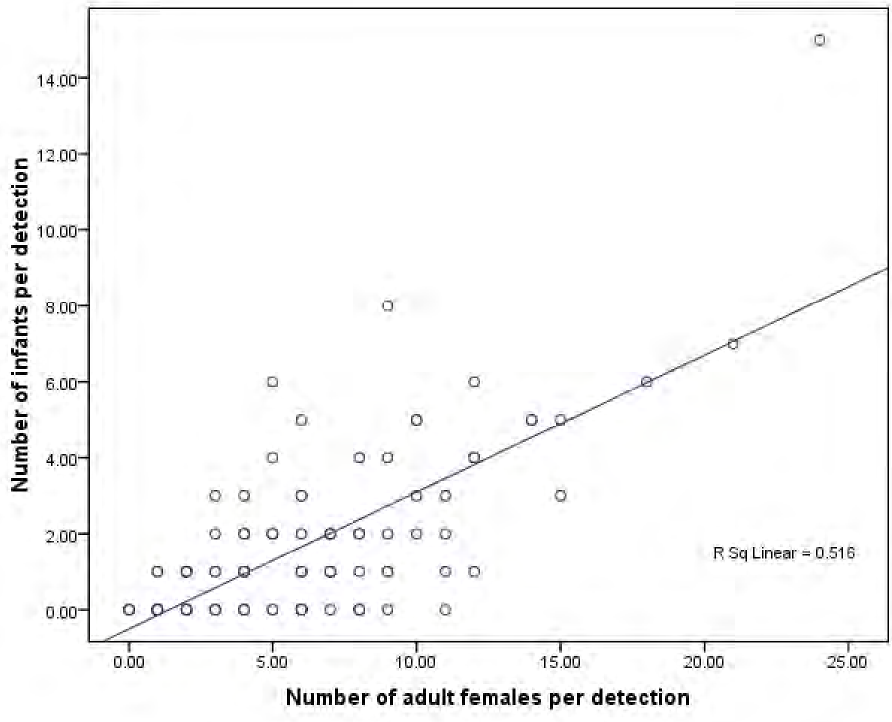

d

Figure 6 c & d. The relationship between different age and sex individuals of rhesus macaque in Una, Himachal Pradesh: c). adult female and immatures and, d). adult females and infants.

The mean number of adult females per adult male was 2.83±2.22$_{SD}$ (N = 104), immatures per adult was 0.42±0.36$_{SD}$ (N = 107), immatures per adult females was 0.58±0.48$_{SD}$ (N = 107), and infants per adult female was 0.25±0.27$_{SD}$ (N = 107) (Table 5). The mean ratio of adult females per adult male (t = 13.01, df= 103, p < 0.001), immatures per adult (t = 12.09, df= 106, p < 0.001), immatures per adult females (t = 12.64, df= 106, p < 0.001), and infants per adult female (t = 9.62, df= 106, p < 0.001).

4.2 ACTIVITY PATTERN AND SOCIAL BEHAVIOUR

Of the 2222 activity records from the scan sampling, 44.10%, 25.25%, 13.86%, 11.16%, 2.79%, 1.71 and 1.13% time was spent by the study group on resting, moving, feeding, grooming, other social behaviour, foraging and agonistic behaviour respectively (Fig. 7).

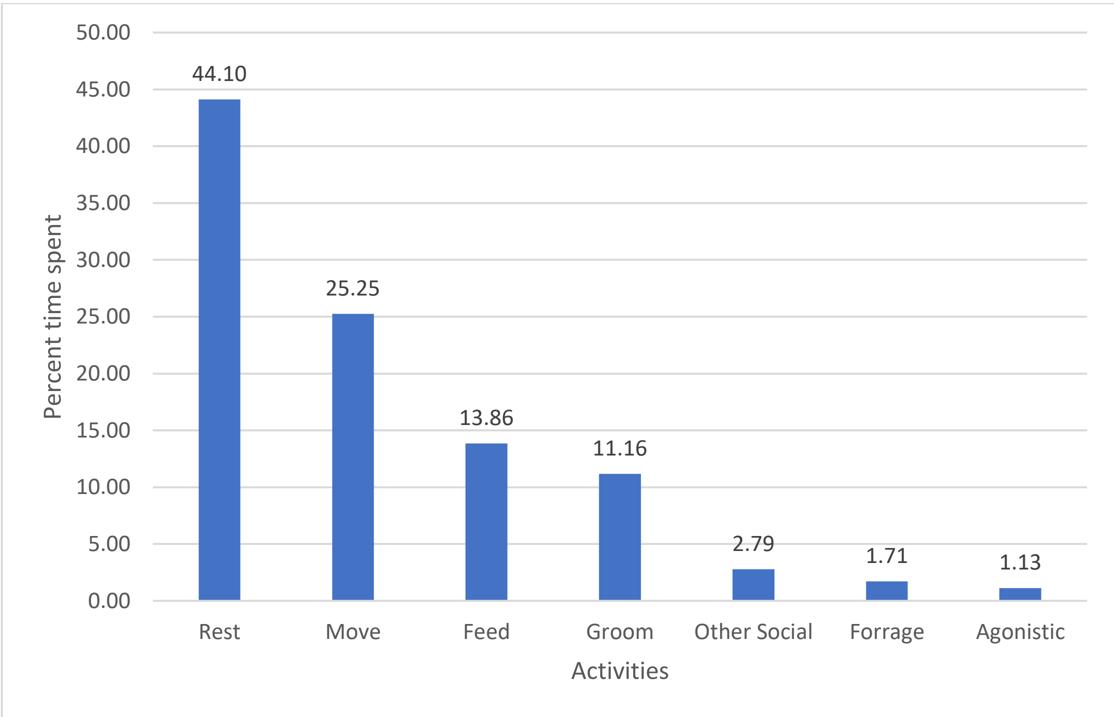

Figure 7. Percent time spent on different activities by study group of rhesus macaque

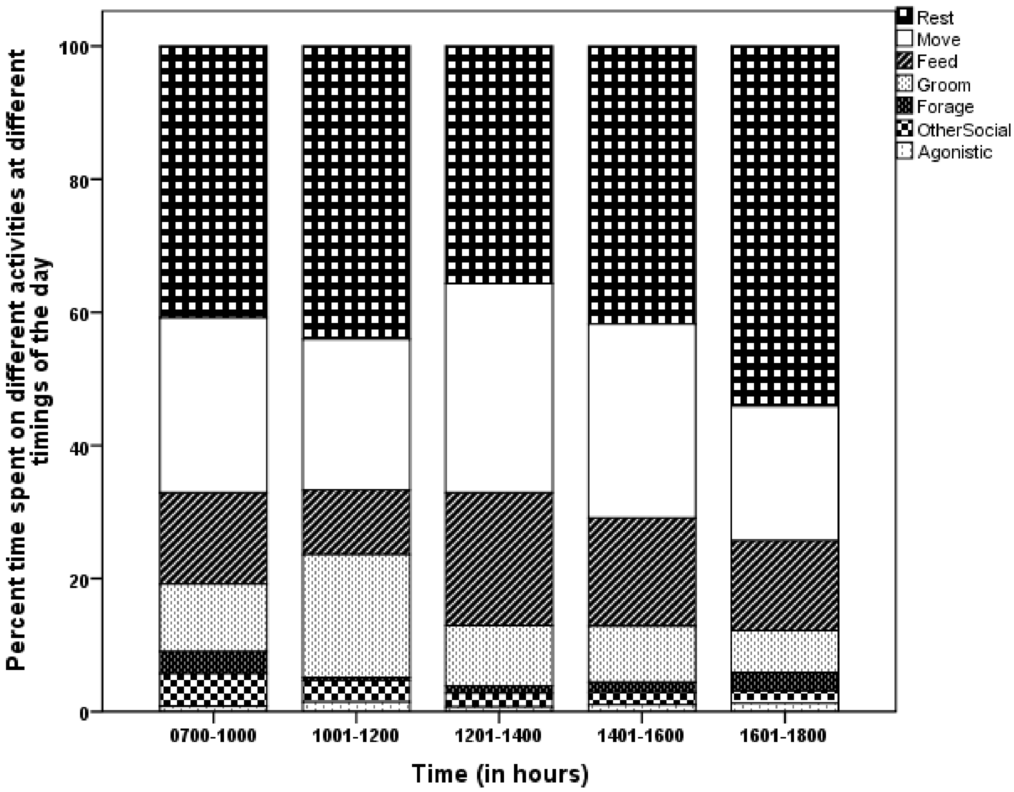

Figure 8. Percent time spent on different activities by the macaques at different timings of the day

The time spent on different activities varied signifacatly (χ^2 = 2306.27, df = 6, p <0.001). The pattern of percent time spent on different activities by the macaque at different timings of the day did not differ (Friedman χ^2 = 1.143, df =4, p =0.882) (Fig. 8). But percent time spent on each activity by the macaques on different activities varied (resting: G = 16.49, df = 5, p < 0.01; movement: G = 13.72, df = 5, p < 0.01; feeding: G = 17.51, df = 5, p < 0.01; grooming: G = 41.76, df = 5, p < 0.01; foraging: G = 15.33, df = 5, p < 0.01), except other social behaviour (G = 8.85, df = 5, p =0.11) and agonistic behaviour (G = 1.48, df = 5, p = 0.91). The mean group spread area was $130.12 \pm 128.52_{SD}$ m^2.

The Eigenvector centrality values for the group individuals ranged from 0.015 (CK, an adult male) to a high of 0.387 (ASAB, and adult female) (Appendix 1). It shows a gradient of eigenvector centrality values which suggests a hierarchical structure showing that some females like ASAB and KKCM are more central to the grooming distribution in the group (Appendix 1).

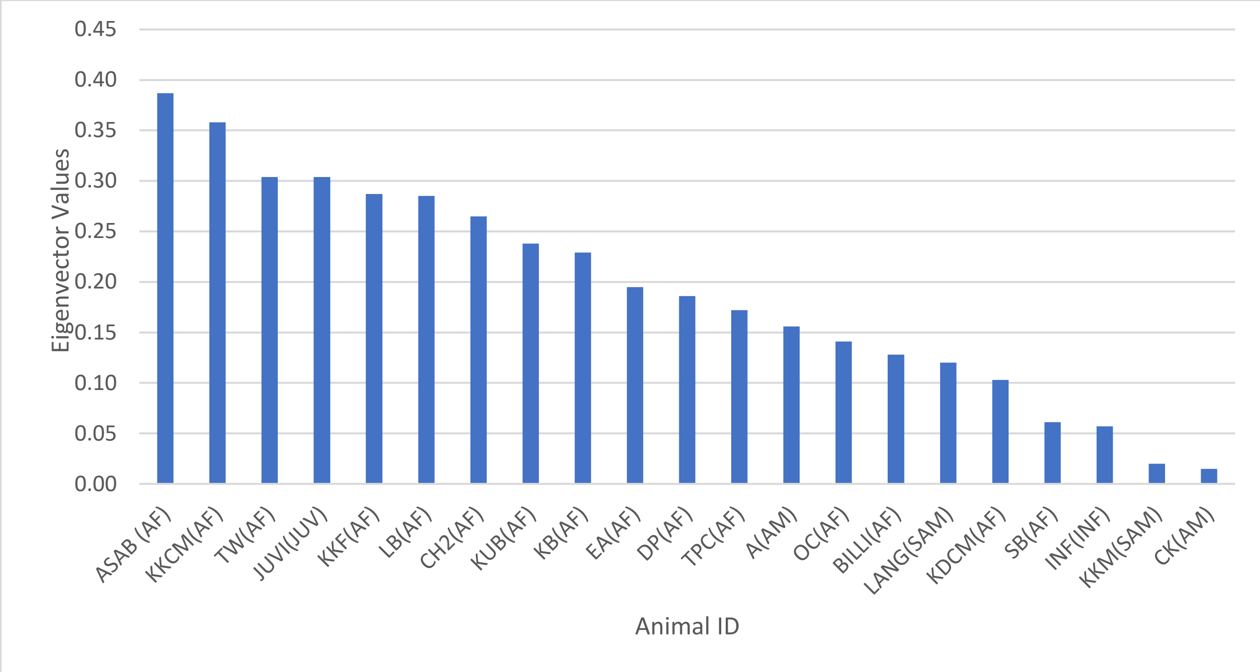

Figure 9. Distribution of eigenvector centrality values showing different role played in the grooming distribution in the group by different individuals. (AM : adult male ; AF : adult female ; SAM : sub adult male ; JUV : juvenile ; INF : infant)

The top half of the sociogram shows the densely networked individuals which play a central role in the distribution of grooming in the group (Fig. 10). The lower half is less dense and consists of individuals less important in the grooming distribution. Interestingly, each individual played a role in the grooming network as there were no outliers.

Males groomed only twice and hence statistical methods could not be used to assess their grooming patterns, also it can be safely presumed that males participated less in grooming. Immature individuals were involved in four episodes and showed a positive correlation, however, the data is not adequate to conclude. Grooming given and received among the females were not correlated (Table 6).

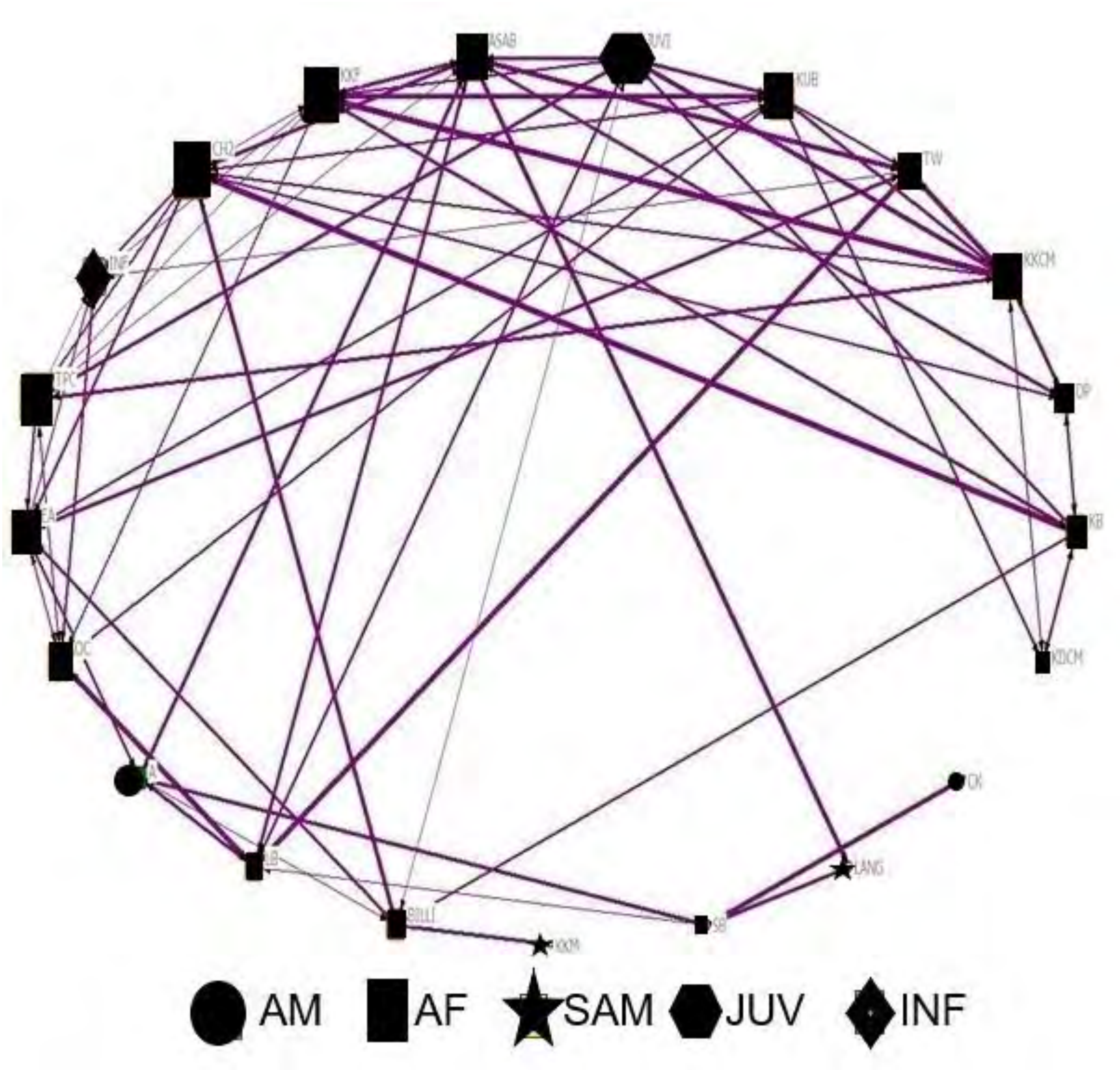

Figure 10: Representation of grooming network in the study group. Thickness of the edges (connections of the nodes) represent the strength of ties, that is, total bouts of grooming. Size of the nodes correspond to eigenvector centrality values. (AM : adult male ; AF : adult female ; SAM : sub adult male ; JUV : juvenile; INF : infant)

Table 6. Correlation values of degree centrality of grooming among study group different age-sex individuals. (AM : adult male ; AF : adult female ; IMM : immature ; AD : adult; INF : infant)

Correlations				
			OUT	IN
AM	OUT	Pearson Correlation	1	1
		Sig. (2-tailed)		.
		N	2	2
	IN	Pearson Correlation	1	1
		Sig. (2-tailed)	.	
		N	2	2
AF	OUT	Pearson Correlation	1	0.24
		Sig. (2-tailed)		0.39
		N	15	15
	IN	Pearson Correlation	0.24	1
		Sig. (2-tailed)	0.39	
		N	15	15
AD	OUT	Pearson Correlation	1	0.32
		Sig. (2-tailed)		0.21
		N	17	17
	IN	Pearson Correlation	0.32	1
		Sig. (2-tailed)	0.21	
		N	17	17
IMM	OUT	Pearson Correlation	1	0.98
		Sig. (2-tailed)		0.02
		N	4	4
	IN	Pearson Correlation	0.98	1
		Sig. (2-tailed)	0.02	
		N	4	4

5. DISCUSSION

5.1. GROUP SIZE AND SOCIAL ORGANISATION

This is a first-ever study on the population of rhesus macaque that has undergone severe randomisation of individuals due to the capture and release of individuals. The macaques were captured by private monkey catchers, and they were paid the money by the forest department for the number of macaques they capture and produced to the sterilisation center. In the initial years of the program, macaques were picked up from locations that were close to each other and were brought for sterilization as one group. After the sterilisation, the macaques were not released to the exact location or to the parental groups, but they were released at random locations. Thus, I expected randomisation of individuals from and between the macaque groups. Usually, it is expected that the group size show bell shaped curve being the mean group size in the center in the unaltered populations. However, my results showed that the mean group size is smaller than many other populations (Table 7), and the group size is positively skewed. There were more groups with the group size of less than 10 individuals in small clusters with an odd ratio. This indicates the randomization is apparent in the macaque population in Una, which is more impacting on the social organisation of macaque than sterilisation of them. Further, since the sampling area was within a 31 km radius of the sterilization center, most groups were bound to have at least some sterilized individuals that were captured from a different location. This may also have led to fissioning of the macaques into smaller groups as they may be unrelated individuals.

Table 7. A review of group size and parameters of social organisation of rhesus macaque in different sites (AM : adult male ; AF : adult female ; IMM : immature; AD : adult)

STUDY SITE	NO. OF ANIMALS	AVE. GROUP SIZE	%AM	%AF	%IMM	AM:AF	AF:IMM	AD:IMM	SOURCE
North India	493	41.9	17.6	34.3	48.1	1:2.0	1:1.4	1:0.9	Southwick *et al.* (1961)
Central India	136	41.9	22.8	43.4	33.8	1:1.9	1:0.8	1:0.5	Southwick *et al.* (1961)
Bangladesh	22-91	41.3	11.0	21.0	68.0	1:1.9		1:2.1	Hasan *et al.* (2013)
Bangladesh	5313	30.2				1:2.9		1:1.7	Hasan *et al.* (2013)
Una, HP	**1362**	**12.3**	**20.6**	**48.3**	**31.1**	**1:2.4**	**1:0.6**	**1:0.45**	**Current study**

A relatively high percentage of females in the population is interesting, and further, they constitute more percentage of the group as they may be trying to be in a group than adult males as their dispersion rate is relatively higher than in adult females compared to many other populations (Table 7). Although, the number of females in the population is more but immatures are in less numbers, and less immature ratio to the adults is indeed a result of sterilisation program. The significant variation in all the age-sex ratios between the groups also indicates the destabilised grouping of rhesus macaque in the study area.

5.2 TIME ACTIVITY PATTERN AND SOCIAL BEHAVIOUR

The current study showed that the study group spent less percent time (13.86%) on feeding when compared to all sites except in Cayo Santiago -not provisioned (7.2%) (Baulu & Redmond, 1980). The provisioning decreases the time spent on feeding, thus, the study group partially gets its food from provisioning. However, provisioned groups get more time to spend on resting and social activities (Table 8). The same is reflected in the study group, and a similar pattern was reported in the urban group of rhesus macaque in Sadhona, Bangladesh (Jaman & Huffman, 2012). The study group spent ~15% of the time on different social activities including ~11% of the time on grooming. Female macaques depend on a stable social network to cope with stress (Cheney & Seyfarth, 2009). One explanation for high rates of affiliative interactions among female members of the same group as observed in social networking is that they function to maintain the group's cohesion in competition for resources against other groups (Cheney, 1992). In a larger perspective, even though there are some differences in the time spent on different activities by my study group in comparison with other sites with different habitat conditions, but the differences are not that distinct (Table 8). This indicates that the pattern of time spent by the study group is on par with the other sites. Since the study group was partially provisioned, they spent more time on resting and social activities when compared to groups in the forests.

Rhesus macaque females have highly stable matrilines (Judge *et al*., 1997). Social stability is an important determinant of primate aggression and affiliation (Bercovitch & Lebrón, 1991). One explanation for high rates of affinitive interactions among female members of the same group is that they function to maintain the group's cohesion in competition for resources against other groups (Cheney, 1992).

Table 8. Percent time spent on different activities by rhesus macaque in different sites. (FE: feed; RE: rest; LOCO: locomotion; GR: groom; PL: play; VIG: vigilance)

Study Site	**TI**	**FE (%)**	**RE (%)**	**LOCO (%)**	**GR (%)**	**PL (%)**	**VIG (%)**	**Source**
Bangladesh Urban	81-94	22.4	46.1	10.8	16.5	3.1	0.6	Jaman and Huffman (2012)
Bangladesh Rural	47-57	36.2	36.8	11	11	4.4	0.5	Jaman and Huffman (2012)
Cayo Santiago (prov)	16	31.8	26.1		5.4	0.1	19.1	Baulu and Redmond (1980)
Cayo Santiago (not prov)	16	7.2	38.4		26.1	1.8	13.3	Baulu and Redmond (1980)
Una, Himachal Pradesh	21	13.86	44.10	25.25	11.16			Present study (2020)

The rhesus macaques are known as one of the least tolerant macaque species (Thierry, 2007). These macaques are also highly commensal and in places like Himachal Pradesh they are considered as pests as they are highly dependent on provisioning and most of their habitat matrices significantly overlap with human habitation (Kaburu et al 2019). In such uncertain conditions, staying vigilant becomes imperative for the macaques and that reduces time on socio-positive interactions like grooming.

Males are expected to groom less as they compete for mating which is a non-sharable resource and they migrate after becoming adults (Wrangham, 1980). Females compete for food which can be shared and they remain in the same group are born into (Wrangham, 1980). Although, I did not find any correlation between grooming given and received among the females as it may suggest that grooming was perhaps exchanged with other benefits like access to food which seems to be an important selective agent in a human-dominated landscape (Seyfarth, 1977). Thus, females groom each other more forming a close-knit social structure. The patterns are similar in my study as the adult females were found to be the central individuals in the distribution of grooming as they assumed the highest eigenvector centrality values. Adult males held lower positions in the grooming network. The sociogram shows an interesting pattern showing group stability as all the individuals were groomed during the study period showing the familiarity among the individuals (Silk, 2007). Grooming is a social currency used to form social bonds among individuals and it is a form of reciprocal altruism (Schino & Aureli, 2009). Thus, the grooming is targeted to valuable individuals or familiar individuals. Thus, it can be safely presumed that the grooming pattern in the group acted as a proxy for group stability. This indicates that still some groups are stable, or they have formed stable to overcome the chaos of randomisation, however, the long-term data and comparative data with unaltered population would through more clarity on their social stability pattern.

CONCLUSION

The results for social organization in Una showed that the mean group size of rhesus macaques is smaller than many other populations, and the group size is positively skewed. Also, the number of females in the population is more but immatures are in less numbers indicating less immature ratio to the adults. This indicates that randomization is apparent in the macaque population, which is more influential on the social organisation of macaque over sterilisation as such. Whereas the ratios between adults and immatures are the results of sterilization. The significant variation in all the age-sex ratios between the groups also indicates the destabilised grouping of rhesus macaque in the study area. The results for ethological study showed that there are some differences in the time spent on different activities by the study group in comparison with other sites with different habitat conditions, but the differences are not that distinct. The adult females were found to be the central individuals in the distribution of grooming and adult males held lower positions in the grooming network.

The study was designed to have comparative data on the control population that were not having any sterilised individuals and had a relatively unaltered population. However, I could not collect data on the control population due to the COVID pandemic. Thus, the final conclusion could not be made, and the findings are only stand-alone information of the population having some sterilised individuals.

Appendix 1. Eigenvector centrality values for all individuals in the study group. (AM : adult male ; AF : adult female ; SAM : sub adult male ; JUV : juvenile ; INF : infant)

SL. NO.	ANIMAL ID	AGE-SEX	EIGENVECTOR CENTRALITY	NOUTDEGREE	NINDEGREE
1	ASAB	AF	0.387	0.21	0.19
2	KKCM	AF	0.358	0.15	0.14
3	TW	AF	0.304	0.16	0.04
4	JUVI	JUV	0.304	0.09	0.18
5	KKF	AF	0.287	0.06	0.15
6	LB	AF	0.285	0.15	0.12
7	CH2	AF	0.265	0.10	0.16
8	KUB	AF	0.238	0.14	0.05
9	KB	AF	0.229	0.15	0.07
10	EA	AF	0.195	0.08	0.13
11	DP	AF	0.186	0.07	0.08
12	TPC	AF	0.172	0.10	0.07
13	A	AM	0.156	0.05	0.11
14	OC	AF	0.141	0.07	0.10
15	BILLI	AF	0.128	0.10	0.02
16	LANG	SAM	0.12	0.03	0.05
17	KDCM	AF	0.103	0.04	0.05
18	SB	AF	0.061	0.04	0.08
19	INF	INF	0.057	0.02	0.05
20	KKM	SAM	0.02	0.00	0.03
21	CK	AM	0.015	0.04	0.00

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