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Population status and post-sterilisation behaviour of rhesus macaque *Macaca mulatta* in Himachal Pradesh

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Content

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EXECUTIVE SUMMARY

A high population of free-roaming animals is a major problem across the world like macaques in India. Macaques have lost their natural fear of humans over the years due to frequent contact with people in human-dominated landscapes. This sometimes led to excessive aggressive behavior shown by animals towards humans usually when seeking food. The close contact between humans and primates may have led to the transmission of pathogens due to biting or during contact with macaques' hands when feeding them. This issue is even more severe in developing countries where religious beliefs and other cultural perspectives impede the implementation of population control strategies. Chemical or surgical sterilization to control reproductive growth is the most used method serving as an ethical alternative to culling and translocation. Although, various sterilization projects and studies have been carried out across the world, however, large-scale sterilization is less common and its impact on the natural population is not clear. Forest Department, Himachal Pradesh started the sterilization program for rhesus macaque, following the surgical tubectomy and vasectomy as this is a wild population and non-surgical methods such as contraceptive pills or implants are not feasible options. A total of seven sterilization centers were established in the entire state since 2006, wherein 170169 macaques were sterilized between 2006 and 2021. Although the number of captured macaques was high in the number, some individuals were either juveniles or pregnant females, and some already sterilized individuals were recaptured, thus they were released back without re-sterilization. Out of these sterilized animals, 88187 were males and 81982 were females. The sterilized macaques were relocated to their natural habitat. The Forest Department of Himachal Pradesh initiated a monitoring program in the state as they also have been doing the sterilization of macaques since 2006. Our study provides the consequences of sterilization on population status, social organization, and behaviour of rhesus macaques in Himachal Pradesh.

Population status: The estimated realized niche of rhesus macaque in Himachal Pradesh was 27276.83 km^2. The temperature seasonality and annual precipitation were the most important determinants for predicting habitat suitability. A total of 4746 groups were observed along 23440 km of a walk across the state except for the Pangi division. The mean overall group density was estimated to be 0.17 groups km^{-2} with minimum group density in Dehra and Rohru divisions (0.01 groups km^{-2} each) and maximum group density in Kunihar division (1.04 groups km^{-2}). Extrapolating group density with the predicted suitable area and average group size observed, the total population of rhesus macaque was estimated to be 1,36,443

individuals in 3336 groups with the lowest population in Hamirpur Wildlife Division (37 individuals) and highest in Una division (10123 individuals). The wild population of macaques in the state was estimated to be 1,05,627 individuals excluding urban macaques. There has been a drastic decrease in the rhesus macaque population in the last four years however, the population in divisions of Solan, Nalagarh, Sarhan Wildlife Sanctuary, Theog, Rampur, Kotgarh, Kinnaur, Parvati, Poanta Sahib, Churah and Shimla urban has increased. The rest of the forest divisions have shown a decline in the macaque population from the 2015 census. We also came across a report of the culling of macaques by local people, however, the same is not reported or recorded in any documents. Thus, the number of culling incidents and the number of individuals culled could not be ascertained. Probably, culling in many areas in the state has also led to a decrease in the overall number of macaques.

Social organisation: A total of 6394 macaques were counted (1065 adult males, 2267 adult females, 830 sub-adults, 1279 juveniles, and 881 infants) in 391 groups in 9945.2 km of effort around sterilisation centres (Chamba, Gopalpur, Hamirpur, Mandi, Paonta Sahib, Shimla, and Una) in Himachal Pradesh. This provided the encounter rate of 0.04 groups/km and 0.64 macaques/km. The mean group size of the macaque was $16.35 \pm 12.62_{SD}$. The rhesus macaque groups had $8.56 \pm 6.46_{SD}$ adults and $7.68 \pm 6.64_{SD}$ immature; composed of $2.73 \pm 1.82_{SD}$ adult males, $5.82 \pm 4.96_{SD}$ adult females, $2.13 \pm 2.23_{SD}$ sub-adults, $3.28 \pm 3.40_{SD}$ juveniles and $2.27 \pm 2.21_{SD}$ infants. A significant variation in the mean number of individuals of sub-adults, juveniles, and infants, was observed between the seven sites. The number of groups observed tends to decrease in relation to the increasing group size. Rhesus macaque groups with ≤ 10 individuals were 138, which is followed by 132 groups under 11-20 individuals, 80 groups under 21-30 individuals, 27 groups under 31-40 individuals, nine groups under 41-50 individuals, and five groups under ≥ 51 individuals. The mean number of adult females/adult male was $2.14 \pm 1.39_{SD}$, infants/adult female were $0.38 \pm 0.28_{SD}$, immature/adult female was $1.36 \pm 0.83_{SD}$, and adults/immature was $1.39 \pm 1.03_{SD.}$ The study reveal, one of the consequences of such measures on macaques was more number of smaller groups and very few larger groups. The mean group size of macaques in Himachal Pradesh (16.40) was lower than in Hoshiarpur (29.10). Even the mean group size of macaques in Himachal Pradesh was much lower than the earlier records e.g., 33.10 in 1980. The mean group size of macaques in Himachal Pradesh is much lesser than in many other locations in its distribution range. This clearly indicates that the drop in the mean group size of macaques within Himachal Pradesh over a period, and also lesser than the many other locations is the

consequence of the sterilization program and also the randomization of the macaques while capturing and releasing of the macaques as indicated by genetic study of relatedness of individuals from different sterilisation centres.

Behaviour: We studied two groups of macaques located at Una, Himachal Pradesh. The T1 and T2 groups were followed from June 2021 to August 2022. Initially, the T1 group had 19 individuals with 2 adult males, 15 adult females, and 2 immatures. At the end of May 2022, a new infant was born for an adult female named MTR in the T1 group which is the only one birth recorded in T1 group during the study period. The T2 group consisted of 7 females, 3 males, and 3 immatures. During the study period, 2 adult females (BM and SM) from T2 had given birth once. No deaths were recorded in both groups during the entire study period. A total of 2141 activity records from T1 group and 2305 activity records from T2 group were used for analysis. A total of 157:30 hr and 122:00 hr of observation was made for T1 and T2 groups respectively. Both the groups spent more time on Resting (T1- 37.46%, T2-33.80%) and Moving (T1- 34.80%, T2- 28.46%).

A combined total (T1 and T2) of 203:30 hrs of observation was made between October to December 2021. During this period, reproductive behaviour was observed in both T1 and T2 groups. 22 matings were recorded in T1 group during the study period by two males (BAB and NH) and four females (MTR, SF, GRY, and ES i.e., females: 26.67%), in which the NH immigrated to the T1 group during the starting phase mating season. 190 matings were recorded by four males (HED, LC, 1E, and MP) in T2 group, in which 1E joined the group during the mating season and six females (BM, SM, PRT, HMP, LMP and SHD). The percentage of males recorded mating is 100% whereas the percentage of females recorded mating was 85% in T2 group. The limited opportunity of mating probably has resulted in less cohesion, high dispersal of individuals, more emigration and immigration, also highly skewed group composition, and male band in macaques.