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Pre and Post Sterilization Behaviour Studies of Rhesus macaque (Macaca mulatta) in Himachal Pradesh, India

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Abstract: ***Rhesus Macaque (Macaca mulatta) population in India has been on a rise due to their high breeding rate and ability to acclimatize to various environments (Imam 2013). They are often seen in Human habitations especially in agricultural fields, raiding crops and becoming a nuisance to the farmers. According to agricultural department, the marauding macaques have raided agricultural crops worth Rs 185 crore and horticulture crops worth Rs 38 crore in various districts of HP in 2014. To address this menace, sterilization programme is carried out at respective Monkey sterilization centre (MSC's) established at 8 monkey affected districts across Himachal Pradesh. This study aims to investigate and understand the various behavioural changes that may occur (intra specific, social , feeding, stress/aggression) in the period of post sterilization of Rhesus macaque. The proposed study site for this project is a Village called Gopalpur located in Kangra District of Himachal Pradesh. For pre-sterilization monitoring, a virgin Troupe was identified and selected for capture based on the MSC's record on capture locations and sterilized monkeys. The virgin troupe was monitored for their behaviour which included changes and their usual aggression, Feeding, grooming, sleeping, and mating and home range, for a period of 3 weeks. 100 % capture of this troupe was aimed for sterilization at a time. But failure of the same, the remaining population was to be monitored for their behavioural changes due to separation from their parent troupe. Capturing Rhesus of Chamunda Area near the addressed site was challenging due to many reasons which are discussed in the report. Three monkeys were caught successfully out of which two escaped and one turned out to be pregnant. The identified troupe couldn't be captured and sterilized to study their post behavioural changes. The pregnant monkey was released back at the point of capture as it can't be sterilized. This study on pre-sterilization behaviour will form a baseline data for future studies on their post-sterilization behavioural changes. The study will also help in streamlining the monkey capturing process.***
Keywords: Rhesus macaque, Behaviour, Monkey sterilisation centre, MSC, Sterilisation program.

I. INTRODUCTION

Man, and monkey struggle is a common problem in Indian subcontinents. Among the 22 species of non-human primates of India three are already commensal to human (Singh et al., 2016). They are the Rhesus macaque *(Macaca mulatta)*, the Bonnet macaque *(Macaca radiata)* and the Hanuman langur *(Semnopithecus entellus)* (Chaturvedi and Mishra 2014). Nonhuman primates have role in economic, cultural and scientific significance on the other hand human facing problem because of crop raiding monkeys. Human activities like urbanization, conversion of forest into agriculture land, deforestation has been reducing wildlife habitat, therefore increasing monkey habitation problems, easy availability of food made monkeys become habituated to human habitats. (Sharma et al., 2011, Chaturvedi and Mishra 2014, Estrada and Raboy 2012) **.**Rhesus macaque share habitat ranging in northern India and central India in the states of Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Orissa, Punjab, Rajasthan, Sikkim, Tripura, Uttaranchal, Uttar Pradesh and West Bengal www.iucnredlist.org/species.Human monkey conflict is a major issue in India. Monkey management is a challenging task because they have cultural role in Indian community. In some part of India, rhesus and langur are believed to be an incarnation of lord Hanuman. In agriculture based population and urban area feelings are not similar since they destroy crop fields and snatch food from houses, shops leading to the conflict between human and monkey. The human-monkey conflict management includes use of bioacoustics, Immuno-contraceptive vaccines, sterilization to control their population growth and protecting agriculture crops and orchards with live/appropriate fencing etc. Himachal Pradesh is the most affected state by rhesus macaque adapted sterilization of Rhesus to control their population growth. (Reddy and Chander., 2016). Even though Himachal Pradesh Forest department convinced with the success of rhesus sterilization, behavioural changes has been observed by locals of rhesus affected area.

We chose Daadh as our study area for this project as it is mainly based on the complaints from the public and also includes human habitat. Daadh is a semi urban area and has famous Hindu pilgrimage site where monkeys are fed by devotees and are easily accessible to food from Langar Bhavan. In the villages nearby Daadh, monkeys mainly relay on crop fields and sometime snatch food from public. Mainly because of the absence of natural predator and very high birth rate, the population of rhesus monkey is multiplying every year which has led to increase in commensal monkey and reason for monkey human conflict. Himachal Pradesh government taken corrective measures to control the population of monkeys and sterilization process is one of the affective methods.

II. OBJECTIVE

To understand the impact of 'sterilization' on behaviour of Rhesus macaque.

III. METHODOLOGY

1) Virgin troupe identification
2) Monitoring the same troupe for their behaviour (movement pattern, individual identification marks, aggressive behaviour towards humans, Intra and interspecific behaviour, mating behaviour, feeding, drinking, grooming, sleeping) for a period of 2-3 weeks.
3) Capturing at least half the population depending on the habitat and probability of capture of the target troupe and marking GPS co-ordinates of capturing location.
4) Sterilization of the captured monkey troupe at the Gopalpur MSC by the veterinary doctor and recording their morphometric parameters (temperature, heart rate, respiration rate etc.) under the vet's guidance. Sterilization process is video graphed.
5) Troupe behaviour (feeding, stress) is observed in captivity. And monitoring the behaviour of the troupe members that were not captured will be observed to understand the change occurring in their day to day activities.
6) Releasing: Monkeys released after 3 days in captivity to recover from effects of anesthesia (min period of 72 hrs.) for complete wound healing and avoid post-operative complications. Release is photographed at the capturing GPS location.
7) Post Sterilization monitoring: The released monkey troupe is then monitored for their behavioural changes on basis of the baseline data obtained during pre-sterilization monitoring.

A. Implementation of the standard protocol:

1) *Virgin Troupe Identification*: It is difficult to identify a virgin or already operated/sterilized monkey troupe just by looking at the individuals unless the monkey is marked by tattooing or dyeing. But neither of the marking methods has been used before. As the species is free ranging, observing them from a distance will hardly reveal their sex. Since this sterilization program is in effect from 2007 in Himachal, there is no monkey troupe that is 100% virgin. Therefore, the monkey troupe was selected on the basis of previous records on sterilized troupe locations and presence of high number of adult females and sub adults that can potentially be future breeding population.

B. Capturing

Both NET and CAGE methods were used to capture the monkeys.
Three traps were set at the same location (two cage and one net) as this location formed a frequent passage of locomotion from temple to Dump yard/Village and vice-versa.

Fig. 1. First attempt by cage method.

Fig 2.Attempt by net method.

In NET method, the alpha male was seen entering the trap alone and feeding while not allowing his troupe members to enter thereafter. The monkeys came in one by one to steal the food and wouldn't stay inside at once which made capturing tricky.
In CAGE method, the monkeys just hung around studying it and not daring to enter. Any individual trying to go near the cage was warned by the alpha by a distinct call. Camouflaged Cage was successful in deceiving the monkey's up to some extent. Three monkeys managed to get inside the cage, lured by the bait inside. Out of which, two escaped and one turned out to be a pregnant female.

Fig 3.Capturing locations using Google maps.

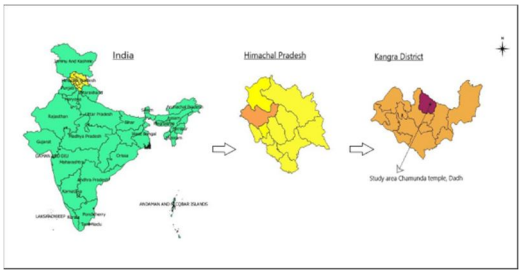

Fig 4.Study site.

The famous temple of Ma Chamunda is in Kangra district of Himachal Pradesh, India. The study was carried out surrounding the Temple area in Daadh locality. The location lies between latitude 32° 8'49.50"N and longitude 76°25'15.17"E. It is around 10 km west of Palampur,and 6kms from Gopalpur zoo, on the Baner river. Many devotees from all over India come and visit this sacred place. Tuesday, Friday, Saturday and Sundays are the most visited days by devotees. The habitat is suitable for the macaque existence due to ample of food and water availability. This human dominated habitat has a temple, Shamshan ghat, Langar bhavan, Dump yard that forms ideal sources of food. Along with these human food sources, there are alternative plants and grass which are preferred too. There is not only food and water but resting spots away from the human disturbance.

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IV. OBSERVATION

A total of 65-70 individuals were counted in the study area. Initially they were thought of as a single troupe since there were no major territorial fights observed. But later it was found that there were three different troupes which were sharing the same habitat and resources and maintaining safe distance from other troupe members. The three troupes were named as

1)Langar bhavan troupe 2) Village troupe 3)Dump yard troupe.
All the troupes move in an area of 1-1.5kms.

A. Langar bhavan troupe

This troupe prefers to stay in and around langar bhavan every day. There are around 20 individuals in this troupe.

1) Individuals Identified on the basis of injuries/ Diseases

Fig 1. Individual identified with lipoma.

Fig 2.Female with Amputed left leg.

Fig 3.Male with deformed Nose.

Fig 4.- Individual identified with alopecia.

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B. Dump Yard Troupe

This troupe moves in a range of 1km radius from Daadh chowk (Dump yard) to the opposite side village to the temple. It consists of 25 monkeys.

Fig 5. Aged individual

Fig 6. Both hands amputed female named chameli.

C. Village troupe

Consists of 21 individuals. 6 individuals (mostly adults) remain isolated from the other troupe members, while other members locomotive in search of food.

1) Pre- sterilization Behavioural Observations

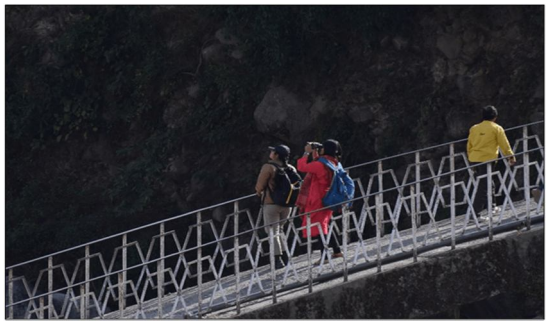

Fig 1.Researchers observing monkeys.

Fig 2. Infant feeding on puffed rice.

Fig 3.Individual feeding on dumpyard.

Natural food sources include grass, Litchi, mango, willow, fig tree leaves, Curry leaves, Lantana and nettle leaves, wheat crops and young pine seeds, Soil. Few individuals were seen stealing sweets, fruits from the fruit vendor and food from peoples hand.
The troupe/group from the village area is observed feeding upon plant sources, twigs, seeds and local crops than human food.

a) *Feeding behaviour*: The troupe was seen foraging and feeding from 11:30am to 2pm and again from 4pm to 5 pm. Mostly rely on food from the dump yard and garbage bins [including vegetables (carrots, tomatoes, capsicum), fruit peels, leftover food], food given by the devotees (Puffed rice, Sugar balls, Chana seeds, Banana, Orange) , Wheat and rice grains that are put at Shamshan Ghat near the temple. 6-7 Infants had seen feeding on their mother's milk. Almost the entire troupe (Langar bhavan) is seen at the shamshan when a body is burnt and offerings are done. Langar Bhavan and Dump yard troupes gather for food near the Langar bhavan in the evening at 7:30pm.
b) *Drinking behaviour*: The troupe is seen drinking water from the tributary of Beas river called as Baner Khad that flows between the Chamunda temple and Shamshan ghat, from the water collected on the under constructed roof or sometimes from a small pond. Usually monkeys seen drinking water during around 9:30am and 2 pm.
c) *Social behaviour*: Infants are always with their mothers and rarely seen under the care of their male parent. Half of the troupe members are seen near the Daadh bus stop ie. Dump yard/ near the road (on top of the buildings , restaurants, trees) and around 20 of them are constants near the temple/Langar Bhavan. A dominant alpha male is identified on the basis of body structure and command given in each of the three troupes. Infants are seen playing most of the time with sub adults and other infants. Aggression towards human shown only when provoked. At least three to four nursing mothers are always together. The adult female with no hands is always alone with no one to look over her. Fights within the troupe were rare and hard to decipher .Monkeys were seen chasing birds, a cat, dogs, a calf and goats.
d) *Grooming:* Grooming is the most performed activity apart from foraging and feeding. Intermittent Grooming is seen. Grooming can go from 2mins to 15mins to maximum 30 mins at a go. Grooming was mainly done by Females on adult males, sub adults and infants. Sub adults grooming each other and infants were observed. Also instances of infants grooming adults and sub adults were observed. Monkeys had seen grooming on goats several times.
e) *Mating*: Adult male seen mating with a sub adult at few instances. Mating attempt was seen at least thrice per day in the month of February. One particular sub adult was trying to mate several times with an infant which may indicate his sexual maturity. One adult male was seen self-gratifying. Mounting by sub adults on infants was seen almost every day. Alpha male of the langar bhavan troupe was seen mounting on adult female for 8 times in a row.
f) *Locomotion*: A pattern was observed in the locomotion of the individuals that are constants near the temple. They start moving from the temple and crematorium area towards Langar Bhavan in the afternoon around 1:30/2pm and then rest and play behind the bhavan in and around the residential area. 6 individuals (mostly adults) stay in the village at all times. Dump yard troupe travels from village to the balcony area (where they groom and bask) to dump yard to temple. All the troupes move in an area of about 1.5kms radius.
g) *Sleeping*: Early morning and late afternoon naps are quite common. Naps last for just a few minutes / seconds at just any place. Two individuals were observed taking nap for a longer time than usual [at a stretch of 1 hour].
h) *Aggressive behaviour*: Aggression was observed within the troupe, within two individuals as well as within two groups. Some individuals show aggressiveness towards humans while they steal food from the shop. Some individuals are observed giving alert calls to the group by shaking the tree branches vigorously. Aggressiveness towards a particular sub adult was shown by a female individual of the group several times.

Fig 2-Individual drinking water collected in a pole.

Fig 3. Monkeys raiding crops.

Fig 4.Monkey playing with pet **dog.**

V. DATA ANALYSIS

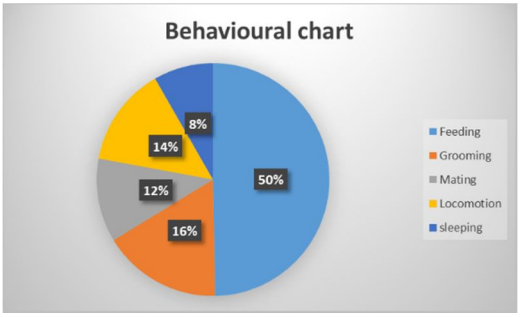

Fig 5.Pie chart showing the percentage of primates involved in various activities.

Table 1: Capturing Information

Date	Sr No.	GPS location		Type of trap	From time	To time	Capturer	Capture
		Latitude	Longitude					
11-Mar-19	1	32°8'49.97"N	76°25'9.98"E	NET	10am to 3pm		Madan Mukesh	Nil
	2	32°8'45.17"N	76°25'7.85"E	NET				Nil
12-Mar-19	1	32°8'49.97"N	76°25'9.98"E	Cage	9am to 10:30am		Madan Mukesh	Nil
24-Mar-19	1	32°8'49.91"N	76°25'10.45"E	Cage	8am to 6pm		Madan	1 SA and 1A Female
26-Mar-19	1	32°8'28.71"N	76°24'42.36"E	Cage	8am to 12pm		Rakesh	1 Pregnant female
	2	32° 8'43.19"N	76°25'7.54"E	Cage				
	3	32°8'49.88"N	76°25'10.45"E	Cage				
28-Mar-19	1	32°8'32.86"N	76°24'45.96"E	Cage	9:00am to 2:30pm		Narender	Nil
	2	32° 8'56.00"N	76°25'4.27"E	Cage				Nil
	3	32°8'56.20"N	76°25'4.49"E	Cage				Nil
29-Mar-19				No trap				

VI. CONCLUSION

Capturing may be unsuccessful due to reasons listed below

1) Capturing time As per the guidelines, early mornings and late evenings should be targeted for capture as monkeys are active in groups. Traps were not set early mornings but in the late morning/ afternoon when the troupe was more scattered.
2) Capturer's poor co-operation and unwillingness to spend time in capturing
3) Capturer's were unavailable for a long period of time.
4) The capturers should be skilled and more trained to attract the monkeys into the trap.

A. *General Observations*

1) *Troup Constitution:* In chamunda monkeys, the female ration outcompete male in numbers. In village troupe Alpha male always associated with one female. One peripheral group of six monkeys have been observed with village troupe. Hind quarters and facial colour change: skin coloration is the sexually inherited trait in rhesus monkeys. Skin redness is linked to fecundity in both male and female rhesus. (Petersdorf et al., 2017, Dubuc and Allen 2014) www.sciencedaily.com. Chamunda monkeys seen to be develop dark coloration of facial and genital parts during reproduction period.
2) *Grooming by Infants:* Infants were observed grooming their mothers, this indicates infants are quick learners of process. Human perception: Daadh area is a human dominated place surrounded by famous Chamunda Devi temple, and village area where people relay on agriculture. India is a religious country; most of the Hindu followers believe monkeys as a form of god Hanuman. Devotees of Chamunda temple feed monkeys, in the villages the situation is entirely different, the village troupe ride on crop fields, attacks people and snatch food from them. People try to get rid of monkeys by throwing stone to them, air guns used to scare away the monkeys and also some people enjoy provocation of monkeys by stone felt. People are complaining, action against this monkey problem has not implemented well and if this situation continues as such, which may lead to growing conflict.

B. Suggestions and Discussion

1) Project should be carried out in long term period, at least for 6 months to study behaviour of monkeys because three months are not enough to draw proper behavioural inference.
2) Project should be started before mating season.
3) Staffs should have enough knowledge on the monkey sterilization project
4) Capturers should well equipped with capturing tools and should use different methods to capture monkeys instead of using same method or using same method more skilfully.

C. Short term solution

1) Usage of immuno-contraceptive vaccines
2) Bioacoustics
3) Culling
4) Use of laser pointers for scaring monkey
5) Monkey repellent device
6) Monkey control Spikes
7) Long term solution
8) Waste management model
9) Availability of abundant wild fruit bearing trees in forest throughout the year
10) Awareness programs arranged by forest department on not to feed monkeys.
11) Monkey repeller shock tape

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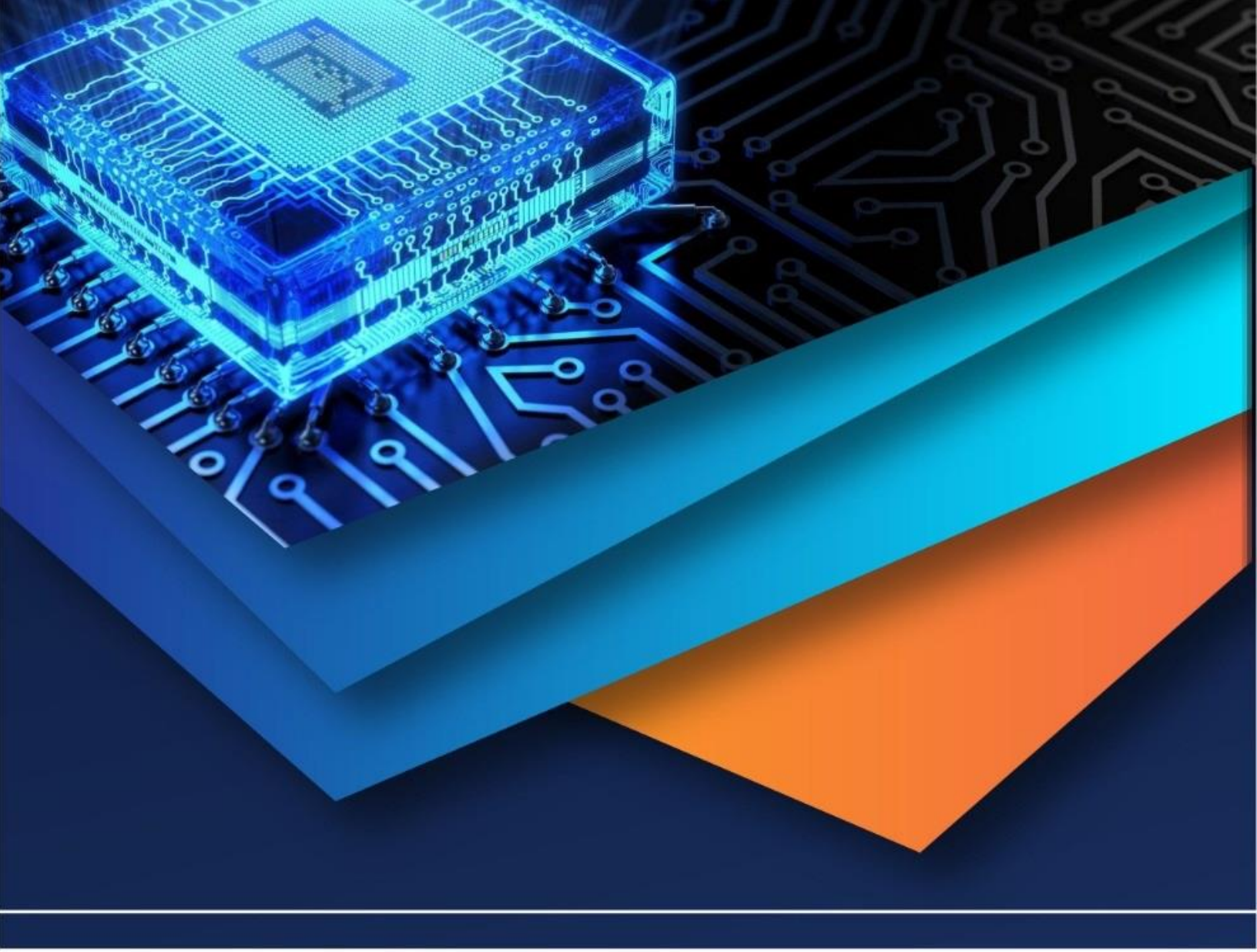

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