

# Changes in the Behavior and Population Growth of Rats Providing Favorable Conditions in Limited Space: A Review

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**Abstract:** During the present study, a review was carried out on changes in the behavior and population growth of rats providing favorable conditions in limited space. Overpopulation suppresses the carrying capacity of a particular geographical area. Overpopulation has become one of the most threatening global issues that impact the world adversely. Every year it grows by 1.2%. Scientists are fascinated about the fate of the human population and the behavioral influence among the population due to limited living space. Many Biologists and Ethologists perform various experiments taking rat population as model and consider it relevant to human population. Rats are social animals and have very similar societies like humans. Scientists can relate many behavioral and social similarities between human and rats. All the favorable conditions like bedding for nest, food and water in unlimited amount was provided to an inbuilt closed enclosure of rats but the only restriction was limited space. Population of rats increased exploitantly due to these conditions and got more catastrophic results throughout the study of over-population in the past years. Results are in the form of their behavioral breakdown which can be seen in the form of parental care and social fabrics. These results can predict the fate of the growing human population. High populated conditions concern Health-related issues and depressingly predict pro-reproductive attitude to have offspring in addition to optimistically predicted anti-reproductive attitudes above the influence of age, gender, and spiritual status.

**Keywords:** Overpopulation, Rats, Behavior, Ethology, Population growth, Rat Eutopia.

## I. Introduction

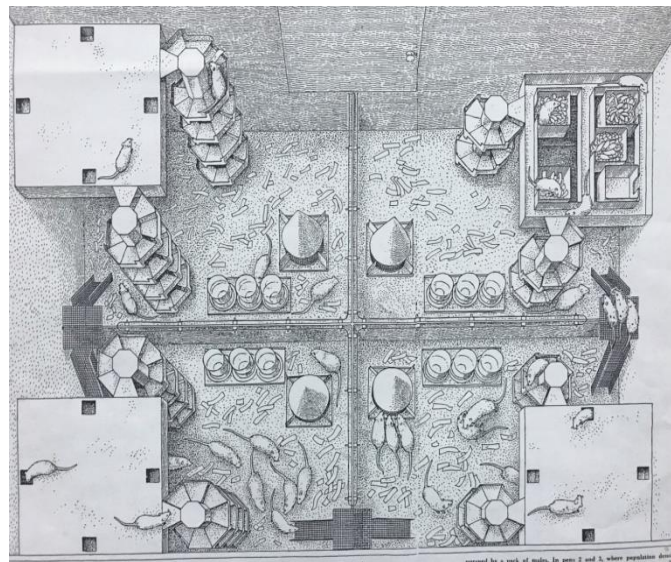
Man advances in their activities in cultural, social, economic and technology to enhance their livelihood. On behalf of these, humans have four distinctive features: (I) Humans have long lifespan, (II) Slightly long time period of immature dependency, (III) Ability to reproduce in post-reproductive period and (IV) Male support and protect females and their infants (Kaplan, 1997; Kaplan *et al.*, 1999). The death rate among human is decreasing due to present day medical services and high quality food resources. This leads to tremendous increase in the human population. Increasing population also affects the social and cultural behavior of species and the community structure. Population is considered over-population when the environment is unable to sustain population because overpopulation suppresses the carrying capacity of that geographical area (Kopnina and Washington, 2016; Peacock, 2018). Hence, overpopulation has become one of the most threatening global issues impacting the world. Andreassen *et al.* (2021) studied population cycles and outbreak of small rodents and highlighted the ten essential questions still needed to be solved. Many biologist and ethologists perform various experiments taking rat population as model and consider it relevant to human population. As rats are social animals which have very similar societies like humans, scientists can relate many behavioral and social similarities between human and rats. Dr. John Calhoun was one of pioneer in this field. He built an enclosure of 10 feet by 14 feet. These facilities included unlimited food, water and nesting material. He divided the rats in 6 populations and allowed them to grow twice the size of available space and observed for 6 months. This paper is a review of the various researches that have been conducted in past years on the impact of overpopulation on behavior of individuals. In this review, to explore our knowledge of mechanism underneath dynamics of populations, we have reinvestigated the pioneer work of Calhoun (1962 a, b, c).

## II. Objectives

To understand the

- ✓ Population growth patterns
- ✓ Behavioural alterations
- ✓ Social Structures of the society

- ✓ Parenting patterns
- ✓ Communication
- ✓ Life span



### III. Review of the Literature

Population is concerned with the growth, termination, movement and the effects on the behavior of the individuals. Population is the collection of individuals of same species in a particular geographical area but the excess number of individuals causes overpopulation and this has very drastic effects on the environment too. Calhoun (1962) worked on behavioral changes due to over-population in white albino Norway rats. He planned a completely new enclosure which was more upright with 16 wall-mounted housing areas for the rats at the tops of long metal tubes which he called the “walk-up apartments”. At the bottom of each apartment house, there was unlimited supply of food, water and nesting material with the space provided. He introduced 8 rats in the enclosure, 4 male and 4 female and simply wait and watch. The four phases observed among population were: (1) Phase A (the stride phase or the adjustment phase), (2) Phase B (the exploitation phase), (3) Phase C (the stagnation phase or the equilibrium phase) and (4) Phase D (the death phase). Pathological effect of over-population on the female rats was also studied. Fertility and fecundity rate decreased in the females. Males showed hyperactivity and hypersexual behavior in overpopulation. Homosexual rats were unable to differentiate between the male, female and young. Some males used to eat and drink only when other fell asleep. Some males attacked females, infants or weak males for no reason. Dominant females were also observed in population. Four types of violence were observed: (I) Preliminary behavior, (II) Attacking behavior (III) Escaping or defensive behavior (IV) Non-competitive violence (Calhoun, 1973). This experiment formed a base for the future studies in this field. Further development in this field will lead us to understand the population biology and psychology through which we might be able to control our growing population. Calhoun (1973) concluded that the rats could not efficiently deal with the frequent interactions of many individuals. The evidence of brutality increased to the point where most of the rats had bitten tails to some degree. Eventually the entire rat population perished. The experiment performed by Calhoun (1973) is a classic example of a distinctive population growth when population was left unchecked.

### IV. Observations

#### *Population growth*

- ✓ Phase A (Day 0-104) – The Stride Phase – Rats basically adapted themselves, established territories and built nests.
- ✓ Phase B (Day 104-315) – The Exploitation Phase – The population of the rats doubled in every 55 days. Use of resources became unequal as there was unlimited amount of food and water in every identical unit of the facility. Despite this, only in several areas the consumption of resources were more which was associated with rats eating and drinking in company of other members of the group. Hence, there was crowding of rats.
- ✓ Phase C (Day 315-560) – The Equilibrium Phase – it was found that the rats population was levelling off and developed equilibrium. Calhoun (1973) noticed that the members of the new generations were inhabited as most of the room was

previously engaged. Some abnormal behaviour became visible among rats population. Violent behaviour turned into more widespread. Males couldn't protect their females. So, females were compelled to defend their nest. Mother rats would forget some of their infants while moving one nesting site to another due to stress of defending their nests. Some mother rats reabsorbed the unborn rats in the womb further decreasing the fertility rate. Young rats that grew in that adulthood exhibited even more different type of behaviour. Calhoun (1973) called these individuals "the Beautiful ones". These beautiful ones spend their most of the time in grooming, eating and sleeping. They had almost no involvement with the others. They neither engaged themselves in sex nor in the violence.

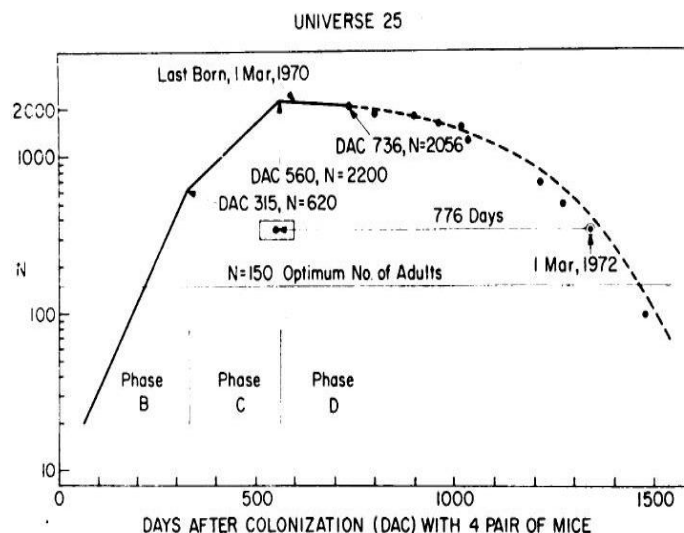
- ✓ Phase D (Day 560-X) – The Death Phase – This stage was described to a great extent by a whole generation of young ones who had been rejected by their mothers early and drove away from the home and they were consequently unfit to display normal social behaviour. This showed from various perspectives, the females of this 18 generation had far less offspring and those that had infants came up with lack of maternal instincts important to raise them beyond weaning. This led to the extermination of the overall population. As the last rats with reproductive impulses matured beyond their fertility, Calhoun (1973) declared that the last male would die around Day 1780 of the experiment successfully delivering the colony dead as it could not produce any more young ones. As this "Universe 25" was developed to house about 3,000 rats but the population began to decline when housing attained 2,200 rats. This decline shifted from "the equilibrium phase" to "the death phase".

Behavioral Pattern (Behavioral Sink)

- ✓ Depressed Maternal Behaviour
- ✓ Hyper Sexual Activity
- ✓ Lack of Parental Care
- ✓ Increase in the Aggression and Brutality
- ✓ High Infant Mortality Rate
- ✓ Emergence of Beautiful Ones (the stupid Ones)

Social Patterns

- ✓ Collective Feeding Habitat
- ✓ Conflict for Dominancy and Territory
- ✓ Struggle for status
- ✓ Depressed Community Structure
- ✓ Decrease in Tolerance
- ✓ Loose interest in Nesting



## V. Conclusion

Research on the psychological and social behavior of the population is worth study. Researchers revealed the adverse effects of the overpopulation on the social structure and functionality of the society. Despite the criticism, work of Calhoun (1962) was a great success in understanding the physiological and psychological effects of overpopulation. These effects were in the form of depression, stress, aggression, reproductive failures, chewing of tails, infant mortality, struggle for status, loss of maternal instincts and inability of building nest etc. Calhoun (1973) also found an unusual behavior in rats that showed no interest in any activity. They were well groomed and calm with shiny fur but they were literally stupid. While having all things they just gave up on everything. Loseva *et al.* (2013) tracked down that long term overcrowded conditions also led to reciprocal changes in the level of the dopamine and norepinephrine. These chemicals decrease in the septum and hypothalamus of the rodents. Latest studies of Brown *et al.* (2020) showed that the relationship between density and dispersal was not static temporarily as female dispersal was more density dependent than males in the population of wild deer mice *Peromyscus maniculatus*. Further investigations ought to be done in this field in light of the fact that these tests straightforwardly address mankind and can be utilized to comprehend the physiology and psychology of overpopulation on society. The majority of the experiments directed on rodent population can be related with human population. Results were so extraordinary and were able to predict the destiny of human population in future. These results have shown many discouraging, perilous, severe and concerning face of overpopulation to the world since it also faces much criticism. But overall it will be able to make us understand the limitations of our social structures.

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