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IN POOLESVILLE STUDY

Rats Given 'Culture' As Defense Against Overcrowding

To what degree do such cultural patterns as marriage and social class help individuals cope with overcrowding?

Such role playing and membership in social networks act as a bulwark against overcrowding's encroachments upon complex behavior, theorize NIMH intramural researchers.

By introducing what they regard as an equivalent of "culture" into a society of rodents, the scientists hope to triple the animals' capacity for surviving otherwise devastating increases in population density.

The team, led by Dr. John Calhoun, is launching the novel experiment this month at the NIMH animal laboratory in Poolesville, Md., where new computer-programmed environments are being used for the first time in the latest in a series of studies on psychopathology due to overcrowding.

In his now famous earlier experiments, Calhoun demonstrated that if mice are allowed to multiply in a big metal box, overcrowding eventually causes them to develop "autistic-like" behavior — to cease social interaction and mating — and ultimately to die out. The animals typically stop reproducing after their population reaches four times its normal density.

Calhoun first attempted to determine whether a more beneficial environment might offset this process. In an experiment still underway at Poolesville, hundreds of mice are living in what was a roomy, airy "universe" more than 18 feet in diameter, specially designed to give them virtually every advantage— every one, that is, except more space as they multiply.

Optimal for about 100 - 200 mice, the habitat now has nearly 800 residents, and many of the younger generation are showing signs of stress. They are finding it more and more difficult to establish small group ties and a territory of their own, according to Calhoun.

He estimates the rodent society might hold out in the increasingly confined space until its population reaches from 800 to 1600 members before succumbing to the deleterious effects of inescapable overcrowding. He is interested in watching the process develop, for previous studies have shown that in the last generation to survive, the animals betray no physiological signs of stress; they simply become incapable of interacting with each other and reproducing.

"We need to understand this process as a clue to what to watch for in human society," he remarked. "Once a population reaches this stage, there is no way to undo the damage. They are bound for extinction."

The habitat's radial architecture features compartments that lend themselves to the mice's need for small group contacts and territorial boundaries. Also, each generation of mice is given a chance to raise two or three litters which are removed before they reach maturity. This gives subsequent offspring the advantage of being reared by experienced parents.

But even the best layout and parenting are not enough. "I'm convinced that you can't completely compensate for density in a static environment," said Calhoun. Hence his new effort to see how crowded rodents fare if they are given a bit of "culture."

The Poolesville team has devised an ingenious technology for the new study. Two identical computer-controlled rat "universes" are employed. Each starts out with 16 rats—about the right number for the space. However, the programmed environment operates in only one universe; the other is a control.

Each rat has a glass-encapsulated coil embedded under its belly skin that tells the computer its location at all times. Whenever a rat passes through an opening or "portal" between compartments, the coil creates a disturbance in an electromagnetic field, indicating its identity and direction of travel.

To foster male-female pair bonding, the environment is programmed to provide water only when two rats of the opposite sex are present at the fountain, an arrangement Calhoun dubs "marriage."

Since the computer tracks the movements of every rat throughout its life, it has been possible to identify empirically two "social classes" among the animals: the more active, those who move between compartments frequently, and the less active. The latter tend to be less well-adjusted socially. Food is made available in a "dining room" only when all rats present in that compartment are of the same class.

Via such technological guidance, the rodents in the experimental group are given the advantage of becoming members of small subgroups and developing cooperative social roles. Calhoun hopes these arrangements will maintain the animals emotionally unscathed despite a fourfold increase in density. Lacking this cultural edge, the rats in the control group will become autistic-like at that level of density, he predicts.

Overcrowding takes its toll on a species' most complex behaviors, according to Calhoun. In the case of rodents, these have to do with territoriality, attachment to place, caring for others, the young, courtship and mating.

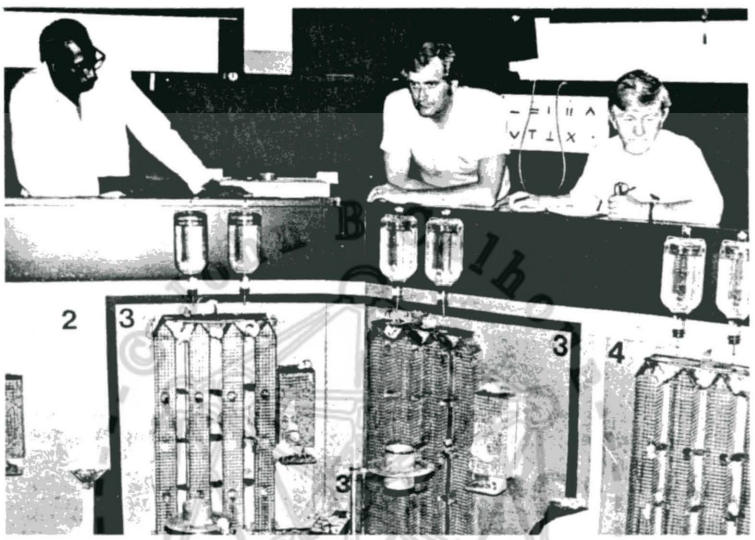
Calhoun theorizes that the "social networking" and cooperative role playing learned in the programmed environment help the animals resist the breakdown of such complex behavior. This proved correct.

"Individuals are genetically adapted for needing just a certain number of satisfactory personal contacts," he explained. When the number of social contacts is excessive, the proportion of unsatisfactory relationships increases to a point where they become a drag on coping capacity. Membership in smaller groups cuts down the number of unsatisfactory interactions produced by generalized overcrowding, suggested Calhoun.

"We're reducing the whole evolution of culture to a simple paradigm," he explained. "If you can design environments to guide social relationships, you can give each individual an optimal number of contacts."

The animal ecologist says his work has implications for human society but he cautions that "when you work across animals from mice to men you have to ask the right questions." For instance, unlike rodents human fertility rates have been shown to increase with crowding.

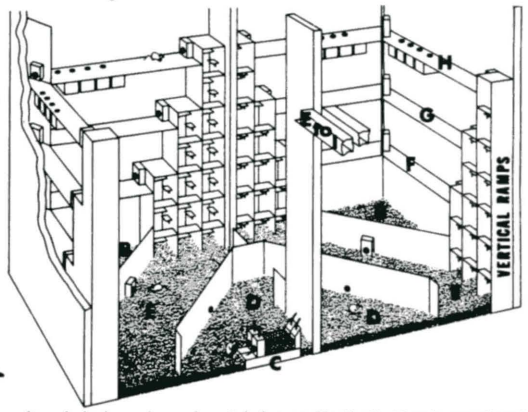
Calhoun suggests this is because intellectual behavior is the most complex for man. Crowding threatens the ability of humans to come to grips with the complexity of world ecology and problems of overpopulation, in his view. —JA



NIMH researchers overlook the "mouse universe" at the Institute's intramural laboratory in Poolesville, Md. The compartmentalized habitat is used to study the effects of environmental design on the development of psychopathology due to overcrowding. From left: mathematician Garret Bagley, behavioral biologist Dr. James Hill, and ecologist Dr. John Calhoun. ←UNIV. 33, STUDY 183

Photos by Lela Garlington

Computerized Rat Habitat



A drawing of the culture-inducing universe for rats being used for the first time in experiments beginning this month at the NIMH Poolesville lab. The movement of each animal between compartments is tracked by a computer programmed to foster certain kinds of cooperative behavior as a defense against the effects of overcrowding. For instance, food is dispensed in a "dining room" (area B) only when all animals present are members of the same "social class."

clear I.D. differentiation kept population per UNIVERSE to 40 individuals, i.e. 2.5X optimum density

[A glitch (unresolvable) forced deletion of this objective.]