Populations of House Mice

What controls the abundance of animals? Here the question is approached by way of a small pest which has the experimental advantages of an accessible habitat and rapid multiplication

by Robert L. Strecker

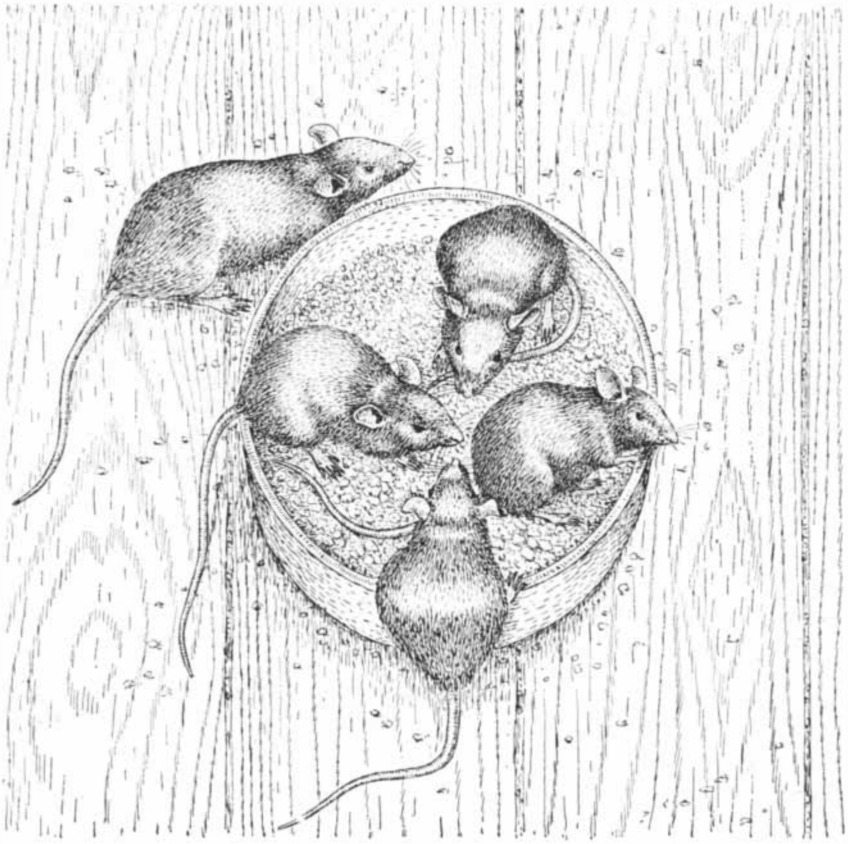
"The proper study of mankind," wrote Alexander Pope, "is man." He might equally have said that a very proper study of man is mankind, considering mankind as a population. Studies of human populations as such tell us many things about what kind of creature man is. This is also true of other animals. The survival, behavior and success of any living organism depend to a considerable degree on its characteristics as a population.

No animal voluntarily lives in a social vacuum. It must congregate with others of its own kind, even if only to propagate; if by some chance an individual gets isolated from its kind, that is the end of the line. Plainly, then, a primary need of every kind of animal is to maintain itself as a population. There are laws of population development, just as there are laws governing all other mass phenomena in nature. Consequently we can learn something about any animal, including man, by studying populations in general, whether they be yeast cells, insects, mice or elephants.

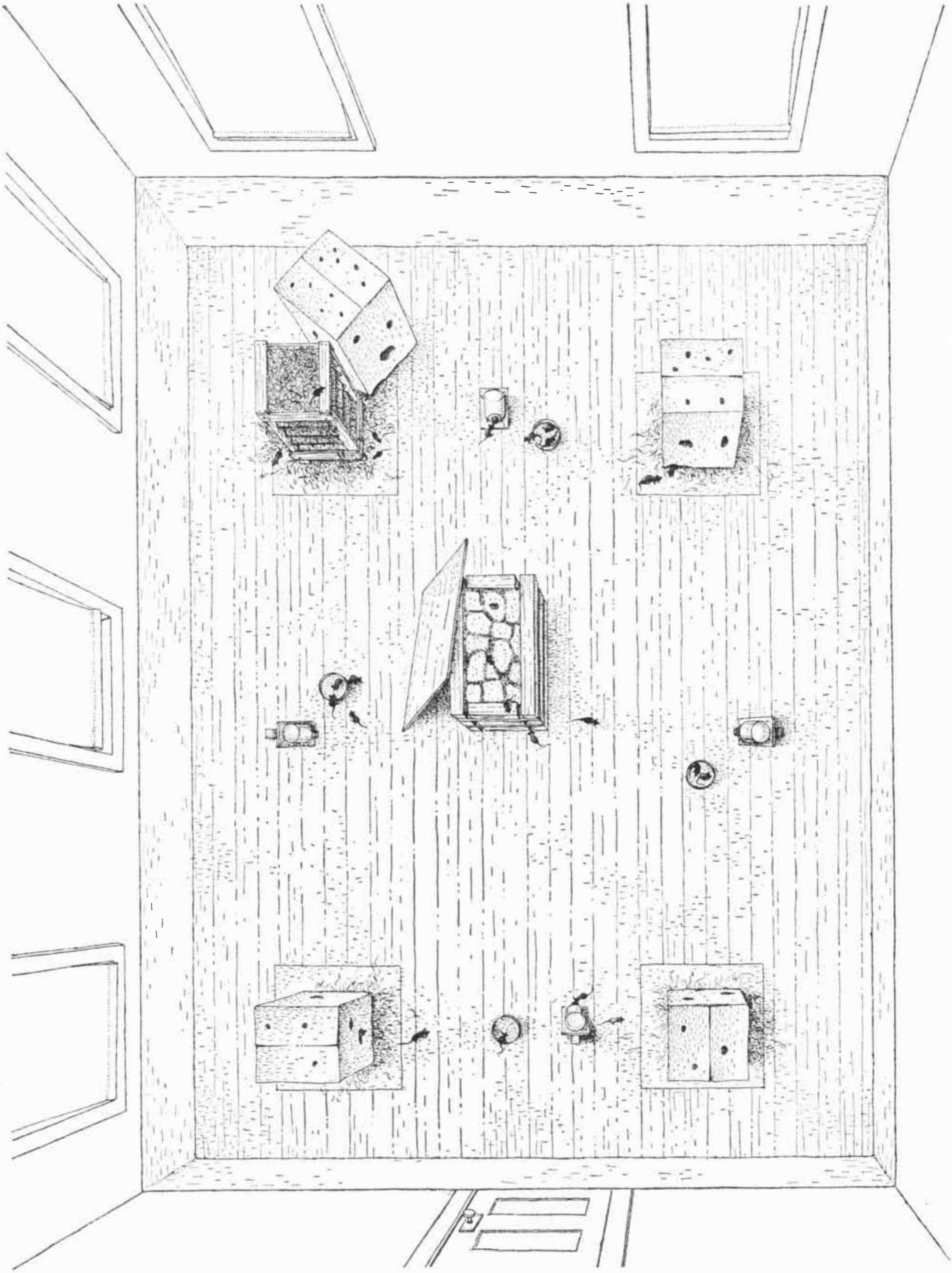
In theory all populations follow a certain basic pattern of development: they tend to multiply according to a growth curve which rises slowly at first and then picks up momentum until it shoots upward almost vertically. If we start with a pair of mice, say, we may expect them to produce a litter of six young, half male and half female, in three weeks. The offspring will mature sexually in five or six weeks and themselves begin contributing to the increase. Within 12 weeks after the beginning the population might total some 32 mice, and soon its numbers would be increasing at a tremendous rate.

A colony of yeast cells, which may divide every 30 minutes, could reach the stage of very rapid growth in numbers in a matter of hours. Elephants, which do not mature sexually until the age of 15, might take a century. But in theory the shape of the curve is essentially the same in each case.

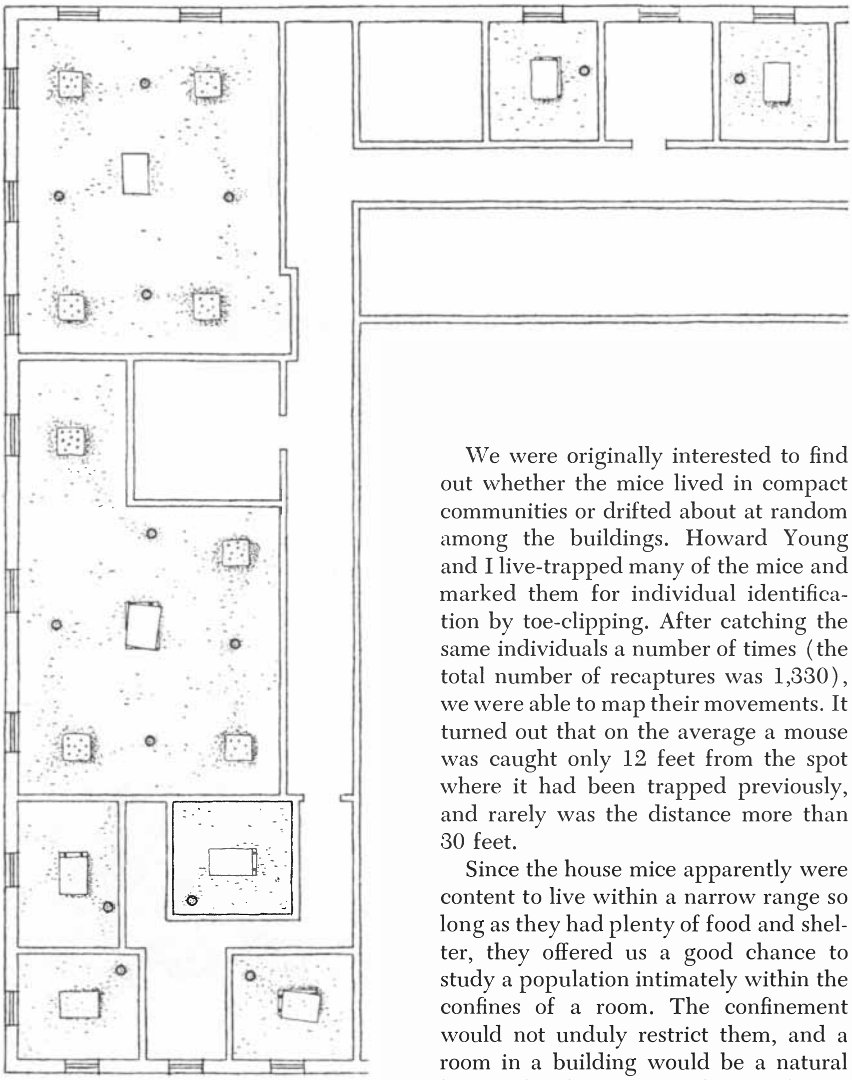
Actually for various reasons populations do not follow this curve of unrestrained growth except on rare occasions such as a sudden plague of insects. Normally the population increase is held in check by the limits of food and water and living room, by predators, accidents and diseases. These factors tend to put a ceiling on the population rise, so that the actual curve of population growth is usually shaped somewhat like an S—first rising slowly, then rapidly, then leveling off. If one of the major limiting factors (*e.g.*, predators) is removed, the population may start rising again, but the



POPULATION OF HOUSE MICE in the principal experiment described by this article was given a total of 250 grams of food per day. The species was the common *Mus musculus*.



HOUSE MICE WERE CONFINED in pens which had been mouse-proofed with sheet iron to a height of 22 inches. This pen has four locations for food and water and two kinds of shelter. One (*corners*) is filled with paper and cotton; the other, with beaverboard.



EIGHT PENS were constructed in an empty army barracks. The small pens were used chiefly to check on reproduction in winter.

other limitations will soon stop it at a new plateau.

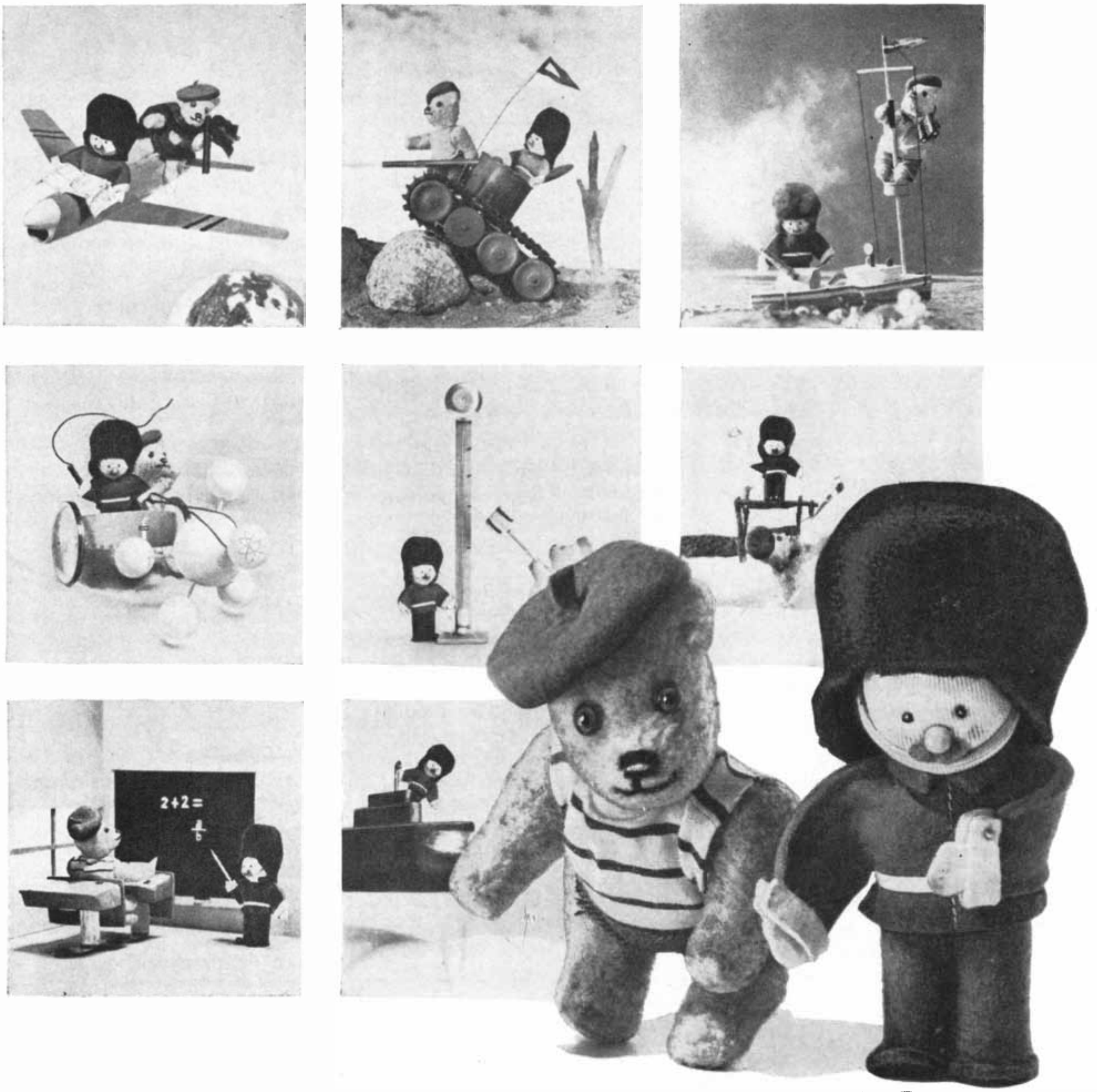
Many attempts have been made to investigate just how the limiting factors control the abundance or scarcity of animals. The studies I shall describe were carried out at the University of Wisconsin under the guidance of John T. Emlen, Jr. The subjects were house mice. Around some of the campus laboratories where various experimental animals were kept in cages, there were several flourishing colonies of the ordinary little wild mice that infest houses. They fed mainly on food they stole from the cages of the laboratory animals. It was curiosity about their movements and community life that led us to discover they would make ideal subjects for detailed population studies.

We were originally interested to find out whether the mice lived in compact communities or drifted about at random among the buildings. Howard Young and I live-trapped many of the mice and marked them for individual identification by toe-clipping. After catching the same individuals a number of times (the total number of recaptures was 1,330), we were able to map their movements. It turned out that on the average a mouse was caught only 12 feet from the spot where it had been trapped previously, and rarely was the distance more than 30 feet.

Since the house mice apparently were content to live within a narrow range so long as they had plenty of food and shelter, they offered us a good chance to study a population intimately within the confines of a room. The confinement would not unduly restrict them, and a room in a building would be a natural habitat for them, as any housewife can testify. Furthermore, house mice are excellent subjects for population study because they reproduce rapidly, frequently and more or less continuously throughout the year.

The home we first chose for the mice was a large room in the basement of one of the campus buildings. It had several large ventilating fans, boxes, jars, lumber, tile and other stored equipment which would supply hiding and nesting places for the mice. The room was closed, but the mice could escape from it if they had to by way of heating pipes and ventilating shafts.

We first undertook to study the effect of limiting the population's food supply. Our plan was to colonize the room with a few mice, to give the colony just 250 grams of food each day and to see what would happen when the number of mice increased to the point where this supply of food could no longer support the growing population. We trapped the mice in the room at frequent intervals to weigh them and mark them individually



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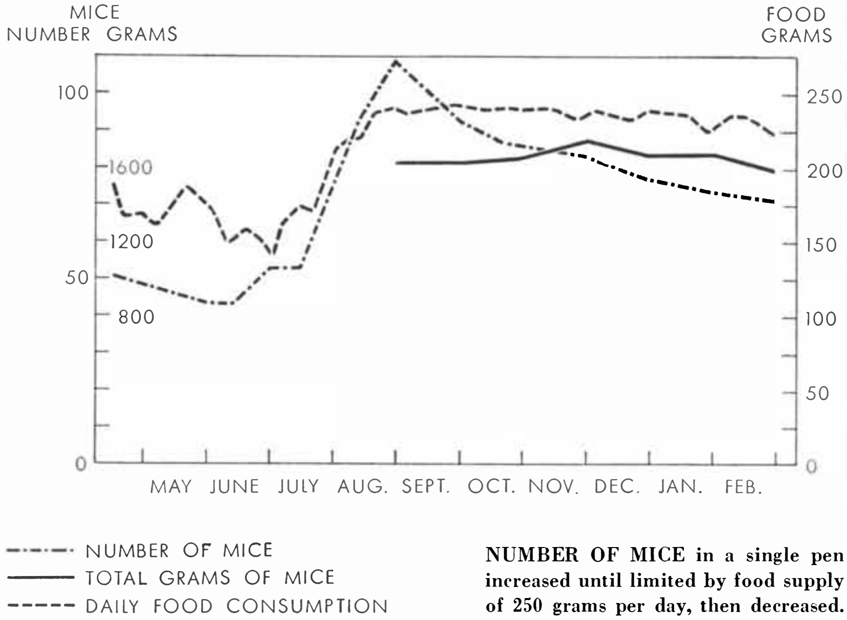
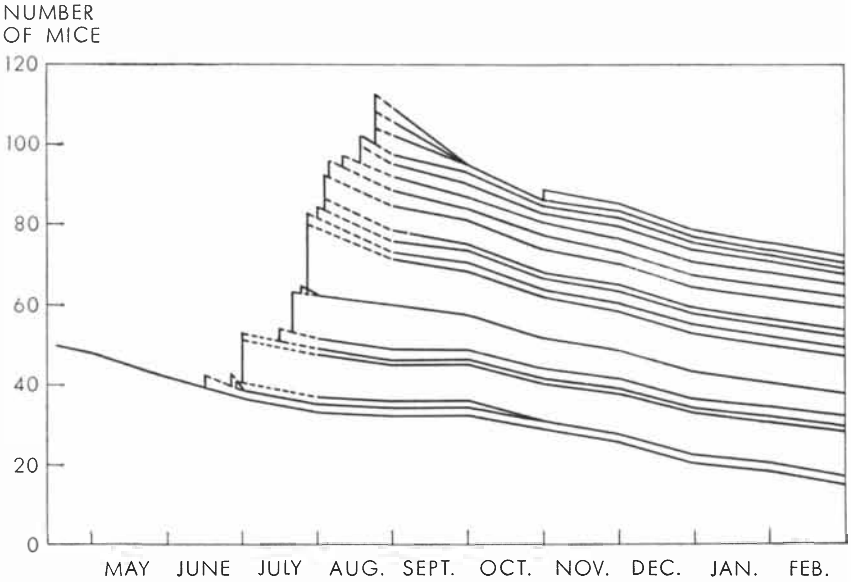


NUMBER OF MICE in a single pen increased until limited by food supply of 250 grams per day, then decreased.

for identification, and we set other traps throughout the building to catch members that strayed from the colony.

During the first eight months only nine marked mice left the room and were caught outside. But by the end of the eighth month, when the population had grown to the point where it was consuming nearly all the daily food supply in the room, the mice began to leave in substantial numbers. In the next three months we caught 82 migrants outside the room. This increased flight from the colony was clearly due to the food limit. Enough mice left so that no actual food shortage developed within the colony.

The tide of mice throughout the classrooms and offices of the building was not enthusiastically received, and we had to put an end to the colony. After trapping the mice, we were interested to see whether the group that had left the colony differed from the population which stayed behind. Did the youngsters tend to move out, while older, established mice remained; or did the vigorous young mice drive out the older ones? Were males more likely to leave than



MAKE-UP OF POPULATION in the same pen developed in this manner. The appearance of each new litter is indicated by a vertical jump from the uppermost line. The solid lines refer to marked mice; the dotted lines extend the record of litters back to the estimated time of birth. The small jump at top right is due to two outside mice which got into the pen.

females? Examination of the groups showed that both were about the same, with no sex or age predominating, except that very young mice still dependent on their mothers of course stayed in the colony. Of the 87 mice trapped in the room at the end of the experiment, a fifth were babies barely out of the nest. Many of the mature females were pregnant, indicating that reproduction had been going on steadily.

To summarize, then, this study showed that as long as there was sufficient food the population stayed pretty much intact, with only an occasional individual deserting; that as a food shortage approached, migration from the colony increased sufficiently to tap off mice as quickly as new ones were born; that reproduction apparently continued normally, and that the population which remained was a cross section, with no unusual features as to sex or age composition. The experiment clearly demonstrated that when some stress, such as an approaching food shortage, is brought to bear on a population, it will spread out and occupy new areas.

We wondered what would happen to the mouse population if members could not escape, if they had to remain in a confined place with only a limited amount of food available. Would the young or the old have the better chance to survive? Would the mice begin fighting and killing one another? Would reproduction slow down or stop?

In an attempt to answer this question we started two colonies of mice in two rooms of an empty building. The rooms were sealed so that mice could not escape. Each room was supplied with shelters, water and 250 grams of food per day. One colony was started with 10 mice, the other with 50 mice, and both were closely watched for 11 months. All mice were individually marked so they could be identified. Every two weeks a thorough search was made to find the newly born mice and record them. Once every four weeks each mouse was caught, weighed and examined for physical condition.

The colony that started with 10 mice did not grow large enough within the 11 months to press on its food supply, so it served only for comparison. The 50-mouse colony grew up to the food limit within four months. When it began to consume all the food each day, reproduction stopped completely. No new baby mice were born, and those already present soon died. However, all the animals past weaning seemed to hold their own. The older members of the colony

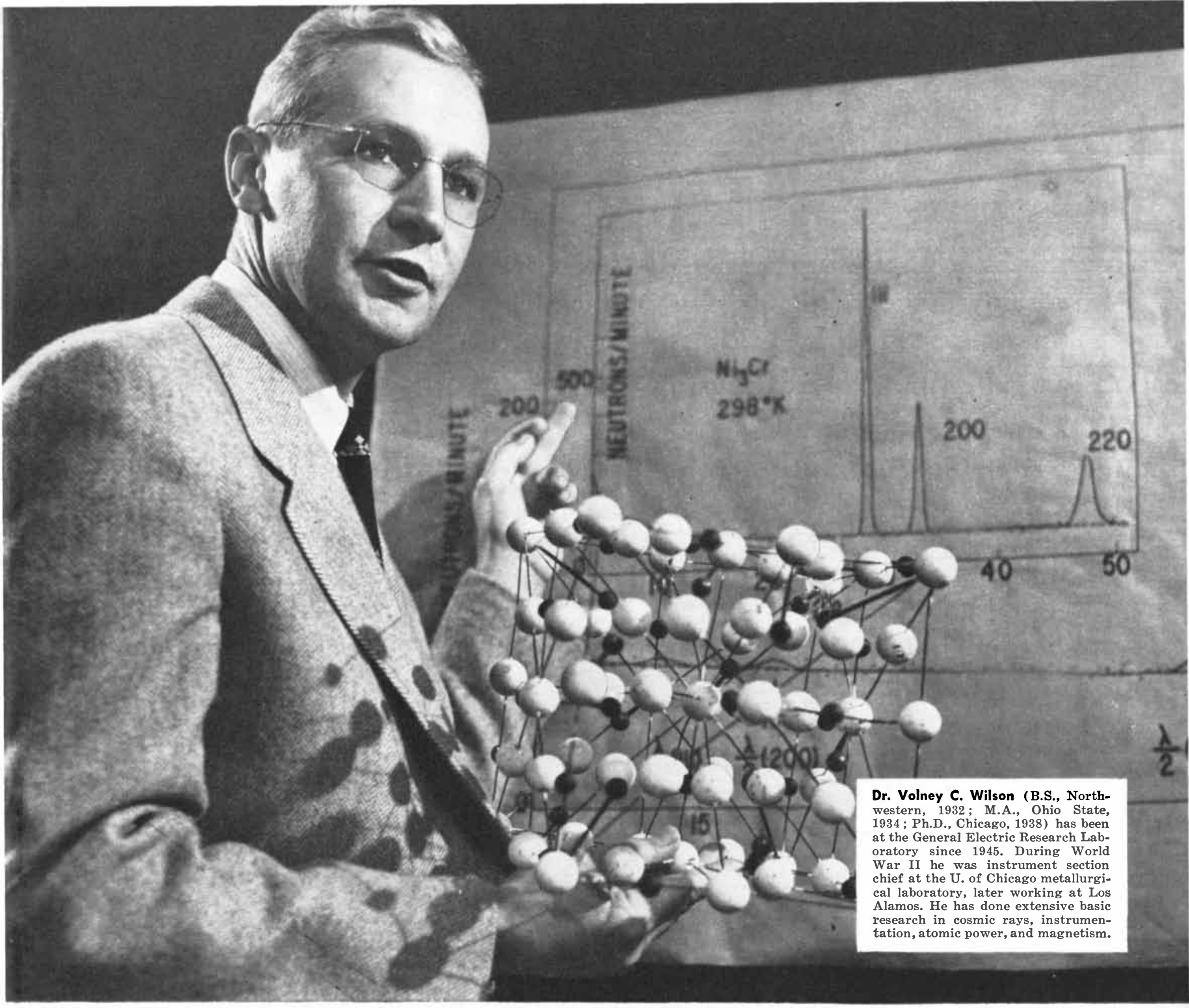
declined in numbers, presumably dying of old age. But the total weight of the colony remained fairly constant, as the weight put on by the growing younger members offset the losses by death. In other words, the food supply maintained a certain weight of live mice for the colony as a whole.

When, at the end of the 11 months, the surviving mice were autopsied, all showed heavy deposits of fat on their bodies, because the experiment was terminated in March, at the end of winter. None of the females was pregnant, as far as could be determined. The building had been unheated during the winter, and the cold would account in part for the suppression of sexual activity. However, it could not have been wholly responsible, for in the companion colony, where the mice had an abundance of food, reproduction did occur during the winter.

The experiments described give us a basis for speculation about the dynamics of population growth and spread, at least among house mice. The population grows rapidly and stays together in a restricted area until the limits of the food supply put pressure upon it. Then some of its members begin to migrate to new areas if they can. If they cannot, the colony may eventually stop reproducing. Probably it does not resume producing young until the pressure is relieved. Unfortunately we lost our building before we could investigate the latter point by observing developments in the spring.

Of course food is not the only factor that influences the development of a population. Other specific studies of house mice have shown, for example, that when mice are strangers to one another, they fight a great deal in establishing social position. The mice already living in an area are very antagonistic to newcomers. Obviously the amount of living space, in terms of the cover available for shelters, will influence the size of the population. Crowding interferes with the construction and maintenance of nests and increases the mortality among baby mice.

While there is no denying that the organization and development of a population, even of house mice, is a complex affair, we need not be discouraged by the complexity. The experiments on house mice indicate that the determining factors can be studied individually, and such investigations should lead us eventually to a fairly clear picture of the related parts played by the various influences on the abundance and scarcity of animals.



Dr. Volney C. Wilson (B.S., Northwestern, 1932; M.A., Ohio State, 1934; Ph.D., Chicago, 1938) has been at the General Electric Research Laboratory since 1945. During World War II he was instrument section chief at the U. of Chicago metallurgical laboratory, later working at Los Alamos. He has done extensive basic research in cosmic rays, instrumentation, atomic power, and magnetism.

Why magnets are magnets

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While Volney C. Wilson was director of instrumentation and control for the first atomic pile, under the University of Chicago stadium, Enrico Fermi demonstrated to him and others working on the project that neutrons could be diffracted in the same manner as x-rays. Several years later, when Wilson's interests turned to an intensive study of magnetism, he recognized the special value neutrons would have in revealing atomic arrangements in magnetic materials. Neutrons are not affected by *electric fields*, but—since they are very much like little magnets themselves—they are scattered by *magnetic fields* within crystals.

Accordingly, Dr. Wilson designed and constructed a unique *neutron diffraction spectrometer* at the General Electric Research Laboratory. It is now in operation at Brookhaven National Laboratory, giving G-E scientists new insight into the problem of why magnets are magnets. Wilson believes that learning new fundamental facts about "atomic-magnetic" structure will result in better magnetic materials—and that even a small improvement in these materials will significantly increase their usefulness in computers, control equipment, and color television.

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