

THE DANCING MOUSE

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IN LOVE AND GRATITUDE
THIS BOOK IS DEDICATED TO
MY MOTHER
PREFACE

This book is the direct result of what, at the time of its occurrence, seemed to be an unimportant incident in the course of my scientific work—the presentation of a pair of dancing mice to the Harvard Psychological Laboratory. My interest in the peculiarities of behavior which the creatures exhibited, as I watched them casually from day to day, soon became experiment-impelling, and almost before I realized it, I was in the midst of an investigation of their senses and intelligence.

The longer I observed and experimented with them, the more numerous became

the problems which the dancers presented to me for solution. From a study of the senses of hearing and sight I was led to investigate, in turn, the various forms of activity of which the mice are capable; the ways in which they learn to react adaptively to new or novel situations; the facility with which they acquire habits; the duration of habits; the roles of the various senses in the acquisition and performance of certain habitual acts; the efficiency of different methods of training; and the inheritance of racial and individually acquired forms of behavior.

In the course of my experimental work I discovered, much to my surprise, that no accurate and detailed account of this curiously interesting animal existed in the English language, and that in no other language were all the facts concerning it available in a single book. This fact, in connection with my appreciation of the exceptional value of the dancer as a pet and as material for the scientific study of animal behavior, has led me to supplement the results of my own observation by presenting in this little book a brief and not too highly technical description of the

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general characteristics and history of the dancer.

The purposes which I have had in mind as I planned and wrote the book are three: first, to present directly, clearly, and briefly the results of my investigation; second, to give as complete an account of the dancing mouse as a thorough study of the literature on the animal and long-continued observation on my own part should make possible; third, to provide a supplementary text-book on mammalian behavior and on methods of studying animal behavior for use in connection with courses in Comparative Psychology, Comparative Physiology, and Animal Behavior.

It is my conviction that the scientific study of animal behavior and of animal mind can be furthered more just at present by intensive special investigations than by extensive general books. Methods of research in this field are few and surprisingly crude, for the majority of investigators have been more deeply interested in getting results than in perfecting methods. In writing this account of the dancing mouse I have attempted to lay as much stress upon the development of my methods of work as upon the results which the methods yielded. In fact, I have used the dancer as a means of exhibiting a variety of methods by which the behavior

and intelligence of animals may be studied. As it happens the dancer is an ideal subject for the experimental study of many of the problems of animal behavior. It is small, easily cared for, readily tamed, harmless, incessantly active, and it lends itself satisfactorily to a large number of experimental situations. For laboratory courses in Comparative Psychology or Comparative Physiology it well might hold the place which the frog now holds in courses in Comparative Anatomy.

Gratefully, and with this expression of my thanks, I acknowledge my indebtedness to Professor Hugo M

unsterberg for placing at my command the

resources of the Harvard Psychological Laboratory and for advice and encouragement throughout my investigation; to Professor Edwin B. Holt for valuable assistance in more ways than I can mention; to Professor Wallace C. Sabine for generous aid in connection with the experiments on hearing; to Professor Theobald Smith for the examination of pathological dancers; to Miss Mary C. Dickerson for the photographs of dancing mice which are reproduced in the frontispiece; to Mr. Frank Ashmore for additional photographs which I have been unable to use in this volume; to Mr. C. H. Toll for the drawings for Figures 14 and 20; to Doctors H. W. Rand and C. S. Berry for valuable suggestions on the basis of a critical reading of the proof sheets; and to my wife, Ada Watterson Yerkes, for constant aid throughout the experimental work and in the preparation of this volume.

R. M. Y.

CAMBRIDGE, MASSACHUSETTS,

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CHAPTER I

CHARACTERISTICS, ORIGIN, AND HISTORY

The variety of mouse which is known as the Japanese dancing or waltzing mouse has been of special interest to biologists and to lovers of pets because of its curious movements. Haacke in Brehm's "Life of Animals" (7 p. 337)[1] writes as follows concerning certain mice which were brought to Europe from China and Japan: "From time to time a Hamburg dealer in animals sends me two breeds of common mice, which he calls Chinese climbing mice (*Chinesische Klettermäuse*) and Japanese dancing mice (*Japanische Tanzmäuse*). It is true that the first are distinguished only by their different colors, for their climbing accomplishments are not greater than those of other mice. The color, however, is subject to many variations. Besides individuals of uniform gray, light yellow, and white color, I have had specimens mottled with gray and white, and blue and white. Tricolored mice seem to be very rare. It is a known fact that we also have white, black, and yellow mice and occasionally pied ones, and the Chinese have profited by these variations of the common mouse also, to satisfy their fancy in breeding animals. The Japanese, however, who are no less enthusiastic on this point, know how to transform the common mouse

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into a really admirable animal. The Japanese dancing mice, which perfectly justify their appellation, also occur in all the described colors. But what distinguishes them most is their innate habit of running around, describing greater or smaller circles or more frequently whirling around on the same spot with incredible rapidity. Sometimes two or, more rarely, three mice join in such a dance, which usually begins at dusk and is at intervals resumed during the night, but it is usually executed by a single individual."

[Footnote 1: The reference numbers, of which 7 is an example, refer to the numbers in the bibliographic list which precedes this chapter.]

As a rule the dancing mouse is considerably smaller than the common mouse, and observers agree that there are also certain characteristic peculiarities in the shape of the head. One of the earliest accounts of the animal which I have found, that of Landois (22 p. 62), states, however, that the peculiarities of external form are not remarkable.

Landois further remarks, with reason, that the name dancing mouse is ill chosen, since the human dance movement is rather a rhythmic hopping motion than regular movement in a circle. As he suggests, they might more appropriately be called "circus course mice" (22 p. 63).

Since 1903 I have had under observation constantly from two to one hundred dancing mice. The original pair was presented to the Harvard Psychological Laboratory by Doctor A.G. Cleghorn of Cambridge. I have obtained specimens, all strikingly alike in markings, size, and general behavior, from animal dealers in Washington, Philadelphia, and Boston. Almost all of the dancers which I have had, and they now number about four hundred, were white with patches, streaks, or spots of black. The black markings occurred most frequently on the neck, ears, face, thighs, hind legs, about

the root of the tail, and occasionally on the tail itself. In only one instance were the ears white, and that in the case of one of the offspring of a male which was distinguished from most of his fellows by the possession of one white ear. I have had a few individuals whose markings were white and gray instead of white and black.

The method by which I was able to keep an accurate record of each of my dancers for purposes of identification and reference is illustrated in Figure 1. As this method has proved very convenient and satisfactory, I may briefly describe it. With a rubber stamp^[1] a rough outline of a mouse, like that of Figure 1 A, was made in my record book. On this outline I then indicated the black markings of the individual to be described. Beside this drawing of the animal I recorded its number, sex,^[2] date of birth, parentage, and history. B, C, and D of Figure 1 represent typical color patterns. D indicates the markings of an individual whose ears were almost entirely white. The pattern varies so much from individual to individual that I have had no trouble whatever in identifying my mice by means of such records as these.

[Footnote 1: For the use of the plate from which this stamp was made, I am
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indebted to Professor W.E. Castle, who in turn makes acknowledgment to Doctor G.M. Allen for the original drawing.]

[Footnote 2: I have found it convenient to use the even numbers for the males and the odd numbers for the females. Throughout this book this usage is followed. Wherever the sex of an individual is not specially given, the reader therefore may infer that it is a male if the number is even; a female if the number is odd.]

All of my dancers had black eyes and were smaller as well as weaker than the albino mouse and the gray house mouse. The weakness indicated by their inability to hold up their own weight or to cling to an object curiously enough does not manifest itself in their dancing; in this they are indefatigable. Frequently they run in circles or whirl about with astonishing rapidity for several minutes at a time. Zoth (31 p. 173), who measured the strength of the dancer in comparison with that of the common mouse, found that it can hold up only about 2.8 times its own weight, whereas the common white mouse can hold up 4.4 times its weight. No other accurate measurements of the strength, endurance, or hardiness of the dancer are available. They are usually supposed to be weak and delicate, but my own observations cause me to regard them as exceptionally strong in certain respects and weak in others.

[Illustration: FIGURE 1.—Typical markings of dancers. A, blank outline of mouse for record. B, markings of No. 2 [symbol for male], born September 7, 1905, of unknown parents, died March 30, 1907. C, markings of No 43 [symbol for female], born November 10, 1906, of 212 and 211. D, markings of No. 151 [symbol for female], born February 28, 1906, of 1000 and 5, died February 26, 1907.]

What the Japanese have to say about the dancing mouse is of special importance because Japan is rather commonly supposed to be its home. For this reason, as well as because of the peculiar interest of the facts mentioned, I quote at length from Doctor Kishi (21 p. 457). "The dancing mouse has received in Europe this name which it does not bear in its own home, because of the fact that the circular movements which it makes are similar to the European (human) dance. Sometimes it is also called the Japanese or Chinese mouse; originally, however, China must have been its home, since in Japan it is mostly called 'Nankin nesumi,' the mouse from Nankin. When this animal came from China to Japan I shall inquire at a later opportunity. There were originally in Japan two different species of

mouse, the gray and the white; therefore in order to distinguish our dancing mouse from these it was necessary to use the name of its native city.

"In Japan, as in Europe, the animal lives as a house animal in small cages, but the interest which is taken in it there is shown in quite another way than in Europe, where the whirling movements, to which the name dancing mouse is due, are of chief interest. For this reason in Europe it is given as much room as possible in its cage that it may dance

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conveniently. In Japan also the circular movements have been known for a long time, but this has had no influence upon our interest in the animal, for the human fashion of dancing with us is quite different from that in Europe. What has lent interest to the creature for us are its prettiness, its cleverness in tricks, and its activity. It is liked, therefore, as an amusement for children. For this purpose it is kept in a small cage, usually fifteen centimeters square, sometimes in a somewhat broader wooden box one of whose walls is of wire netting. In this box are built usually a tower, a tunnel, a bridge, and a wheel. The wheel is rather broad, being made in the form of a drum and pierced with holes on one side through which the animal can slip in and out. Running around on the inside, the mouse moves the wheel often for hours at a time, especially in the evening. Moreover, there are found in the box other arrangements of different kinds which may be set in motion by the turning of the wheel. No space remains in the box in which the animal may move about freely, and therefore one does not easily or often have an opportunity to observe that the animal makes circular movements, whether voluntarily or involuntarily. This is the reason that in its home this interesting little animal has never been studied by any one in this respect."

It is odd indeed that the remarkable capacity of the dancer for the execution of quick, graceful, dextrous, bizarre, and oft-repeated movements has not been utilized in America as it has in Japan. The mice are inexhaustible sources of amusement as well as invaluable material for studies in animal behavior and intelligence.

Concerning the origin and history of this curious variety of mouse little is definitely known. I have found no mention of the animal in scientific literature previous to 1890. The fact that it is called the Chinese dancing mouse, the Japanese dancing mouse, and the Japanese waltzing mouse is indicative of the existing uncertainty concerning the origin of the race.

Thinking that Japanese literature might furnish more information bearing on the question of racial history than was available from European sources, I wrote to Professor Mitsukuri of the University of Tokyo, asking him whether any reliable records of the dancer existed in Japan. He replied as follows: "I have tried to find what is known in Japan about the history of the Japanese waltzing mice, but I am sorry to say that the results are wholly negative. I cannot find any account of the origin of this freak, either authentic or fictitious, and, strange as it may seem to you, no study of the mice in a modern sense has been made, so you may consider the literature on the mouse in the Japanese language as absolutely nil ." In explanation of this somewhat surprising ignorance of the origin of the race in what is commonly supposed to be its native land, Professor Mitsukuri adds: "The breeders of the mice have mostly been ignorant men to whom writing is anything but easy."

In response to similar inquiries, I received the following letter, confirmatory of Professor Mitsukuri's statements, from Doctor S. Hatai of

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Wistar Institute, Philadelphia: "If I remember rightly the so-called Japanese dancing mouse is usually called by us Nankin-nedzumi . Nankin means anything which has been imported from China, and nedzumi means rat-like animal, or in this case mouse, or Chinese mouse. I referred to one of the standard Japanese dictionaries and found the following statement: 'The Nankin-nedzumi is one of the varieties of *Mus spiciosus* (*Hatszuka-nedzumi*), and is variously colored. It was imported from China. These mice are kept in cages for the amusement of children, who watch their play.' *Mus spiciosus* , if I remember correctly, is very much like *Mus musculus* in color, size, and several other characteristics, if not the same altogether."

In Swinhoe's list of the mammals of China, which appeared in the Proceedings of the Zoological Society of London for 1870, *Mus musculus* L . is mentioned as occurring in houses in South China and in Formosa. It is further stated that black and white varieties which are brought from the Straits are often kept by the Chinese (p. 637).

The statements of Kishi, Mitsukuri, and Hatai which have been quoted, taken in connection with the opinions expressed by various European scientists who have studied the dancer, make it seem highly probable that the race appeared first in China, and was thence introduced into Japan, from which country it has been brought to Europe and America. Accepting for the present this conclusion with reference to the place of origin of the dancer, we may now inquire, how and when did this curious freak, as Professor Mitsukuri has called it, come into existence? Concerning these matters there is wide divergence of opinion.

Haacke (6 p. 514), as quoted in Brehm's "Tierleben," says that an animal dealer with whom he discussed the question of the possible origin of the dancer maintained that it came from Peru, where it nests in the full cotton capsules, arranging the cotton fibers in the form of a nest by running about among them in small circles. Hence the name cotton mouse is sometimes applied to it. Haacke himself believes, however, that the race originated either in China or Japan as the result of systematic selectional breeding. Of this he has no certainty, for he states that he failed to find any literature on the "beautiful mice of China and Japan." Whether Haacke's description of the dancing mouse was published elsewhere previous to its appearance in Brehm's "Tierleben" I am unable to state; I have found nothing written on the subject by him before 1890. Zoth (31 p. 176) also thinks that the race was developed by systematic breeding, or in other words, that it is a product of the skill of the Asiatic animal breeders.

Another account of the origin of the race is that accepted by Kishi (21 p. 481) and some other Japanese biologists. It is their belief that the forms of movement acquired by the individual as the result of confinement in narrow cages are inherited. Thus centuries of sub jection to the conditions which Kishi has described (p. 6) finally resulted in a race of mice which breed true to the dance movement. It is only fair to add, although Kishi

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does not emphasize the fact, that in all probability those individuals in which the dancing tendency was most pronounced would naturally be selected by the breeders who kept these animals as pets, and thus it would come about that selectional breeding would supplement the inheritance of an acquired character. Few indeed will be willing to accept this explanation of the origin of the dancer so long as the inheritance of acquired characters remains, as at present, unproved.

Still another mode of origin of the mice is suggested by the following facts. In 1893 Saint Loup (28 p. 85) advanced the opinion that dancing

individuals appear from time to time among races of common mice. The peculiarity of movement may be due, he thinks, to an accidental nervous defect which possibly might be transmissible to the offspring of the exceptional individual. Saint Loup for several months had under observation a litter of common mice whose quick, jerky, nervous movements of the head, continuous activity, and rapid whirling closely resembled the characteristic movements of the true dancers of China. He states that these mice ran around in circles of from 1 to 20 cm. in diameter. They turned in either direction, but more frequently to the left, that is, anticlockwise. At intervals they ran in figure-eights ([Symbol: figure eight]) as do the true dancers. According to Saint Loup these exceptional individuals were healthy, active, tame, and not markedly different in general intelligence from the ordinary mouse. One of these mice produced a litter of seven young, in which, however, none of the peculiarities of behavior of the parents appeared.

In view of this proof of the occurrence of dancing individuals among common mice, Saint Loup believes that the race of dancers has resulted from the inheritance and accentuation of an "accidental" deviation from the usual mode of behavior. It is scarcely necessary to say that this opinion would be of far greater weight had he observed, instead of postulating, the inheritance of the peculiarities of movement which he has described. It might be objected, to the first of his so-called facts, that the litter resulted from the mating of mice which possessed dancer blood. Until the occurrence of dancers among varieties of mice which are known to be unmixed with true dancers is established, and further, until the inheritance of this peculiar deviation from the normal is proved, Saint Loup's account of the origin of the dancing mouse race must be regarded as an hypothesis.

The occurrence of dancing individuals among common mice has been recorded by several other observers. Kammerer (20 p. 389) reports that he found a litter of young wood mice (*Mus sylvaticus* L.) which behaved much as do the spotted dancers of China. He also observed, among a lot of true dancers, a gray individual which, instead of spinning around after the manner of the race, turned somersaults at frequent intervals. It is Kammerer's opinion, as a result of these observations, that the black and white dancers of China and Japan have been produced by selectional breeding on the basis of this occasional tendency to move in circles. Among albino mice Rawitz (25 p. 238) has found individuals which whirled

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about rapidly in small circles. He states, however, that they lacked the restlessness of the Chinese dancers. Some shrews (*Sorex vulgaris* L.) which exhibited whirling movements and in certain other respects resembled the dancing mouse were studied for a time by Professor Hacker of Freiburg in Baden, according to a report by von Guaita (17 p. 317, footnote).

Doctor G. M. Allen of Cambridge has reported to me that he noticed among a large number of mice kept by him for the investigation of problems of heredity^[1] individuals which ran in circles; and Miss Abbie Lathrop of Granby, Massachusetts, who has raised thousands of mice for the market, has written me of the appearance of an individual, in a race which she feels confident possessed no dancer blood, which whirled and ran about in small circles much as do the true dancers.

[Footnote 1: Allen, G.M. "The Heredity of Coat Color in Mice." Proc. Amer. Academy, Vol. 40, 59-163, 1904.]

Although it is possible that some of these cases of the unexpected appearance of individuals with certain of the dancer's peculiarities of behavior may have been due to the presence of dancer blood in the parents,

it is not at all probable that this is true of all of them. We may, therefore, accept the statement that dancing individuals now and then appear in various races of mice. They are usually spoken of as freaks, and, because of their inability to thrive under the conditions of life of the race in which they happen to appear, they soon perish.

Another and a strikingly different notion of the origin of the race of dancers from those already mentioned is that of Cyon (11 p. 443) who argues that it is not a natural variety of mouse, as one might at first suppose it to be, but instead a pathological variation. The pathological nature of the animals is indicated, he points out, by the exceptionally high degree of variability of certain portions of the body. According to this view the dancing is due to certain pathological structural conditions which are inherited. Cyon's belief raises the interesting question, are the mice normal or abnormal, healthy or pathological? That the question cannot be answered with certainty off-hand will be apparent after we have considered the facts of structure and function which this volume presents. Everything organic sooner or later is accounted for, in some one's mind, by the action of natural selection. The dancing mouse is no exception, for Landois (22 p. 62) thinks that it is the product of natural selection and heredity, favored, possibly, by selectional breeding in China. He further maintains that the Chinese dancer is a variety of *Mus musculus* L. in which certain peculiarities of behavior appear because of bilateral defects in the brain. This author is not alone in his belief that the brain of the dancer is defective, but so far as I have been able to discover he is the only scientist who has had the temerity to appeal to natural selection as an explanation of the origin of the race.

Milne-Edwards, as quoted by Schlumberger (29 p. 63), is of the opinion that the Chinese dancer is not a natural wild mouse race, but instead the

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product of rigid artificial selection. And in connection with this statement Schlumberger describes a discovery of his own which seems to have some bearing upon the problem of origin. In an old Japanese wood carving which came into his possession he found a group of dancing mice. The artist had represented in minute detail the characteristics of the members of the group, which consisted of the parents and eight young. The father and mother as well as four of the little mice are represented as white spotted with black. Of the four remaining young mice, two are entirely black and two entirely white. The two pure white individuals have pink eyes, as has also the mother. The eyes of all the others are black. From these facts Schlumberger infers that the dancer has resulted from the crossing of a race of black mice with a race of albinos; the two original types appear among the offspring in the carving.

Experimental studies of the inheritance of the tendency to dance are of interest in their bearing upon the question of origin. Such studies have been made by Haacke (19), von Guaita (17, 18), and Darbishire (13, 14, 15, 16), and the important results of their investigations have been well summarized by Bateson (5).

By crossing dancing mice with common white mice both Haacke and von Guaita

obtained gray or black mice which are very similar to the wild house mouse in general appearance and behavior. The characteristic movements of the dancers do not appear. As the result of a long series of breeding experiments, Darbishire (16 pp. 26, 27) says: "When the race of waltzing mice is crossed with albino mice which do not waltz, the waltzing habit disappears in the resulting young, so that waltzing is completely recessive in Mendel's sense; the eye-color of the hybrids is always dark;

the coat-color is variable, generally a mixture of wild-gray and white, the character of the coat being distinctly correlated with characters transmitted both by the albino and by the colored parent." When hybrids produced by the cross described by Darbishire are paired, they produce dancers in the proportion of about one to five.

Bateson (5 p. 93, footnote), in discussing the results obtained by Haacke, von Guaita, and Darbishire, writes: "As regards the waltzing character, von Guaita's experiments agree with Darbishire's in showing that it was always recessive to the normal. No individual in F1 [thus the first hybrid generation is designated] or in families produced by crossing F1 with the pure normal, waltzed. In Darbishire's experiments F1 x F1 [first hybrids mated] gave 8 waltzers in 37 offspring, indicating 1 in 4 as the probable average. From von Guaita's matings in the form DR x DR the totals of families were 117 normal and 21 waltzers.... There is therefore a large excess of normals over the expected 3 to 1. This is possibly due to the delicacy of the waltzers, which are certainly much more difficult to rear than normals are. The small number in von Guaita's litters makes it very likely that many were lost before such a character as this could be determined."

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Bateson does not hazard a guess at the origin of the dancer, but merely remarks (5 p. 86) that the exact physiological basis of the dancing character is uncertain and the origin of this curious variation in behavior still more obscure. "Mouse fanciers have assured me," he continues, "that something like it may appear in strains inbred from the normal type, though I cannot find an indubitable case. Such an occurrence may be nothing but the appearance of a rare recessive form. Certainly it is not a necessary consequence of inbreeding, witness von Guaita's long series of inbred albinos." (von Guaita (17 p. 319) inbred for twenty-eight generations.)

From the foregoing survey of the available sources of information concerning the origin and history of the race of dancing mice the following important facts appear. There are four theories of the origin of the race: (1) origin by selectional breeding (Haacke, Zoth, Milne-Edwards); (2) origin through the inheritance of an acquired character (Kishi); (3) origin by mutation, inheritance, and selectional breeding (Saint Loup, Kammerer, Cyon); (4) origin by natural selection, and inheritance, favored by selectional breeding (Landois). Everything indicates that the race originated in China. It is fairly certain that individuals with a tendency to move in circles appear at rare intervals in races of common mice. It seems highly probable, in view of these facts, that the Chinese took advantage of a deviation from the usual form of behavior to develop by means of careful and patient selectional breeding a race of mice which is remarkable for its dancing. Even if it should be proved that the mutation as it appears among common mice is not inherited, the view that slight deviations were taken advantage of by the breeders would still be tenable. The dancing tendency is such in nature as to unfit an individual for the usual conditions of mouse existence, hence, in all probability human care alone could have produced and preserved the race of dancers.

In answer to the question, how and when did the race of dancers originate, it may be said that historical research indicates that a structural variation or mutation which occasionally appears in *Mus musculus*, and causes those peculiarities of movement which are known as dancing, has been preserved and accentuated through selectional breeding by the Chinese and Japanese, until finally a distinct race of mice which breeds true to

the dance character has been established. The age of the race is not definitely known, but it is supposed to have existed for several centuries.

CHAPTER II

FEEDING, BREEDING, AND DEVELOPMENT OF THE YOUNG

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In this chapter I shall report, for the benefit of those who may wish to know how to take care of dancing mice, my experience in keeping and breeding the animals, and my observations concerning the development of the young. It is commonly stated that the dancer is extremely delicate, subject to diseases to an unusual degree and difficult to breed. I have not found this to be true. At first I failed to get them to breed, but this was due, as I discovered later, to the lack of proper food. For three years my mice have bred frequently and reared almost all of their young. During one year, after I had learned how to care for the animals, when the maximum number under observation at any time was fifty and the total number for the year about one hundred, I lost two by disease and one by an accident. I very much doubt whether I could have done better with any species of mouse. There can be no doubt, however, that the dancer is delicate and demands more careful attention than do most mice. In March, 1907, I lost almost all of my dancers from what appeared to be an intestinal trouble, but with this exception I have had remarkably good luck in breeding and rearing them.

My dancers usually were kept in the type of cage of which Figure 2 is a photograph.^[1] Four of these double cages, 70 cm. long, 45 cm. wide, and 10 cm. deep in front, were supported by a frame as is shown in Figure 3. The fact that the covers of these cages cannot be left open is of practical importance. A similar type of cage, which I have used to some extent, consists of a wooden box 30 by 30 cm. by 15 cm. deep, without any bottom, and with a hinged cover made in part of 1 cm. mesh wire netting. Such a cage may be placed upon a piece of tin or board, or simply on a newspaper spread out on a table. The advantage of the loose bottom is that the box may be lifted off at any time, and the bottom thoroughly cleansed. I have had this type of cage constructed in blocks of four so that a single bottom and cover sufficed for the block. If the mice are being kept for show or for the observation of their movements, at least one side of the cages should be of wire netting, and, as Kishi suggests, such objects as a wheel, a tower, a tunnel, a bridge, and a turntable, if placed in the cage, will give the animals excellent opportunity to exhibit their capacity for varied forms of activity.

[Footnote 1: This cage was devised by Professors W.E. Castle and E.L. Mark, and has been used in the Zoological Laboratories of Harvard University for several years.]

[Illustration: FIGURE 2. —Double cage, with nest boxes and water dishes.]

The floors of the cages were covered with a thin layer of sawdust for the sake of cleanliness, and in one corner of each cage a nest box of some sort was placed. During the warm months I found it convenient and satisfactory to use berry boxes, such as appear in Figure 2, with a small entrance hole cut in one side; and during the cold months cigar boxes, with an entrance hole not more than 5 cm. in diameter at one end. In the nest box a quantity of tissue paper, torn into fragments, furnished material for a nest in which the adults could make themselves comfortable

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or the female care for her young. Cotton should never be used in the nest boxes, for the mice are likely to get it wound about their legs with

serious results. Apparently they are quite unable to free themselves from such an incumbrance, and their spinning motion soon winds the threads so tightly that the circulation of the blood is stopped.

[Illustration: FIGURE 3.—Double cages in frame.]

The cages and nest boxes were emptied and thoroughly cleaned once a week with an emulsion made by heating together one part of kerosene and one part of water containing a little soap. This served to destroy whatever odor the cages had acquired and to prevent vermin from infesting the nests. In hot weather far greater cleanliness is necessary for the welfare of the mice than in cold weather. The animals attend faithfully to their own toilets, and usually keep themselves scrupulously clean.

For water and food dishes I have used heavy watch glasses^[1] 5 cm. in diameter and 1/2 cm. deep. They are convenient because they are durable, easily cleaned, and not large enough for the young mice to drown in when they happen to spin into one which contains water. It is said that mice do not need water, but as the dancers seem very fond of a little, I have made it a rule to wash the watch glasses thoroughly and fill them with pure fresh water daily. The food, when moist, may be placed in the cages in the same kind of watch glass.

[Footnote 1: Minot watch glasses.]

There is no need of feeding the animals oftener than once a day, and as they eat mostly in the evening and during the night, it is desirable that the food should be placed in the cage late in the afternoon. For almost a year I kept a pair of dancers on "force"^[1] and water. They seemed perfectly healthy and were active during the whole time, but they produced no young. If the animals are kept as pets, and breeding is not desired, a diet of "force," "egg-o-see,"^[1] and crackers, with some bird-seed every few days, is likely to prove satisfactory. As with other animals, a variety of food is beneficial, but it appears to be quite unnecessary. Too much rich food should not be given, and the mice should be permitted to dictate their own diet by revealing their preferences. They eat surprisingly little for the amount of their activity. I have had excellent success in breeding the mice by feeding them a mixture of dry bread-crumbs, "force," and sweet, clean oats slightly moistened with milk. The food should never be made soppy. A little milk added thus to the food every other day greatly increases fertility. About once a week a small quantity of some green food, lettuce for example, should be given. It is well, I have found, to vary the diet by replacing the bread and "force" at intervals with crackers and seeds. Usually I give the food dry every other day, except in the case of mice which are nursing litters. One person to whom I suggested that lettuce was good for the dancers lost four, apparently because of too much of what the mice seemed to consider a good thing. This suggests that it should be used sparingly.

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[Footnote 1: A cereal food.]

Success in keeping and breeding dancing mice depends upon three things: cleanliness, warmth, and food supply. The temperature should be fairly constant, between 60 and 70 Fahr. They cannot stand exposure to cold or lack of food. If one obtains good healthy, fertile individuals, keeps them in perfectly clean cages with soft nesting materials, maintains a temperature of not far above or below 65, and regularly supplies them with pure water and food which they like, there is not likely to be trouble either in keeping or breeding these delicate little creatures.

Several persons who have reported to me difficulty in rearing the young or in keeping the adults for long periods have been unable to maintain a sufficiently high or constant temperature, or have given them food which

caused intestinal trouble.

The males are likely to fight if kept together, and they may even kill one another. A male may be kept with one or more females, or several females may be kept together, for the females rarely, in my experience, fight, and the males seldom harm the females. Unless the male is removed from the cage in which the female is kept before the young are born, he is likely to kill the newborn animals. When a female is seen to be building a nest in preparation for a litter, it is best to place her in a cage by herself so that she may not be disturbed.

The sex of individuals may be determined easily in most cases, at the age of 10 to 12 days, by the appearance of teats in the case of females.

The period of gestation is from 18 to 21 days. The maximum number born by my dancers in any single litter was 9, the minimum number 3. In 25 litters of which I have accurate records, 135 individuals were born, an average of 5.4. The average number of males per litter was precisely the same, 2.7, as the number of females.

On the birth of a litter it is well to see that the female has made a nest from which the young are not likely to escape, for at times, if the nest is carelessly made, they get out of it or under some of the pieces of paper which are used in its construction, and perish. Several times I have observed nests so poorly built that almost all of the young perished because they got too far away to find their way back to the mother. It is surprising that the female should not take more pains to keep her young safe by picking them up in her mouth, as does the common mouse, and carrying them to a place where they can obtain warmth and nourishment. This I have never seen a dancing mouse do. For the first day or two after the birth of a litter the female usually remains in the nest box almost constantly and eats little. About the second day she begins to eat ravenously, and for the next three or four weeks she consumes at least twice as much food as ordinarily. Alexander and Kreidl (3 p. 567) state that the female does not dance during the first two weeks after the birth

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of a litter, but my experience contradicts their statement. There is a decreased amount of activity during this period, and usually the whirling movement appears but rarely; but in some cases I have seen vigorous and long-continued dancing within a few hours after the birth of a litter.

There is a wide range of variability in this matter, and the only safe statement, in the light of my observations, is that the mother dances less than usual for a few days after a litter is born to her.

The development of the young, as I have observed it in the cases of twenty litters, for ten of which (Table I) systematic daily records were kept, may be sketched as follows. At birth the mice have a rosy pink skin which is devoid of hair and perfectly smooth; they are blind, deaf, and irresponsive to stimulation of the vibrissae on the nose. During the first week of post-natal life the members of a litter remain closely huddled together in the nest, and no dance movements are exhibited. The mother stays with them most of the time. On the fourth or fifth day colorless hairs are visible, and by the end of the week the body is covered with a coat which rapidly assumes the characteristic black and white markings of the race. For the first few days the hind legs are too weak to support the body weight, and whatever movements appear are the result of the use of the fore legs. As soon as the young mice are able to stand, circling movements are exhibited, and by the end of the second week they are pronounced. Somewhere about the tenth day the appearance of the teats in the case of the females serves to distinguish the sexes plainly. Between

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