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Some Indices of the Behaviour of Wild and Laboratory House Mice in a Mixed Population

[With 7 Figs. & 10 Tables]

Using the *CMR* method investigations were made of a population composed of wild and laboratory house mice. It was found that white mice differ from wild mice in respect of trappability, distribution of intensity of captures between inspections of the traps, daily rhythm of trappability, attachment to trapping sites and intensity of transition between them. With the exceptions of two cases in which mixed progeny occurred in one litter (sired by both wild and white fathers), the white females were not observed to copulate with wild males. The question is discussed as to whether the differences observed form the expression of changes which have taken place in the behaviour of the white form during the process of domestication, or whether they were due to the competitive interaction of the two forms under the conditions formed by a mixed population.

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1. INTRODUCTION

The house mouse has become the object of numerous studies on population structure, organisation and dynamics. The results of such studies, in addition to describing the ecology of this species, are referred as models of different population problems to other species of animals. The studies are either carried out on populations of wild house mice (*e.g.* Southwick, 1955; Petrusewicz & Andrzejewski, 1962; Adamczyk & Ryszkowski, 1965; Crowcroft, 1955 and others) or on populations of the domesticated laboratory form (white) of this species (Calhoun, 1956; Petrusewicz, 1957 and others). Results obtained in investigations of these two forms are compared and treated jointly as studies carried out on one species (Anderson, 1961).

The assumption appears probable that the laboratory form of the house mouse has, in the course of the process of domestication continued over a large number of generations, undergone such changes as would be capable of causing behaviour different from that of the wild form under the conditions formed by life in a population (interaction of individuals in a population). In consequence populations composed of individuals of the laboratory form may under identical external conditions possess characteristics of population structure, organisation and processes different from those in populations composed of individuals of the wild form. If this assumption is correct the it would be impossible directly to extend the results of ecological studies on one of the forms to apply to the other form also. Comparison of analogical data for the two forms would, on the other hand, contribute to the theoretical picture of population problems in general.

On the basis of the above consideration it was decided to aim in the present study at camparing some of the indices of behaviour of the wild and laboratory forms of house mice in a mixed population composed of individuals belonging to both forms of existing under conditions favourable to both. The creation of a mixed population ensured that identical conditions were maintained for the two forms, and also made it possible to trace the consequences to a population of the co-existence in it of individuals with genetically conditioned differences in the way the population affects them.

2. LOCATION OF STUDIES, METHODS, MATERIAL

The studies were carried out in the Field Station of the Institute of Ecology, Polish Academy of Sciences, at Dziekanów Leśny near Warsaw, during the period from Sept. 15th to October 15th 1965.

The study area was located in the attic of the Station building, measuring 535 m^2 (Fig. 1). Several other studies had previously been carried out in the attic on the wild house mouse, and it had been established, that the conditions there are suitable for this species (Petrusewicz & Andrzejewski, 1962; Adamczyk & Ryszkowski, 1965; Kaczmarzyk, 1964). Knowing the habitat requirements of laboratory mice it was also possible to say that at early autumn the conditions for the laboratory form would also be fully suitable. A detailed description of the attic is to be found in the study by Petrusewicz & Andrzejewski (1962).

In order to form a source of food for the mice and to concentrate their penetration in certain places, and also in order to be able to keep a record of the animals, 12 live-traps were placed on each of five sites (*A*, *B*, *W*, *E*, *S*) in the attic. Bait (oats and the standard food for laboratory mice) and also water *ad libitum* were placed on these five sites. The bait thus formed the animals' only food.

The live-traps were arranged in three groups of four on each of the five sites — each group being surrounded on three sides by panes of glass about 30 cm high, on the fourth side, common to all three groups, there was free access to the traps. The traps were placed at intervals of about 20 cm (Fig. 1), and were numbered on each of the sites.

Captures were made continuously three times every 24 hours, at 8-hour intervals (at 7, 15 and 23 hours), the traps being set again immediately after removal of the animal. Every time animals were removed from the traps the food supply in the latter was replenished.

Two hours after the animals had been removed the traps were inspected and those occupied were marked, without however removing the animals. This made it possible to mark individuals caught during the first two hours.

In addition on the 1st, 2nd, 5th, 10th, 14th and 27th day of the experiment, records were made of the animals' entries into the traps every two hours, which enabled the daily cycle of trapping to be established.

The mixed population of house mice (*Mus musculus* Linnaeus, 1758) was artificially established by introducing 80 white individuals (30 ♂♂ and 50 ♀♀) and 51 wild individuals (32 ♂♂ and 19 ♀♀) into the attic. The white mice were of uni-

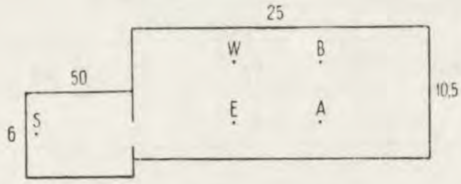

Fig. 1. Distribution of groups of traps in attic.

form age, about 10 weeks old; the females had not as yet mated. The wild mice had been caught in farm buildings in villages situated near the Station at Dziekanów Leśny. They were kept in cages for about 6 weeks before being released. The weight of all individuals was similar and showed that they were adults. The females had closed vaginas.

All the animals were marked with individual numbers. Before releasing the animals from the traps a note was made of the day and hour of release, the number of the mouse, sex, place of trapping, time of trapping and body weight.

Trapping was begun directly after the animals' release.

In order to check whether the distribution of the mice alters in relation to different groups of traps, after 45 captures had been made (15 days of the experiment), all the individuals which had been captured on site *W* were caught and removed during the three following captures. A similar operation was carried out after the next 30 trappings (*i. e.* after 25 days of the experiment) catching and removing mice trapped on site *A*. On completion of the experiment (90 trapping within 30 days) mice caught on all sites, with the exception of site *S*, were removed. Captures were continued until all the individuals had been caught. In the *S* group all the traps were closed to prevent the mice being caught and to deprive animals on this site of access to food.

All the white females caught and removed were placed in separate cages and kept there for 3 weeks in order to obtain their progeny.

The material collected during the experiment is presented in table 1.

3. RESULTS

3.1. Variations in Numbers of Mice Following Introduction

The high degree of trappability (this will be discussed in greater detail in the following sections) made it impossible for mice to remain for long in the attic without being caught. There was very little chance of an individual leaving the attic and later returning to it. The period of a given individual's stay in the attic was therefore defined as the period from the moment of its release there until its last capture. Such an individual undoubtedly remained in the attic for a certain time after its last capture, and its stay should be in fact extended by this period, but as it was impossible to assess this final period accurately, the last capture was taken as the limit of its stay there. This would appear to be sufficiently close to the real duration of stay in the experiment (Petrusewicz & Andrzejewski, 1962).

Table 1.
Amount of material.

Mice	No. of individuals released	No. of individuals caught at least once		Number of captures
		n	%	
White	80	79	99	2881
Wild	51	46	90	784

Determination of the periods of stay of different individuals in the attic made it possible to ascertain variations in the numbers of both white and wild mice in the attic by the »calendar of captures« method (Petrusewicz & Andrzejewski, 1962; Andrzejewski, 1963 and others).

These variations show that the rate of disappearance from the attic was different in the case of white and wild mice (Fig. 2). This rate was at first higher in the case of wild mice, forming 24% after 3 days of the experiment (only 5% for white mice), after which the differences in the disappearance rate of the two forms of mice disappeared. Capture and removal of mice visiting the *W* group of traps and the *A* group of traps, caused a distinct reduction in the numbers of white mice with a slight decrease in the numbers of wild mice of little importance from the point of view of their total numbers. This state corresponds to the numbers of animals caught and removed, being in the case of white mice 13 in the *W* group of traps, and 14 in the *A* group, and correspondingly for wild mice 3 and 4.

3.2. Description of Trappability

3.2.1. Effective Trappability

From 19 to 41 white mice and from 15 to 16 wild mice were caught and removed at every inspection. In order to describe the effective trappability of the two forms of mice, calculation was made of what percentage of animals were caught in traps during successive inspections in relation to the number of animals present at that time in the attic (estimated according to assumptions discussed in the preceding

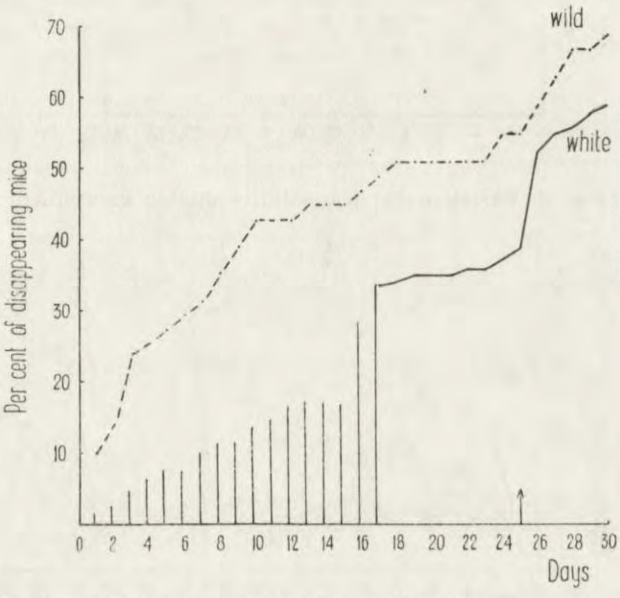

Fig. 2. Comparison of disappearance of white and wild mice.

section). It was found that the effective trappability of mice (percentage of individuals caught and removed is higher in the case of the white form than the wild, except for the first captures made after introduction (Fig. 3). In white mice effective trappability increases during the first captures, reaching 50% of the individuals present in the attic by the 4th inspection, and never falling below this level throughout the whole of the experiment. The maximum trappability is exhibited by the captures made during the 22nd inspection of the traps, when 74.5% of all the white individuals in the attic were found in traps (Fig. 3).

3.2.2. Average Interval Between Captures

The average interval between two captures of an individual in a given group of mice is the reciprocal of effective trappability (ratio of number of captures to the number of individuals living in a given area) (Petrusewicz & Andrzejewski, 1962). The analysis of the average interval between captures, both for white and wild mice, gives analogical conclusions to those discussed in the preceding section. The mean interval between captures calculated for the whole of the material

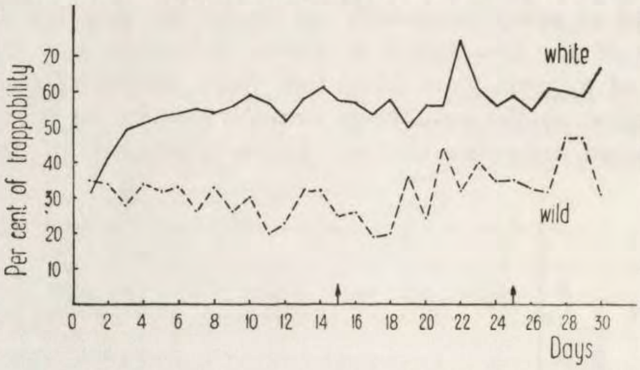

Fig. 3. Variations in trappability during experiment.

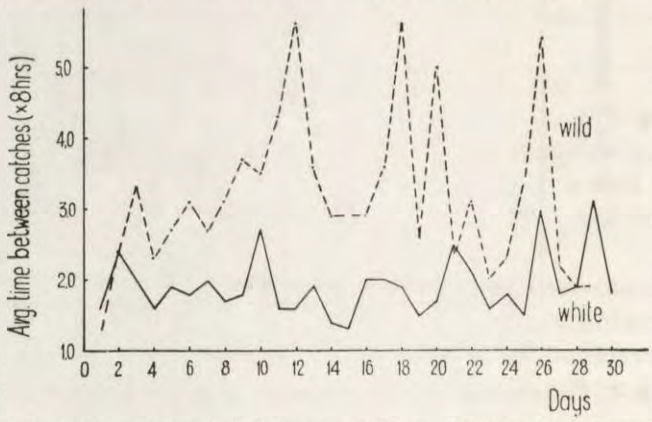

Fig. 4. Mean interval between captures during experiment.

is 1.78 of the interval between two successive inspections of traps in the case of white mice and 3.15 of this interval in the case of wild mice. The difference between these averages is statistically significant on a level of 0.05 (Tab. 2).

When analysing the average interval between captures during the experiment (in successive inspections of the traps) no great variations in the index, but its constant predominance in wild mice over white mice are observed (Fig. 4).

Capture and removal of mice visiting the *W* and *A* groups of traps and thus reducing the total numbers (density) of the population did not lead to a change in frequency of captures (average interval between captures calculated for successive inspections of traps) (Fig. 4).

3.2.3. Trappability of the First Capture

Calculation was made of the interval between introducing the mice into the attic and the first capture of each individual, and also the average interval between introduction and first capture in the case of white and wild mice. This interval describes the trappability of the first capture (tendency to entering the trap for the first time) in the different groups of animals (Andrzejewski, *in litt.*).

The average interval from introduction to first capture calculated for all individuals of the white form is greater than in the case of the wild form. It must be pointed out that in principle the overwhelming majority of individuals of both forms of mice are caught for the first time during the period of the first nine inspections of the traps (3×24-hour periods). During this period 74 of the 80 white mice introduced were caught for the first time, and 45 of the 51 wild mice. After the 9th inspection of traps only one wild mouse was caught for the first time (found during the 13th inspection) and 5 white mice (during the 16th, 21st, 26th, 62nd and 86th inspection of traps). This latter group of white mice is the cause of the difference between the average interval from introduction to first capture of white and wild mice being significant. If the group of these 5 individuals is omitted from calculations, the mean interval does not differ significantly between the two forms of mice (white mice 3.18, wild mice 3.04). White mice do not therefore differ in principle in respect of trappability of the first capture from wild mice, except that among the white mice a group of individuals with a lesser degree of trappability of first capture was observed.

Comparison was made of the mean interval between introduction and first capture of individuals (trappability of first capture index) and mean interval between further captures (trappability of further captures index). It was found that the average interval between introduction and first capture in the group of white mice is statistically significantly greater than the average interval between further captures. These intervals do not differ statistically in the group of wild mice (Table 2, 3).

3.2.4. Relation Between Trappability of White and Wild Mice

Calculation was made of the rectilinear correlation coefficient between the number of captures of white and wild mice in different

Table 2.
Distribution of intervals between consecutive captures of mice.

Length of interval	Number of intervals	
	White	Wild
1	1910	311
2	478	181
3	178	80
4	88	51
5	44	26
6	33	12
7	18	15
8	14	12
9	10	7
10	7	4
11	4	10
12	4	6
13	2	2
14	1	5
15	2	1
16	1	2
17	—	1
18	—	1
19	1	—
20	—	1
21	2	—
22	1	—
23	1	—
24	—	1
25	1	2
27	—	2
28	—	1
31	—	1
32	—	1
34	—	1
37	—	1
41	1	—
62	1	—
	2802	738
	1.78	3.15

Table 3.
Distribution of intervals in capture units from of release to first capture of mice.

Length of interval		Number of intervals	
		White	Wild
1		25	19
2		9	6
3		14	4
4		9	2
5		7	4
6		6	4
7		1	2
8		1	2
9		2	2
10		—	—
11		—	—
12		—	—
13		—	1
14		—	—
15		—	—
16		1	—
21		1	—
26		1	—
62		1	—
86		1	—
All individuals	Σ	74	45
	x̄	3.04	3.18
Individuals caught up to 9th trapping	Σ	79	46
	x̄	5.51	3.67

trappings in order to ascertain whether there is any relation between them. From the start of the experiment up to the 45th inspection of traps there is a statistically significant negative correlation ($r = -0.44$) between the above animals. Capture of a large number of white mice therefore corresponds to less numerous captures of wild mice and *vice versa*. This regularity was not observed during the period from the 46th inspection of traps to the end of the experiment.

3.2.5. Distribution of Intensity of Captures Between Consecutive Inspections of Traps

Observations of the number of animals caught in traps in consecutive 2-hour intervals between inspections of traps made it possible to trace the distribution of intensity of captures during the period between one release of mice and the next (Table 5).

Table 4.
Table of correlations between number of white and wild mice.

No. of captures		White mice								
		19—21	22—24	25—27	28—30	31—33	34—36	37—39	40—42	43—45
Wild mice	1—3								1	
	4—6					1	1	2		2
	7—9						2	6	2	3
	10—12					1	2	3		2
	13—15	1			1	2	1	4	5	
	16—18				1		1			
	19—21			1						

Table 5.
Distribution of intensity of captures between consecutive releases of mice from traps.

Mice		Intervals in hours from release of mice from traps				Σ captures
		2	4	6	8	
White	No. of captures	352	120	72	48	597
	% of captures	59.0	20.1	12.1	8.0	100
Wild	No. of captures	104	54	37	15	210
	% of captures	49.5	25.7	17.6	7.1	100

During the first two hours after releasing the animals from the traps half of all the individuals caught between successive inspections of traps were caught again. During the next 2-hour periods the number of captures decreases rapidly, reaching during the last 2 hours before inspection of the traps scarcely 8% in the case of white mice and 7% of wild mice.

As already mentioned during the description of study methods, individuals caught during the first hours after trap inspection were recorded in all trap inspections, and not only during the 24-hour inspections. Throughout the whole experiment the number of captures which occurred during the first two hours after inspection was 65% for white mice and 45% for wild mice, in relation to all the captures. The difference is statistically significant and points to the white mice having a greater tendency to enter the raps during he first hours after inspection than the wild mice.

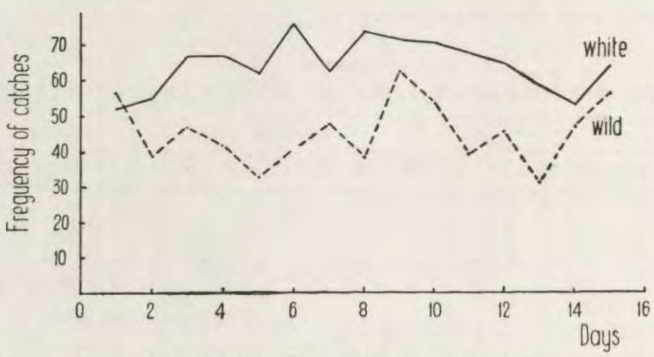

Fig. 5. Percentage of captures during first 2 hours after release on successive days of observation.

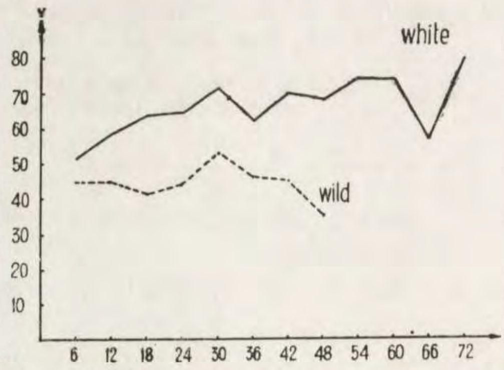

Fig. 6. Relation between % of captures during first 2 hours after releasing mice from traps (y) and number of captures in given trapping (x).

The percentage of captures during the first two hours after trap inspection in the successive catches of the experiment does not exhibit regular changes and varies from 52% to 76% for white mice and from 31% to 63% for wild mice (Fig. 5).

An increase in the percentage of mice caught during the first two hours after trap inspection is observed together with an increase in the number of captures of white mice. This means that the greater general tendency to be trapped produces a simultaneous greater tendency to be caught during the first two hours after trap inspection. This phenomenon was not observed in the case of wild mice (Fig. 6).

3.2.6. Daily Rhythm of Trappability

In order to observe the daily rhythm of trappability the number of individuals caught in three different inspections of traps over the course of 24 hours was expressed in percentages (at 7,00, 15,00 and 02,00 hours) in relation to the sum total of captures obtained during this 24-hour period (Table 6). Thus mice removed from traps at 7,00 hours represent activity between 23,00 and 7,00 hours, but bearing in mind the distribution of intensity of captures between inspections discussed in the preceding section, they represent more than 50% of the activity between 23,00 and 01,00 hours at night. Correspondingly

Table 6.
Ratio of number of captured mice in 3 trappings to total sum of captures during day.

Mice		Hours			Sum of captures
		7—15	15—23	23—7	
White	No. of captures	221	198	178	597
	% of captures	37.0	33.2	29.8	100
Wild	No. of captures	60	33.2	29.8	210
	% of captures	28.6	40.0	31.4	100

mice removed from traps at 15,00 hours represent mainly early morning activity, and mice removed at 23,00 hours — evening activity.

The intensity of trapping distinguished during the three periods of the day differed in white and wild mice, although differences are not very great. Maximum trappability of white mice occured during morning hours (37%), and of wild mice during evening hours (40%). The minimum number of captures of white mice was observed at night (29.8), and of wild mice in the early morning (28.6). No changes in the daily rhythm were observed during the experiment.

Minimum trappability of wild mice was therefore observed during the period of maximum trappability of white mice, but the maximum trappability of the former occurred during the period of medium intensity of trappability of white mice.

3.2.7. Differences in Trappability Between Individuals

In order to ascertain whether there are differences between the trappability of the two forms of mice the following calculations were made. If the trappability of all individuals were similar, this would mean that the probability of catching each individual was similar. Therefore when during a given inspection (t_1) A_{t1} individuals were caught, then with the above assumption, of these A_{t1} individuals the following should be caught in the next inspection (t_2):

$$A_{t_2} = \frac{A_{t_1} \cdot n}{N}$$

where N — number of individuals of the given form living in the attic, n — number of individuals of this form caught in inspection t_2. If during inspection t_2 there were a individuals from group A_{t1} among the n animals caught, then the ratio $\frac{a}{A_{t_2}} \approx 1$ shows that the assumed uniform probability of catching all individuals (their uniform trappability) in fulfilled. Where $\frac{a}{A_{t_2}} > 1$ then there are some individuals with greater trappability in the population (group of individuals). Where this ratio is smaller than unity then it must be concluded that the individuals which have been caught once, avoid recapture [1]), at least when the next inspection is made.

Calculation was made of the ratio $\frac{a}{A_{t_2}}$ for all successive inspections of traps, separately for the white and wild forms, then the average value of this ratio was calculated. The calculated ratio usually has a positive value (in 96% of cases); its average value is 1.27 in wild mice and 1.13 in the white form. The difference between these means is statistically non-significant. Thus in both the white and wild forms there is a certain group of individuals characterised by high trappability, caught with more than fortuitous frequency.

The distribution of number of captures of individuals also points to the above difference (Table 7). The existence among white mice of individuals, the number of captures of which is close to the number of inspections (maximum possible number of captures) and of individuals with an extremely small number of captures confirms the assumption that some of the individuals of this form possesses constant exceptionally high trappability, and others extremely low.

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1) Where $\frac{a}{At_2} < 1$; it is more convenient to calculate the reciprocel of this ratio, marking it with a minus sign.

3.3. Spatial Distribution

3.3.1. Description of the Population's Distribution

Spatial distribution was described by the number of individuals visiting a given group of traps and their attachment to a given group of traps (exclusive character of visits to a defined site by a given individual). In defining the number of individuals visiting different groups of traps it was accepted that a given individual is caught on a given site if it was caught there at least once. It was found that the distribution of the animals is uneven in different groups, the *S* group of traps at the greatest distance having a relatively large number of wild mice, and few white mice.

Table 7.
Distribution of number of captures.

No. of captures	1—5	6—10	11—15	16—20	21—25	26—30	31—35	36—40	41—45	46—50	51—55	56—60	61—65	66—70	71—75	76—80	81—85	86—90	Total
No. of white mice	9	5	5	1	4	5	6	9	8	7	3	3	2	3	4	1	2	2	79
No. of wild mice	13	6	5	4	3	4	4	3	1	1	2								46

In order to describe what number of groups of traps are visited by different individuals, the distribution of number of white and wild individuals which visited 1, 2 and 3 *etc.* groups of traps over the whole course of the experiment was elaborated (Table 8). Material presented in this way shows that the majority of individuals of the two forms of mice visited only one group of traps (79% of white individuals and 78% of wild individuals). The number of individuals which visited three groups of traps is inconsiderable (1.0 and 0.5% respectively) and there are no mice which visited all 5 groups of traps.

The frequency of visits by a given individual to a new group of traps in the 15 capture periods of the duration of the experiment was analysed (Table 8). It was found that visits to a new group of traps (not yet visited in the given period) occurred more often at the beginning of the experiment (1—30 captures) than in the later period (second). After the 30th inspection individuals visited two groups of traps at most.

The above material shows that the attachment of individuals to different groups of traps in considerable and increases with the passage of experiment time. No significant differences were observed in this respect between the white and wild forms.

In order to analyse frequency of transitions made by given individuals from one group of traps to another the ratio of each capture of a given individual to its previous captures was determined. If the given capture was made in the same group of traps as the previous capture, then the capture was termed *h*, but when in a different group, it was termed *m*.

Table 8.
Distribution of number individuals visiting defined number of groups of traps.

Captures	Mice	No. of groups of traps				Total
		1	2	3	4	
1— 15	White	42	23	7	3	75
	Wild	34	6	5	1	46
16— 30	White	60	9	2	1	72
	Wild	27	7	1		35
31— 45	White	54	13			67
	Wild	23	7			30
46— 60	White	45	8			53
	Wild	21	4			25
61— 75	White	45	4			49
	Wild	20	4			24
76—100	White	34	2	1		37
	Wild	13	4			17
Total	White	280	59	10	4	
	Wild	138	32	6	1	

Table 9.
H/m ratio (explanation in text).

Mice	Days of observations					
	1—5	6—10	11—15	16—20	21—25	26—35
White	1.3	3.8	4.3	5.6	11.2	11.3
Wild	2.7	3.4	3.3	5.2	5.2	4.5

The ratio of number of *h* to *m* captures expresses the degree of the individuals fidelity to certain groups of traps (unvarying character of visits) (Petrusewicz & Andrzejewski, 1963).

The *h/m* ratio differs in the white and the wild forms, the latter changing the group of traps visit more frequently than white mice. White mice are more conservative, being caught more often in the same group of traps (Table 9).

When variations in the value of h/m ratio over the course of the experiment were examined it was found that fidelity to a given place increases with an increase in the length of time spent by individuals in a population. This is particularly marked in the case of white mice (Table 9).

3.3.2. Captures of Individuals Connected with Two Groups of Traps and the Distribution of the Animals

After the experiment had lasted 15 days all individuals captured in the *W* group of traps had been removed from the population, and after 25 days all those in the *A* group. The process of capture and removal of these animals extended over the period of 5—7 inspections, 17 white and 2 grey individuals being removed as early as the first inspection. In all, 27 white mice and 7 wild mice were caught and removed. During this time 3 white and 4 wild individuals moved from other groups of traps to the *A* group, and 1 white and 3 wild individuals to the *W* group, thus of the 11 mice which moved to the emptied sites, 7 were wild mice. It is possible that this is a manifestation of a certain increased tendency on the part of this form to transition from one place to another, but the sample was too small to give a definite opinion on this question.

Generally speaking however, in relation to the number of individuals visiting the groups of traps from which no animals were removed, the number of individuals which transferred to them is very small. This is evidence of the considerable stability of the spatial population system during the experiment.

3.3.3. Capture (removal) of All Mice in the End Phase of the Experiment

The final capture and removal for laboratory studies of mice visiting the *A*, *B*, *W* and *E* groups of traps, with the exception of group *S*, in which the traps were merely closed to deprive the animals attached to that group of food, caused 6 individuals of the wild form attached to the *S* group to move to the *A* and *W* groups of traps, where they also were caught and removed. This transition had taken place by the 5th inspection of the traps, counting from the beginning of capture and removal of mice in the attic, and also from the time the traps in group *S* were closed. No individual of the white form was found to transfer in connection with the final phase of the experiment from *S* group to the other groups of traps.

The above facts indicate that the white mice are connected to a greater extent with the different groups of traps than individuals of the wild form.

3.3.4. Variations in Captures in Different Traps within One Group of Traps

Examination was made of the frequency with which individuals were captured in different traps within one group of traps. This frequency is far greater than a change to another group of traps. No case was found of an individual being captured only in one trap.

In order to discover whether there were any changes in frequency of capturing mice in different traps during the experiment, calculation was made of this ratio of changes of trap to all the captures made (Fig. 7). It was found that this frequency was greater at the start of the experiment (up to 18th inspection of traps for white mice and 36th for wild mice). At that time from 50—64% of captures took place in a different trap from that in the preceding capture (and thus captures of the

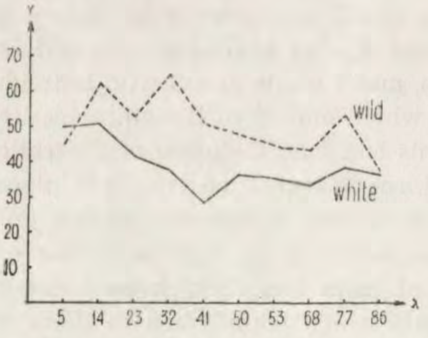

Fig. 7. Variations in frequency of captures of mice in different traps.

h type defined in relation to different traps within one group). During the period from the 55th inspection frequency of change of traps decreased to 33% in the case of white, and 43% in the case of wild mice. This is evidence of the increasing attachment of the mice to various traps as the experiment proceeded. At the same time wild mice were observed to change traps more frequently then white mice over the whole course of the experiment (Fig. 7).

In order to establish whether repeated captures of the same individual influence the habit of visiting the same traps, the number of captures of mice and number of type *h* captures within one group of traps were compared in the form of a correlation table. When the material was set out in this way it was found that in the case of both white and wild mice the percentage of changes of traps (% of *h* captures) increases with an increase in the number of captures. The correlation observed for both forms of mice is statistically significant, but the correlation coefficient is significantly higher in the wild than in the white form. This indicates that the capture of the wild form in different traps takes place more fortuitously than in the case of white mice. Wild mice have a more constant probability of *h* capture taking place within a given group of traps over a sequence of successive captures, and thus white mice are in some way more attached to various traps within the given group of traps.

3.4. Cross-breeding Between the White and Wild Mice Within the Mixed Population

The purpose of keeping all the white females caught in the attic in cages after completion of the experiment was to ascertain whether, and to what extent, mating had occurred with males of the two forms.

Of the 30 white females kept in cages 18 gave birth to a total number of 92 young, out of which 16 litters were composed exclusively of white young. There were no litters composed exclusively of young of the wild mouse colour. Two litters were composed of mixed young (one consisted of 5 white young and 3 young similar in colour to wild mice, and a second litter with 6 white young and one of the wild mouse colour).

4. DISCUSSION

The differences and similarities in the behaviour indices of white and wild mice in a population (Table 10), indicate that there is an important difference between both forms as regards their trappability. This was

Table 10.
Comparison of indices for white and wild mice.

	White		Wild
Of released mice — caught		>	
Losses during first 3 days		<	
Effective trappability		>	
Trappability of 1st capture		=	
Interval between captures		<	
Intensity of captures between inspections of traps		>	
Maximum captures during day	morning		evening
Occurrence of groups of mice trapped with non-fortuitous frequency		=	
Attachment to defined group of traps		>	
Attachment to trap		>	

manifested in effective trappability (number of captures per individual or average interval between captures) and in the quicker transfer of the white form to traps after they had been emptied. The absence of differences in trappability of the first capture indicates that both forms have similar capacities for searching for traps.

The bait in the traps was in principle the only source of food in the attic, although the mice caught in traps or entering them scattered some of the bait on the outside or carried it out of the trap before the latter closed and confined the animal. Under such conditions differences in trappability might become apparent either as the result of the smaller food requirements of wild mice or their greater capacity for taking advantage of bait scattered or carried from the traps, or in constant incomplete satisfaction of the food requirements of wild mice.

It is also possible that the group of white mice »resistant« to the first capture, were in a similar situation. These individuals also had to find whatever food they could outside the traps.

The frequency of captures succeeding the first increases in the white form, and can be compared to the phenomena of increase in trappability with the occurrence of successive captures of an individual, observed by different authors in the case of the wild form of *Mus musculus* (Young *et al.*, 1950). In our studies, however, it happened that the trappability of the first and successive captures remained unchanged in the wild form.

The reciprocal negative influence of trappability of the two forms of mice which was observed is remarkable. This is revealed by the negative correlation of number of captures of the two forms of mice in trapping. Differences in the daily cycle of trappability may also point to a similar phenomenon, although this is not wery sharply defined.

In the light of these facts it would be logical to interpret the retarded trappability of wild mice in relation to the white mice after their release from traps as yet another manifestation of the negative (blocking) effect of the white on the wild form with regard to trappability. Finally it is possible that the absence of increase in trappability of the wild form after the first capture may also be based on the effect exerted by the white mice on the wild mice.

Following this up logically by assuming that the white form monopolises the traps to a certain extent, the reduced trappability of the wild form might explained as completely due to the influence exerted by the white form. The experiment made is not therefore »pure« in this sense; it does not provide an unambiguous answer to whether a different degree of trappability is a characteristic of the given form of mouse or whether it has been created by the reciprocal influence of the two forms on each other.

Differences in trappability of individuals were similar in both forms. Numerous authors observed the existence of differences in trappability and showed that they are due *inter alia* to the social relations in the population (Andrzejewski *et al.*, 1959). In view of this it may be concluded that relations of this kind were created in the case of both forms.

The considerable attachment of individuals to given trapping sites, which increased during the course of our experiment, indicates that a process of establishment of orderly relations between individuals in the population took place (Petrusewicz & Andrzejewski, 1962). This process, more sharply defined in the case of white than wild mice, makes possible its interpretation as a difference connected with the form of the mice, or following on the previous discussion, as a difference caused by the effect of the white on the wild form.

That relations in the population examined are given an orderly form is also indicated by the result of capture and removal of individuals from two trapping sites (*A* and *W*) during the course of the experiment. The fact that »occupation« of these sites does not take place after capture and removal of their previous »occupants« proves that there is very sharply defined division and stability of feeding places.

The results of final capture and removal of animals and frequency with which individuals change traps within one trapping site also follow a consistent pattern, a greater degree of fortuitousness being observed in the visits to traps by the wild form, as compared with the greater stability in visits to traps by the white form. Interpretation based on the different characteristics of the form and on the mutual interaction of the two forms is also possible.

The result of determination of paternity in relation to the progeny of white females merits separate discussion. In the first place the almost complete absence of mating between white females and wild males is important. In the second the high percentage of exclusively white litters indicates that in general mice mated animals of their own form. Mixed litters could only occur as the result of a female's copulating with at least two males, one white and one wild. In view of the fact that when normal copulation takes place in mice a post-copulative plug is formed, making repeat covering of the female impossible during the given oestrus, the conclusion that a female had copulated with at least two males would seem to show that in at least one of them some disturbance must have occurred during the course of copulation resulting in the post-copulative plug not forming. It may also be considered that the second copulation must have followed the first quickly enough for the eggs from the given ovulation to have been fertilized by the spermatozoa of the two males (white and wild).

This result would also appear to agree with the interpretation of an active, negative influence of the white form on the wild form, as it constitutes evidence that the wild males are not permitted to copulate.

If decreased trappability, and in particular frequent change of trapping sites and traps within the site were connected with the generally greater »living activity« of this form, then this would probably also involve predominance in finding white females to cover during the oestrus. This phenomenon was not observed.

The interpretation that wild males, kept shorter of food, were physiologically incapable of copulating, is not sufficiently borne out in view of the occurrence of mixed litters (copulation with both white and wild male).

The study presented does not therefore solve the problem as to whether, when the different components of behaviour are considered, significant differences occurred during, the domestication period in the behaviour peculiar to wild and to white mice. It does however show that under conditions in which both forms are together in a mixed population, these forms behave differently, these differences being capable of intrepretation as arising from reciprocal and in a certain sense competitive interaction, with predominance of white mice over wild mice.

Thus from the point of view of the theory of phenomena occurring in one-species populations (Petrusewicz, 1965; Andrzejewski *et al.*, 1965) the experiment described permits of formulating the problem, and indicating prospects for research on it, of the formation of competition between individuals leading to splitting up into two populations within a genetically differentiated species. The preliminary, short-term and merely indicative character of this study does not permit of presenting any solution in this field, but points out the way to continued studies.

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PEWNE WSKAŹNIKI ZACHOWANIA SIĘ DZIKICH I LABORATORYJNYCH MYSZY DOMOWYCH W MIESZANEJ POPULACJI TYCH DWÓCH FORM

Streszczenie

Celem pracy było porównanie pewnych wskaźników zachowania się dzikiej i laboratoryjnej myszy domowej (*Mus musculus* Linnaeus, 1758) w populacji mieszanej. Stworzenie populacji mieszanej miało na celu zachowanie jednorodności warunków dla obu form. Dawało to też możliwość prześledzenia konsekwencji współżycia w niej osobników o genetycznie uwarunkowanych różnicach w sposobie oddziaływania populacyjnego.

Miejscem badań był strych budynku Stacji Terenowej Instytutu Ekologii PAN w Dziekanowie Leśnym, na który introdukowano populację złożoną z 80 osobników białych i 52 osobników dzikich. Badania, które trwały przez okres miesiąca prowadzono przy pomocy stałych połowów tych zwierząt w pułapki żywołowne, ustawione na strychu w 5 grupach po 12 pułapek, w których przynętą była zarazem jedyną karmą dostarczaną zwierzętom (Ryc. 1).

Wszystkie osobniki znakowane były indywidualnymi numerami. Przy wypuszczaniu zwierząt z pułapek notowano dzień i godzinę wypuszczenia, numer myszy, płeć, miejsce połowu, okres złowienia się myszy (w pierwsze dwie godziny po poprzednim wypuszczeniu czy też później) oraz ciężar ciała. W końcu doświadczenia wszystkie osobniki odłowiono, samice myszy białych umieszczono w oddzielnych klatkach do czasu urodzenia młodych i ustalenia czy ich ojcem był samiec biały czy dziki.

W wyniku badań stwierdzono szereg różnic w zachowaniu się obu form myszy w warunkach wspólnej populacji.

Realna łowność osobników formy białej była wyższa niż dzikiej z wyjątkiem pierwszych połowów po introdukcji (Ryc. 3). Na podobną właściwość tych dwóch form wskazuje analiza średniego odcinka między złowieniami (Tabela 2). Myszy białe nie różnią się zasadniczo od dzikich łownością pierwszego złowienia (czasem dzielącym introdukcję i pierwsze złowienie danego osobnika), jednak wśród myszy białych zaobserwowano grupę osobników o wyraźnie zmniejszonej łowności pierwszego złowienia. Średni odstęp czasu między introdukcją a pierwszym złowieniem w grupie myszy białych jest większy od średniego odcinka czasu między złowieniami. U myszy dzikich różnicy takiej nie obserwuje się (Tabele 2 i 3).

Od początku doświadczenia do jego połowy obserwuje się ujemną korelację (r = — 0,44) między liczbą złowień myszy białych i dzikich w poszczególnych połowach. Obie formy myszy około połowy złowień realizują w pierwsze dwie godziny po poprzednim wypuszczeniu z pułapek (Tabela 5). Tendencja ta ostrzej wyrażona jest u myszy białych niż dzikich. Większej liczbie złowionych osobników w danym połowie odpowiada wzrost procentu zwierząt złowionych w pierwszych dwóch godzinach. Oznacza to, że większa tendencja do wchodzenia w pułapki realizuje się głównie w pierwszych dwóch godzinach po wypuszczeniu zwierząt z pułapek. To ostatnie zjawisko występuje tylko u myszy białych (Ryc. 6).

Obserwuje się nieznaczne wymijanie się obu form w rytmie dobowym złowień. U obu form istnieją w populacji zróżnicowania łowności osobników i grupy osobników łowiących się szczególnie często (Tabela 7).

Liczba osobników odwiedzających kilka grup pułapek zmniejsza się w trakcie doświadczenia przy czym myszy dzikie częściej łowią się w różnych grupach pułapek niż myszy białe (Tabela 9). Na duże przywiązanie osobników do poszczególnych punktów wskazuje również bardzo małe przemieszczenie się osobników do punktów, w których związane z nimi osobniki zostały odłowione. Zaobserwowano również większe przywiązanie do poszczególnych pułapek w ramach jednej ich grupy, osobników formy białej niż dzikiej.

Z odłowionych na końcu eksperymentu 30 samic formy białej 18 urodziło łącznie 92 młode. Tylko dwa mioty składały się z młodych mieszanych, białych i dzikich, co wskazuje, że samice białe nie były w zasadzie kryte przez samce dzikie.

Otrzymane wyniki pozwalają na wysunięcie hipotezy o wystąpieniu zjawisk konkurencyjnych w mieszanej populacji formy dzikiej i białej z dominacją tej ostatniej. Różnice między formami można jednak interpretować jako wynik udomowienia formy białej. W pracy dyskutuje się również problem rozdzielenia się dwóch populacji w ramach genetycznie zróżnicowanego gatunku.