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Author(s): S. A. Barnett and Mary M. Spencer

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FEEDING, SOCIAL BEHAVIOUR AND INTERSPECIFIC COMPETITION IN WILD RATS

by

S. A. BARNETT & MARY M. SPENCER

(Ministry of Agriculture & Fisheries Infestation Control Division, London)

(With 2 figs. and 4 plates)

(Rec. 27-VI-1950)

During a study of the food preferences of wild *Rattus norvegicus* Berkenhout (BARNETT & SPENCER, 1950a), observations were made on other aspects of rat behaviour. Some observations were made also on the behaviour of *R. rattus* L., and especially on the relations between the two species. Certain features of feeding and social behaviour in both species were filmed.

The animals were wild rats which had been trapped in various places, and kept for a time in the laboratory. They were then released into rat-proof rooms each in area about 180 square feet. Sacking and biscuit tins were available for nesting (plate VIII), and there was a continuous supply of water. Normally they received an excess of cereal food, with cabbage once a week and horse liver once a fortnight.

The size of the colonies varied from 5 to about 40 rats; the larger colonies arose from the smaller by breeding.

The most important observations were made in a room which was fitted with an observation window from which the rats could be observed without disturbance (plate VIII).

FEEDING AND SOCIAL BEHAVIOUR IN *R. NORVEGICUS*

(a) Feeding: general

In all the colonies feeding began at or shortly before sunset, and most of the feeding was done during the night. By restricting the food supply, however, it was possible to induce rats to feed during the day as soon as a fresh supply was put down (*cf.* CHITTY & SHORTEN, 1946).

One colony that was regularly watched consisted of five rats marked by the method described by THOMPSON (1948): two males (U and N) and

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three females (S, P and I). Watching was done at the beginning of the evening feeding period, and usually went on for two hours. The first indication of activity was the appearance of one rat, generally U. This rat first stretched up the wall by the nest and then visited the feeding point. Within 5-10 minutes of this first visit the whole colony became active. Not all the activity was directed towards eating or drinking: there was a good deal of apparently aimless wandering over the nest and round the room. After the first period of activity, lasting 30-60 minutes, there was often a period of quiet, lasting 15-30 minutes, after which the colony again became active. Most of the watching was done during the evening, and we have no full account of activity throughout the night. It is possible that the longest period of activity is in the early hours of the morning (THOMPSON, 1948); CHITTY and SHORTEN (1946) however found no evidence of a cycle of activity during the night.

Drinking and eating occurred during the same periods, with no evident alternation or other regularity. Rats spent up to three minutes at the drinking point. Although U was generally the first to appear, he was not the most active. On one day of watching (when the rats were hungry) U visited the feeding point 101 times in two hours, while N visited it 157 times. The fewest appearances were made by P, which made only 18 visits during the same period. These differences were characteristic, and varied little on different days of watching.

The feeding of hungry rats differs from that of normal well-fed rats only in that they concentrate their activity at the food and water points. There is little or no wandering about. This confirms the observation of CHITTY (unpublished) that in all respects except intensity of feeding hungry rats feed in the same way as well-fed rats.

(b) Carriage of food to nest

A commonly observed feature of the feeding of rats is the tendency to carry food to the nest before it is consumed.

Our main observations were on flour or flour mixtures, whole wheat, cabbage and liver. Our observations on flour and wheat confirm those of SOUTHERN, WATSON & CHITTY (1946), who watched rats in the dark, with an infra-red apparatus. In general, flour was eaten on the spot, and not carried back, but occasionally rats would take a mouthful of flour and run back to the nest with it. Sometimes when this happened a rat would take a handful of flour out of its mouth with its fore-paw and eat it by the nesting site. At the feeding point flour was normally scooped up in one or both fore-paws, and eaten while the rat sat on its hindquarters.

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Plate I. View of room 3 through observation window, showing nesting sites and choice tray.

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Plate 2. *R. norvegicus* dragging liver towards nest.

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Plate 3. Two *R. norvegicus* (left) and three *R. rattus* (one black) feeding together at choice tray. The aggressive *rattus* (centre) is hissing at the *norvegicus*.

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Plate 4. Two *R. norvegicus* (left) and three *R. rattus* (one black) feeding together at choice tray. The aggressive *rattus* (centre) is hissing at the *norvegicus*.

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With wheat behaviour was different. The rats more usually ran out to the feeding point, took a mouthful of wheat and ran back to the nest. A few rats however regularly ate wheat at the feeding point. A rat of medium size (200-250 g.) was found to take 6-8 grains of large grain English wheat in its mouth at a time; the weight of this mouthful was about 2.1 g. In some instances, when the rat remained in view outside the nest, the mouthful was seen to be disgorged on to the ground, and the grains taken up and eaten one by one; in other instances mouthfuls were disgorged but not eaten, and wheat was in this way accumulated at a point in or near the nest (*cf.* PISANO & STORER, 1945).

On one occasion 2-300 g. wheat was found in a nest, but this was the only occasion on which appreciable storage of cereals was observed. It occurred in a colony which had not been starved, during a test on the deterrent action of the odour of peppermint oil. Only plain wheat was available. The wheat was found hoarded in a nest box which was probably not being used for sleeping. At the end of this experiment the rats were starved for one day and then given poison bait at the feeding point. Since all the rats were killed it is clear that they were not relying on the hoarded wheat for food, but were continuing to visit the feeding point.

Withdrawal of food into the nests was observed especially with cabbage and liver. Individual cabbage leaves and cabbage hearts were often immediately removed. The pieces of liver (weighing about 500 g.) were put into the rooms about midday. All the rats, when they reached the liver, tried to drag it back to the nest, but the smaller ones were unable to move it more than a few inches; the larger rats (300-400 g.) often dragged the whole piece in before beginning to eat it (plate IX). This behaviour has been repeatedly observed in a number of separate rat colonies in which none of the rats could have been hungry. It was usual, when cabbage or liver was put in, for it to have disappeared within 15 minutes; often it was taken within 5 minutes. It is possible that the movements of the experimenter helped to induce the rats to behave in this way, since some relatively undisturbed colonies left nibbled portions of cabbage (though not liver) in the open for days or weeks.

Various motives have been suggested for "hoarding" in rats. MORGAN, STELLAR & JOHNSON (1943) report that dietary deprivation leads to hoarding, but there is no evidence of this from our observations. BINDRA (1948a) also reports hoarding due to hunger or to food frustation. In a later paper BINDRA (1948b) claims that a factor in hoarding behaviour is the "difference in security" offered to the animal by a nesting site or home cage; our observations are compatible with this view, but they do not

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support his further assertion that "shy" rats hoard whereas less shy ones do not; direct observations of the behaviour of our rats showed that the carriage of mouthfuls of food such as grain to the nest without eating it was usually done by the most active rats and those which appeared earliest during feeding periods..

There are two elements in "hoarding" behaviour: (I) withdrawal of food, and (II) storage. The first appears to be the usual response of wild *R. norvegicus* to any easily carried food. The second is less usual, and our only example of it is that of the wheat quoted above.

(c) Individual behaviour

In prolonged observations of a rat colony the observer is impressed by the individuality displayed by different rats in the details of their behaviour. Individual behaviour was observed especially in marked rats but rats can often be recognised without marking.

An example is the time of appearance of the rats at the beginning of feeding period. In particular, there is usually a "pioneer" rat which regularly appears first. This applies equally to normal rats when they are beginning to feed in the evening, and to hungry rats after fresh food has been put down. In one instance the colony of 5 marked rats described above was observed on 18 days during a period of 27 days. On 14 out of 18 observation days the large male marked U was seen to be the first to visit the food. During another period of about 4 weeks, in another colony of 40 rats, a female of about 200 g., marked O, was invariably the first to appear.

Other individual behaviour was regularly observed in the mode of feeding. For example the particular procedure, *e.g.* the posture, adopted at the feeding box or tray was usually the same for each individual rat at least for several days, but differed between different rats (plates X and XI). Some rats fed only rarely at the main feeding point but relied instead on scavenging fragments left by other rats on the floor round the feeding point or round the nests.

During resting periods, when no feeding was going on, the rats for the most part remained in their nests. Some individuals, however, regularly roosted in the open. In one colony a group of rats habitually assembled in the roof, in a pocket formed by two overlapping layers of wire netting, where, despite the dim light, they were in full view. In another room several rats were in the habit of resting for long periods on a ledge ten feet from the floor. In a third room one rat (recognisable by an injury to its tail) was often seen during daylight sitting on a projection 18 inches from the floor.

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When disturbed this rat returned to its nest, but a visit 5-10 minutes later often found it back on the projection.

A few rats regularly made distinctive noises, one in particular a noise very much like the clucking of a domestic fowl. These noises seemed to have no significance for the other rats: the only noises heard which had an obvious significance were the squeaking and squealing which accompanies fighting and mating.

(d) Avoidance and "approach behaviour"

The avoidance by rats of unfamiliar objects and situations has been extensively studied at Oxford by SHORTEN (unpublished) and others. Clear instances in our experiments occurred when the food tray was replaced by a new one of different structure, and when an electric light was left on all night (fig. 1). The response to a light which was left on for only one night was a sharp decline in feeding; in another colony the light was regularly left on all night, and this had no permanent effect on feeding. A more marked inhibition of feeding occurred whenever a new colony of rats was introduced into one of the rooms. Usually no feeding took place for two nights, but on the third night a normal amount was eaten.

Tentative behaviour was directly observed while feeding was being watched or filmed; it occurs especially when something unfamiliar is present. When feeding was about to begin the first indication was commonly the appearance of the head of one rat at an entrance to the nest. It was common for rats to remain in this position for some minutes before they finally emerged; sometimes they did not emerge but withdrew, only to appear again perhaps at another entrance. Sometimes groups of rats collected by the nest and remained for a time looking in the direction of the food, without moving towards it. During the periods of waiting the rats could be seen to be moving their nostrils and they gave the impression that they were sniffing the air. Occasionally a rat approaching the feeding point would stop, rear up on its hind legs and again apparently sniff the air.

Unfamiliar noises, especially those of high frequency, caused rats to remain in their nests or to flee if they were outside when the noise began. This is a commonplace observation, and the important feature of this behaviour was not the avoidance of the unfamiliar noise but the extent to which rats can become accustomed to repeated noises such as those made during filming. Hungry rats, in fact, quite rapidly overcame their reaction to the presence of a man, a camera, a tripod and three floodlights and fed normally while filming was going on. Rats accustomed to feeding in these conditions reverted to more normal behaviour when a surplus of food had been restored.

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(e) Social behaviour

By social behaviour is meant any activity which directly influences the behaviour of other individuals of the same species.

There is a widespread belief that rats are highly social and co-operative animals. This belief depends no doubt partly on the tendency for rats to take suitable food back to their nests, and such behaviour may indeed benefit other members of the colony. We have seen rats which had not yet visited the feeding point eat wheat brought back by bolder rats, such as the "pioneer" rats described above. Sometimes rats have even taken fragments of food from the paws or mouth of another rat, without evoking any expression of hostility; this has occurred when the rats were hungry.

It is possible that in some conditions hearing or seeing rats feeding stimulates others to feed. This apparent "social facilitation" was observed in hungry rats given a distasteful food mixture. Two feeding points were provided, 2 ft. apart, one with plain wheat and the other with wheat mixed with aniseed. Aniseed is a deterrent to rats (BARNETT & SPENCER, 1950b), and only the plain wheat was eaten. When the rats had fed for about 60 minutes the positions of the boxes were exchanged. The first rats that appeared after the change consequently went to the box with the aniseed: after sniffing it, often several times, they went to the other box, sniffed that, and then took some wheat. Rats which appeared later, however, when feeding was already going on in the new position, went as a rule straight to the box with the plain wheat.

These rats had already been subjected to a number of experiments of this kind for the purposes of filming, and a conditioning effect is probable. Their behaviour may be contrasted with that of the colony of five marked rats referred to above, during one of the early experiments on the response to aniseed. Wheat mixed with aniseed was offered in one box and plain wheat in the other, and the positions of the boxes were exchanged each day. On the first day all the rats except P found the plain wheat during the first two hours of feeding; an the next day however, when the boxes had been changed over, only one rat (U) visited the box with plain wheat during the first 3¾ hours of feeding: in this period the other four rats had visited the other box (without feeding) at least once each, and N no fewer than eight times. Two days later both males found the plain wheat during the first two hours, but the three females each made two visits to the contaminated wheat and retired to the nest without eating. Four days later, after a period of partial deprivation of food, the rats all quickly found the plain wheat. By this time, however, they had had eight days' experience

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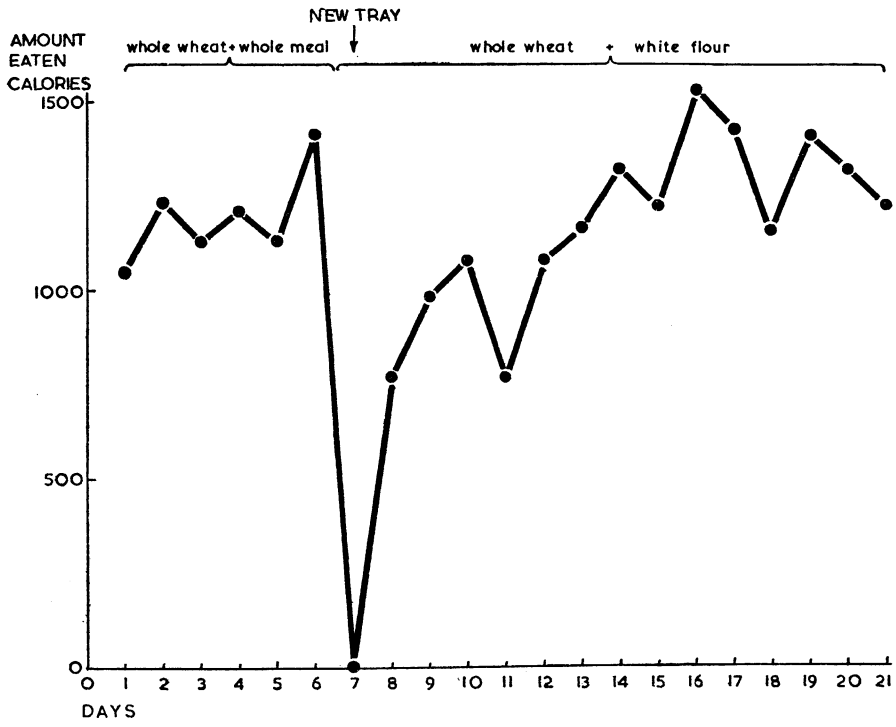
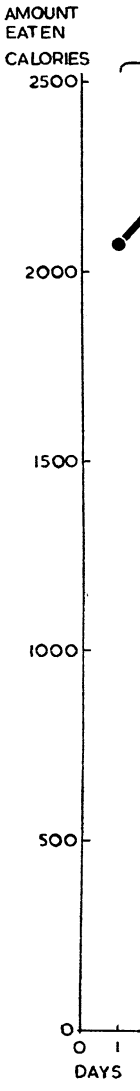
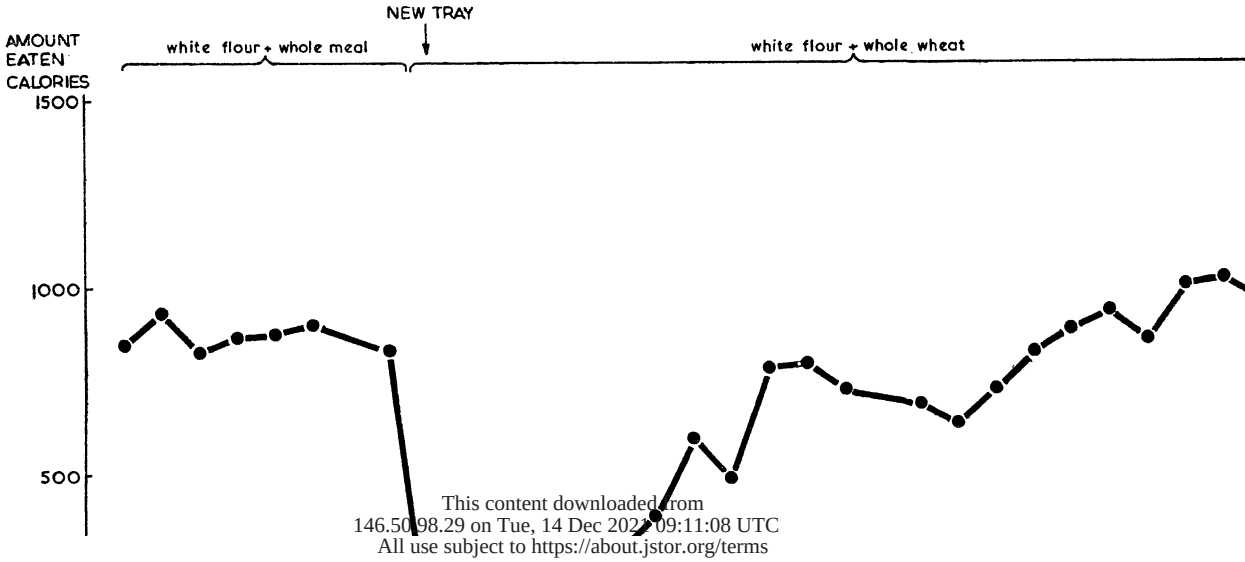


Fig. 1A

Fig. 1. Examples of "new object reaction", or avoidance behaviour.





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3/6,7

flour

16 17 18 19 20 21

nce behaviour.

4/7.8

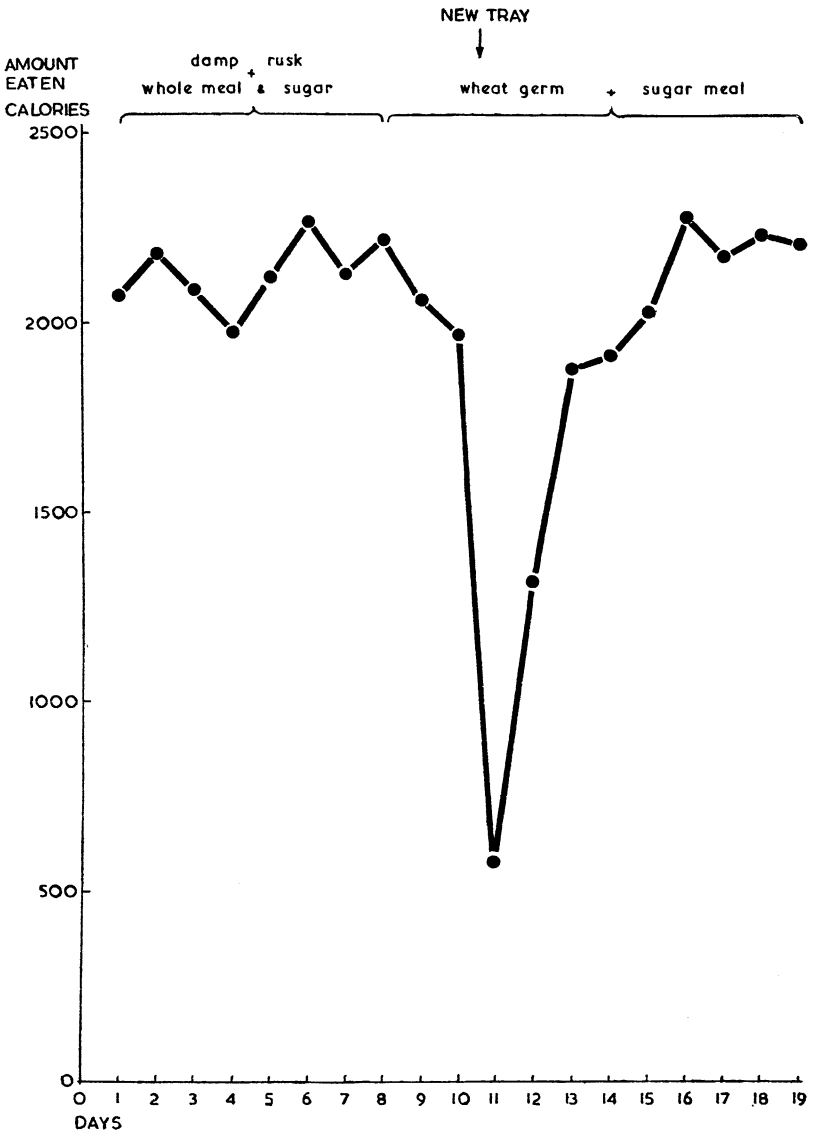
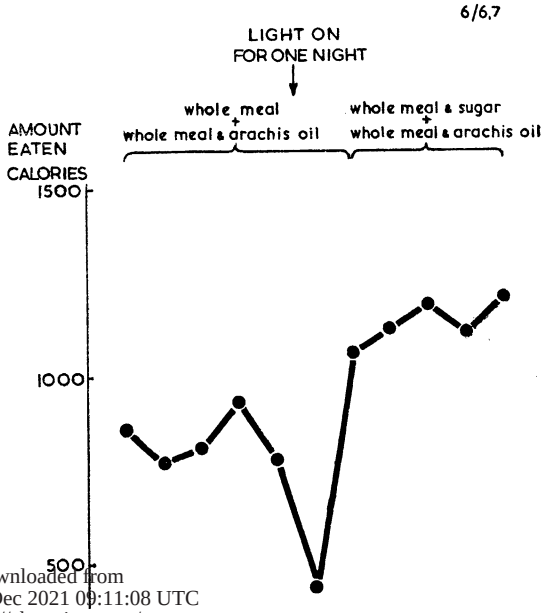


Fig. 1C

4/1,2

white flour + whole wheat

6/6,7



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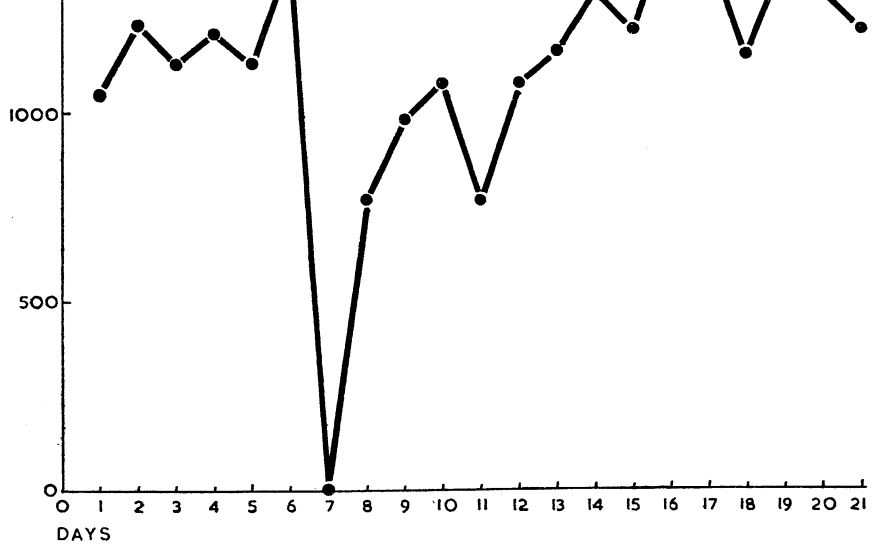
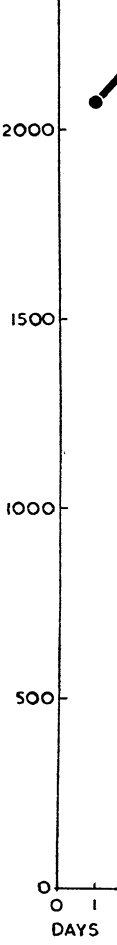


Fig. 1A

Fig. 1. Examples of "new object reaction", or avoidance behaviour.



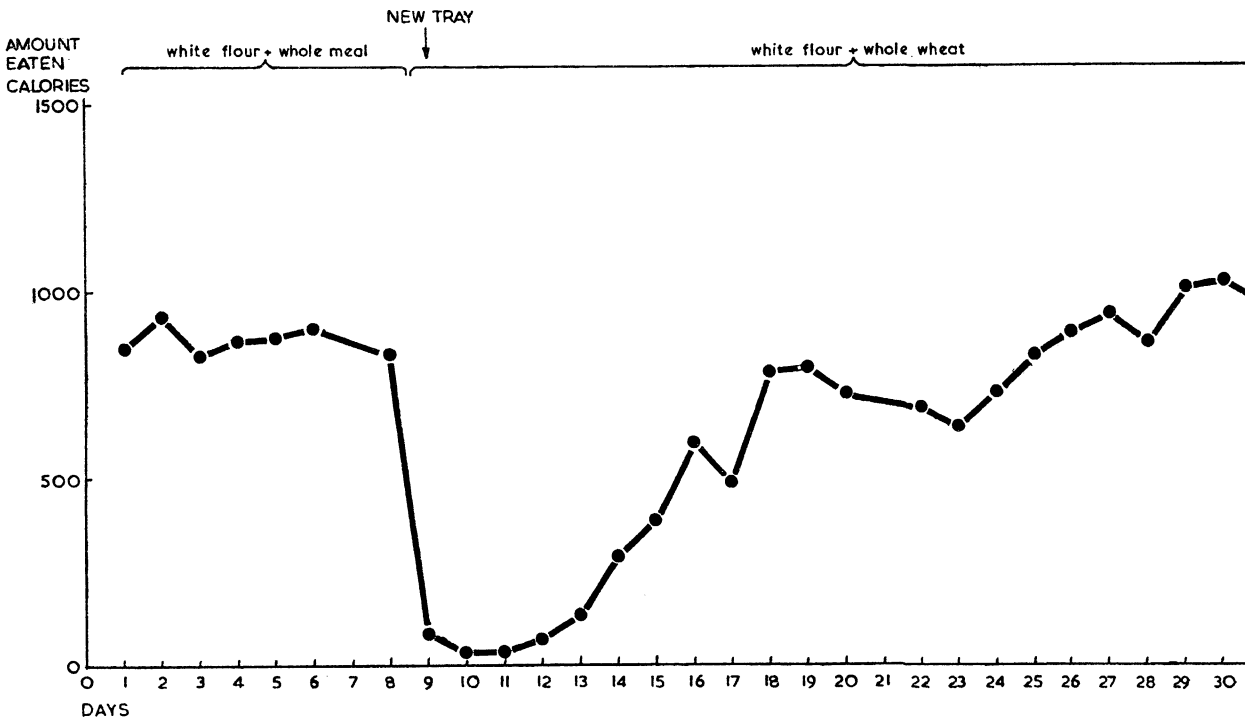


Fig. 1B

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nce behaviour.

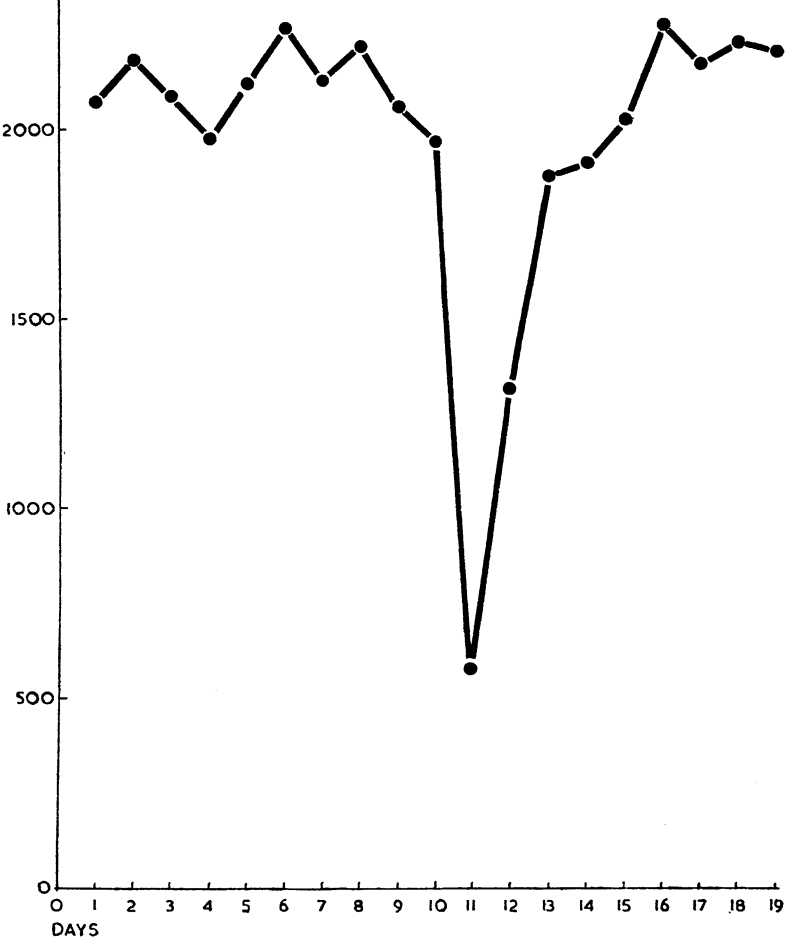

Fig. 1C

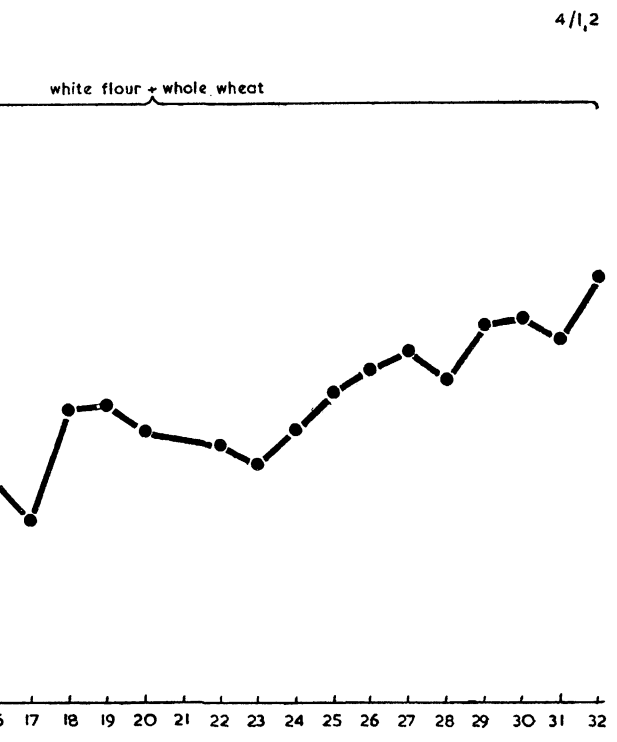

Fig. 1B

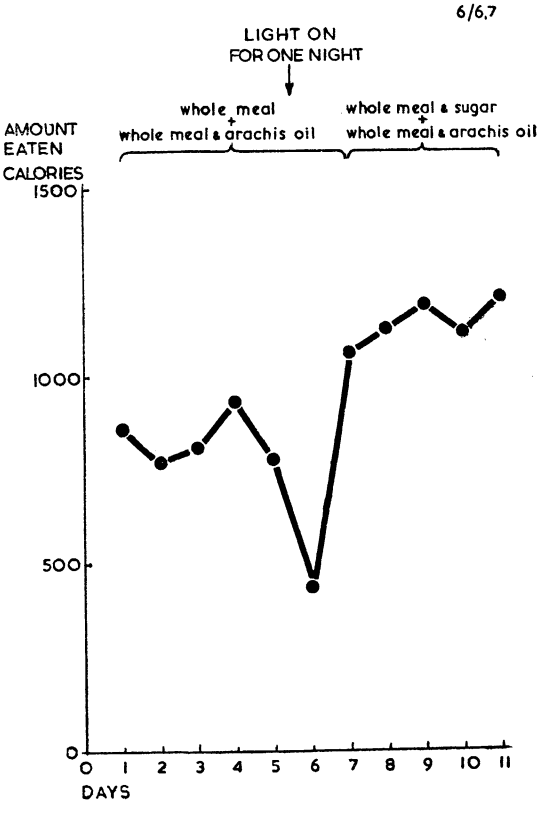

Fig. 1D

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of the alternation of the bait boxes. The implication of these observations is that imitation is not an important factor in feeding behaviour for adult rats which are not hungry: on each day, regardless of what other rats are doing, the previous day's experience influences the behaviour of each individual rat.

The activities of pioneer rats do, however, seem to have a social importance in another way. This is reflected in the excitement produced in the nest when food is first brought into the nest after it has been put down. We have observed the behaviour of colonies of hungry rats when cabbage has been put down and cabbage leaves have been brought back into the nest. A great deal of noise and running about has followed; on several occasions one rat has seized a fragment of cabbage and run from place to place among the nesting sites; wherever such a rat settled to feed on the cabbage other rats had evidently attempted to take it for themselves. This does not suggest a very high degree of co-operation. The lack of co-operation, at least among hungry rats, is reflected also in the behaviour towards liver. We have observed (and filmed) on several occasions two or three large rats each attempting to drag the same piece of liver in a different direction. Such violent tugs-of-war have always ended in the liver reaching the nest, but there was no evidence of behaviour directed towards anything but the satisfaction of each individual's needs.

We have also observed young rats (about 50 g.) being trodden on by larger ones when there was much movement between the nest and feeding point. On several occasions adult rats have been seen to collide head on while running to and fro.

We have little direct information on what goes on within the nest. Examination of nests, from time to time, and observations made when colonies were removed from the rooms, showed that there was a tendency for the rats to collect in one part of the available nesting sites, and to sleep there together. As many as twelve adult rats have been found in one tin measuring 24 by 22 by 22 cm. Even a litter of nestlings may be found in a box with 3 or 4 adults, but this is unusual. The particular box used varied from time to time for no evident reason. The obvious function of sleeping in a group is to keep warm. Nest temperatures, measured by putting the bulb of a mercury thermometer well into the sacking of which the nest was made, ranged from 17.0-24.5° C when outside air temperatures were 9.5-18.7° C [1]). There was no evidence of a relationship between nest temperature and outside temperature within these ranges.

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1) We are indebted to Mr A. SMITH for these measurements.

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(f) Hostility between individuals of the same species

CALHOUN (1949) has reported observations suggesting that rats resist the approach of strange individuals of the same species to their nests. In our rat colonies, each of 5 to 40 rats all living in a small group of nesting sites, hostility between individuals was rarely seen except among males competing for a female. We have, however, on a few occasions directly observed the sort of effect described by CALHOUN. For example, rats newly introduced into one of the rooms generally took cover at once in the nesting sites; if a rat has occupied one of the tins and another rat enters, the second rat may be at once ejected. This occurs also, as might be expected, when new rats are introduced into an established colony. In one instance a stranger was seen to remain an outcast for 4 days, after which time it either died or became absorbed into the rat community. The outcast was chased away from the food by the original inhabitants, and was conspicuous for its dejected appearance. After the first day young rats were seen to sniff the stranger, whereon the latter tended to run away even if there were no active aggression.

In another case an established group of 5 rats had another 5 added. Of the second 5 only 2, one of each sex, was absorbed into the colony. The other 3 died within 24 days.

Hostility to strange individuals is in accordance with the observation by CALHOUN (1948) that wild rats trapped and released in a neighbouring infested area for the most part either return to their original habitat or soon die. In a series of experiments in each of which 10 rats were put into a room to start a colony, an early mortality was always found, even though later the surviving rats settled down successfully and bred (BARNETT, 1950). It is possible that in our experiments a factor responsible for this mortality was the lack of opportunity for burrowing, since the space for nesting was limited. In addition there was only one feeding point.

When, in an established colony, one rat interferes with another, the result is as a rule not a fight but only that the heavier rat pushes the lighter out of the way. This has been observed especially at drinking points. When the two rats are of about the same weight they take it in turns at the drinking point, one pushing the other away after a short period of waiting.

Fighting was observed over females in oestrus. In one instance such a female was observed to copulate 25 times, in a period of 1 hour 35 minutes, with at least 3 males, and during this time there was some fighting among the males; no serious injury was observed.

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COMPETITION BETWEEN *RATTUS NORVEGICUS* AND *R. RATTUS*

(a) Method

Our observations on the relations between the two rat species come from a single experiment. Two colonies, one of each species, were established in two of the rooms already described (fig. 2). There was a communicating door between the rooms. In room 3 there were 29 *R. norvegicus,* in room

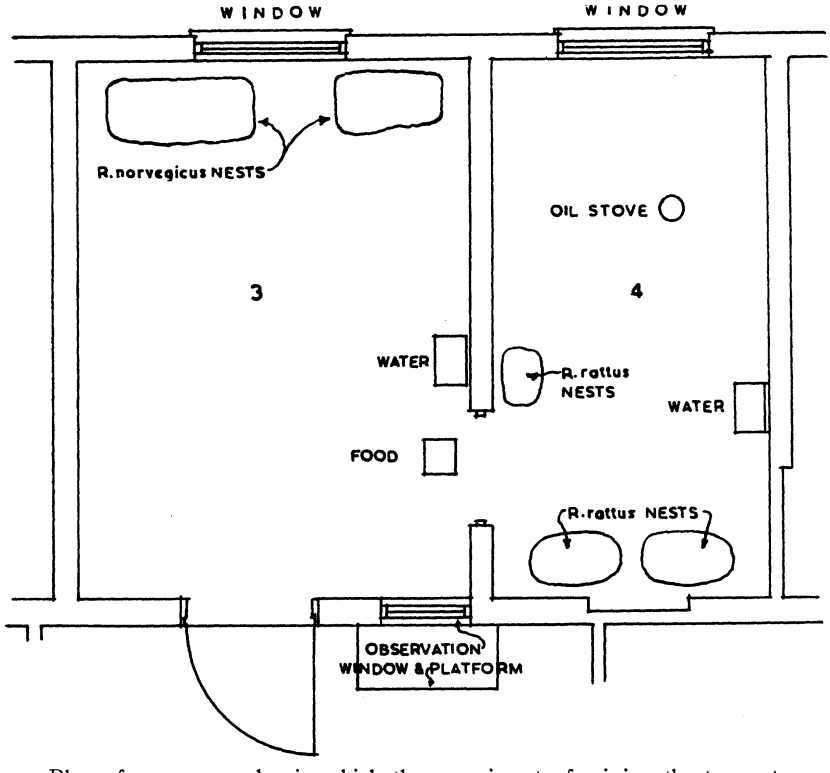

Fig. 2. Plan of rooms 3 and 4 in which the experiment of mixing the two rat species was carried out.

4, 19 *R. rattus*. The time was winter, and no reproductive activity was observed. Since *R. rattus* does not tolerate the full rigours of an English winter an oil stove was kept alight continuously in room 4 throughout the experiment. A limited amount of food was provided for both colonies near the door between the rooms.

After a fortnight the communicating door was opened, a single feeding point was provided in the doorway, and the rats were allowed to move

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freely between the two rooms. All the observations described below were made on hungry rats.

(b) Observations

On the first day members of both species fed together without conflict. Members of one species tended to sniff at individuals of the other, but at the feeding point no other special behaviour was observed.

On several occasions, however, rats of one species entered the nests of the other. Whenever this happened it provoked uproar. A. *norvegicus* of about 200 g. weight entering *rattus* nests was driven out after a good deal of squeaking and banging. Similarly *rattus* entering *norvegicus* nests was driven out. (None of the *rattus* weighed more than about 200 g.). After these incidents a larger *norvegicus,* a male of 440 g., entered room 4 and systematically explored the *rattus* nests. This foray created an exceptional degree of disturbance and ended in all the *rattus* being driven out of their nests to take refuge on the wire netting in the roof.

On the second day nearly all the *rattus* were found to be in the roof or on a ledge 10 feet from the floor. Only one was seen to emerge from the nesting sites. The large *norvegicus,* with all the other members of his species, had returned to his own nest. During the feeding period of about 2 hours all except one of the *rattus* were attracted down from the roof.

When food was put down the first rat to feed was a *rattus* of the black variety, but other individuals of that species appeared only very much later. The *norvegicus* fed confidently, but seemed to be more "nervous" than usual. The *rattus* were unquestionably very nervous. The *rattus* were disturbed by the appearance of the *norvegicus,* and on several occasions individual *norvegicus* made attacking motions towards the *rattus* and drove them off. These attacking motions were made only by certain individuals, and were not common to all the *norvegicus* that appeared. On several occasions the *norvegicus* themselves ran away after driving off the *rattus.*

Despite all this feeding did take place with both species together. When this feeding was going on without disturbance members of both species tended to sniff at individuals of the other species; they also sometimes sniffed at members of their own species, but less often.

After the second day a surplus of food was supplied for 5 days, followed by a reduced quantity for 2 days. This procedure enabled us to watch the feeding behaviour on the ninth day. Only 6 *rattus* were seen on this occasion. Of these, 5 fed almost as soon as food was put down. The *norvegicus* began to come out after about 15 minutes. When the *norvegicus* first reached the feeding point one of the *rattus* already feeding there made aggressive

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motions and a hissing noise. At first this was successful in driving off the *norvegicus,* but later they took little or no notice and fed in their usual manner (plates X and XI). When this happened the aggressive *rattus* tended to become more violent and to hiss even at members of its own species. There was very little actual fighting, and when fighting occurred each incident lasted only one or two seconds. There were periods when both species fed peacefully together.

At this stage we were obliged to end the experiment and to remove the rats. Poison (zinc phosphide) was therefore mixed with the food, and on the next day the bodies of the rats were collected. In room 3, previously occupied by *norvegicus,* 8 *norvegicus* were found dead in the nests and 6 in other parts of the room. In room 4, previously occupied by *rattus,* 5 *rattus* were found, all in one nesting box. Ten *norvegicus* were found in other nesting boxes, and 2 *norvegicus* in other parts of the room. Three *norvegicus* had therefore died out of the original 29, while 13 or 14 *rattus* had died during the same period; most or all of the *rattus* deaths took place after the two species had been allowed to mix. Some bodies were found, all partly eaten, but there was no evidence of the cause of death.

DISCUSSION

Two general questions will be discussed: (a) the problem of "intelligence" and social behaviour in *R. norvegicus;* (b) the significance of our observations on the relations between the two species.

Nothing we saw suggests that rat colonies have any highly organised social structure comparable, for instance, with that of the American beaver. Most of the special features of rat behaviour are quite simple in form: they avoid the unfamiliar, but overcome this avoidance within a few hours or days; they tend to withdraw food to their nests before eating it, though not in a co-operative way; sometimes they hoard food; on the whole they ignore other members of their own colony except when mating or when sleeping in groups in the nest.

The complexity of rat behaviour arises not from any ability to perform single acts of an elaborate kind, but from the marked adaptability shown to a wide range of conditions. New object reaction, which is so conspicuous a feature of rat behaviour, is balanced by the ability to overcome the avoidance rapidly, and to feed and nest in any environment which provides, within a wide range of temperatures, the basic necessities of food, shelter and nesting materials.

Although, however, the special items of rat behaviour are superficially

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simple, there is much worth studying in them. The avoidance of new objects alone deserves more detailed analysis (*cf.* BARNETT, 1948). We do not know, for instance, the full range of stimuli that can cause the reaction. We do know that the avoidance due to some stimuli is not new object reaction, because the avoidance is continued indefinitely; this applies to the responses to certain olfactory and gustatory stimuli (BARNETT and SPENCER, 1950b). Another feature of rat behaviour, of great physiological interest and requiring much more study, is the "dietary self-selection" reported by various authors (*e.g.* RICHTER, 1942; YOUNG, 1946; SCOTT & VERNEY, 1947); this is paralled by the "shyness" which appears when the food has caused illness (RZOSKA, unpublished), and which seems to be the obverse of the selection of beneficial foods (ARMOUR & BARNETT, 1950).

The way in which rats recognise individuals of their own colony is also unknown and of considerable interest. This feature of colony organisation was the most notable aspect of social behaviour among the rats we observed.

The second question, that of the relations between the two species, can be discussed only tentatively, since only one experiment was done on it. At first sight the observations suggest that the relationships between individuals of different species is the same as that between strangers of the same species: strangers are expelled from nests; they may be driven away from food; and they are sniffed at suspiciously when not actually attacked. The most obvious difference arises from the fact that *R. norvegicus* grows to a larger size than *R. rattus,* and the result of this is illustrated in our one observation on the effect of an invasion of *rattus* nests by a large *norvegicus.* If this is typical it suggests that the relationship between the species is asymmetrical simply because one is larger than the other. It appears from the final distribution of the two species that *norvegicus* had successfully invaded some of the *rattus* nests and occupied them. It is not however clear how the death of 13 out of the 19 *rattus* was brought about: nothing we saw suggests that it was directly due to fighting, and it may have been due to shock, cold or even to starvation through inadequate access to food. (The same problem arises with the death of "outcast" *norvegicus*).

Until early in the 18th century *R. rattus* was the only English rat, and was widespread both in the country and the towns. By 1900 *R. rattus* had become comparatively rare and appeared to be maintained only in port districts, as a result of continued re-entry from ships (BARRETT-HAMILTON & HINTON, 1912-20; MATHESON, 1939). Our results, as far as they go, support the hypothesis that the decline of *R. rattus* and its replacement by *norvegicus* was due to competition between the two species, perhaps especially for nesting sites, in which *norvegicus* was successful because of its greater

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size. There is, however, scope for much more experiment on this case of inter-specific competition.

SUMMARY

1. Observations were made on the behaviour of colonies of wild *Rattus norvegicus* kept in closed rooms with nesting sites of tins and sacking.

2. Wheat, cabbage and liver were eaten mainly in or near the nest. Exceptions were when the cabbage or liver was too heavy to be dragged in; possibly when colonies were exceptionally free from disturbance; and when individual rats ate wheat at the feeding point instead of taking mouthfuls back. Flour was mainly eaten at the feeding point, but mouthfuls were occasionally taken back. Storage of wheat was observed on only one occasion.

3. Marked individual differences were observed in certain details of behaviour: in particular, in every colony observed one particular rat came out to feed first at the beginning of a feeding period. These "pioneer" rats probably influenced the behaviour of other rats.

4. New object reaction and tentative behaviour were observed. The avoidance of new objects and conditions was rapidly overcome, especially when the rats were hungry.

5. There was no co-operative effort in feeding. When more than one rat tried to drag liver into the nest, a tug-of-war commonly resulted.

6. Strange rats of the same species were ejected from nests as soon as they entered them, and were also sometimes driven away from food.

7. Rats of different species aroused a similar antagonism. In one experiment, in which two colonies were brought together, a colony of *R. rattus* were driven from their nests by a large *R. norvegicus,* and 13 out of 19 *rattus* died within 9 day of this incident. There was little or no mortality among the *norvegicus* during this time, and the latter occupied some of the *rattus* nests.

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ZUSAMMENFASSUNG

1. Das Verhalten von Gruppen wilder *Rattus norvegicus* wurde beobachtet. Diese wurden in Zimmern aufgeschlossen welche mit Zuchtstellen aus Blechbüchsen und Sackleinwand ausgerüstet worden waren.

2. Weizen, Kohl und Leber wurden zum grössten Teil gefressen entweder in den Zuchtstellen oder gleich nebenan, ausser den folgenden Ausnahmen: als Kohl oder Leber zu schwer waren zum Hinschleppen; vielleicht als Gruppen ausserordentlich ungestört waren; als einzelne Ratten Weizen am Futterpunkt frassen statt dass sie Mundvolle zurück trugen. Mehl wurde meistens am Futterpunkt gefressen, Mundvolle wurden aber gelegentlich zurückgetragen. Weizenauflagern wurde nur einmal beobachtet.

3. Bemerkbare individuelle Unterschiede wurden in den Einzelheiten des Verhaltens beobachtet: im besonderen kam in jeder der beobachteten Gruppen am Anfang der Futterzeit eine bestimmte Ratte zum Fressen der erste aus. Diese bahnbrecherischen Ratten hatten wahrscheinlich einen Einfluss auf das Verhalten der anderen Ratten.

4. Neophobia und versuchendes Verhalten wurden beobachtet. Das Vermeiden neuer Gegenstände und neuer Zustände verschwand bald, besonders als die Ratten hungrig waren.

5. Beim Fressen war keine Zusammenarbeit zu beobachten. Als mehr als eine Ratte versuchte Leber in die Zuchtstelle zu schleppen, kam es öfters zum Tauziehen.

6. Fremde Ratten der selben Art wurden aus den Zuchtstellen geworfen so bald sie einkamen: sie wurden manchmals vom Futter weggetrieben.

7. Ratten verschiedener Art weckten eine gleiche Feindschaft auf. Bei einem Versuch, als Gruppen von *R. rattus* und *R. norvegicus* zusammenkamen, wurde die Gruppe von *R. rattus* von einer einzelnen *R norvegicus* aus ihren Zuchtstellen weggetrieben, und infolge dessen waren neun Tage später 13 der 19 *rattus* gestorben. Unter den *norvegicus* gab es während dieser Zeit keine oder nur geringe Sterblichkeit und diese letzten hatten einige der Zuchtstellen der *rattus* in Besitz genommen.

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