

THE BEHAVIOUR OF RATS AND MICE FEEDING ON WHOLE GRAINS

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(With Plates 2 and 3)

Samples of kibbled (broken) grain have been collected and examined during experiments on rodent control in the field and on rats and mice in the laboratory. The behaviour of rats and mice when eating whole grains has been observed, both in the laboratory and in colonies in conditions approximating to the wild. Kemper (1940) describes similar observations, though in less detail than is given here.

The species studied were *Rattus norvegicus* Berkenhout, *R. rattus* Linnaeus and *Mus musculus* Linnaeus. The grains studied were wheat, barley, oats and maize.

RATS

Rattus norvegicus and *R. rattus* do not differ greatly in the way in which they eat cereal grains. Direct observation of hungry rats shows that *R. norvegicus* more often takes mouthfuls of whole wheat back to the nest from an exposed position than does *R. rattus*; the grains are then disgorged and eaten one by one (Barnett & Spencer, 1951). Both species pick up one grain at a time, generally with their mouths and, squatting on their hind-quarters, hold the grain in their forepaws while eating it. The grain is held with the long axis towards the mouth, as a man holds a cigar, and is bitten across the long axis (Pl. 2, figs. 1 and 4-6; Pl. 3, figs. 7, 8). Both species leave similar residues of broken grain.

Kibbled grain is found only when well-fed rats are supplied with a surplus, and its occasional absence in the field may be due to the fact that all the grain taken is removed to a nesting site or to a point under cover before it is consumed.

Wheat. Wheat residues are shown in Pl. 2, figs. 1-4. When wheat is kibbled the proportion of a grain discarded usually varies from a quarter to a half of its length. The discarded part is nearly always the bearded end of the grain. Small pieces of the bran consisting of pericarp and testa are also dropped and these may have pieces of endosperm attached (Pl. 2, fig. 1).

Soaked wheat residues are shown in Pl. 2, fig. 3. These residues are quite different from those of plain wheat. Discarded bearded ends though present are less apparent; the more noticeable feature of the kibbling is the large semi-transparent pieces of bran which have been peeled off. There is also a marked increase in the number of grains which have been held at both ends and nibbled along the cheeks: the discarded pieces usually consist of the crease with small pieces of endosperm attached at each end.

Oats. Oats contain a relatively large proportion of husk even after threshing. These husks are always bitten off and discarded, and the grain is then eaten from

one end like wheat; the bearded end of the grain is usually left together with fragments of bran (Pl. 2, figs. 5 and 6).

Barley. The inner pales of barley invest the grain more closely than those of oats and are less readily detached. The easier part to detach is the end where the pales enclose the germ, and these detached ends are a feature of kibbled barley (Pl. 3, figs. 7, 8). Smaller pieces of pales and bran are discarded, as they are with wheat, together with a quarter to a half of the grain. In contrast to wheat and oats, one end of the grain is not so consistently selected. It is not certain whether this would occur in the field, for both samples of kibbled barley were obtained in the laboratory.

Maize. There is a higher proportion of wastage with this grain. Kibbled maize left by *R. norvegicus* was collected from a depot containing several tons of the grain; that left by *R. rattus* (Pl. 3, fig. 9) was collected in the laboratory. Grains kibbled by *R. norvegicus* had only the germ and scutellum removed. The fragments left by *R. rattus*, from a more restricted supply, were more varied but the germ and scutellum were again the first parts to be attacked. Often the pericarp was discarded almost in one piece and most of the cracked endosperm was uneaten.

MICE

Mice typically hold a grain of *wheat*, *oats* or *barley* at right angles to the long axis of the body, as a man holds corn on the cob (Pl. 3, figs. 10–12). They also rotate the grain about its long axis while eating it. The cheeks of the grains are nibbled away and some of the endosperm is left attached to the crease. Small fragments of bran with endosperm attached are discarded. Occasionally mice nibble out a part of the endosperm of oats and barley without detaching the grains from the pales.

The germ and scutellum of *maize* are attacked first. In the samples collected in depots the difference between those nibbled by mice and those attacked by rats is very slight; mice perhaps eat a little less of each grain.

DISCUSSION

The difference between rats and mice in the method of holding grains is probably determined by convenience and arises from differences in size and strength. Mice can and sometimes do hold and nibble grain with the long axis towards the mouth, but grains nibbled from end to end are characteristic of mouse kibbling.* The rat rarely kibbles grain in this way.

The discarding of half-eaten grains by the rat or mouse probably occurs when the grain becomes too small or too irregular to hold. It is then dropped and a whole grain picked up instead.

The choice by rats of the germ end of the grain may be due to several causes. First, the germ has, in some respects at least, a higher nutritional value, for its vitamin B₁ content is very high (Hinton, 1947). There is evidence that rats given a choice select mixtures containing B vitamins (Scott & Verney, 1947).

Secondly, the germ may be preferred for its flavour. There is evidence against this from experiments in which rats given a choice between wheat germ and white

* During field work it has been noticed that kibbling probably attributable to *Apodemus sylvaticus*, *Clethrionomys glareolus* and *Microtus agrestis* resembles that due to the house-mouse.

flour (75% extraction) took very little of the wheat germ and fed almost entirely on the flour (Barnett & Spencer, 1953). These observations are also against the explanation of the choice being due to nutritional value. However, some colonies of rats of both species will occasionally take only the germ of wheat grains (Pl. 2, fig. 2). Wheat kibbled in this way is practically indistinguishable from wheat attacked by insect pests such as *Gnathocerus cornutus* Fabricius and *Palorus ratzeburgi* Wissmann.

Finally, it may be that texture is the determining factor. This is the obvious explanation with maize, in which the germ and scutellum are much softer than the endosperm. Carlson & Hoelzel (1949) consider that the preference of laboratory rats for maize germ is wholly to be explained by its softness. The germ end of wheat and oat grains is also the softest part, but it is relatively small and some endosperm is usually eaten with it. The increase in the number of grains nibbled from end to end when the wheat is soaked in water suggests that texture is more important than nutritional value, though the taste of soaked wheat is likely to differ from that of dry owing to the formation of sugar from starch which would increase palatability. The dry oat grain, however, although much softer than the dry wheat grain is attacked in a similar way. (The oat grains on which the observations were made could be broken between the thumb nail and forefinger easily, but similar treatment made almost no impression on the wheat grains.) It is possible that the feel of the bearded end of both wheat and oat grains is the only reason why rats select the opposite end. Questions of this sort can be answered finally only by experiment.

SUMMARY

The way in which rats and mice eat whole grains of wheat, barley, oats and maize has been studied.

Rats (*Rattus norvegicus* and *R. rattus*) hold grains with the long axis parallel to that of the body and eat the germ end of the grain in preference to the rest.

Mice (*Mus musculus*) hold grains with the long axis at right angles to that of the body and attack first the cheeks of all grains except maize, of which only the germ and scutellum are eaten.

It is suggested that texture is in the main responsible for the selection of a particular part of a grain.

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REFERENCES

- BARNETT, S. A. & SPENCER, M. M. (1951). Feeding, social behaviour and interspecific competition in wild rats. *Behaviour*, **3**, 229–42.
- BARNETT, S. A. & SPENCER, M. M. (1953). Experiments on the food preferences of wild rats (*Rattus norvegicus* Berkenhout). *J. Hyg., Camb.*, **51**, 16–34.
- CARLSON, A. J. & HOELZEL, F. (1949). Influence of texture of food on its acceptance by rats. *Science*, **109**, 63–4.
- HINTON, J. J. C. (1947). The distribution of vitamin B₁ and nitrogen in the wheat grain. *Proc. Roy. Soc. B*, **134**, 418–29.
- KEMPER, H. (1940). Über die von tierischen Gesundheits- und Wohnungs-schädlingen hinterlassenen Spuren. *Z. hyg. Zool. Schädlingsbekämpfung*, **32**, 1–37.
- SCOTT, E. M. & VERNEY, E. L. (1947). Self selection of diet. VI. The nature of appetites for B vitamins. *J. Nutrit.* **34**, 471–80.

EXPLANATION OF PLATES 2 AND 3

PLATE 2

- Fig. 1. *R. norvegicus*: wheat kibbled by an established and breeding colony.
- Fig. 2. *R. norvegicus*: selected grains of wheat showing removal of germ.
- Fig. 3. *R. norvegicus*: kibbled soaked wheat.
- Fig. 4. *R. rattus*: wheat kibbled in laboratory.
- Fig. 5. *R. norvegicus*: oats kibbled in laboratory; discarded husks and bearded tips.
- Fig. 6. *R. rattus*: oats kibbled in laboratory; discarded husks and bearded tips.

PLATE 3

- Fig. 7. *R. norvegicus*: barley kibbled in laboratory; pales detached from germ end of grain and discarded grain.
- Fig. 8. *R. rattus*: barley kibbled in laboratory; detached pales and discarded grain.
- Fig. 9. *R. rattus*: maize kibbled in laboratory.
- Fig. 10. *M. musculus*: kibbled wheat.
- Fig. 11. *M. musculus*: oats kibbled in laboratory.
- Fig. 12. *M. musculus*: kibbled barley.

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