

R A T S

and their destruction

RATS

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BULLETIN No. 30 OF THE MINISTRY
OF AGRICULTURE AND FISHERIES
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HIS MAJESTY'S STATIONERY OFFICE
SIXPENCE NET

*"Great rats, small rats, lean rats, brawny rats,
Brown rats, black rats, grey rats, tawny rats"*



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MINISTRY OF AGRICULTURE AND FISHERIES

BULLETIN No. 30

RATS

AND THEIR DESTRUCTION



LONDON: HIS MAJESTY'S STATIONERY OFFICE

1949

FOREWORD

THE introductory section comprising pages 1-4 of this Bulletin is reproduced mainly from an article contributed by the late Professor Sir J. Arthur Thomson, M.A., LL.D., of the University of Aberdeen, to the Ministry's JOURNAL for May, 1925, but some necessary alterations have been made in the light of more up-to-date information. The remainder of this 7th edition has been prepared by Mr. C. D. Hornby, Technical Adviser for Land Pests Destruction of the Ministry of Agriculture and Fisheries, in consultation with Mr. Charles Elton, Director of the Bureau of Animal Population, University of Oxford, and his staff. It is hoped that the information brought together will prove of value to all who are concerned in the task of rat destruction.

The attention of readers is directed to the Orders made under Defence (General) Regulations, 1939, a summary of which is given on page 15.

Ministry of Agriculture and Fisheries,

September, 1945.

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RATS AND THEIR DESTRUCTION

WITH NOTES ON HOUSE MICE, VOLES, FIELD MICE AND GREY SQUIRRELS

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INTRODUCTION

One of the most injurious animals in Britain is the rat, and in spite of the energetic measures taken to reduce its numbers it remains a very serious menace. Rats destroy enormous quantities of stored food, and spoil much more than they destroy; they do great damage to property by burrowing and gnawing; and they are vehicles of several formidable diseases.

The Black Rat. Neither of the two varieties of rats now represented in Britain can be called a native: both are aliens from the East, the first to come being the Black Rat (*Rattus rattus*), the arrival of which in this country dates from the time of the Crusades. In the Mediterranean region and in the East it is represented by varieties of a much lighter colour. Thus the Alexandrine variety, frequenting Asia Minor and North Africa, is brownish-grey on the back, and the Roof Rat of the Mediterranean region has the same part of its body yellowish- or reddish-brown. It seems that the black dress was acquired after the originally light-coloured *Rattus rattus* got a footing in colder countries, but all three varieties occur in this country. It must be borne in mind that many of the "Black Rats" (*Rattus rattus*) in Britain are actually brown, and occasional "Brown Rats" (*Rattus norvegicus*) are black. This is a source of frequent confusion, and shows that little

importance can be attached to colour until the species has been identified on other grounds, to be referred to later on. For many years the black rat was a serious pest in Britain, as in Europe generally, not only because of its destructiveness but because it harboured the microbe of the plague (or Black Death). In the early eighteenth century, however, its rival the brown rat was introduced, and within fifty years this newcomer had prevailed. About the middle of the nineteenth century the black rat was a rarity in Great Britain. In several places, principally ports, it has become common again, being introduced afresh by ships. Its climbing powers favour its prevalence as a ship rat, and in this respect it is more successful than its cousin.

The Brown Rat. The original home of the Brown Rat (*Rattus norvegicus*) is in temperate Asia, and wild forms are still abundant in the region between the Caspian Sea and Tobolsk, and also to the west of Lake Baikal. It has become closely associated with man, and has been his shadow wherever he has sailed. It was not known in Western Europe till 1716, nor in Britain before 1728. The colder the country the closer is the dependence of the brown rat on man.

Darwin referred to the internecine struggle for existence between the brown rat and the black rat, which resulted in the latter becoming almost extinct in Britain. But four points must be kept in mind: (1) the brown rat is the hardier species, more of an outdoor creature and not averse to the wetness of sewers and the like; (2) the brown rat is more of a burrower, and therefore less baulked than the black rat by barriers of stone and lime; (3) the brown rat is a much more indiscriminate eater; and (4) it is more plastic and tamable, as is well seen in the behaviour of its albino derivative the "white rat." No doubt the two species will fight when they must, but it is too simple to say that the brown rat directly killed off the black rat in the struggle for existence. As Dr. Chalmers Mitchell says: "Each species has its different aptitudes, capacities and preferences, and each insinuates itself into the most suitable environment. Possibly the extension of sewers and drains in this country has been a major cause of the greater success of the brown rat." Moreover, we cannot forget that the black rat is becoming common again in some places.

How to Distinguish Black and Brown Species

(See also Figs. 1 and 2)

BLACK RAT (*Rattus rattus*)

Smaller, of slim build, with sharp muzzle.

Ears large, naked, almost translucent, meeting when pressed across the top of the head.

Tail slender, at least as long as head and body.

Pads on soles of feet relatively large.

Many slender, grooved bristles in the soft fur. Usually ten teats.

Adult weight rarely over 8 oz.

BROWN RAT (*Rattus norvegicus*)

Larger, of heavier build, with blunt muzzle.

Ears small, hairy, thick, not meeting when pressed across the top of the head.

Tail stout, never so long as head and body.

Pads on the soles relatively small.

Grooved bristles fewer and more slender. Usually twelve teats.

Adult weight normally 14-17 oz.

The two species are nearly related, but they differ through and through—even in the crystals that form when their blood is dried. There are marked differences in the skulls and teeth, but to appreciate these requires some

apprenticeship. It must again be noticed that no reliance can be placed on differences in colour; and that differences in size and weight cannot be much utilized unless one knows that the contrasted animals are of the same age. A brown rat of 30 oz. is not uncommon, and one of 44 oz. has been recorded.

There should be no possibility of confusing either of the rats with the Water Vole (*Arvicola amphibius*), badly called the "Water Rat," for the water vole is a heavily built animal, marked by a broad head, a blunt muzzle, inconspicuous ears, and a tail with a good deal of hair. It is not infrequently found exploring in fields at a distance from the water.

Habits of Rats. Rats are most active in the darkness or semi-darkness. Their eyes can make much of dim light; and they have acute tactile sensitiveness in their whisker-hairs (or vibrissae) and in their feet. They usually spend much of the day in their holes or burrows, resting and sleeping, often in comfortably-lined nests; they often lay in stores of food. In their coming and going in the open they make runs, which are marked by their spindle-shaped droppings. Their inclination to keep to these wonted paths makes trapping easier; but everyone knows of their suspicious wariness.

They are practically omnivorous, though vegetarian in wild conditions. Their chisel-edged incisors are well adapted for gnawing, and part of the rat's activity in this direction, which sometimes seems gratuitous, is necessary to keep the continuously-growing incisor teeth from becoming too long. When the upper and lower teeth fail to meet properly, strange overgrowths occur, which sometimes end fatally. Rats may attack hard wood, lead pipes, bricks and cement; but what they gnaw in such cases is not swallowed.

The brown rat is not such a clever climber as its cousin, but still it can do wonders. It is a better burrower than the black rat and is much more inclined to take to the water. It swims and dives well, and follows water-courses in spreading from place to place. Although it often lives among filth, it is cleanly by inclination. Frequently there is a spring movement of rats from human habitations to the open country and a return to shelter in autumn. There is often a vigorous hunting of small animals in the open and a not inconsiderable destruction of eggs and young birds. The seasonal movement is to be distinguished from a trekking from one locality to another when overcrowding becomes intolerable, or when something occurs that makes flitting desirable. There are records of a unanimous departure from a haunt where the mortality from poisoning had been great.

Rats are sociable among themselves, though there is evidently an instinct that prompts them to kill and devour the maimed or weakly. Records of their "courage" in attacking man are probably misunderstandings, for the circumstances usually point to the desperate boldness of starvation. Moreover such abnormalities of appetite as attacking the feet of elephants are apt to seem stranger than they really are; for it is very improbable that it occurs to the rat that it is gnawing at the toes of a giant mammal! There is no doubt, however, of the resourcefulness, ingenuity, and educability of rats; they form associations readily and they can learn in a short time to scamper through the passages of a Hampton Court maze.

Family Affairs. Brown rats may be sexually mature when three and a half or four months old, and they can breed all the year round. The sexual season

for a particular female extends for about nine months, and "heat" occurs at intervals of about ten days. The male is always ready to pair: the female cannot be impregnated except at the period of "heat," which lasts for only a few hours. The period of gestation is a little over three weeks, and the female is ready to be impregnated within a few hours of the birth of a litter. The average number in a litter is eight, but there are often a dozen; and there may be five or six litters in a year. The female ceases to be fertile as she grows older—a fact sometimes overlooked in estimating the rate of multiplication. She is a careful mother, but in conditions of overcrowding, inadequate food-supplies, or captivity, she may devour her offspring. The young are born blind and hairless, with their ear-trumpets sealed down; their eyes open in about a fortnight and they are weaned in the course of their fourth week. It will be understood that many of the figures, such as the number of litters in a year and the number of offspring in a litter, vary greatly according to the conditions of life.

Prolificacy of the Rat. Two female rats kept in captivity are known to have had 26 litters in 13 months, amounting altogether to 180 immediate offspring, but the average number of litters per female is much smaller, fewer than ten per year. But the young would begin to breed in $3\frac{1}{2}$ —4 months, so that the total number of descendants would be much greater. The relative rate of increase of *Rattus norvegicus* under optimum conditions has been estimated to be from 8 to 10 per cent per week. This would be equivalent to a population of rats multiplying from 60—180 times. This allows for the death rate under optimum conditions, i.e., good food and shelter, but no enemies or epidemic disease. But of course such increase cannot occur in nature, because there are many checks to numbers, both from the existence of breeding seasons, and from additional mortality through enemies, disease, control measures and so on.

The Indictment of the Rat. DAMAGE. The damage caused by rats is difficult to assess in actual loss of food and property because of the very varied nature of the damage and the great diversity of its diet. Rats will eat almost any food normally used for human or animal consumption and spoil a great more by fouling it and gnawing containers. Probably the biggest single item of rat damage is in corn-ricks on farms, where, although each rat eats only about an ounce per day, the total annual loss must be many thousands of tons. Farm rats also cause heavy losses in stored grain, meals, roots and other crops and feeding stuffs, besides doing serious damage to buildings and corn sacks. In towns and urban areas their depredations continue among stored foods of all kinds, particularly cereals, and here the structural damage to property is generally worse than on farms. Every rat that lives is, in fact, an active or potential source of damage to food and goods needed by human beings.

DISEASE. A more serious matter is their connexion with human disease. Bubonic plague is a disease carried by rats and transmitted to human beings by certain fleas. Fortunately the disease is now very rare in this country, thanks to the cumulative effects of rat control measures in seaports; but the danger still exists that ship-borne rats may bring the disease to this country.

The dangerous *Trichina* worm, which causes trichinosis in man, is primarily at home in the rat. When a pig eats an infected rat it becomes trichinosed, and from the pig's flesh, if it is imperfectly cooked, the parasite may reach man.

The dwarf tapeworm (*Hymenolepis nana*), which is very common in man, has the rat as its preliminary host. Rats disseminate the organism (*Leptospira*) of spirochaetal jaundice or Weil's disease, which is capable of remaining infective in water for some time after it has left the body of the rat. This is a serious disease, occurring especially in mines, sewers, slaughter-houses and other damp places where man comes into close contact with rats. Ratbite may cause a peculiar and serious fever.

Issuing from filthy places the rat may contaminate the food of man and beast with its germ-laden droppings which may contain bacteria responsible for dangerous food poisoning in man; in fact the circle of the rat's life cuts man's at many points, and always inimically.

PREVENTIVE MEASURES

It is essential as part of the general campaign against rats that in addition to the methods of extermination referred to later in this bulletin, every means should be utilized to discourage their increase, and their access to places where they can do damage.

Some of the measures enumerated below apply more particularly to rural areas. It is the farm, as a rule, that is most difficult to free from rats, and farmers often do not realize the damage done by these rodents working incessantly, silently and relentlessly, devouring corn in the stack, killing chickens, worrying animals in stalls, damaging buildings and defiling grain and feeding-stuffs in barns and stores. Unfortunately, it is harder actually to visualize the enormous collective damage done by colonies of rats on farms and to determine the loss in terms of hard cash, than it is for a trader in an urban area to compute his losses from such sources.

The following are some measures which might be adopted:

1. Rendering buildings, such as poultry houses, rat-proof by erecting clear of the ground (see Fig. 5) or by means of concrete floors and foundations, brick-work laid in cement, and galvanized iron sheeting.

2. Properly constructing, protecting and repairing drainpipes, ventilators, doors and basement windows, to prevent access by rats. Special attention to drainpipes is essential, as the "brown" rat generally uses defective drain connexions to gain access to premises; it is impossible to keep buildings free from rats if there are defective drains. Where the "black" rat is about, all sources of possible ingress to buildings from roofs should be suitably protected. Basement windows may be protected by a covering of heavy galvanized wire-netting of $\frac{1}{2}$ -in. mesh. The lower parts of the doors of buildings may usefully be covered with thin metal sheeting. (See Figs. 3 and 4.)

3. Using concrete or metal bins for grain and meal and covering the angles of wooden receptacles already in use with metal sheeting, or the whole receptacle with heavy, galvanized wire-netting of $\frac{1}{2}$ -in. mesh. Surplus food should not be left lying about in stables, cow-houses or poultry-runs.

4. Stopping burrows under floors or in walls from which rats have been driven by filling the holes with concrete; a mixture of cement, sand, and broken glass or crockery, or a mixture of broken glass and tar.

5. Burning or, pending disposal, keeping garbage and refuse of all kinds in metal rat-proof receptacles. Rubbish heaps, and all places which might afford shelter for rats to breed, should be cleared away. Stores of old materials should be frequently moved and examined and kept thoroughly clean.

6. Encouraging rats' natural enemies. Everything should be done to encourage and protect those carnivorous mammals and birds of prey which undoubtedly levy a useful toll on rats. Among the former may be mentioned weasels and stoats, and among the birds, buzzards, hawks, kestrels, owls, ravens and seagulls. Cats are often able to keep premises clear of rats once the latter have been reduced to low numbers by vigorous poison or other campaigns, although without this preliminary assistance they cannot so easily succeed.

METHODS OF EXTERMINATION

The various methods employed in the destruction of rats may be grouped under four headings: *poisoning; gassing; trapping; hunting*. Poisoning and gassing should generally be sufficient. Trapping and hunting may be considered as auxiliary to other methods of extermination.

When an occupier contemplates dealing with his rat problem himself, the following general plan should be adopted:

- i. (a) A complete inspection of the affected area;
- (b) A poison baiting campaign;
- (c) A follow-up treatment with poison-baiting, gassing or trapping;
- (d) Application of rat proofing measures when the population is reduced to negligible limits;
- (e) Regular inspection and maintenance of control.

2. In the first place it is necessary to study the habits of rats and to *make a thorough survey of the sites of infestation*. Rats are mostly active at dusk and at night, but their presence can be confirmed by damage to food and food containers, burrows with freshly excavated earth or smooth worn passages, fresh droppings, regular runways, holes gnawed in woodwork, dark body smears on woodwork or flooring, and footprints. By means of these signs you should find the living-holes of the rat colonies, their feeding places, and the runways between the two. It is extremely important that as much as possible should be ascertained about the size and complete distribution of rat colonies *before control operations are begun*.

3. When it has been discovered exactly where the rats are living, running and feeding, the strategy of control is to kill them, either in their holes by poison baiting or gassing, or on the runways between their holes and their normal food supply by poison baiting or trapping.

4. If possible the whole of the infested area should be treated at one time, otherwise much trouble may be experienced in getting rid of the final remnants.

Poisoning. There is no doubt that poisoning is the most effective and economic method of rat destruction since it can be used almost anywhere and does not involve heavy expenditure on labour or apparatus. Poisoning can be done simply by placing poison baits in the rat holes and runs. It has, however, been amply proved that far better percentage kills and more consistent results are obtained by "pre-baiting" before poisoning.

Pre-baiting simply means accustoming the rats to eating a plain food to which the poison will be added in the final baiting. This practice consists essentially of laying unpoisoned food at selected points late each day for two to four days before laying the actual poison baits of the same material at the same points. The rats become attracted to these points, realizing that a meal awaits them, and, in consequence, eat heavily of the poisoned material when substituted—sufficient, in fact, to ensure a full lethal dose of the poison. Pre-baiting results in a more economical use of poison baits, for the rats are brought to the points where the pre-bait is laid, so that broadcast scattering of the poison baits over a large area, some of which may not be visited by the rats, is avoided. Here is an indication of how to carry out a poison treatment:

I. DECIDE on the poison and base to be adopted.

The poisons in ordinary use are red squill (powder and extract) arsenic and zinc phosphide. Baits containing red squill, which is not a poison subject to sale or other restrictions under the Pharmacy & Poisons Act, 1933, are less dangerous to man and to domestic animals than the other poisons, but they cannot be said to be harmless. This poison is contained in the red squill bulb, which is dried and ground down to a fine powder. The bulb grows on the shores of the Mediterranean Sea.

Special care is necessary to prevent domestic animals, stock or poultry from gaining access to baits.

The bases, which are used as pre-baits and for making the poison baits, are:

(i) Ordinary National Standard flour	...	...	...	...	9 oz.
Sugar	...	...	...	...	1 oz.

(ii) *Bread-and-water paste.* Brown or white bread that has become stale or hard may be softened by soaking in water. Surplus water is then drained off and the bread broken up into a porridge-like consistency.

(iii) *Sausage rusk.* This is a dry, coarse material looking like ground-up biscuit, used for sausage fillings. It can be obtained from many butchers. It should be of medium grade, not fine like flour. It is moistened with water in the proportion of:

Sausage rusk	...	...	...	...	...	2 measures
Water	...	...	...	...	...	1 measure

If this mixture is made up by weight, equal weights should be used. The result should be a crumbly moist bait and not a porridge.

The following are a few simple recipes for the actual poison baits:

(i) Red squill powder	...	...	...	...	...	1 oz.
Bread-and-water paste (or moistened sausage rusk)	...	...	...	...	...	9 oz.
(ii) Arsenic	...	...	...	...	...	1 oz.
Flour and sugar	...	...	...	...	...	6 oz.
(iii) Arsenic	...	...	...	...	...	1 oz.
Bread-and-water paste (or moistened sausage rusk)	...	...	...	...	...	9 oz.

(iv) Zinc phosphide	...	...	...	...	...	1 oz.
Flour and sugar	...	...	...	...	...	19 oz.
(v) Zinc phosphide	...	...	...	...	...	1 oz.
Bread-and-water paste (or moistened sausage rusk)	...	...	...	...	...	39 oz.

Plain sugar meal will keep indefinitely but moist baits must be made fresh and used each day, because they soon go mouldy and thus become less attractive to the rat.

Arsenic-sugar meal can be stored for one week and zinc phosphide-sugar meal up to three weeks without deterioration.

2. ESTIMATE from your inspection of the area the number of bait points required and from this the quantity of bait required.

Normally each bait should be of about the quantity to fill a dessertspoon, i.e., about 1 oz.

3. BAITING. *Hole-Baiting.* (i) Hole-baiting is an efficient and safe method, provided that the poison baits are laid well inside the holes so as to be inaccessible to human beings, animals or birds. The holes must be carefully blocked in as soon as possible after the night of poisoning.

(ii) Baits should be placed in every occupied ground hole, in holes in stone walls, brickwork or double-boarded walls where there are rats, and in rat runways under heaps of junk or other cover.

(iii) Provided a sufficient number of points are baited, one heaped dessertspoonful at each pre-baiting or poisoning should be enough, but two spoonful of *poison bait* should be laid at points where the pre-baits have been very well taken. *Do not be surprised if there is poison bait left by the rats;* this is an indication that an adequate supply was put down. If all is eaten, it is likely that some rats did not get enough to kill them.

(iv) Sometimes you will have over-estimated the scale or misjudged the distribution of the infestation, and some pre-bait points will be left untouched. No poison baits need be put down at such points.

(v) The following system will be found very reliable for hole baiting:

Pre-bait on the first day with plain bait.

Leave one day gap.

Pre-bait on third day with plain bait, in the same holes, etc.

Leave one day gap.

Place poison bait on fifth day, in same holes, etc.

Always use the poison in the same base as the pre-bait.

Container Baiting. (i) Container baiting will sometimes be found necessary, where there are not enough suitable holes or safe surface baiting spots. If baiting is done either inside a box with a 3-in. hole cut in the side; or in pipes, of which the 3 in. diameter kind used for mole-draining (with one end blocked with cement) is very convenient; the container should be placed by a rat hole or on a runway. These containers reduce the danger to human beings, dogs, cats, etc., but are not safe for poultry. The danger for poultry can, however, be much reduced by placing a brick or stone three inches in front of the entrance of the container or by facing the entrance three inches from a wall.



FIG. 1. BLACK RAT (*Rattus rattus*). Half natural size.

Illustration by courtesy of the British Museum (Natural History).



FIG. 2. BROWN RAT (*Rattus norvegicus*). Half natural size.

Illustration by courtesy of the British Museum (Natural History)

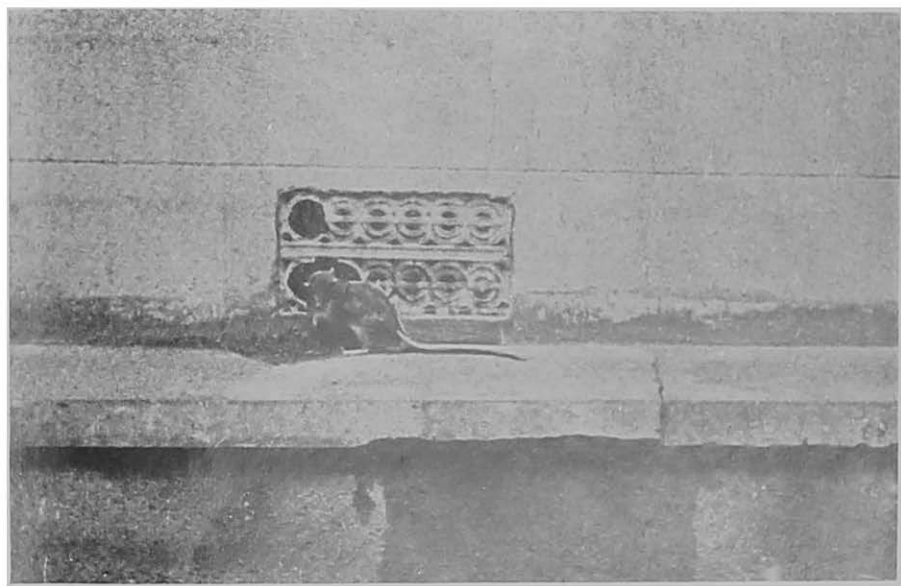


FIG. 3. A DEFECTIVE VENTILATOR.

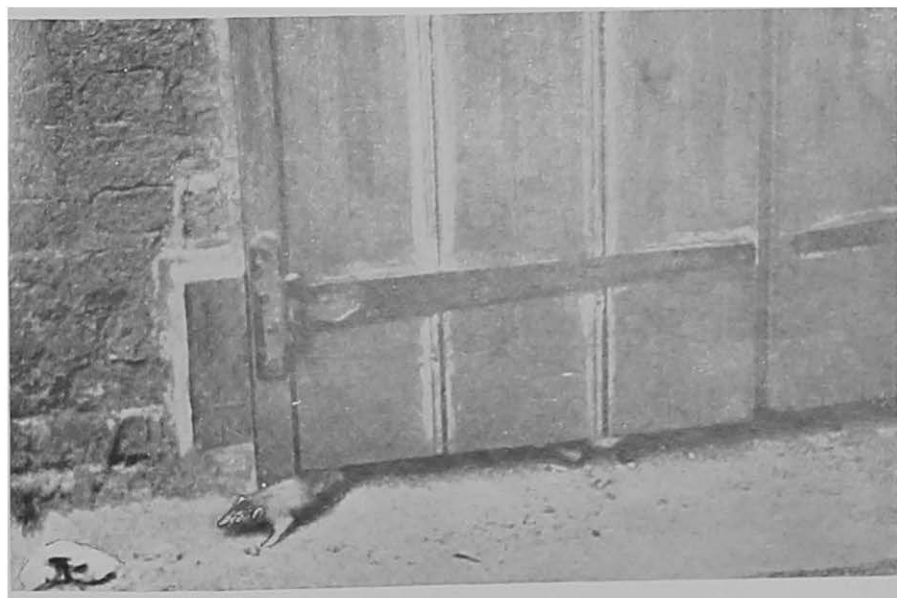


FIG. 4. A BADLY-FITTING DOOR.

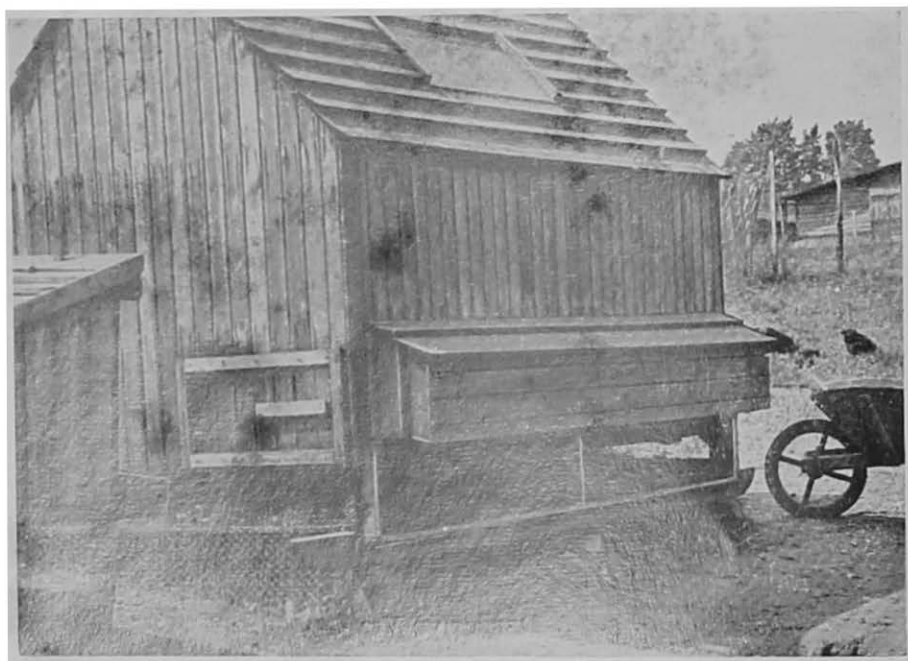


FIG. 5. RAT-PROOF FOWL HOUSE, BUILT CLEAR OF THE GROUND.



FIG. 6. GASSING RATS IN A BANK.

(ii) Because of the suspiciousness of rats towards new objects, the containers should be left down for some time before the main baiting campaign is begun. This period, of a week or more, may be considerably shortened by putting some dry sausage rusk or stale bread scraps in each container. During this time and during the baiting, the containers must be *kept on exactly the same spot*. *Regular pre-baiting should be started simultaneously in all the containers.*

(iii) As a rule fewer points are used than if baiting were being done in holes or on the surface. To get the same results *pre-baiting should be done for five days continuously*, and poisoning on the sixth. If possible use moist baits for first treatment in containers, putting four spoonfuls of pre-bait every day, and, on the last day, eight spoonfuls of poison bait, into each container.

(iv) The containers should be thoroughly cleaned after use, allowed to dry and laid by for further operations.

Surface Baiting. (i) Where it is safe to do so, baits need not be placed in holes or in containers but can be laid on the surface, e.g., on the floor of a building, or on wall ledges. This is a very quick and convenient method, permitting easy inspection and removal of residues. It is mostly used indoors, in places inaccessible to children and domestic animals and birds.

(ii) Surface baiting can also be combined with hole baiting or with container baiting. If used in conjunction with hole baiting it should be done on the same days and with the quantities recommended for putting down holes. If used in conjunction with containers, the full five days pre-baiting and the larger amounts should be used. Bait should not be laid at surface points during the container "lag" period.

(iii) *If surface baiting alone is being done, it is best to use the five days pre-baiting system and size of baits as for containers.*

(iv) Surface baits must be kept away from loose foodstuffs, and residues of poison bait collected and burned as soon as possible after the night of poisoning.

4. FOR THE CONTINUANCE of operations, it is necessary to have available two quite different baits, one for the first treatment and another for a follow-up treatment of any survivors. Rats that survive a poison bait for any reason are usually shy of taking the same bait again and, unless the treatments are more than three months apart, it is necessary to change both the poison and the bait base, otherwise many failures will be experienced.

5. PRECAUTIONS. (i) All the poisons are dangerous if eaten accidentally. However, the amount present in small quantities of rat bait is not a serious danger in practice, provided (1) utensils employed for mixing and holding baits are cleaned after use, hands washed, (2) poisons are clearly marked as such and stored in a safe place and stale poison bait disposed of, (3) poison baits are laid well inside holes, surface baits in safe places or at safe times, or else suitable containers used, (4) cats and dogs are shut up or removed or at any rate kept well fed during poisoning, to prevent them eating poisoned rats, (5) all accessible remnants of poison bait are trodden into the holes or cleared up and burned the day after poisoning.

(ii) Moist baits containing zinc phosphide give off small amounts of phosphine gas (which has a strong smell). They must only be mixed in well-ventilated rooms, otherwise there is a danger of cumulative poisoning among people exposed constantly to the gas.

(iii) Poisoned rats dying under wooden floors or in hollow walls, can become a nuisance on account of corpse smell. For this reason it is best in inside jobs of this kind to do first treatments with arsenic, which causes much less corpse smell than other poisons; or the rats should be trapped in such places.

Gassing. In banks, hedgerows, solid refuse tips and other places in the open, rats can be effectively destroyed by the use of gas, provided that the holes can be effectively blocked to hold the gas. Gassing is especially valuable for following up poison treatments where a residue of rats is left which have become poison shy.

Various gases are used, that in most extensive use being *hydrogen cyanide*. This is produced from the cyanide powders which release the gas when in contact with moist earth or the moisture of the air.

There are two methods of using cyanide powders. Probably the better known is that of blowing the powder into the burrows by means of a pump or dust gun. In using a pump, the rubber hose is introduced about 12 in. into the rat hole and pumping continued until dust emerges from the neighbouring holes. All such holes are then blocked. Pumping is the better method when undergrowth is heavy because it tends to indicate holes which might otherwise remain unnoticed.

The other method is to insert about $\frac{1}{4}$ oz. (a *heaped* teaspoonful) of the powder by means of a spoon on the end of a short rod as far as possible down each hole needing treatment, the hole then being "stopped" with a sod of turf or earth or a stone, taking care that none of the stopping earth or sod drops over the heap of powder. In wet weather conditions a second spoon should be used as a ladle, in order to avoid dipping a wet spoon into the powder in the tin.

It is often recommended that every hole should be stopped and gassing and restopping carried out only on such holes as have been re-opened 48 hours later. This is doubtless the best method where adequate labour is available. On the other hand, if a considerable distance has to be travelled to the job, it is cheaper to gas all recently used holes and stop all holes on the first visit. One or more treatments of re-opened holes may be necessary in order to secure complete destruction of rats.

Unlike rabbits, some rats, and especially any that happen to be near the entrance to a hole, tend to bolt. These are sometimes so affected by the gas that they may easily be killed by means of a stick or a spade. An attempt should be made to see that any unaffected rats that bolt do so in the direction of the holes not yet gassed so that they may be destroyed later in the proceedings.

Although perfectly safe when used with ordinary care, cyanide powders are highly dangerous poisons and the following points should be noted:

(i) Cyanide dust or the gas from it, swallowed or breathed in by operators or dogs, is a deadly poison. An open tin should never be left in a closed room or car. Care should be taken that an enthusiastic terrier or other good "ratter" does not start to dig out a rat hole soon after gassing.

(ii) The powder and apparatus must be kept dry. It should not be used when there is rain or a very strong wind.

(iii) The operator's back should be turned to the wind as far as possible.

(iv) If any cyanide powder is accidentally spilled, it should immediately be buried, covered with earth, or, if on a hard surface in the open air, sluiced away with copious quantities of water, taking care that such washing water does not run into any water supply used by domestic animals, stock or poultry.

(v) Gassing should not be carried out in dwelling houses, or in places where food is stored, or animals kept; neither should it be employed in burrows which are likely to pass under such buildings.

In buildings, fumigation with this gas is subject to the provisions of the Hydrogen Cyanide (Fumigation) Act, 1937, and to Regulations* made thereunder.

Carbon-monoxide, a deadly, colourless and odourless gas, is a component of the exhaust gases of petrol engines. If, therefore, a rubber hose is attached to the exhaust pipe of a motor vehicle, and the engine allowed to run for a few minutes on a rich mixture, the fumes conducted by the hose into the rat runs will kill the rats. Care must be exercised, however, as carbon-monoxide, being light, rises rapidly and may therefore do harm to the operator. Risk may be minimized by slightly over-lubricating the engine, thus rendering the exhaust fumes visible.

Sulphurous gases, generated by the slow combustion of cartridges in a tube which is inserted into the mouths of the runs are also employed.

Trapping. Many types of trap are employed with success. These include the ordinary steel gin or spring trap, the break-back trap, the wire cage trap and the snare.

Premises can be almost cleared by an expert trapper, but it is doubtful if the labour costs compare favourably with a poison treatment. Trapping is often valuable for clearing up small infestations or the residual populations remaining after poison treatments.

Trapping inside buildings is best done with break-back traps (the large type specially made for rats). The traps should be placed at the holes or with the treadle at right angles across the runways, preferably where these are close to a wall or other object. Put down the traps baited, but do not set them until the rats have begun to visit and take the baits. Then set them all at once. Baits can be fish heads, crusts, etc. They should be visited daily until they catch no more rats.

For outdoor work, the 3 in. steel gin trap is the most suitable although some trappers prefer the ordinary rabbit gin trap with 4 in. jaws. Outside traps are most effective when set in well-used runs and lightly covered with grass, leaves or other material to match the surroundings; 3 in. traps should

* The Hydrogen Cyanide (Fumigation of Buildings) Regulations, 1938 (S.R. & O., 1938, No. 1578).

be fastened to a peg but the heavier 4 in. trap needs no fixing. For successful trapping, large numbers of traps are essential and the trapper should inspect and reset traps at frequent intervals during the night. It is better to trap intensively in this way for two or three nights only, rather than keep a small number of traps in operation for a long period as this tends to make the rats shy of traps.

Hunting. The rats are made to bolt by the use of ferrets, and then killed by dogs or by means of sticks. Where a localized heavy infestation exists, it is an advantage to surround the area with a 2 ft. 6 in.-high fence of $\frac{1}{2}$ in. wire-netting or hessian so placed as to allow a 6 ft.-runway round the location. Rats will bolt into the runway where they can be killed more easily, with less risk of their escaping to fresh quarters.

Corn ricks at threshing time provide an admirable example of such a localized heavy infestation; here, fencing is absolutely essential.*

Maintenance of Control. (i) A careful search of the area for signs of rats should be made at intervals of a month, and all re-infestations dealt with on the principles given above.

(ii) If re-infestation by invasion from fields or premises outside is suspected the co-operation of those responsible should be enlisted.

(iii) It is a common thing to put the blame on one's neighbour as the source of rat infestation. This is usually a wrong accusation, and *a permanent solution of the problem can only be reached by a carefully planned block control project in which all parties co-operate.*

GENERAL

Need for Combined Effort. The destruction of rats is essentially a matter for local effort; but local effort should not be isolated or unsystematic. It is true that in many places rats can be kept down by cats, traps, and occasional rat hunts. That is so in most dwelling-houses, especially if the kitchen and outhouses are kept clean and tidy so that the rats find it difficult to procure an abundance of food, and provided also that drains and buildings are in good structural repair. It is also true of many farms where the buildings are well kept; but on other farms, or in mills, malt-houses, and establishments where large supplies of food are stored, especially where several such buildings stand close together, combined effort is essential. The occupiers of a group of farms or buildings should therefore unite in a systematic attempt to *exterminate* the rats over as large an area as can be conveniently dealt with.

For this purpose reliance should not be placed solely on one of the methods recommended above; but as far as possible *all these methods should be employed.* A combined effort should be made simultaneously, the attack in each instance commencing on the boundary and working gradually towards a central spot where it is considered that the final work of destruction can

* The Rats Orders, 1941 and 1942, require the fencing of ricks of corn, rye, beans, peas, linsseed and clover at threshing time. (See p. 15).

be accomplished with least difficulty. Every precaution should be taken to see that no rats escape outwards; their holes should be closed, and their runs and nests destroyed as the cordon is gradually drawn closer.

Period of Work. The chief operations should be conducted from October to April, and should start with a general campaign throughout the area. The badly infested areas should be gone over twice, at an interval of not less than a fortnight; in many places fumigation should be employed a second time. The area should be carefully worked at least twice before the spring, and very badly infested spots or places where a sudden rat epidemic is found should be visited even more frequently. During the winter the rodents will be found near their food supply, many living and breeding in cornstacks; in April they generally migrate, especially those living in rural areas, to hedges or other summer quarters, where they breed. Town rats mostly remain in their habitations, and generally only migrate when disturbed. In rural districts, ferreting, fumigating and trapping will kill off a lot of the breeding stock and young ones in the summer, while poisoning, though usually more effective in the cold season when food is scarce, can take place all the year round.

Deodorants. If by mischance a rat should die in such a position that its carcass cannot be recovered without trouble, and a stench results, chloride of zinc will be found a good deodorizer, and combines with and neutralizes the offensive chemical products of putrefaction. When possible, a hole should be bored with a bit and brace in the vicinity of the supposed origin of the odour. Some perfume or pinewood oil can be added to the zinc chloride, which should be applied through the hole. A cork will close the hole, and can be withdrawn from time to time to ascertain whether the nuisance has ceased.

Nitrate of lead (half a dram mixed in 1 pint of boiling water, added to a pail of cold water in which 2 drams of common salt are dissolved) makes a deodorant solution. A large cloth should be saturated in this solution and hung in the room in which the smell is prevalent.

Ordinary disinfectants such as lysol and carbolic acid powders can also be used for this purpose.

HOUSE MICE

Although rats are the chief vermin, House Mice (*Mus musculus*) should not be neglected. The advice to keep foodstuffs in vermin-proof receptacles, and generally to prevent access to food that offers attraction, applies equally to mice.

Break-back traps are the best means of dealing with house mice infestations, the great thing being to use a large number at once. In any reasonably large infestation of house mice, lay 20 to 50 traps, if possible of the type with a flat treadle on to which the mice can run.

There is no need to pre-bait the traps for mice. They can be set baited on the first night. The best bait is flour or rolled oats scattered over the treadle. If the traps have wire prongs instead of a treadle, make one by fixing a stale crust on to the prongs.

The traps should be set at right angles to and against the walls, sacks or other places where the mice are running, not out in the open. It must be

remembered that mice have a very small radius of movement from their nests, often only a few feet, so that traps should be closely spaced, or moved about to cover the whole area thoroughly. They should be visited daily until they catch no more mice.

Unless carried out by specially trained operators, poison baiting is not normally an efficient means of killing house mice.

VOLES AND FIELD MICE

The following kinds of voles and mice are found on the mainlands of the British Isles: Bank Voles (*Clethrionomys (Eutamias) glareolus*), Field Vole or Short-tailed Field Mouse (*Microtus agrestis*), and the Water Vole (*Arvicola amphibius*), found throughout Great Britain; the Long-tailed Field Mouse or Wood Mouse (*Apodemus sylvaticus*), found in Great Britain and Ireland; the Yellow-necked Field Mouse (*Apodemus flavicollis*) found locally in England; and the Harvest Mouse (*Micromys minutus*), now rather rare in Britain. The House Mouse (*Mus musculus*) lives wild in fields and corn-ricks, as well as in buildings). The only important damage to standing crops is done by *Microtus agrestis* and *Apodemus sylvaticus*. The former sometimes attacks plantations of young trees and eats the bark off the stems; it may also attack some garden and allotment bulbs and leaves. The latter will dig up and eat planted seeds and peas, and has also been found doing extensive damage to young wheat plants in the fields, particularly in the early winter.

The normal food of voles is coarse herbage, grasses, roots and shoots of bushes and trees. Excessive multiplication amongst voles and field mice results in injury to crops.

The natural enemies of voles and field mice are the weasel, magpie, owl, buzzard and kestrel, and the protection of these natural enemies is the best means of providing against a large increase in the numbers of voles and field mice.

The following methods can be tried for control of voles and mice:

(i) Removal of grass and other vegetation round the stems of young trees, e.g., in orchards, will diminish damage, by reducing cover for voles.

(ii) Lay down bits of board, roofing felt, or corrugated iron. After a few days voles will often taken cover under them, and can be caught by hand and killed when the cover is turned over.

(iii) Trapping is efficient against small outbreaks of voles or mice (see section on trapping House Mice). Traps should be set under cover, to prevent accidental deaths of small birds.

(iv) Poison baiting for voles and wild mice is still only in the experimental stage and cannot at present be reliably recommended.

THE RATS AND MICE (DESTRUCTION) ACT, 1919

The Rats and Mice (Destruction) Act, 1919, requires the "occupier" of land to take such steps as may from time to time be necessary and reasonably practicable for the destruction of any rats and mice thereon and for preventing such land from becoming infested with rats or mice. The term "land" includes buildings, sewers, drains and culverts. In default he is liable on

summary conviction to a fine not exceeding £5, or not exceeding £20 where he has been served with a notice by a local authority under the Act requiring him to take such steps. It is the duty of county councils and certain other local authorities to see that the Act is complied with. Many of the local authorities employ special officers, and any "occupier" who finds himself unable to cope with rats or mice on his premises is recommended to approach his local authority for advice.

ORDERS UNDER THE DEFENCE (GENERAL) REGULATIONS, 1939

The following Orders under the Defence Regulations were made for the more effective control of rats in war time:

The Rats Order, 1940. This enables County War Agricultural Executive Committees to serve on occupiers Orders requiring the destruction of rats, and, if necessary, to prosecute them for failure to comply therewith. Persons can be authorized by the Committees to enter the lands concerned to execute the Orders, and to charge the cost to the defaulter.

The Rats Order, 1941. This requires the surrounding of all corn ricks before threshing by a fence not less than 6 ft. away and impenetrable to rats, and the destruction of the rats in the rick or the foundation thereof.

The Rats (Amendment) Order, 1942, extends the operation of the Order of 1941 to any rick of rye, beans, peas, linseed and clover.

The Infestation Order, 1943. This Order enables the Minister of Agriculture to deal with the infestation by rats, mice, insects, etc., of foodstuffs, materials, containers, vessels, premises and land other than agricultural land, works, premises or buildings. The Order provides, inter alia, for the notification in writing by the owner or occupier of infested premises or goods and empowers the Minister to give Directions prohibiting the use of infested premises, vessels, foodstuffs or other articles until such time as by specific direction the infestation is remedied to the satisfaction of the Minister.

Every Local Authority in England and Wales may be required to prepare a comprehensive report upon the infestation of land within its area; make proposals for the remedying of the infestation and carry out the necessary remedial measures with the object of ensuring an efficient standard of skill and service; and to assist in the conservation of man-power and material. Pest Control undertakers will be regulated by licence and the Minister may direct what methods shall be employed and substances prepared.

GREY SQUIRRELS

The American grey squirrel (*Sciurus carolinensis*) is a native rodent of the northern United States and southern Canada. The general build of the animal is similar to that of the British red squirrel, but it is considerably larger. The colour effect is, at first sight, silver-grey, but there is a good deal of russet-brown coloration in all specimens. The eyes are prominent, and the ears rather small and without the tufts of hair that characterize the winter coat of the red squirrel.

Introduction and Spread in the British Isles. The widespread distribution of the grey squirrel in this country results from the introductions that have taken place since 1889, but there are records of the existence of grey squirrels

in certain areas as early as 1828. The squirrels first introduced were obtained direct from America, and several other stocks have since been brought over independently, but most of the secondary centres were established by squirrels from one or other of the centres previously formed.

The Grey Squirrels (Prohibition of Importation and Keeping) Order, 1937. Since 31 July, 1937, the importation into and keeping within Great Britain of grey squirrels has been prohibited by the Grey Squirrels (Prohibition of Importation and Keeping) Order, 1937, made under the Destructive Imported Animals Act, 1932.

The Grey Squirrels Order, 1943. This Order, made under the Defence Regulations, enables County Agricultural Executive Committees to serve on occupiers orders requiring the destruction of grey squirrels and, if necessary, to prosecute them for failure to comply therewith. Persons can be authorized by the Committees, if any order served by them is not complied with, to enter upon the lands concerned to execute the order and the cost can be charged to the defaulter.

Habits, Food and Damage. Grey squirrels appear to favour mixed deciduous woods, parklands, orchards and gardens, rather than dense coniferous woods, which are the ideal habitat of the red squirrel. They spend a great deal of time on the ground, and are frequently seen in hedgerows and fields as much as half a mile from any wood or plantation.

The food of the grey squirrel is much less specialized than that of the native red squirrel, and includes:

Green shoots and buds. (The destruction of fruit-tree buds in the spring has a pronounced effect upon the yield of fruit.)

Nuts and seeds.

Fruits, both wild and cultivated.

The inner bark of young trees.

Bulbs and roots of various kinds.

Birds' eggs.

Young birds.

Carrion.

It is clear from the varied character of the food that the grey squirrel eats that there are few branches of agriculture not liable to suffer from its depredations and few parts of the country in which it could not find the food it requires. Its taste for the eggs and young of the small beneficial birds may have a serious indirect effect on agriculture generally.

Methods of Control. There are two methods of attack on the grey squirrel—shooting and trapping. The former provides that element of sport which is absent in trapping, and for that reason it will probably always be preferred.

SHOOTING. Shot-guns (12 bore and .410), small bore rifles (.22) and heavy type air guns can all be used for grey squirrel shooting. The type of weapon used is, however, generally dictated by what the individual possesses. The smaller bore guns are quite as efficient as the larger types, and they are, moreover, cheaper to buy, more economical and less noisy in use.

Where woods are heavily infested, many squirrels can often be shot during the course of casual walks, when, at the same time, the opportunity should always be taken to put a charge of shot into a drey or nest. The squirrels will be driven out and can then be shot. For systematic destruction, however, it is an advantage for guns to work in pairs, with a dog for marking. As the gun is moved, so the squirrels move to keep behind a bough or the trunk of a tree. With two guns, one can circle the tree and the other stand and wait for the kill.

In the late winter and spring the dislodging of dreys with bamboo poles brings many adult and young squirrels within range of the guns and provides an excellent opportunity for shooting.

TRAPPING. This is a more economical method than shooting, and is preferable in these days when supplies of cartridges are restricted. It is difficult to recommend one method of trapping as superior to another, since the taking of any wild animal in a trap is a skilled craft, and the operator must be a craftsman who has studied his trap and the reaction of the animal to it so that it can be used to the best advantage.

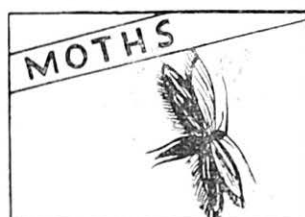
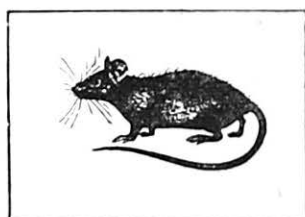
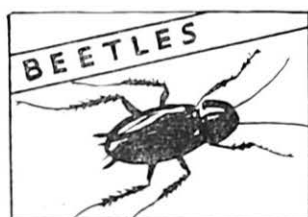
Cage traps, tunnel traps and rabbit traps are all suitable for grey squirrel destruction. Probably the most successful trap in general use is the large wire cage with a sleeve entrance. Such traps should be baited inside with grain or broken egg, and sited at the foot of trees, around feeding runs and near hollow stumps or wood piles. Late winter and early spring, when the squirrels' normal food supplies are restricted, are the best times of the year for trapping.

The foraging propensities of squirrels are well known, so that a tunnel is always an attraction. Dry drains can be used, but if these are not available just where they are wanted, artificial tunnels of turf and stones can be made to take the traps.

When using rabbit traps it must be remembered that, under the Wild Birds Protection Act, 1911, it is illegal to set spring traps on poles, in trees, on the tops of walls or on a cairn of stones or earth.

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