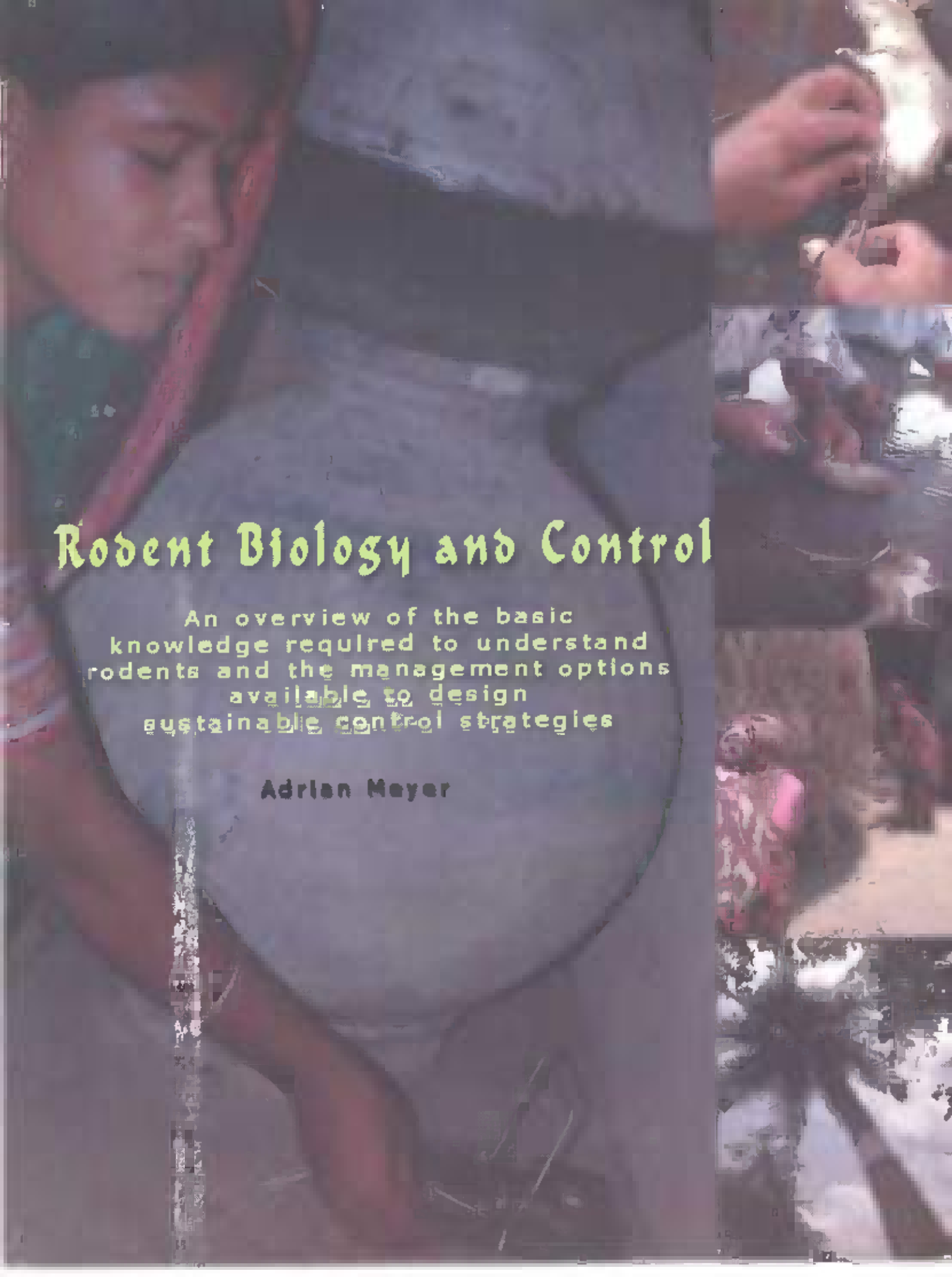

Rodent Biology and Control

An overview of the basic knowledge required to understand rodents and the management options available to design sustainable control strategies

Adrian Meyer

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RODENT BIOLOGY AND CONTROL*

Introduction

The rodents are a large group of mammals with over 1500 representative species world-wide. The word 'rat' may properly apply to any of about 500 species of animal, and the word 'mouse' to at least 130 species. The principal identifying feature of a rodent is that one pair of incisors above and below are greatly enlarged and used for gnawing. In tropical food stores, the main rodent pests are a rat species, several species of mice and in some parts of the Indian sub-continent, South-east Asia and China bandicoots are also very common. The accepted names for the three most common pest species in Bangladesh are the lesser bandicoot (Bandicota bengalensis), the black, ship or roof rat (Rattus rattus), and the house mouse (Mus domesticus). Common names based on colour may be deceptive, since R. rattus is not generally black.

Rats and mice are now present throughout the world. Their adaptability has enabled them to survive extremes of climate from the frozen tundra to dry arid desert.
In many places rat meat is highly regarded as human food, in the rice growing districts of Thailand farmers catch the giant rat Bandicota indica to supplement their diet. In other Asian and African countries the field rat is considered a delicacy.

Biology and behaviour of commensal rodents

Physical characteristics of rodents

Rodents are most easily distinguished from other mammals by the characteristic arrangement and form of their teeth. They have only a single pair of incisors in both the upper and lower jaws and no canines. The wide gap (diastema) between the paired incisors and the molars (or back-teeth) gives the rodent skull an unmistakable appearance (Fig. # 1).

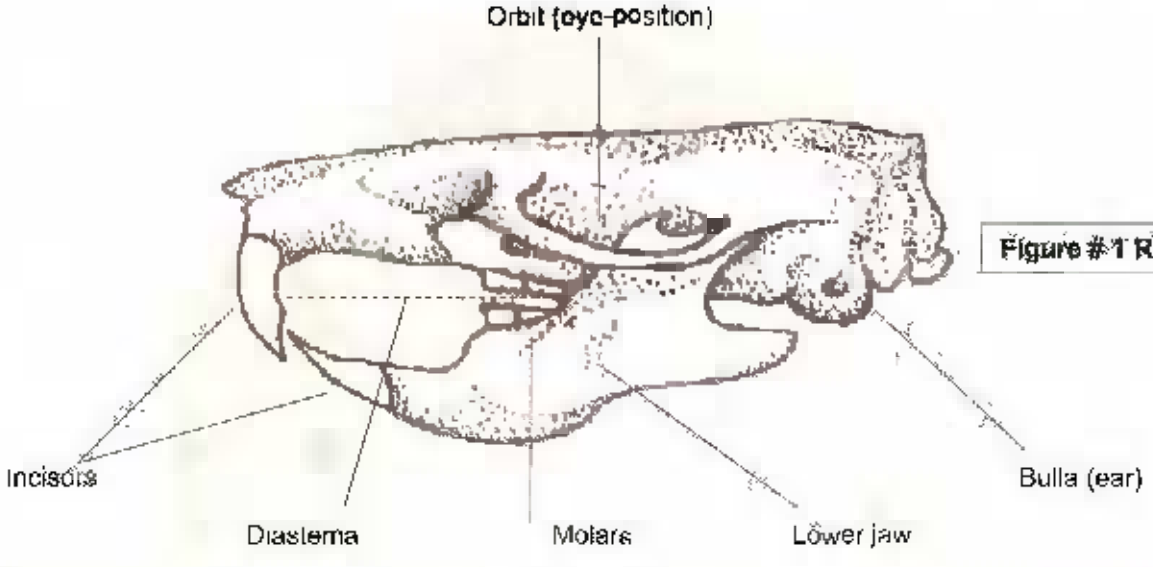


Figure # 1 Rodent skull

*This material is extracted from an MSc training course operated by the Natural Resources Institute, UK.

Figure #1 Diagram of a rodent skull

The incisors are the clue to the tremendous success of rodents within the animal kingdom Rodent incisors have three basic characteristics that together, distinguish them from the teeth of most other animals; they are strongly curved, they grow continuously throughout the animal's life, and they carry a thick layer of enamel on one side only. The fact that rodent incisors grow continuously means that they must also be worn away continuously. It is often stated that rodents must gnaw in order to prevent their incisors becoming too long, but this is not necessarily true. Rodents can wear away their incisors by rubbing the lower set against the upper set; this results in the softer dentine being worn more rapidly than the hard enamel, giving a chisel-like outer edge to the teeth. The effectiveness of the chisel-action of rodent incisors can be seen in the gnawing of bandicoots, rats and mice which, given an edge to bite on, can penetrate soft metals such as lead and aluminium. The diastema allows rodents to close off their incisors from the rest of their mouth by sucking in their cheeks, which enables them to gnaw on non-food items with no danger of ingestion

Differences between mice and rats

The major differences between rats and mice is their size, other differences between the most common species are shown in Figure #2. The length of an adult rat excluding the tail is at least 200 mm, an adult mouse being half this size, the characteristically larger feet of rats help to differentiate between young rats and mice

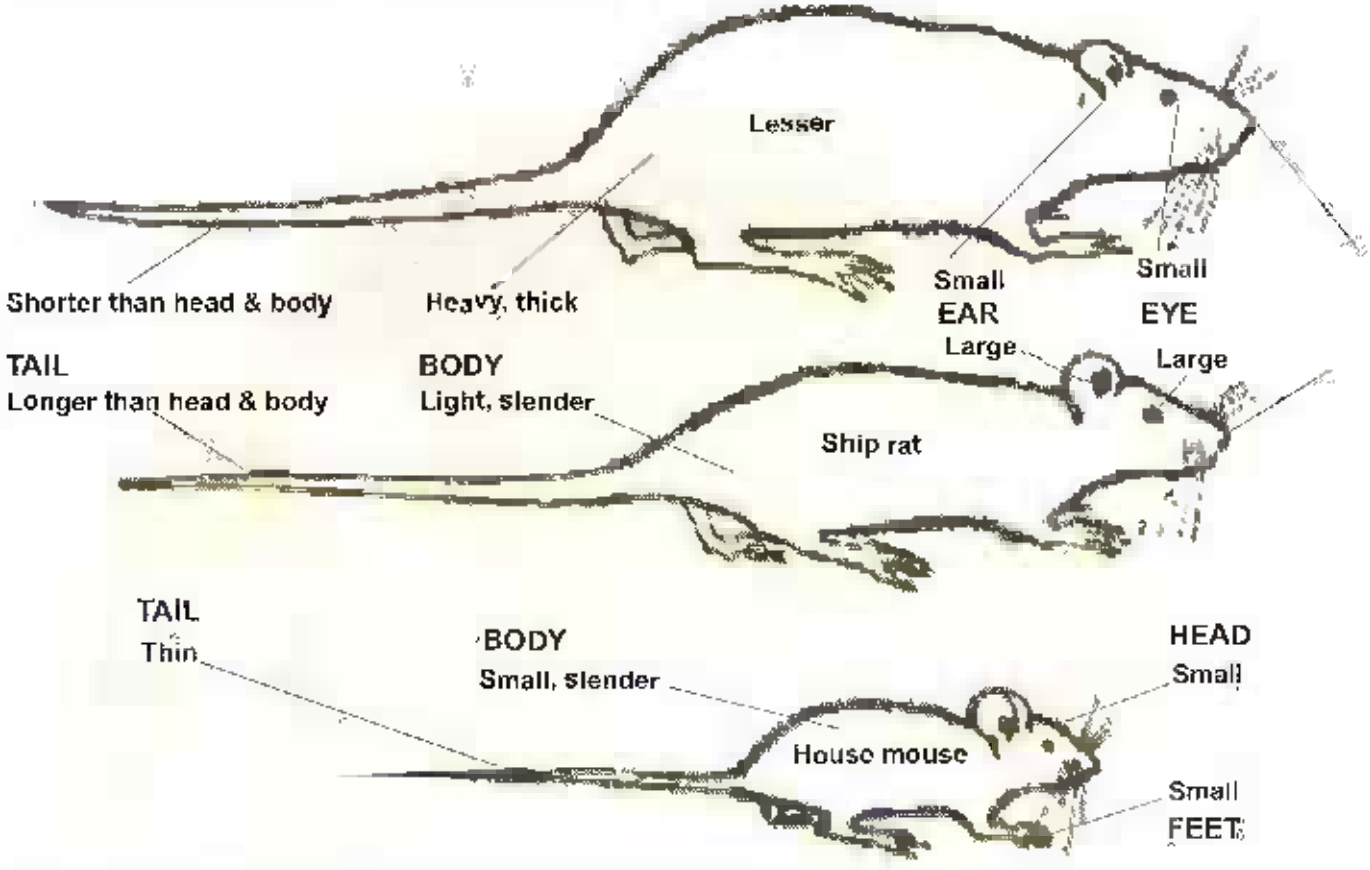


Figure #2 Differentiating characteristics of rats and mice

Common commensal rodent species

Further details about the common commensal rodents, the ship rat, lesser bandicoot and the house mouse are provided below.

Rattus rattus - roof, ship or black rat

R. rattus (Fig. #3) is a global species, which probably originated in equatorial Southeast Asia. The species was certainly present in Europe during Roman times (AD 100). As one of its common names implies, it was reliant upon the old shipping and trading routes for its spread and is most associated with coastal and trading centres.

In tropical and sub-tropical areas it can frequently be found out of doors and can be a serious pest of some agricultural crops.

It is less likely to burrow and is more commonly found sheltering in roofs and other hollow places in the upper parts of buildings, its climbing powers are excellent.

Figure # 3 *Rattus rattus*

Bandicota bengalensis - the lesser bandicoot rat

B. bengalensis (Fig. #4) is found in South and Southeast Asia and looks and behaves in ways that are very similar to R. norvegicus. The size is usually similar to R. norvegicus but can vary from region to region. One different characteristic is the visible presence of very large and distinct guard hairs over its body, which it displays when cornered to make itself look larger.

B. bengalensis is happy to live in damp and wet areas and is a very good swimmer. During the flood period in Bangladesh, this species lives on water (rice fields and water hyacinths expanses) where it builds spherical nests, the size of soccer balls. Over the last 100 years its range has spread and the species has become increasingly commensal. It does not settle indoors as easily as the other main commensal rat species, but burrows extensively out of doors, causing serious damage through its extensive digging. It is able to carry a range of diseases and causes very similar concerns as the other commensal rats.

B. bengalensis is known to directly attack a huge range of agricultural field crops and stored products. Its burrowing activities cause considerable damage to seed beds and seedlings, an individual B. bengalensis can cut 100-200 rice tillers per night.

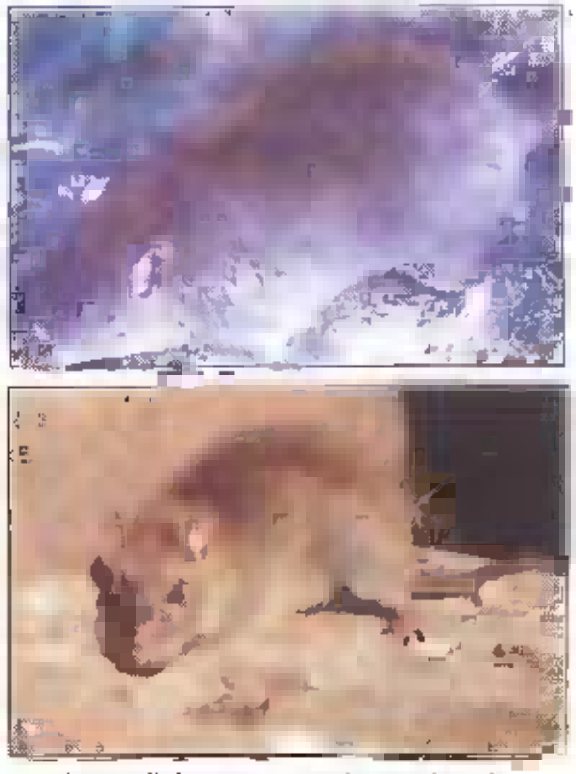


Figure # 4 *Bandicota bengalensis*

House Mouse *Mus musculus*

There are several species of house mice but their respective distributions are not all that clear because they are so difficult to tell apart.
House mice (Fig. #5) are known to have been present in the Middle East 12,000 years ago and to have spread slowly to other Mediterranean areas up to 2,000 BC. At this time they became established in Southern Europe and have since spread to most parts of the world: they continue to extend their range.

House mice are omnivorous and prefer warm, dry conditions. They are however able to live in cold conditions as long as they have access to warm harbourage. They live mainly indoors in temperate regions, but when conditions are dry and warm are able to develop extensive burrow systems and to live out of doors, much as they might have done in their original habitats. They very rarely live in sewers. House mice are fairly active during both day and night. Unlike the above two species of rat, the house mouse can live and breed without drinking provided its food has a fairly high moisture content.

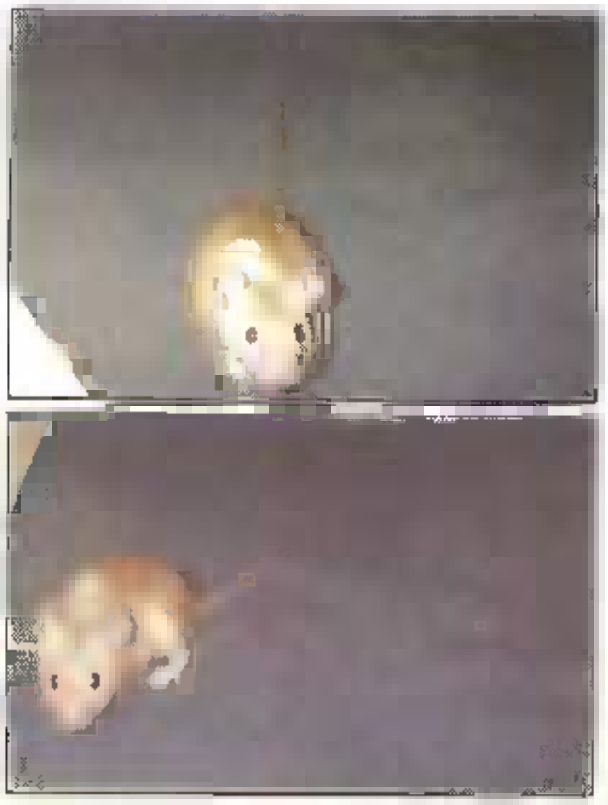


Figure # 5 House Mouse *Mus musculus*

Table 1: Characteristics of common commensal rodent species

Rodent Specie	Average adult weight	Tail length	Ears	Snout	Colour	Life expectancy
Rattus rattus Ship, black, roof rat	Less than 250 g (a specimen of 360 g is known)	Longer than head and body, except in some foreign forms (180-240 mm)	Thin translucent, large, hairless	Pointed	Grey, black, brown or tawny may have white belly	About one year
Mus domesticus House mouse	Usually less than 25g (average perhaps 15-16 g)	Usually longer than head and body (60-110 mm)	Large, some hairs	Pointed	Brownish grey lighter shades occur	8-10 months
Bandicota bengalensis Lesser bandicoot, black field rat	Similar but usually larger than R norvegicus	Black, shorter than head and body	Small	Blunt	Dark brown/ grey back grey belly	About one year

If rodent damage is found in a store, the size and shape of the droppings can be used to decide whether rats or mice (Fig. #6) have caused the damage. Rat droppings are on average about 15 mm long, whilst mouse droppings are only half this size. Rats need to drink water every day, are more active than mice are, and therefore leave more signs. Mice can remain inside stacks of grain, as they can obtain sufficient water from the grain itself.

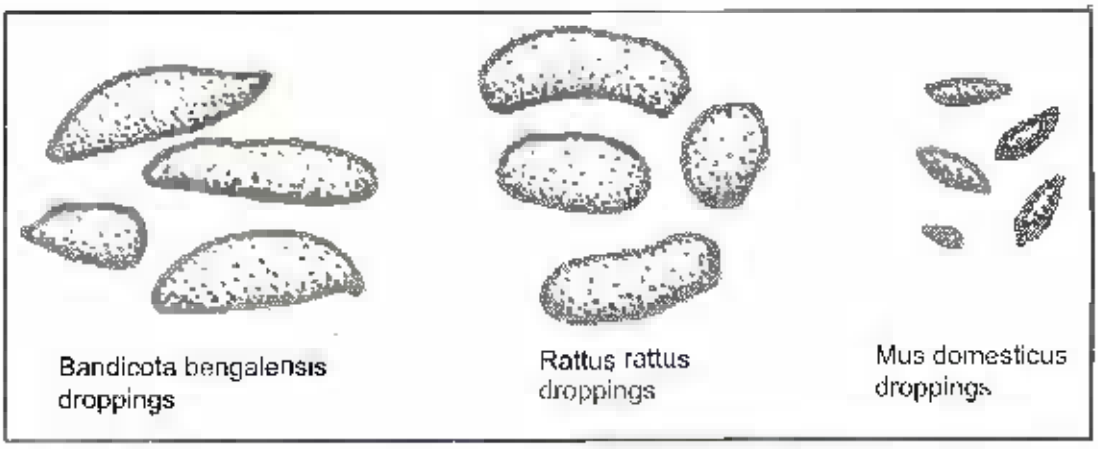


Figure #6 Droppings of the three most common commensal rodent species

SAQ #1

What physical characteristics distinguish rodents from other mammals?

How could you differentiate between B Bengalensis and R. rattus?

Habitats

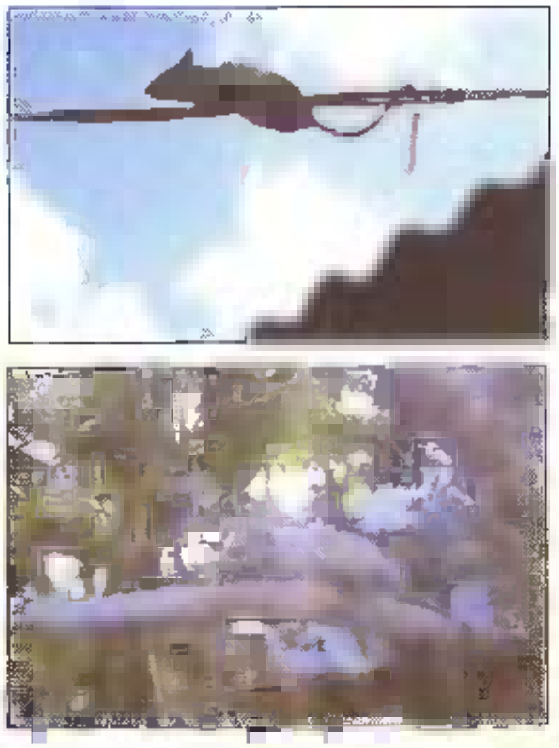
Lesser bandicoots are far more active burrowers but less efficient, although capable, climbers than the other two species. In urban areas, their burrows, which average about 8 cm in diameter and often comprise a complicated tunnel system with several exits, are typically found around the outside walls of buildings, inside walls and under floors and in such places as river and pond banks, highland areas, rubbish tips and tall undergrowth. Lesser bandicoots often gain entry to buildings via their burrows.

Ship rats are more adapted to a climbing way of life. In buildings they are mainly found living at roof height and almost invariably so when Lesser bandicoots are also present. In the absence of the latter species, Ship rats also sometimes burrow beneath the walls of buildings and underneath rocks. In woodland gardens and vegetable plantings, Ship rats can live and nest in the tops of trees, in rotting vegetation and in nearby undergrowth.

Rats and mice are quick to take advantage of cavities in the walls, roof spaces and ducts of buildings, for shelter. In grain stores, they frequently nest in the crevices between sacks Dhollas and, where possible, in the sacks themselves. Mice can shelter in crevices and holes in cultivated and uncultivated ground, and in hedgerows and undergrowth. They also occur regularly in newly harvested cereal and hay crops that are stored in the open.

It is important to recognise that access to appropriate nesting sites is as important as the availability of food in the establishment and maintenance of a rat or mouse infestation

The jumping and climbing capability and relatively small size of the three species allows them to range freely in most environments and to find safe harbourage. They can enter buildings at ground level through small openings in the fabric, and at roof height by climbing the walls (Fig. #7a&b) directly or with the aid of unguarded cables (Fig. #7c). and external pipework Barriers erected against them must be substantial, for the rats can jump to a height of almost 60 cm and mice to 25 cm. Lesser bandicoots swim readily and well. so open water does not necessarily hinder their movements.



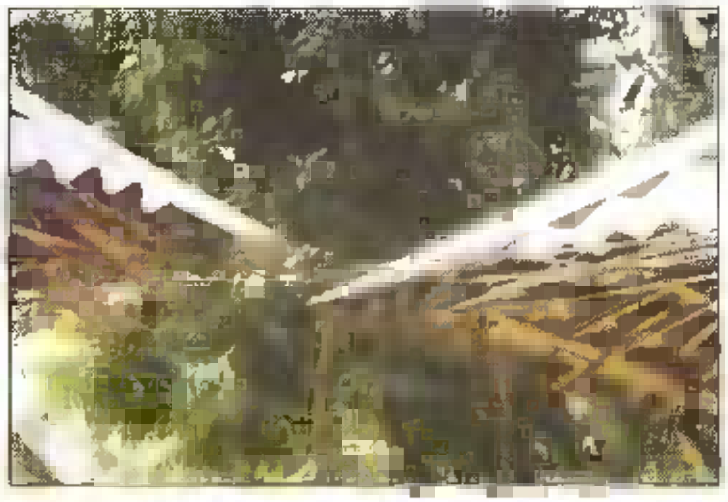


Figure #7 a& b. Rodents are excellent climbers and can walk along narrow pipes or wires using their tails for balance. Figure #7 c shows unguarded cable wires which help rodents climb the roof and move from one house to the other

Reproduction and development

Under optimum conditions of climate, surplus food, free water and shelter, rodents may breed throughout the year. If no action is taken to control them the numbers of rats and mice in a store can increase rapidly.

Rats normally live for about one year and females can begin to breed when they are three months old (Fig. #8), often producing five families in their lifetime. Young rats are born naked, blind, with their ears sealed, completely helpless and unable to walk or fend for themselves. They develop quickly and are weaned after 3-4 weeks.

although for the next month their activity is mainly confined to the area of the nest. The gestation period in both species is only about three weeks and females can produce several litters a year; the number of young in a litter varies according to environmental conditions but averages between six and seven. They are cared for entirely by the mother rat: the male has no interest in them except to eat them if food is scarce.

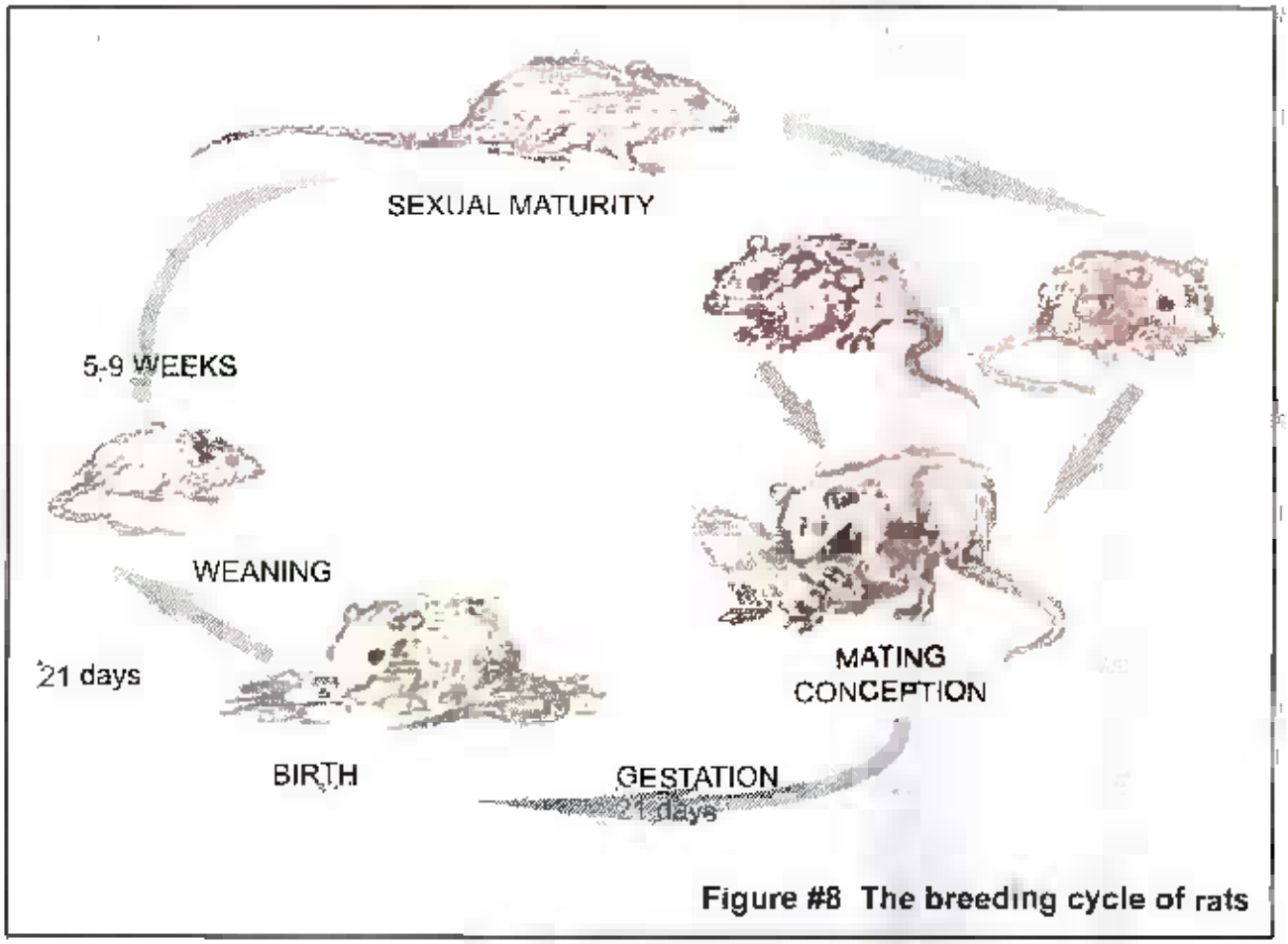


Figure #8 The breeding cycle of rats

The gestation period of the mouse is one of the shortest of all mammals - ranging between 17 and 20 days - and a female may become pregnant again only two days after she has given birth. If pregnancy occurs during the lactation period, the birth of the second litter is usually delayed. Under exceptionally good conditions, a female mouse can produce as many as 10 litters (about 50 - 60 offspring) in a year, which at five weeks old become independent of their mothers, and are themselves capable of reproducing at the age of two months. At birth young mice weigh about 1 g and are bright pink and hairless. By about two weeks, the eyes and ears have opened, the body is covered in hairs and the incisor teeth are fully emerged.

In unfavourable conditions, female house mice adjust their breeding habits to maintain a high reproductive rate. When nesting sites are limited they often share nests. 50 young mice have been found in one communal nest, the adult females will indiscriminately feed any of the young. When population densities become very high, litter sizes are often reduced and reproduction may even cease altogether.

Senses

New-born rats and mice respond to touch, this is probably the most useful of their senses since their eyes do not open and they make little responses to sound until they are 10-12 days old. Compared with their other senses, sight seems to play a minor role in the life of rats and mice; the main functions of the eyes appear to be in detecting movements at close quarters and in appreciating light intensities. Rats and mice have an acute sense of hearing, and are particularly sensitive to any sudden noise and to high frequency sounds. They also have a well-developed sense of smell, and it is likely that much of the information about their environment is obtained in this way or through a combination of smell and taste. Smell is important in the location of food, and taste in discerning the palatability of food including poison baits. The rejection of foods previously recognised as either distasteful or as having been associated with illness - as might occur after the ingestion of a sub-lethal dose of poison - may be on the basis of smell alone. The sense of smell is also used in the detection of runways, in the identification of other individuals and in the delineation of territories.

Away from the nest, touch is probably helpful in judging the shapes of objects and in the recognition of landmarks. The long whiskers (vibrissae) of the nose are particularly sensitive to touch and help rats and mice to travel next to walls and in burrows in the dark. Rodents also have an excellent sense of balance.

Feeding behaviour

All three species are omnivorous and are capable of feeding on a wide range of foods, including rice, wheat, other cereals, nuts, fruits, vegetables, invertebrates and fish. Both rat species sometimes supplement their diet by eating such items as worms and crabs, and occasionally take unusual substances such as soap, glue, plaster and putty. They thrive and reproduce best in localities that provide them with a rich and varied diet containing proteinaceous foods, and least well on single items lacking in certain vitamins.

When they have access to succulent foods, rats and mice can subsist without free drinking water. But under extreme conditions of deprivation the fertility declines. Indoors, rats and mice may obtain water from uncovered fire buckets, dripping taps and via leaking roofs, sources which can all be made unavailable to them. In general rats need access to free water and house mice are able to survive without free water as long as they have food with reasonably high moisture content.

Rats have rather more regular feeding habits than mice and they have a greater tendency to hoard food and to eat it under cover. Bandicoots will store rice panicles in their burrows. Unless food is in short supply, rats are also more strictly nocturnal than mice. Both Bandicoots and Ship rats can regard strange objects placed in their surroundings with suspicion and investigate them cautiously, at a. The term 'new object reaction' or 'neophobia' has been applied to this behaviour and it may be several days before rats will, for example, enter traps or bait-containers and feed freely.

Mice are very curious and readily investigate new objects in their environments and are thus easier to trap and poison.

Population dynamics and activity

The movements of rats and mice are largely determined by climatic conditions and the availability of food, water and harbourage.

Although rats sometimes travel considerable daily distances between shelter and food, extensive wanderings are not the rule. In situations where food and harbourage are adequate, rats and mice tend to have a restricted range and to follow regular routes. Their ranges tend to be smallest when they are living at high densities in such localities as food stores where food and cover are co-incident.

In Bangladesh rice production environments both Bandicoot rats and Ship rats will move into sheltered village and highland areas as the monsoons cause flooding and back out into fields again as waters recede or as crops are planted or ripen.

Losses caused by rodents

It is common knowledge that rats and mice damage foods, crops and buildings. Apart from what rats and mice eat, we know from experience and experiment that the cost of cleaning and repackaging stored and processed commodities that have been attacked by these pests often exceeds the cost of foodstuffs actually eaten.

To obtain some idea of the complexity of the issue, the following problem areas need to be considered individually:

- direct consumption of food
- food contamination and damage
- structural damage
- rodent-borne diseases
- sources of re-infestation of adjoining areas
- cost of control
- loss of goodwill
- initiation of further damage

Direct consumption of food

Rodents eat food directly intended for human consumption or for consumption by domesticated livestock

On average, rodents need to consume about 10% of their body weight per day, but consumption will vary with the size and species of rodent, and with the prevailing climatic conditions.

Although it is relatively easy to estimate the theoretical food consumption of a rodent population, the actual consumption of a population of rodents is difficult to estimate with any degree of precision.

Food contamination and damage

Figure # 9 (a&b) Vegetable damage caused by rodents

Rodents damage and contaminate far more food than they consume (Fig. #9 a&b) Through their gnawing activity they damage the sacking, packaging and storage facilities used to store and transport the food. Food is lost through spillage and wastage and also thrown away as unsuitable for human consumption. Although this food is not consumed by the rodents it is nevertheless made unavailable for human and livestock consumption and is therefore effectively lost. One of the most unpleasant and damaging results of a rodent infestation is the contamination of the infested commodities. This can take gross forms such as rodent bodies or even live rodents in bagged products, or it can be less obvious in the form of hairs, urine, sebaceous secretions and droppings.

Probably the factor with greatest influence on rodent numbers in food stores is the method of storage. A well-managed store will provide the minimum possible harbourage, or access for rodents. The storage structure must be sound in every respect and in particular doors, chutes and augers should be opened only when they are actually in use. If possible, floors should be of concrete and spillage of stored products should be cleared away immediately

SAQ #2

Name three ways in which rodents can contaminate food.

Think about some of the effects of rodent contamination of food.

Structural damage

Damage to structures by gnawing is widespread. Almost any kind of material may be attacked. The enamel on the outer surface of a rat's incisor is very hard and thus a very efficient chisel-like edge is always present. Lead pipes and metal-sheathed cables are sometimes gnawed through, causing interruption of services.

Damage to roofing, walls, insulation, foundations and doors of buildings reduce the efficiency and security of the storage facility. Damage to a roof allows water to enter the building, whereas damage to walls (Fig. #10a), doors, foundations and floors (Fig. #10b) not only weakens the structure of the facility, but also increases the likelihood of infestation of that facility by both rodents and other pests.

Rodents frequently damage electrical wiring, causing electrical failures and fires (Fig. #11).

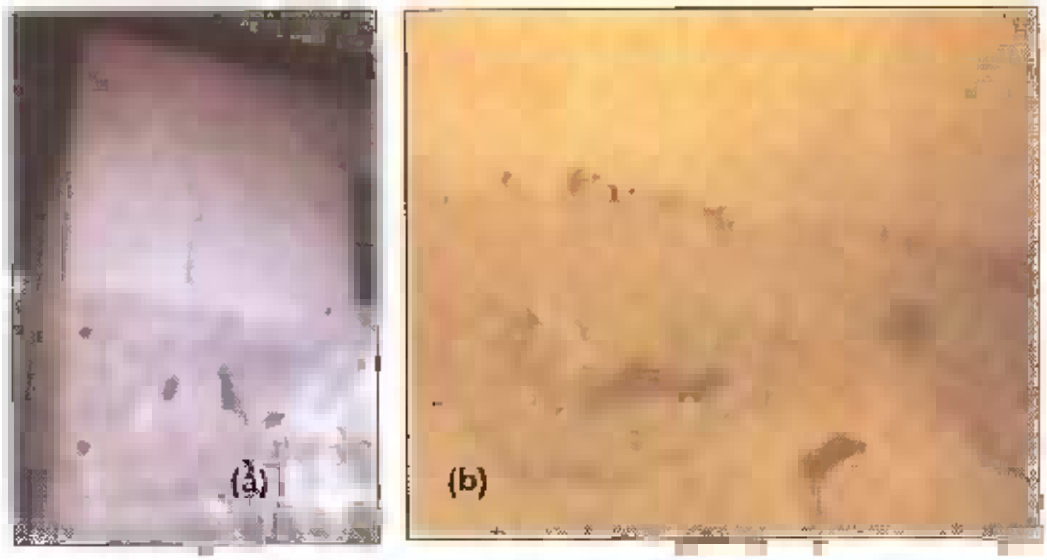


Figure #10 Rodent damage to store floor (a) and house wall (b)

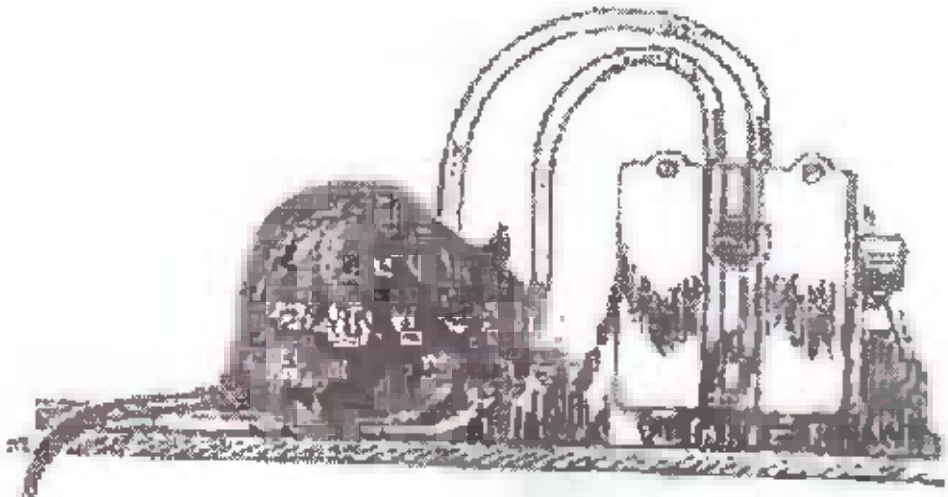


Figure #11 Electrical cables can be chewed by rodents resulting in a fire

Rodent-borne diseases

Rodent infestations present a health hazard to both humans and other animals. The nature of the hazard and severity of the risk will vary with the species of rodent and the geographical position.

Bacterial diseases

Of the many diseases carried by rats and mice, plague at once comes to mind. The 'Black Death' (plague) destroyed a quarter of the population of Europe in the Middle Ages, and has since killed millions in Asia and Africa. The causal organism is spread from rats to man by a flea. When rats are dying of plague, this flea will accept man as an alternative host and transmit the disease to him.

Leptospiral jaundice (Weil's disease) is well known in certain trades, yet relatively unknown by the general public, except when there is a fatality. The causal organism, is excreted in rats' urine, and apparently does not harm rats (Fig. #12). Up to 60% of individuals in rat population samples have been found to be infected. Human infection can occur from contact with wet, rat-infested surfaces. Historically, Weil's disease has been associated with agricultural workers, including those who work in rice fields and others who work in damp places frequented by rats.

Cuts can become infected if contaminated with water containing rats' urine, resulting in leptospiral jaundice

Figure #12 Leptospires are present in rats' urine and can infect humans through cuts and scratches

Salmonella bacteria, which can cause food poisoning, can be carried in the excreta of rats and mice. In many places in the world rats live in sewers, septic tanks and cess pools but visit kitchens and stored food at night, spreading salmonellosis.

There are two illnesses called rat-bite fever caused by bacteria carried in the saliva of rats and mice. Both involve swelling of lymph glands and muscular pains, and relapses may occur long after apparent recovery.

Even non-infective rat bites are painful, likely to leave ugly scars, and are prone to turn septic. Rat bites occur most frequently in babies, small children and the bed-confined elderly, and are often the result of rats trying to get food from their hands or faces. The majority of rat bites are on the hands of young children presumably because they try to pick the rats up.

Rickettsial diseases

The causative organism of **Murine typhus** is Rickettsia typhus, as with the plague the bite of the rat flea (**Xenopsylla cheopsis**) is responsible for transmitting the disease to man. Infected faecal matter from the flea is rubbed into abrasions caused by scratching the bite. This disease is found world-wide

Scrub typhus is also spread by rats and mice, but is confined to Asia, Australia, Japan and other parts of the Far East. The causal organisms Rickettsia tsutsugamushi live in the tissues of certain trombiculid rat mites, without harming them, and pass from generation to generation of the mites. The disease is transmitted to man by the bite of infected trombiculid mites

Viral diseases

A rather uncommon but serious virus infection of human beings (especially children) known as **lymphocytic choriomeningitis**, is carried by house mice. Disease transmission occurs by mouse bites, contamination of food or hands with faeces, and the inhalation of dust containing dried mouse faeces. The symptoms resemble those of influenza, but in some cases meningitis can become apparent.

Helminth and Nematode diseases and infections

Mice also serve as the hosts of numerous intestinal parasites, the two small **tapeworms** Hymenolepsis nana and H. diminuta can be transmitted to man. Infection occurs when food is eaten that has been contaminated by mouse droppings containing, the microscopic eggs of the tapeworm.

Fungal diseases

Favus, a skin disease of fungal origin, may be contracted from mice, or indirectly through cats.

Many additional diseases, including **foot and mouth disease, Korean haemorrhagic fever, Aujeszky's disease** (pseudorabies), **toxoplasmosis** and **brucellosis** can be carried by rodents and transmitted to a range of domestic and agricultural animals.

Initiation of further damage

Damaged grain is more susceptible to further attack by some storage insects and moulds.

SAQ #3

Rats and mice carry many diseases, have you ever heard of cases of any of those listed above or other diseases spread by rodents in your country? The plague is spread to man by a flea, Xenopsylla cheopis. What might cause this flea to leave its rodent host to find a human host? Which species of rat usually transmits plague?

Signs of rodent infestation

The signs made by rats and mice that are of most use in determining their distribution and relative abundance are droppings, runways and tracks smears, holes, and the damage caused to foodstuffs, packaging materials and the fabric of buildings.

Droppings

The droppings of the three commensal species can usually be distinguished on the basis of their size and shape (Fig. #13 a&b), although those of very young rats can be confused with mouse droppings. Droppings are normally found in any area that has been visited by rats and mice, but in buildings they are frequently concentrated in favoured places such as corners, along the edges of, and on the tops of walls, and in crevices between bagged foodstuffs. When fresh, the droppings appear soft and shiny but within a few days depending on climatic conditions, they become hard and dull. Occasionally, rodent urine stains show on hessian or other fabrics.

Figure # 13 (a & b) Rodent droppings on rice

Runways and tracks

Close examination of rat and mouse infested premises will almost certainly reveal their footprints and tail marks, particularly where the rodents have travelled through dusty places. In dim light these and other signs are most readily discovered with the aid of a torch. To help confirm the presence or absence of rodent infestation, chalk, flour or talcum powder can be laid in smoothed patches (about 30 cm long by 10 cm wide) along the suspect areas and the patches examined later for fresh prints (Fig. #14 a&b). Outdoors, runways appear as narrow paths (Fig. #14c)where the vegetation has been trampled down. A well-used run, whether indoors or outdoors, will be free of debris and cobwebs.

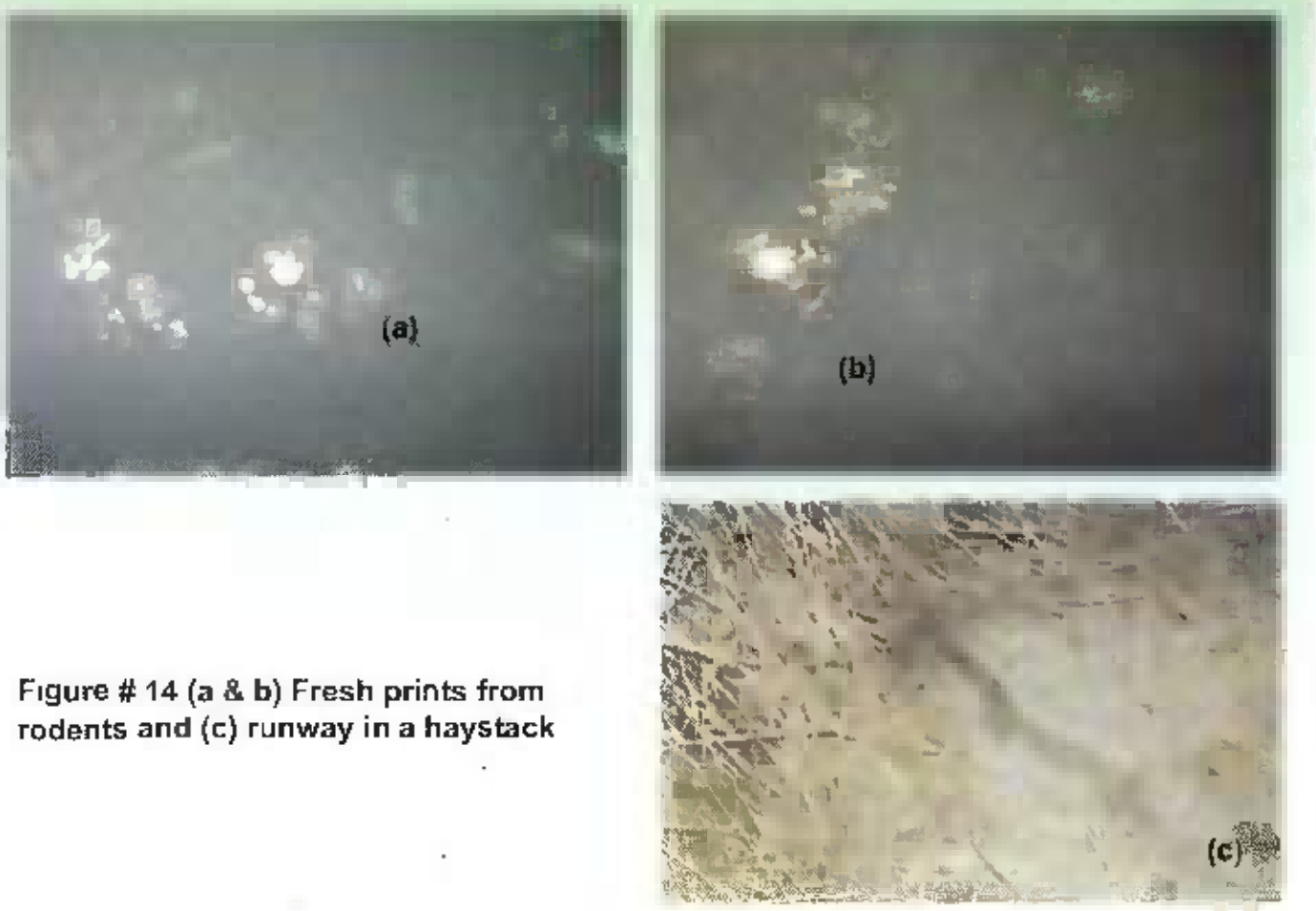


Figure # 14 (a & b) Fresh prints from rodents and (c) runway in a haystack

Smears

Individuals tend to follow much the same route when travelling inside or entering a building, so that dark coloured smears gradually accrue along well-travelled runways, around holes, and along beams and girders, where the grease and dirt on their fur has rubbed off. Thick, shiny and widely distributed smears are indicative of a heavy infestation. Smears are often best seen where rodents have moved beneath ceiling joists and it is often possible to determine the species present from the characteristic appearance of the loops made there. Mice loop smears are similar but smaller than those made by R. rattus. In places where mice have been present for a considerable time, it is also sometimes possible to find small mounds called 'urinating pillars' that consist of a mixture of droppings, dirt, grease and urine

Holes

In and around food stores, holes are commonly found along outside walls (Fig. #15a), beneath foundations and in undergrowth, embankments and hedgerows. Occasionally, footprints may be found at the entrance to a rat hole indicating that the latter is in use; accumulation of debris points to the contrary. Confirmation one way or the other can be obtained by covering holes with soft earth and by noting which ones are re-opened, although interfering with the hole may cause the rodent to use another entrance/exit to its tunnel system.

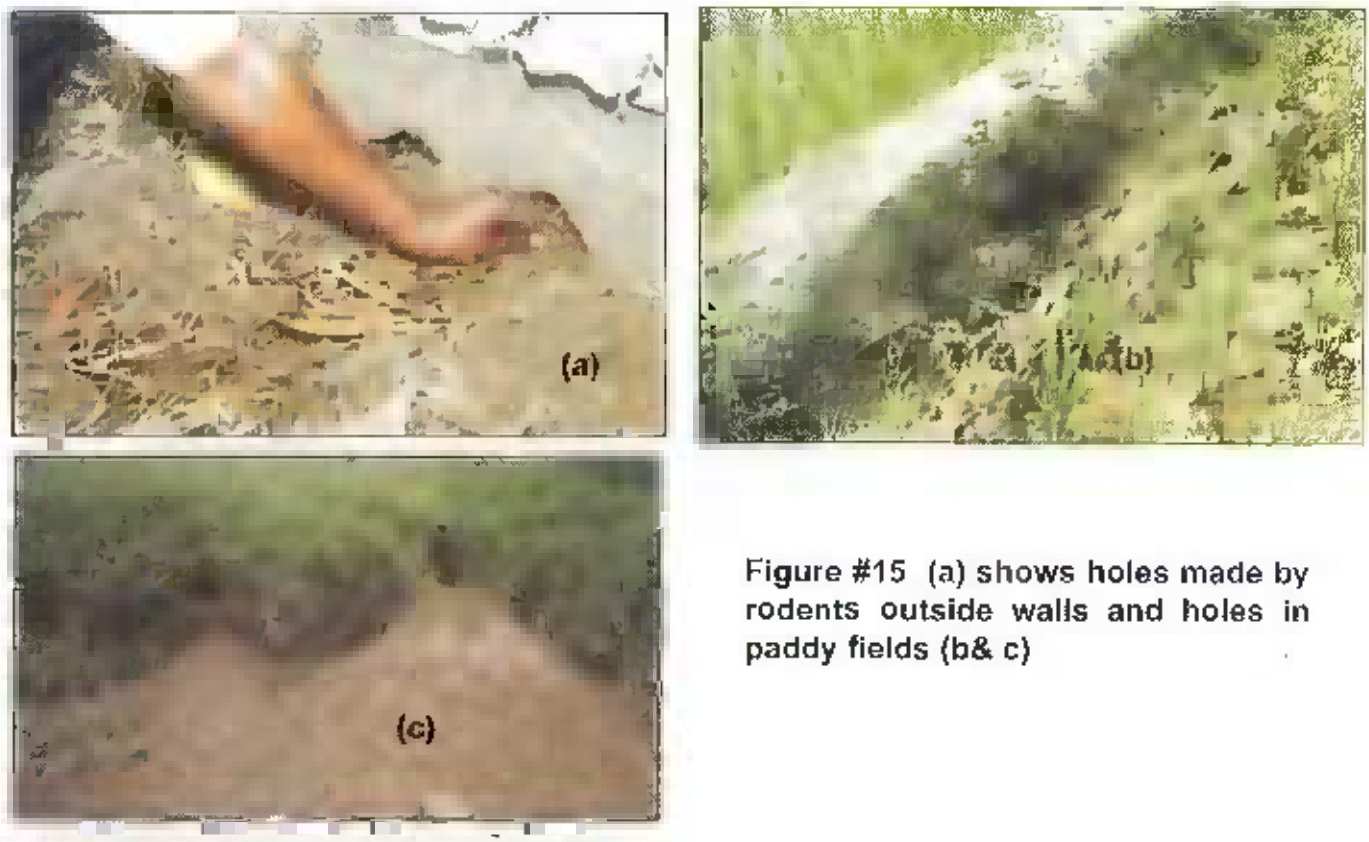


Figure #15 (a) shows holes made by rodents outside walls and holes in paddy fields (b& c)

Damage and gnawing marks

Unfortunately, often the first clear evidence of the presence of rodents is the discovery of partially eaten, spilled or hoarded foods, holed or shredded packaging materials, and other signs of recent gnawing (Fig. #16 a, b, c). Experience has shown that when such signs are apparent on the outside of stacks, the latter are often heavily infested by rodents and the internal damage is usually severe.

Figure #16 (a&b) Grain spillage caused by rodent feeding whereby more grain is contaminated than eaten, locally made rice storage (Dholla)

SAQ #4

You should have now learnt about some of the signs associated with rodent infestation. Have you ever seen any of these signs before?

If you discovered signs of rodent activity in a store how might you find out if the infestation is old or current?

Control of rats and mice

Integrated Rodent Management Strategy

An integrated rodent management (IRM) strategy is simply the plans that will most efficiently and effectively enable a particular house, grain store, group of houses or stores or fields or even an entire village to be kept free of rodents.
An IRM will incorporate

- Effective environmental management
- Proofing of houses to exclude rodent access
- Management of Grain Stores to reduce rodent access
- Intensive trapping to reduce rodent numbers
- Use of poisons to reduce rodent numbers

Remember Rodents require 3 conditions to survive:

FOOD

WATER

SHELTER

Environmental management should aim to reduce the availability of all three of these conditions.

Management of the environment around the store

Figure #17 Rubbish attracts rats. If sealed containers are not available, place rubbish inside deep pits and cover it with earth

In general, the two factors that are of most importance in controlling rat and mouse populations are food and shelter. If one or the other can be eliminated the rodents must go elsewhere. Hence the importance, for rodent control, of strict attention to hygiene. Whenever possible food should always be kept in rat- and mouse-proof containers. Edible refuse and empty food tins should be placed in bins with tightly fitting lids while waiting for collection. Where food has to be stored in bags or other containers vulnerable to rodents, it should be stowed in such a way that it can be inspected at frequent intervals, and the building in which it is housed should be proofed. Piles of rubbish, timber, bricks and other materials should not be allowed to accumulate - either indoors or outside - if rats and mice are to be denied shelter (Fig #17).

In villages in Bangladesh the most common shelter provided for rats are the Korreogadas (Haystacks). These may provide some food because not all the grains have been removed from the rice stalks. However the most important aspect of these haystacks is that they provide an ideal place for rodents (most probably rats) to live (Fig. #18a&b).

To reduce the attractiveness of these haystacks to rats it is necessary to build cradles, off the ground, on which the stacks can be built (Fig. #19a&b)

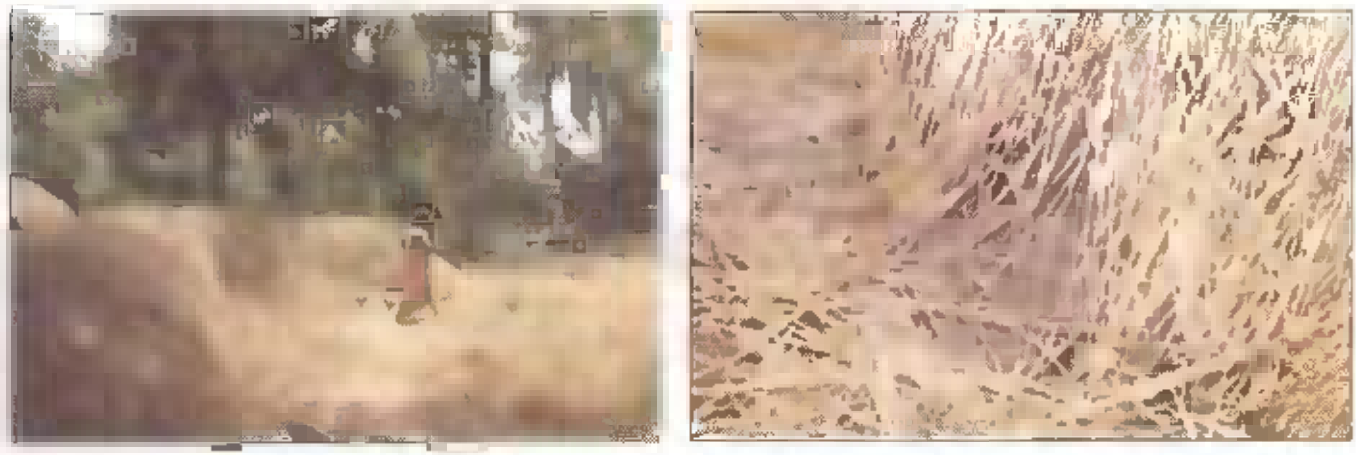


Figure #18 (a &b) Unproofed haystack provides an ideal place for rodents to live

Figure #19 (a & b) Proofed haystack with cone or rat guard made of tin increases probability of preventing rodent attack

Figure # 20 (a&b) Proofed haystack without cones also prevents rodent attack

Ideally the cradles should be 80cms high, minimum height should be 50cms (Fig. #20a&b).

By lifting the base of the haystack off the ground the stacks become difficult for the rodents to access and as a consequence they will hold less rodents.

A village of 100 homes might have 300 haystacks. If each stack held 10 rats then there is the potential to reduce total numbers of rats living in the village by up to 3000 rats. The number of young rats that might be produced from such a population could number some 10,000 per month and although this potential might not be met, the production of several thousand young per month is a realistic proposition. These young rats could then move out of the haystacks into nearby houses and out into the fields to start damaging the rice and other garden and vegetable crops, forming the basis of yet another breeding population

Rodent proofing the storage structure

The objective of rodent proofing the store is simply to prevent rodents gaining access. Entry of rats and mice into buildings may occur in several ways. Rodents are good climbers and can jump very effectively. They can easily gain access to most traditional grain stores because the materials used for store construction provide little or no barrier. Rodents can chew holes in baskets and woodwork of stores and burrow through mud floors and walls to get at stored grain. Grass and palm thatched roofs can provide ideal nesting sites for rodents. Rat guards can be placed on the legs of grain stores (Fig. #21a&b). Rat guards will work best if the store is raised one metre off the ground and there are no plants or poles close to the store up which the rats and mice can climb. The stores legs should be made of smooth materials. The store should be built at least one metre away from buildings or trees.

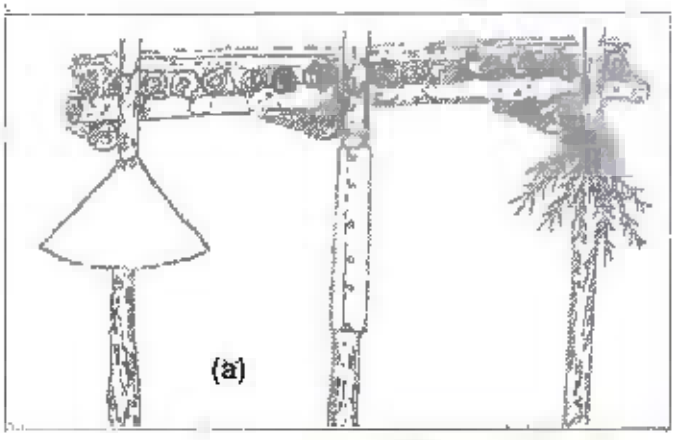


Figure #21 (a) A variety of rat guards that can be placed on the legs of grain stores

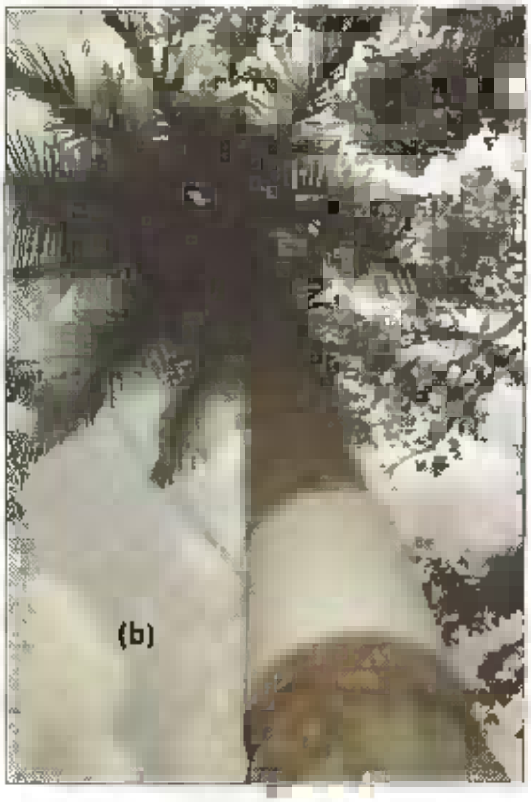


Figure #21 (b) Rat guard made of tin can be placed around the bark of a coconut tree to prevent rodents' movement to the top, usually an ideal nesting site of rodents

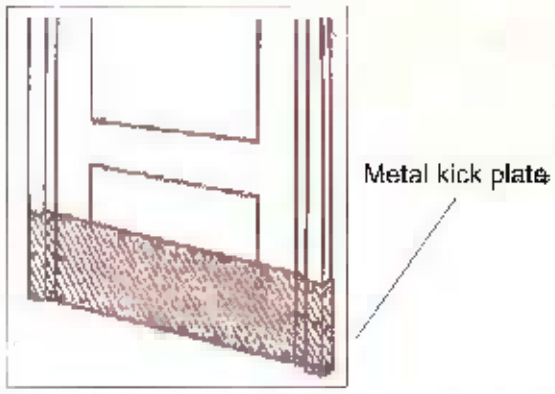


Figure #22 Wooden doors and door frames need to be protected against chewing by rats and mice

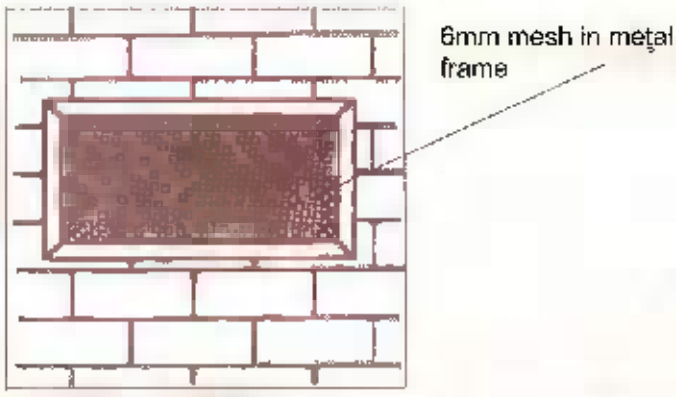


Figure #23 Screens to keep mice out must have a small mesh size

Gnawing at the bottom of doors can be prevented by fitting a 30 cm high 20-gauge, metal kick plate on the outside (Fig. #22). This should have a maximum clearance of 7 mm from the ground. A similar plate should be fixed to the door frames to provide a continuous band of metal. Windows, fanlights and ventilators that are permanently open should be meshed over as described for air-bricks (Fig. #23).

Horizontal pipes and cables between buildings can be fitted with circular 20-gauge metal guards as recommended for vertical pipes

The following spaces are favoured rodent harbourage sites inside buildings:

- in the ceiling space (Fig. #24a&b)
- in hollow partitions;
- in walls
- in any materials that might provide a home.

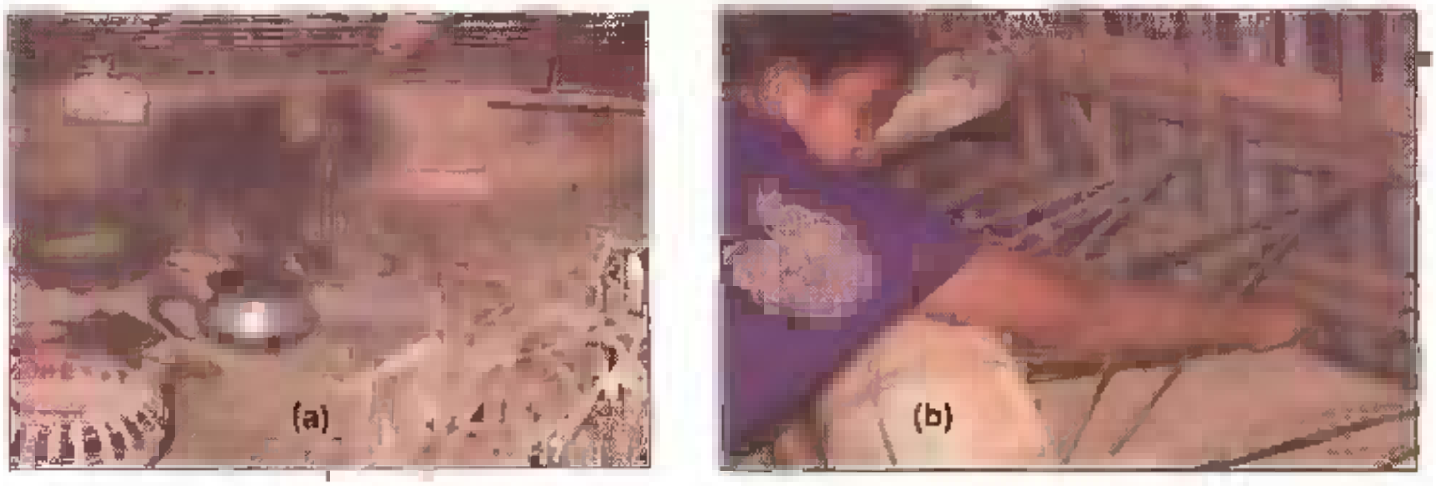


Figure #24 (a) shows a closer view of the ceiling space, a favored harbourage site of rodents and (b) shows a woman

Figure #25 shows all potential access routes of rodents inside the house

Management of the stored product within the store

It is essential that high levels of store management are maintained within the store. Any spillages that may leave food lying around must be removed immediately.

Access to water by the rodent population should be prevented

If food is to be stored in stacks they should be relatively small stacks that can be individually inspected and monitored. These stacks should be at least one metre apart and one metre from any walls to facilitate inspection, monitoring and the application of rodent control measures. Where there is evidence of rodent activity in the roof areas the stacks should be kept at least one metre from adjacent walls and from supporting beams and other structures. All stacks should be stored off the ground on pallets or similar supports.

Where Dhollas (Fig. #26a) are used for storage the base should be one meter from the ground. However this is not always possible due to roof heights and storage conditions. In such conditions the base should be as far from the floor as possible and certainly more than 50cms (Fig. #26b). Cones should be used to help prevent rodents climbing up the leg supports. The base of the supports should ideally be one meter from all walls.

No materials should be kept near to the cradles that might help rats gain access to the Dhollas. The areas around the cradles should be kept clean and free of other materials.

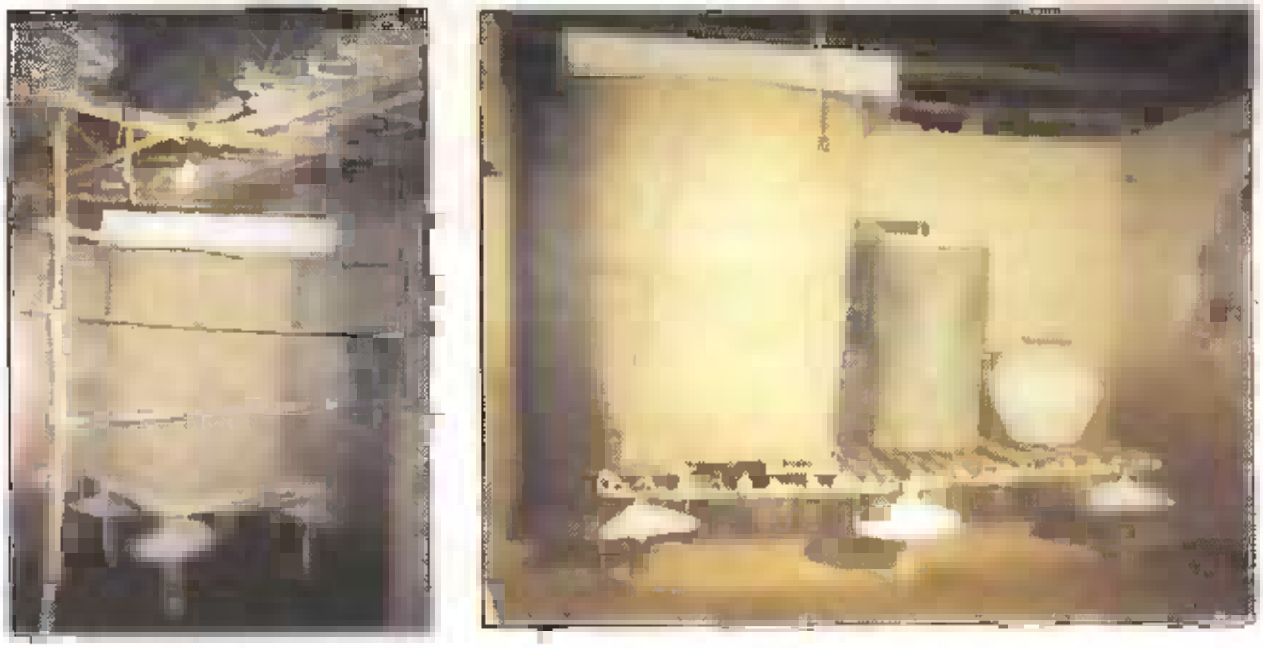


Figure #26 Rice storage called Dholla with base one meter above the ground and protected by rat guards to prevent rodents' movement

Rodent control techniques

Although high standards of proofing, store management and hygiene are essential to maintain a rodent free store, infestation will still occur and it will be necessary to have effective rodent control measures available. A range of control techniques are available and these will be dealt with as either chemical or non-chemical methods of control.

Rodent Control - Trapping

Trapping

Trapping must be amongst the oldest of the control methods employed against rodents as can be testified by the many traditional live and kill traps in different parts of the world. These include pitfall, deadfall, snare and the various types of cage traps. There are pottery traps in the museums of several Middle East countries that date back to the 3rd millennium BC.

Unless the rodent infestation is very small, trapping is not usually used in situations where complete removal of the population is required because some rodents manage to avoid or learn to avoid the traps.

Recent work in Mozambique found that intensive break back trapping, undertaken on a continual daily basis, in home food stores can reduce the rodent population by 70% at low cost and with a significant reduction in food storage losses.

More recent research in villages in Bangladesh has shown that intensive use of break back traps can reduce the level of rodent infestation by about 70%.
Killing traps are active traps usually working on the break back principle. A spring, triggered by the activity of the rodent on the trigger mechanism, drives down a metal bar, breaking the back of the rodent. Break-back traps (Fig. #27) are quite common and should be set at right angles round the base of the walls of a room or up in the roof areas where rodents may be active, rather than in open places. Food placed on the traps may help increase catches used to trap rodents (flour, banana, coconut or sweet potato), but the correct placement of the trap in an area where rodents are active is probably more important.

Figure #27 Break-back traps placed at right angles across rat runways, around the base of walls, and set lightly

If the trap is triggered before the rodent is in the correct position, or if the spring is not strong enough to kill the rodent, the rodent will have survived. In surviving it will have gone through an unpleasant, painful and frightening experience and in exactly the same way as with 'shyness' induced by the acute rodenticides, it will learn to avoid the trap in the future and will become 'trap shy'. This will subsequently make it much more difficult to trap the same animal in a similar trap.

For these reasons it is very difficult to eliminate a rodent population of any size by trapping alone. It may however be possible to eliminate a small population.

Live capture traps (Fig. #28) and sticky glue may also be used, but require more work than break back traps

Traps have a clear part to play in the control of rodents in food storage environments, as they are non toxic and will not contaminate the food. They will be most effective however if they are used intensively, placed carefully in areas where the rodents are active and if thought is given as to how to use the traps to best advantage.

It is essential that trapping is maintained for 365 days of the year and that it is NOT only introduced when there is a rodent problem. By the time a problem has been identified it is probably too late to prevent some serious damage. Trapping MUST be maintained for 365 days of the year, even when there is a very limited or even only a small problem. Trapping will help prevent the rodent infestation increasing in size by removing some of the females that will give birth to the rodents that will lead to even more rodents later.

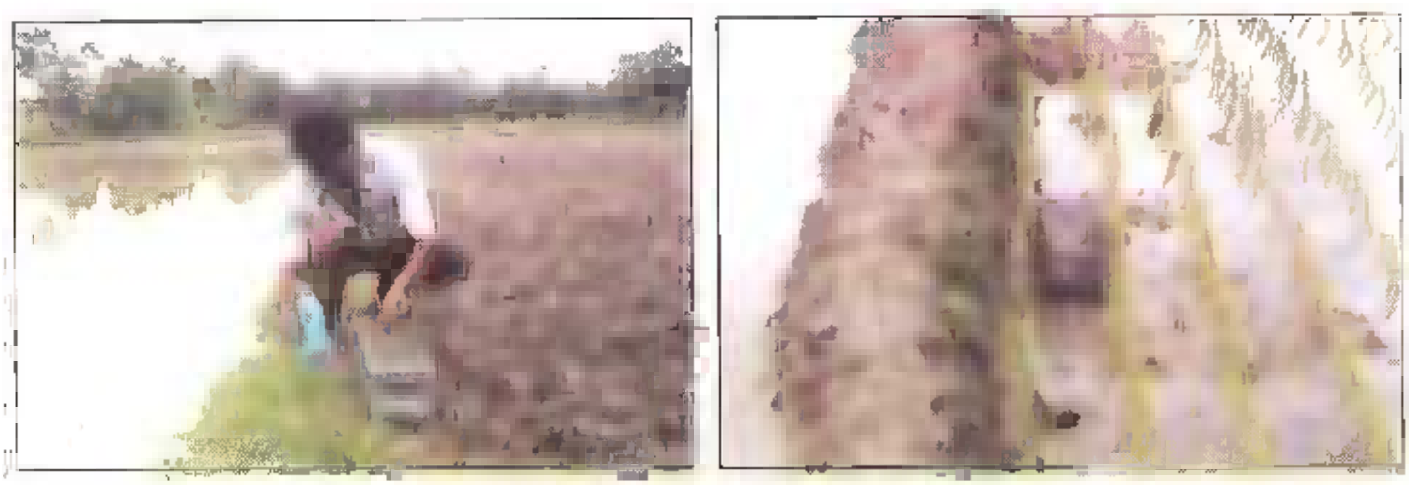


Figure #28 (a&b) Live trap set up by a farmer in a rice field

Figure #28 (c) Live trap set up behind the Trap Barrier System (TBS) in the rice field

Live trap behind the polythene sheet

Using Poisons to Kill Rodents

There are many rat poisons on the market, but they can be divided into two groups.
The oldest group of rodent poisons belong to a group called the Acute rodenticides. These Acute poisons have been used for many thousands of years and are still used today. They may be cheap, but they are not very effective.

The reason why they are NOT very effective is because they work quickly usually starting to affect the rodent before it has eaten enough of the poison to kill it. This results in the rodent ceasing to feed on the bait and surviving the poison treatment. In addition, because these poisons are painful to the rodent, the poisoned animal will have learnt that the poison is bad for it and it will not feed off the poison if it encounters it again. This is called "shyness" to the poison bait.

For this reason these poisons are not worth using. However, because a few rodents will be killed by these poisons and because they will die quickly, they die out in the open where they can be seen. Thus people see bodies and think that the poison is far more effective than it really is, they do not of course see all the rodents that survive the poison!

The main Acute poison that is used is Zinc Phosphide. It may be purchased cheaply but is not as cost effective as the other Chronic poisons. In addition, Zinc Phosphide will work quickly on other animals (including people) that might feed on the bait and there may be little time to treat any accidental poisoning cases.

The newer Chronic poisons are safer than acute poisons where non-target animals are concerned, since a single feed of bait is usually (but certainly not always) insufficient to kill. In addition, because they work slowly (average time to death is about 7 days) there is plenty of time for the animals to eat enough of a Chronic poison bait to deliver a killing dose. In addition there is far less discomfort involved and any animals that might survive a treatment will readily eat the poison again at a later date.

The Chronic poisons are all anti-coagulants and they kill the rodent by causing it to bleed to death. Much of the bleeding occurs internally and there is often little evidence of external bleeding.
A wide range of anti-coagulant rodenticides are available world-wide, but those currently available in Bangladesh are shown in Table 2.

Table 2. Anti-coagulant rodenticides

First Generation	Warfarin
Second Generation	Difenacoum Bromadiolone

Rodenticide formulations

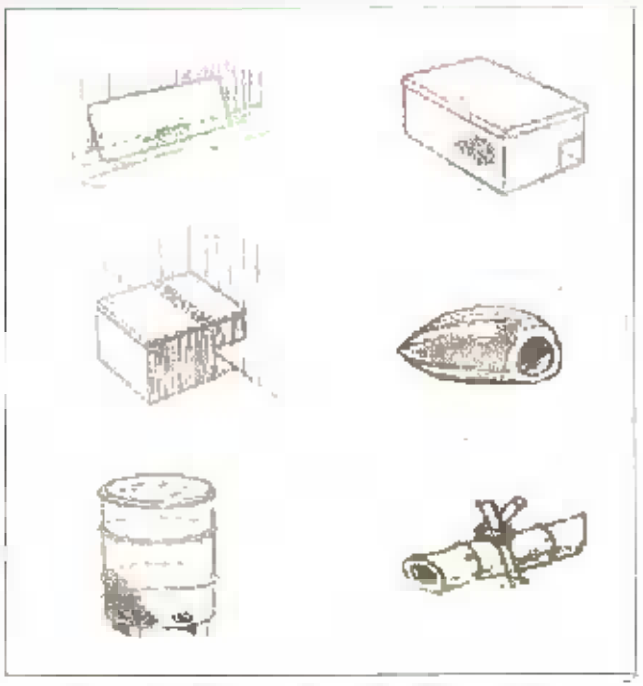


Figure #29 Examples of baiting stations

All the rodenticides mentioned are available in a range of formulations. Some formulations provide advantages in particular situations, others may vary in their effectiveness and palatability. It is important that those using rodenticides are familiar with the product being used and the alternatives. It is also essential that the instructions on the label of the container are followed exactly.

Baits mixed with poisons should be laid in baiting or feeding stations to protect them from the influence of the weather and non-target species Some illustrations of different baiting stations can be found in Fig. #29.

Baits must be inspected every two or three days and more added if the bait is being eaten. If, regular visits are not and the bait runs out before a lethal dose has been eaten, the rodents will recover from any impact the rodenticide may have had.

As a rule of thumb, treatments may be terminated once there have been two visits where there are no signs of feeding at the bait station and no other indications of current activity can be found.
Baiting should continue until no more is eaten. This may last for 4 or 5 weeks and may seem a long time. However, the use of these Chronic poisons will give a far more cost effective result than other poisons Most rodents will die in their shelter and therefore few, if any bodies will be seen.

Baits are best laid in small quantities at many locations in a store, where rats and mice regularly run (alongside walls or bag stacks). All types of poison used in stores for killing rats and mice should be covered (Fig. #30) or sited so that they cannot become mixed with food grains or be eaten by domestic or farm animals, or by children.

When placing rodenticide baits in rice fields to prevent damage to growing rice the same rules should be followed. The bait should only be placed in active burrows to minimise cost and risks Block all burrows before using the rodenticide bait and only bait those burrows that have been opened three days later.

Place the bait, about 20 grams, well inside the burrow and gently re-block the burrow.

Check the burrows at weekly intervals and continue to bait open burrows, re-blocking after baiting Continue until all burrow activity stops.

Dead rats and mice should be collected (Fig. #31), but must not be handled with bare hands because of the risk of fleas that can carry diseases. The bodies should be buried or burnt.

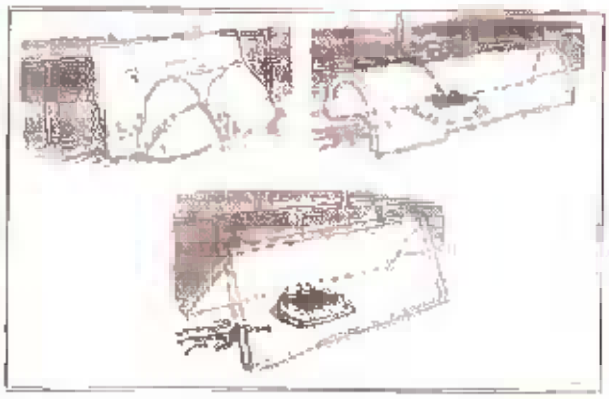


Figure #30 All baits must be protected

Figure #31 Dead rats collected

It is essential that once started, the control treatment is applied appropriately and is taken through to completion, otherwise the risk of resistance developing is high, due to exposure to sub-lethal doses of rodenticide. There is little point in commencing control unless resources are available to complete the task. The need for effective management and training is particularly important in this phase of the operation.

Using rodent poisons safely

It must be remembered that all poisons used for killing rats and mice are harmful to humans and to domestic and farm animals. The manufacturer's instructions must always be read and followed carefully.

Chronic poisons kill rodents by preventing clotting of the blood and will cause the same problem in human poisoning. Treatment to restore blood clotting in humans is with Vitamin K1 that can either be taken by mouth or by injection.

When laying poisons in a store, care must be taken to ensure they can not be reached by cats, dogs, and other small animals or by children (Fig. #32)

As mentioned above, gloves should be worn when collecting and disposing of dead rodents to reduce the risk of disease transmission.

Figure #32 Poisons should be kept in a locked store

SAQ #5

How can baits be protected from the environment?

Why should the rodent carcasses not be collected using bare hands?

How should rodent carcasses be disposed of?

SUMMARY and RECOMMENDATIONS

There are a number of rodent species that can be found in villages in Bangladesh

The three most common are the lesser bandicoot, the ship rat and the house mouse

It is clear from recent research that these rodents can cause significant losses to rice and other stored food in villagers homes and stores.

The lesser bandicoot in particular but also the ship rat can cause field losses to growing crops, particularly rice. However other field crops and vegetables can also be damaged and losses occur

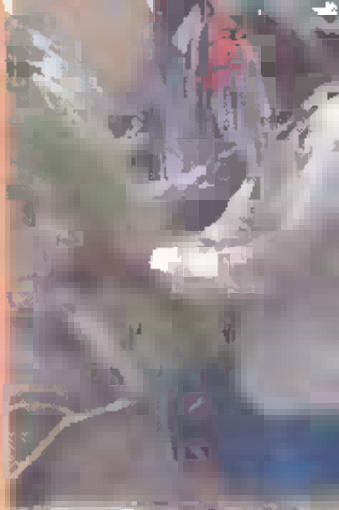
You will now have learnt about a number of elements important in an integrated rodent management strategy. Think of some ways in which the hygiene and proofing of a typical store in your local area might be improved.

Useful website

Detailed notes and photographs on rodent morphology and taxonomy exist in the University of Michigan's Animal Diversity Web

http://animaldiversity.ummz.umich.edu/site/accounts/specimens/Rodentia.html

USEFULL NOTES



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