Chapter I. GENERAL INTRODUCTION

Agricultural productivity is influenced by many factors including soil fertility, climate and weather, crop varieties, crop management practices as well as pests and diseases. The last mentioned factor can reduce crop yield in the field and cause losses of commodities in the storage as well. Among important pests that can cause losses of agricultural products both in the field and storage are rodents. This group of pests has a special place among other groups of pests in that they have prominent instinctive behaviour. Thus, sound understanding of their bio-ecology and behaviour is essential for the success of their control.

RODENTS

Rodents or gnawing animals represent an order of mammals, which are characterised by the presence of two pairs of incisors, each pair on the upper and lower jaw. These incisors are growing in size continuously throughout the life of the animal. This characteristic distinguishes the incisors of rodents from the incisors of other mammals in general, which stop growing after reaching a certain size (Brooks & Rowe, 1987). Most damage in agriculture, as well as to urban structures, caused by rodents is due to their gnawing activities, and less damage is caused by their feeding activities. A species of mammals other than rodents which often cause problems in agriculture and urban areas, especially in buildings (indoor pest), is the house shrew (*Suncus murinus*, Soricidae : Insectivora), particularly in South East Asia (Kaukeinen, 1994).

In terms of the number of species, rodents represent the largest group of mammals, with a total of 2,015 species or 43.5% of the total number of mammalian species (4,629 species) (Wilson & Reeder, 1993). This large number of species, coupled with their explosive demography, adaptable ecology, and opportunistic behaviour, have made rodents capable of surviving and competing successfully with other mammalian species.

There are some rodent species that have successfully adapted to the human environment, this group of rodents is called “commensal rodents”. These animals could exploit resources in the human environment, which are normally difficult to be utilised by other rodents. Three known species of commensal rodents are : The

Norway rat or brown rat or common rat (*Rattus norvegicus* Berkenhout, 1769), the roof rat or black rat or ship rat (*Rattus rattus* Linnaeus, 1758), and the house mouse (*Mus musculus* Linnaeus, 1758). The success of these rodents is supported by their ability to live in a wide range of habitats, high reproductive capacity, and omnivorous feeding habits.

THE NORWAY RAT

Like the roof rat and house mouse, which have a world-wide distribution, the Norway rat ranks high among rodents that cause conflicts with human interest. Until the year of 1700, the Norway rat is believed to have lived in the desserts and savannahs of mainland Asia, north of the Caspian Sea, the area of the present-day Russian Federation. Factors causing emigration of this species from that area to other parts of the world by far is unclear. It is believed that a favourable breeding season at that time resulted in a huge population of the Norway rat which in turn triggered a massive migration (Lund, 1994; Temme, 1981).

The Norway rat spread to the west of Russia in the early eighteenth century. In stables and barns in agricultural areas of Russia, the Norway rat found abundant resources (feed and nests) so that the population increased dramatically. From there, the Norway rat migrated further than ever before with the help of transportation means, spreading out to almost all parts of the world.

Biology

Since two hundred years, the Norway rat has adapted to the temperate areas as well as to the tropics. The spread of the Norway rat in the tropical areas started at coastal areas of big cities or seaports, then they spread to human settlement areas where they did not find indigenous important competitors. Nowadays, particularly in urban areas, the Norway rat lives in sewer or drainage systems around human settlements, where the temperature is relatively uniform and food is available throughout the year. In addition, the Norway rat also settles in agricultural buildings/structures, basements, warehouses, refuse dumps, and market places. The species prefers to live in areas with a high humidity level. In general, Norway rats cluster in places with abundant resources, i. e. food, water, and shelter. Such places can easily be found in rural and agricultural areas all over the world.

On the average, adult Norway rats consume 20 – 30 gram of cereal per day. This means that hundred rats in an agriculture area would require one ton of food during a year. The mean size and body weight of the adults vary with age. Norway rats at an early reproductive stage, about 2.5 – 3 months old, weigh about 100 – 150 grams. The weight of a Norway rat at the height of its age, 8 – 10 months old, could reach 300 – 400 grams. Norway rats with a body weight of more than 400 grams could hardly be found (Lund, 1994). However, Meehan (1984) noted that an adult of Norway rat could reach up to 550 grams in body weight, 220 mm in head and body length and 170 mm in tail length.

Feeding Behaviour

Feeding behaviour of the Norway rat needs to be well understood since it serves as one of the bases in the development of rat control programmes, especially when poisoned baits are to be used. It is necessary to know about the time of day when the rats are searching for food, competition in food searching, and kinds of food that are needed and preferred.

As a nocturnal animal, most food searching activities by the Norway rat are done at night, under the darkness. The peak food searching activity of the Norway rat occurs at about one to two hours after the sunset and another peak, which is normally less intense, takes place at about one to two hours before the sunrise (Meehan, 1984).

In temperate countries, during summer the time available for searching for food or finding their mates is limited. Under such conditions, if food supply is limited, the rats may explore food during the daytime. Although during the daytime, most rats stay in their nest and only a few rats still roam about outside the nest (Chitty & Shorten, 1946; Barnett & Spencer, 1951).

There were three ways how Norway rats consumed non-powdered cereal baits, i.e. the rats stood on a bait container and consumed cereals directly on that feeding site, rats feed on food spills scattered by other rats, or the rats hoard up the food into their nests before it is consumed (Chitty, 1954; Barnett & Spencer, 1951). Sridhara & Krishnamurty (1978) and Parrack (1969) added that some other rodents species even pile up the food in a higher amount than is needed. The explanation for the hoarding behaviour is that the food stored serves as food reserve in case the food needed is difficult to find outside their nest. Female rats, particularly the lactating ones, hoard up

more food than the males. The rats that often suffer interferences from other rats also pile up more food than they normally do. Davis (1979) argued that the hoarding behaviour is learned by the rats from their parents and does not constitute an intrinsic behaviour.

The rats also store various small objects other than food in their nest. The more familiar the object, the more chance the object to be hoarded (Calhoun, 1962). Nevertheless, Miller & Viek (1944) explained that rats preferred to hoard food rather than non-food objects, particularly for rats that have experienced food shortage conditions.

The above hoarding behaviour needs to be soundly considered in the development of Norway rat control programmes using poisoned baits in order to avoid incorrect interpretation of the amount of poisoned bait consumed. In addition, the development of rat control measures using poisoned bait should also consider the preference of rat toward certain baits, bait placement, and bait avoidance or neophobia (Nieder, 1986).

Exploratory Behaviour

Some animals, including the Norway rat, exhibit an exploratory behaviour towards their environment, especially to an area which is strange or new to them. They approach and enter every site that they find. Exploratory behaviour is a kind of movement activity of animals, which is governed by the presence of strange or new objects in their surroundings. This behaviour represents a biological factor that protects the animal from a dangerous situation that could threaten its live. The exploratory behaviour has developed since the rats are still young, but it is doubtful that there is a fixed pattern that underlies its development. It is assumed that this behaviour is shaped by previous experiences (Barnett, 1958b).

A term “new object reaction” could be used to describe a situation that limits the exploratory behaviour. The Norway rat is very sensitive to any change occurring in its environment. The following changes could evoke the new object reaction in the Norway rat: Moving an object from a previously recognised position to a new one, changing an object with a different object which is similar to the previous one, changing the position of a bait container, changing the kind of bait, a minor change in its habitat like sweeping a dirty floor, and changing in illumination (Shorten, 1954).