Review Article مراجعة علمية

Rodent Pests of Agriculture and Their Control in the Near East Region *

J.H. Greaves

Department of Pure and Applied Zoology,

University of Reading, Whiteknights, Readings RG6 2AJ, England.

Abstract

Greaves, J.H. 1989. Rodent pests of agriculture and their control in the near east region. Arab J.Pl. Prot. 7:82 - 75

Information on the status of rodent problems in the Near East region is reviewed. Twenty-two species of rodents are identified as having been reported to be common or occasional pests. The damage that rodents cause and the available damage prevention techniques are outlined. It is suggested that crop losses are highly variable, but may be about 5% on average, ranging from the negligible to about 25% in some situations and, very occasionally, considerably higher.

In agricultural and urban rodent pest situations the use of anticoagulant rodenticides is usually found to be the most dependable control technique.

Because different species endemic to the region vary considerably in their susceptibility to anticoagulants it is normally advisable to use one of the more toxic, second-generation anticoagulants. For many agricultural applications bait containing zinc phosphide is said to give adequate control of infestation, but for field rodent control generally there is a need for a better acute rodenticide than is currently available. Burrow fumigation is sometimes applicable, mainly where it is necessary to control slow-breeding species such as *Hystrix* and *Spalax*.

Training, extension and research needs are discussed briefly. Recent experience suggests that attention to organizational aspects may be the single most important factor in reducing rodent infestation and damage.

Key words: rodents, Near East region.

Introduction

The principal sources of information on rodent pests and their control are papers published in connection with development projects aimed at reducing rodent damage in agriculture,notably in Morocco, Tunisia, Pakistan, Sudan and Egypt. The well-known and uniquely ambitious urban rodent eradication programme of Kuwait (Mohammad, Zaghloul and Zakaria, 1983) should also be mentioned, as should the less publicised but similarly successful urban schemes in Jordan and the United Arab Emirates. A certain amount of useful information on the taxonomy, habits and distribution of rodents is also available from academic works, notably the authoritative accounts of the mammals of Arabia by Harrison (1972) and of Egypt by Osborn and Helmy (1980), and from the results of various zoological expeditions and studies in medical zoology. Much useful information is however relatively inaccessible by reason of being scattered among a wide range of conference proceedings (e.g. the International Congresses of Theriology, the European and Mediterranean Plant Protection Organization conferences, and the California Vertebrate Pest Conferences), and other publications produced outside the region, usually in languages other than Arabic. There appears to be a substantial need for a service by which such information can be systematically collected, indexed and made more readily available to workers in countries of the Near East.

The purpose of this report is to present an overview of and to summarize some of the more immediately relevant information on rodent damage, pest situations, control techniques and training, extension and research needs as a contribution to future strategies to reduce losses to rodent pests in the Near East.

Character of the region

The rodent problems of the region are closely related to its geographical characteristics in relation to agriculture. Much of the area, from Mauritania in the west to Pakistan in the east, and from Afghanistan in the north to Somalia in the south has a predominantly dry climate with a low and variable rainfall. This generally supports crops such as wheat, barley, legumes and alfalfa as the main crops, all of which are liable to attack by desert-adapted, gerbilid rodents. A good deal of the area is given over to marginal agriculture which, though not highly productive in economic terms is of very great social importance to the subsistence farmers who cultivate it and who are highly vulnerable to the sometimes devastating effects of rodent attack on their crops. Much of the effort in agricultural development in some countries is directed towards improving the productivity of semi-arid areas and bringing new land into cultivation. Such schemes are very liable to encounter problems of rodent damage.

Much of the more productive land towards the Eastern Mediterranean and central Asia enjoys moistureconditions, and here palaearctic rodents assume greater importance. Elsewhere, three areas must be regarded as transitional zones. These are first, the Nile valley and delta in Egypt and the northern Sudan, where the predominant field rodent, *Arvicanthis niloticus*, is more characteristic of the Africa

* This article was presented as a Symposium paper in the Third Arab Congress For Plant Protection. * قدم هذا البحث في الندوة العلمية خلال المؤتمر العربي الثالث لعلوم وقاية النبات.

south of the Sahara; second, the area of Somalia, Djibouti and southern Sudan, where the major pest species of eastern and southern Africa, *Mastomys natalensis*, is present; and third, the plain of the river Indus and its tributaries which, both in the crops cultivated and the rodent pest complex, show greater affinity with South Asia than with the Near East.

Food losses and damage caused by rodents

The measurement or estimation of damage caused by rodents requires considerable investment of scarce resources, and there have therefore been few quantitative studies of damage. A great deal of the available information is of a highly anecdotal nature and is often resticted to very general statements and broad guesses about the extent of the damaging activities of rodents, and chiefly where severe damage over tracts of land has been the subject of complaint by farmers. For several countries no information at all is published, though it may be judged that the problems in these countries are no less than elsewhere. A substantial amount of information is available, however, from a few countries where major efforts have been made to get to grips with perceived problems.

The evaluation of rodent damage can bé a complex matter, since crops may be attacked at any stage from the seedbed to maturity, the degree of attack often depending upon very local environmental conditions. In addition there is often evidence that damage varies dramatically on a timescale of 3 - 10 years, becoming severe and widespread with no apparent warning and sometimes decreasing just as quickly and unpredictably. A fully realistic economic evaluation of the status of rodent damage therefore requires continuous study at a large number of field locations, sustained over a period of several years.

Damage to stored food. There is essentially no information on the significance of rodent damage to stored food except for some unpublished estimates made in large export rice godowns in Pakistan in the early 1970's. Here, rodent infestation, though very conspicuous, was found to be of little more than nuisance value in view of the high turnover of stocks and, correspondingly, losses were estimated to be well below 1.0%; in fact, damage to sacks, causing spillage and disruption of the smooth operation of the stores was probably more significant economically. It would be expected that the situation would be similar throughout the region in stores with a reasonable standard of construction, occasional fumigation against insect infestation (which also helps to keep rodents down), and regular turnover of stocks. Nevertheless, a specific regimen for rodent control in food stores is usually cost-effective and has additional side benefits in institutionalising modern rodent control techniques at a focal point within the food handling system.

Where grain is stored in bulk at district village or farm level losses are again expected to be relatively minor, up to one or two percent at worst. But it should be noted that, at farm level, infestation of the food store is frequently co-extensive with domestic rodent infestation which, besides being a constant nuisance to the farmer and his family and destroying their small personal possessions, may adversely affect the health of rural populations by creating rodent-borne disease hazards.

In a number of countries it is customary to store grain on the ear or haulm of the plant in stacks out-of-doors, or on or within the roof of the farmers residence, until it is threshed at a later date. This type of storage is very susceptible to rodent attack and it would be expected that damage could be of the order of 2% per month during the period of storage, amounting to perhaps 10 - 20% over a whole year. It may be noted that a postal questionaire study conducted several years ago suggested that losses of stored food were frequently of the order of 1 - 10% annually, though it is not clear to what extent these estimates were based on scientifically collected data or were pure guesses (Hopf, Morley and Humphries, 1976).

It may confidently be suggested that damage to stored food in the region is normally due to the three cosmopolitan, commensal species, *Rattus rattus, Rattus norvegicus,* and *Mus musculus,* with native species such as *Acomys cahirinus, Arvicanthis niloticus* and *Mastomys natalensis* playing an occasional role and other species such as *Meriones* spp. and *Nesokia indica* being of importance more rarely, where grain is stored in outdoor yards or in the fields.

Damge to crops in the field. Field damage varies very greatly, owing to differences in weather, climate and cropping patterns in different countries, differences in the rodent pest fauna in different areas and variation in the behaviour of the same species in different areas. Probably the most comprehensible way of summarising the situation will be to give some account of what is known, species by species, as follows:

***Rattus rattus* (Roof rat)**

The roof rat is prevalent through much of the region as a pest of human habitation, food stores and orchards, but in the field it is typically replaced by indigenous pest species that are better adapted to living in the countryside. In Cyprus the roof rat has long been known to inflict significant damage on the carob crop by gnawing the bark of younger branches to feed on the cambium in the dry season, thereby killing potentially productive parts of the trees; towards harvest it also feeds on the carob fruits themselves. Many years ago the overall losses were estimated by Watson (1951) to be around 3% annually. Despite this seemingly low figure, damage to carob has been of continuing concern in Cyprus and it is only recently that effective methods of preventing it by anticoagulant baiting have been developed (Krambias and Hoppe, 1984). The species also causes conspicuous damage to a number of fruits in the region generally. Losses of dates and coconuts on the palm are commonly thought to be about 30%. Losses of citrus fruit, especially the sweeter varieties, are frequently stated to be about 3%, and occasionally trees are made unproductive as a result of bark stripping by the roof rat.

***Rattus norvegicus* (Norway rat)**

The Norway rat is the most common pest in many towns and cities of the region, where it is responsible for much of the damage that occurs to stored food and other property. In contrast, it has rarely been identified as a significant field pest, since it seems generally to be out-competed by indigenous rodents. Nevertheless, it has been mentioned as a minor pest of sugar cane in Egypt and may be suspected of playing a more important role in southeastern Iraq. There is little evidence to suggest, however, that it is more than a minor and occasional pest.

***Mus musculus* (House mouse)**

The house mouse is said to be a common pest of domestic premises and grain stores throughout much of the region. In Egypt and some neighbouring countries, however, it is understood to have been replaced to some extent in these habitats by the Egyptian spiny mouse, *Acomys cahirinus*. Though *Mus musculus* is a considerable nuisance in causing damage to sacks and contamination of stocks, it is probably of most importance in terms of food losses in stacks of unthreshed cereals. It can be an intractable domestic pest by reason of its being frequently associated with the more secluded areas of the living quarters.

The house mouse has occasionally been reported to be a significant field pest. In Iraq, the subspecies *praetextus* has been stated to inflict losses of about 20% on «corn» in the field 50km southeast of Baghdad and in some other areas to damage soybeans and cottonseed in the bolls, and to dig up groundnuts (Yaman, 1975). The House mouse is tolerant of arid conditions and is frequently to be found in barren areas. It is of interest therefore that another instance of field damage concerns a desert reclamation scheme in Salhea Shabab, Egypt. Here, high losses of barley, maize, peas, beans, eggplants, tomatoes and cucumbers were reported in the second season after reclamation, and the average damage to barley was estimated to be 19 % (Bahgat Amr, 1984). The attribution of this damage to house mice is complicated somewhat by the presence of small numbers of rodents of the genera *Rattus* and *Meriones;* it appears that the introduction of irrigated cultivation into the area led to an outbreak or explosion of the local rodent population. House mice are occasionally reported to damage cucurbits in isolated gardens in Arabia.

***Spalax leucodon* (Palestine mole rat)**

The Palestine mole rat, also known as the blind or lesser mole rat, is widely distributedin the Eastern Mediterranean. It is almost entirely subterranean in its habits, feeding on roots, tubers and newly planted grain and legumes. According to Richards (1982) it is a major pest of summer crops in northern Syria, destroying whole fields of watermelons and beans, attacking the plants just below the surface of the ground and often dragging entire plants down into its burrows. Celenigil cites the mole rat as causing significant damage to dams, ditches, canals and levees in Turkey, leading to flooding; though population density is generally low (about four mole rats per hectare or less) the burrow of an individual is 8 – 10cm in diameter and 200 – 300m long, extending over an area of about 3000m^2 and down to a depth of 1.5m. The animal may cache up to 50kg of food in its burrow and damage pastures by its digging. Unfortunately no reliable quantitative information is available as to the occurrence of the species or of the economic losses it is responsible for. It does, however, appear to be one of the better recognised field pests of the region.

***Nesokia indica* (Short-tailed bandicoot rat)**

The short-tailed bandicoot is known to range from Egypt eastwards to Afghanistan, Pakistan and beyond. It is apparently common in the riverine plains of Syria, Iraq and Pakistan, and is distinctly fossorial in habit, though less so than the Palestine mole rat. In Iraq it has been stated to be a problem in grain storage yards in towns, to attack vegetables in the field from below the ground and to attack sugar cane at both the mature and immature stages; damage to the growing points of immature canes is apparently sometimes serious, with up to at least 50% of stools being killed in some fields (Kadim, 1980), though damage of this type may well be attributable to a different species. In the province of Sind in Pakistan it has been stated to be responsible for losses to rice in the field of about 9% from the flowering stage onwards, but it is apparently a less important pest of cereals elsewhere (Fulk et al., 1981). The species is commonly noted to dig extensively in the levees of irrigated fields and is therefore implicated as a pest in relation to the management of water resources.

***Bandicota bengalensis* (Lesser bandicoot rat)**

The lesser bandicoot rat is typical, along with the soft-furred rat (see later) of the South Asia region. It is recorded only in Pakistan in the Near East region, where it is probably the most serious pest of rice, wheat, groundnuts and sugar cane. Various estimates have been made of the losses it causes which, in the more heavily infested districts are typically in the range of 20 – 40% for cereals and 10 – 11% for sugar. The bandicoot is a notorious hoarder of grain in the immediate post-harvest period.

***Millardia meltada* (Soft-furred rat)**

The soft-furred rat is also confined to the plains area of Pakistan. It is a relatively small rat, but can become numerous. In one study, pre-harvest losses of rice of about 16% were estimated and it may be assumed that similar losses of other cereals are liable to occur (Fulk et al., 1981).

***Microtus socialis* (social vole)**

The social vole is ubiquitous on agricultural and range lands where annual precipitation exceeds 250mm in Turkey, the Levant, Syria, Iraq and northern Iran. It feeds mainly on leafy material and on grain when it ripens. It is recorded as completely destroying alfalfa fields to the extent that farmers sometimes abandon attempts to grow the crop (Wolff, 1977). Bodenheimer (1949) states that damage may be very severe to wheat, alfalfa, potato, carrot and beet, and less severe but important to barley, flax, vetch and cabbage, and of relatively low importance but still present in maize, sunflowers, beans and some other crops. More recently it has been indi-

cated that preharvest losses of cereals and alfalfa can be up to 30% in some years in Syria. The social vole is regarded as the most serious pest of cereals in Turkey, and while it appears that much remains to be established about crop losses to this species, it is undoubtedly of major economic importance.

***Arvicanthis niloticus* (Nile rat)**

The Nile rat is the dominant rodent pest of the Nile valley and delta in Egypt and may be assumed to rank high in the scale of pests in countries to the south, including Sudan, Ethiopia, Somalia and Djibouti. It may also be prevalent in Mauritania, since it is known to be present in Senegal, immediately to the south. In Africa south of the Sahara the Nile rat is regarded as one of the most serious pests of agriculture. Few details are available of its economic significance in countries of the Near East. However, extensive studies have been made recently in Egypt in connection with the Egyptian-German Field Rat Control Project (EGFRCP, 1985; Bahgat Amr, 1984). Damage by rodents to the key crop, wheat, in the field was estimated at 20% in the early 1980's and was mainly attributable to the Nile rat. More recently, in 1984, losses were lower, averaging between 5.3% and 13.4% in different districts. In addition, extensive losses, ranging on average between about 0.5% and 8.0% were assessed in many other crops including horse beans, soybeans, maize, sugar cane, rice, fruit and vegetables. At the 1984 levels total losses to field rodents, chiefly the Nile rat, were considered to have been worth US $ 50 - 60m annually, and possibly much more. It should be noted that field losses to rodents were gradually decreasing in 1983 and 1984 owing to countermeasures and, possibly, due to a cyclical decrease in the rodent population.

***Mastomys natalensis* (Multimammate rat)**

No information is available about losses to this species, which might, however, be expected to be a principal pest of field crops in the southern Sudan, Somalia, Djibouti and possibly Mauritania. Elsewhere in Africa it is known to be a severe pest of almost every type of crop from sowing until the harvest, and capable in the worst seasons of inflicting catastrophic damage to staple food crops and cotton.

***Meriones shawi* (Shaw's jird)**

Shaw's jird is prevalent in a coastal strip extending from Morocco to Egypt. It damages mainly cereals, and at high densities of 34 - 40 jirds/ ha is estimated to consume about 1.8kg /ha of vegetable matter daily. It is also a tireless grain collector and the amount stored per burrow may attain many tens of kilos. It does much secondary damage in fields when the soil it excavates in burrowing covers up to a third of the cultivated land area. Besides cereals, it attacks forage crops such as alfalfa, collects the fruits and barks of olive, almond and pistachio trees. It can inflict catastrophic damage on interplanted cucurbits in olive groves and its extensive burrows can cause dessication of the roots of olive trees. There is little information to indicate the extent of damage. Cereal losses have been estimated to range btween 10% and 100%, depending on the level of infestation in Morocco and Tunisia. The species is subject to major population outbreaks, the causes of which remain little understood, but which seem to occur irregularly at intervals of 2 - 10 years. The information on this species is drawn mainly from a review by Bernard (1977).

***Meriones libycus* (Libyan jird)**

The Libyan jird is very widely distributed in the Region, extending from the Atlantic to Afghanistan and beyond. Ecologically, it is clearly associated with rocky desert and occupies drier areas than Shaw's jird. Damage is apparently similar to that of Shaw's jird, but is said to also include destruction of levees in terraced cultivation in mountainous areas. Remarkably little information is available concerning its pest significance, possibly because the areas it inhabits tend to be distant from the main centres of human habitaion. It is said to be capable of inflicting devastating losses to cereals in the field, the evidence being largely anecdotal. It is suspected that the Libyan jird may be one of the more important rodent pests of the Region, and of major significance in rangeland and marginal areas of agriculture, but this needs careful confirmation.

Other species

Several other species are occasionally referred to as causing agricultural damage, and may be of local importance, though often the species identification seems doubtful. Among the species more likely to be of significance are:

Hystrix spp. - throughout most of the region
Meriones tristrami - Turkey to western Iran
Meriones crassus - eastern Sahara to northern India
Apodemus spp. - Morocco to Iran
Cricetulus migratorius - Turkey to Baluchistan
Gerbillus campestris - Morocco to Somalia
Gerbillus gerbillus - Algeria to Jordan
Gerbillus pyramidum - North Africa
Gerbillus poecilops - southwestern Arabia
Heterocephalus glaber - Somalia
Spermophilus citellus - Turkey and Syria

The above information indicates that the worst food losses to rodents throughout the Region are pre-harvest losses in the field. The extent of the losses are indeterminate, since much of the information is anecdotal and little of it is recent, but an informed guess suggests that endemic infestation may well be responsible for food losses averaging around 5% per annum ranging, in different localities, between a few percent and 25% per annum, with occasional more severe losses.The losses may not be noticeable everywhere or at all times, but considering the Region as a whole and over a period of a few years, some experts may regard this estimate of endemic damage as being conservative.

Control techniques currently available

Rodenticides. The effectiveness of rodenticides is highly dependent not only on the use of an appropriate compound but also on the choice of a suitable formulation and method of application. Relatively little information is available on the latter points with reference to the Near East region, but in the following paragraphs, based on a general consideration

of the technical literature, it will be assumed that suitable methods and formulations can be made available. It is very advisable to try out a compound and formulation in practical conditions of use before selecting it for use on a large scale, since not all products and species have been tested.

1. **Older coumarin anticoagulants.** Compounds such as warfarin, coumafuryl and coumachlor are probably unsuitable for most rodent control in the region because of their low toxicity. They should however be effective for the control of *Rattus norvegicus* and *Arvicanthis niloticus*. Coumatetralyl, is something of an exception, being generally more potent than the others and effective against warfarin-resistant Norway rats; its applicability is probably more similar to that of the indandione and second-generation anticoagulants.
2. **Indandione anticoagulants.** These long-established rodenticides including chlorophacinone, diphacinone and pival are more toxic than the older coumarins and should be useful against the above species and also against *Mastomys natalensis, Microtus socialis, Bandicota bengalensis, Mus musculus* and *Millardia meltada* in the field.
3. **Second-generation anticoagulants.** These more recently developed, high-toxicity compounds, including difenacoum, bromadiolone, brodifacoum and flocoumafen are usually effective not only against resistant strains of commensals but, due to their high toxicity, can be effective (and often with reduced application rates) against most rodents other than *Acomys cahirinus* and, possibly, the jirds. This gives them a significant advantage over the older anticoagulants.
4. **Zinc phosphide.** This broad-spectrum, acute rodenticide is frequently regarded as representing a useful compromise between cost, effectiveness and safety. The stability of its formulations is sometimes suspect, and its performance is less reliable than that of the anticoagulants. In unskilled hands it can have disadvantages from the standpoint of safety. As far as is known it is effective against all species other than *Hystrix* and currently it is probably the most widely used compound for the control of jirds. It can be useful for quick knockdown of large infestations, particularly when its use is followed up with that of an anticoagulant.
5. **Calciferol.** This broad-spectrum, subacute rodenticide is believed to be generally effective but, owing to its cost, is likely to be used mainly for the control of house mice in small urban infestations and in food stores.
6. **Other acute poisons.** Strychnine is understood to be in common use against *Meriones shawi* in North Africa and has been reported to be effective against *Spalax leucodon* in Turkey. Strychnine, however, along with three other older compounds, crimidine, fluoroacetamide and sodium fluoroacetate are regarded as very hazardous materials, suitable for use only by highly trained staff in low risk environments. One further compound which deserves mention is the relatively new material, bromethalin. Preliminary reports of bromethalin suggest that, compared with other acute poisons, it may combine a high degree of efficacy with useful safety factors. So far its formulations have been registered only for use in the field of public health but its possible future development for agricultural use will be watched with interest.
7. **Burrow fumigants.** Aluminium phosphide tablets are generally effective in damp, well consolidated soil. They are laborious and relatively expensive to use for most purposes and are therefore probably unsuitable except against low density rodent population of species such as *Spalax* and *Hystrix*. Cyanide gassing powders have a similar value and are less costly, but in the author's view too hazardous to the operator to be generally recommended.
8. **Rodenticidal «contact» dusts.** Many anticoagulant rodenticides are available as dusts for application to burrows. These can be very useful where rodents cannot be readily attracted to baits, as in cereal fields towards harvest, but they are relatively costly to use on a large scale.
9. **Liquid baits.** Soluble rodenticides dissolved in water are especially suitable for use in food stores, provided that the risk of spilling the solution on the commodity can be prevented. Many anticoagulants are available in soluble form and probably have a useful role though, at present, these are usually the less toxic older anticoagulants. If second-generation compounds become commercially available in soluble form they may have a valuable part to play. Sodium fluoroacetate and fluoroacetamide, both water soluble, may be widely available in connection with rodent control on ships carried out under the International Health Regulations, and they could play a wider role. Because they are dangerous materials they should, however, be used only in secure premises by highly trained operators.

It should be noted that acute rodenticides, if they are safe and efficient, have great potential for agricultural use because the costs of material, transport and field application tend to be low compared with the anticoagulants.

The general situation as regards rodenticides may be summarised as follows: the range of materials available appears to be sufficient to ameliorate all known rodent problems in the region, though not perhaps to solve them completely. The anticoagulant rodenticides particularly the second-generation compounds, are the safest and most effective for general purposes, although they are apparently unsuitable for use against certain pests, notably *Acomys cahirinus*. All anticoagulants are slow acting and usually require repeated applications to be fully effective. This tends to deter the less sophisticated user. Most farmers would prefer rapid rodenticidal action to follow upon a single application of a small quantity of bait. Zinc phosphide partly satisfies this requirement, but there is a need to develop or exploit other compounds that have a more reliable rodenticidal action.

Non-chemical control techniques. A variety of non-chemical approaches to rodent control exist and are undoubtedly practised to some extent in the Region, particular-

ly where the use of rodenticides is not widely established. In Syria and Turkey, for example, traps have been used for the control of *Spalax*. In most countries traps of various kinds, particularly snap traps are available, but their use is generally impractical except, possibly, for the control of small infestations in the home or in food stores. The digging out or flooding of rodent burrows in fields is occasionally practised in some countries.

Many less specific techniques, such as clean farming, weed control, predator protection, rodent-proofing of stores, general environmental hygiene and efficient land use have a more valuable contribution to make, although their application tends to be determined more by general agronomic and social imperatives than by the need for rodent control. Where rodent problems exist, their solution almost invariably requires an integrated combination of both non-chemical and chemical control techniques.

Special Problems in rodent control

Superimposed upon the general situation with regard to rodent damage and control techniques, there are three phenomena to which special attention should be directed. These are: the occurrence of rodent outbreaks, the extension of cultivation into previously barren land and the possible development of resistance to anticoagulant rodenticides.

Rodent outbreaks. Rodent populations generally fluctuate regularly each year in response to seasonal changes in the climate and food supply. In addition, many species fluctuate dramatically from one year to another. When rodent numbers increase to a peak, usually at irregular intervals of 3 – 7 years, they can devastate crops over very large areas, sometimes over several countries in an ecological zone. Such events are usually described as outbreaks, invasions, plagues or pullulations and have been recorded since ancient times.

Outbreaks have been recorded in several of the species mentioned above as being significant pests, including *Mus musculus, Bandicota bengalensis, Millardia meltada, Microtus socialis, Arvicanthis niloticus, Mastomys natalensis,* and *Meriones shawi*. In the Near East outbreaks involving several species, notably *Mus musculus, Mastomys natalensis, Arvicanthis niloticus,* and *Meriones* spp. have been reported in the last 10 – 15 years. Since outbreaks seem to appear suddenly and to abate quickly when the rodents have destroyed their food supply, they have almost never been studied by competent observers. Bernard (1977) refers to invasions of varying size and intensity of *Meriones* in North Africa and some experts believe that smaller unrecorded outbreaks occur locally in almost every year in different species. The causes of outbreaks are very poorly understood, but are usually thought to be attributable to climatic factors or possibly to an interaction between climate and predator populations. It may be observed that similar outbreaks of *Microtus arvalis* in France have been controlled with the aid of a highly organised surveillance programme (Spitz, 1985), but there seems no reason to suppose that field rodent outbreaks could not be prevented by any reasonably efficient, permanent rodent control policy.

Effects of irrigation and reclamation. Severe rodent damage to field crops has been reported to occur, usually in the second and subsequent seasons, when irrigation is improved or extended. The best known examples are in the Nile valley and delta where year round irrigation replaced seasonal inundation when the High Dam came into operation, and the Gezira scheme in the Sudan. Bahgat Amr (1985) also reports outbreaks of *Mus musculus* in desert reclamation schemes in Egypt. The author has heard described elsewhere severe and sustained attack, apparently by *Meriones libycus,* on wheat in reclaimed land elsewhere in North Africa, and by *Microtus socialis* in the Levant.

Rodenticide resistance. Anticoagulant rodenticides are the primary means of rodent control throughout much of the world. This primacy is due, historically, to their development to control the Norway rat, which is now known to be the most susceptible species. Extension of the use of these compounds against other species has enjoyed much success, particularly in south-east Asia and against the Nile rat in Egypt, but has been variable against several other species owing to their lower natural susceptibility, particularly to the older compounds such as warfarin. Genetic resistance to first-generation anticoagulants has been known to occur in the three commensal species in Europe for more than 20 years, and its development in Near East rodent populations is a distinct possibility in the long run.

Laboratory studies in the last decade indicate that in the Near East region *Acomys cahirinus,* the least susceptible species, probably cannot be adequately controlled by even the most toxic of the second-generation anticoagulants. Some other species, including *Mastomys natalensis* and *Meriones shawi* have a relatively high natural tolerance for anticoagulants, particularly the first-generation compounds, and it has yet to be convincingly demonstrated that they can be fully controlled with these compounds; the golden hamster, *Mesocricetus auratus* though not at present known to be a significant pest, is also known to be highly tolerant of certain anticoagulant rodenticides. It should be noted that the development of resistance to strychnine in *Meriones shawi* has been mentioned by Bernard (1977), though not confirmed experimentally. To prevent resistance from becoming a problem several measures may be advocated, notably the general use of second-generation anticoagulants, which were developed specifically for the control of rodents resistant to the first-generation compounds and, where necessary, the tactical use of non-anticoagulant rodenticides.

Rodent control research needs

At present the primary need seems to be for crop loss studies and development work to study available control techniques, to adapt them to local conditions and to promote their more widespread use. There is also some need for supporting research on the more important aspects of the biology of the pest species.

Damage measurement and surveillance. Surveillance and evaluation of crop losses is necessary in order to assess how much investment in rodent control can be justified and to

direct it into priority areas. Simple indices of damage that can be assessed regularly and at low cost by agricultural extension workers should be developed for key crops and pests. In addition, more detailed studies should be carried out to enable such damage indices to be interpreted in terms of actual economic losses and to enable economic thresholds to be determined.

Damage reduction. In most countries laboratory and field trials need to be conducted for key crops and pests to adapt standard rodent destruction techniques to local conditions and to optimise them for use by farmers and others. In addition suitable integrated control packages should be designed and tested in pilot trials in cooperation with the ultimate user groups at farm and village level.

Biological support studies. For several pest species it is desirable to strengthen the scientific basis of control measures by conducting studies of their population dynamics, life cycles, movements, feeding habits and distribution. Longer term studies should also be made of species subject to periodic outbreaks in order to determine the nature and causes of the outbreaks, how to predict them and prevent them, or at least to develop early warning systems.

To satisfy the above requirements it would usually be desirable to nominate, and provide adequate facilities to a suitably qualified national specialist to foster rodent control development. A case could also be made out for establishing a Regional centre, the functions of which could usefully include the promotion of development studies and provision of training, technical information, advice and assistance to countries of the Region. There are currently five well-known national centres in the Region, in Cyprus, Egypt, Kuwait, Morocco and Pakistan, at least one of which might develop a wider , regional role in the future.

Systems, extention and training

The objective of a practical control strategy should be to reduce losses to rodents to a specified, economically and culturally acceptable level. In agriculture this can usually only be accomplished on a large scale through the activities of the farmers. Farmers can only help themselves, however, if a suitable system, or infrastructure is in place to support their efforts. Extension and training are important elements in such a system, but the most essential element is the logistical one, that rodenticides should be made available to farmers when they need them, and in suitable formulations and packaging, at an appropriate price, and their distribution supported by any necessary farmer credit or subsidy arrangement. There is no universal prescription as to how this should be done but the general aim proposed is that every farmer should be able to obtain a supply of the right products within about four hours of his deciding that he needs them; this will usually mean that adequate stocks should be immediately available within about 5km of every farmer.

The next most important requirement is training. Training is successful only if it changes the behaviour of its recipients in the desired direction subsequent to the training. Experience in the provision of training frequently suggests that much of it is unsucessful, either because the trainees lose their skills subsequently instead of using and improving them, or because the conditions have not been created in which the newly acquired skills and knowledge can be effectively put to work. This situation can best be remedied by ensuring that the training prepares the trainees to perform the specific tasks that they will subsequently be required to carry out in an actual rodent control programme. Training is usually, but not always, most effective when carried out as near as possible in time and place to the real-life situation in which these tasks are to be performed; the main exception is that advanced graduate training should usually be carried out in an institution of higher learning where a wide ranging and strategic approach to the subject can be inculcated.

Extension services usually have an interest, and sometimes a very active interest, in facilitating rodent damage prevention in agriculture. Their work is sometimes limited to giving technical advice to farmers who request it, but may be much wider and include active promotion and organisation of rodent control and the monitoring of infestation and damage. In some cases applied research such as field trials may be conducted by extension officers. In cases where levels of damage are excessive, the right amount and type of extension activity is a necessary part of the system for reducing the damage to an acceptable level. However, it is important not merely to establish what activities the extension service should perform in a general sense, but to be specific about the problem and the practical results that are required. For example, if *Rattus rattus* damage to conconut is a problem, the aim of the extension effort might be to reduce the average loss by 90% by a specified date. This can be described as the required output of the extension programme. When the required output has been specified, then the necessary administrative and technical inputs must be specified in terms of manpower, transportation, organisation, training, damage evaluation, promotional activities and supplies; external criteria must also be established to determine what progress is being made in achieving the required output. Extension programmes can tend to continue for decades without clearly defined aims or perceptible results, a situation that can only be corrected by the application of effective management procedure of this kind.

الملخص

جريفز، جون. 1989. القوارض كآفات زراعية ومكافحتها في منطقة الشرق الأدنى. مجلة وقاية النبات العربية 7: 82 - 75.

تم تقويم المعلومات الخاصة بالمشكلات التي تحدثها القوارض في منطقة الشرق الأدنى، وتبيّن أن اثنين وعشرين نوعاً من هذه الحيوانات مسجلة كآفات شائعة أو عَرَضية في المنطقة. كما جرى تبيان الأضرار التي تحدثها هذه الآفات،

والتقنيات المتاحة للوقاية منها. وقد اقتُرح أن الخسائر التي تحدثها للمحاصيل متباينة جداً، وقد تكون في حدود 5% بالمتوسط، علماً أن نسبتها تتذبذب بين 0 - 25%، وقد تصل أحياناً إلى مستويات أعلى من ذلك. وجد، بشكل عام، وفي الحالات التي تكون فيها القوارض آفات للمناطق الزراعية والحضرية، أن استعمال مبيدات القوارض من مانعات التخثر، هو تقنية يمكن الاعتماد عليها. على أنه نظراً لتباين حساسية الأنواع المختلفة المستوطنة في المنطقة، فقد يكون من الحكمة استخدام واحدة أو أكثر من مواد الجيل الثاني لمانعات التخثر الأشدّ سميّة. وبالرغم من أن استخدام الطعوم الحاوية على فوسفيد الزنك في المجالات الزراعية، قد أعطى مكافحة معقولة لهذه الآفات، إلا أن مكافحة فئران الحقل تتطلب استعمال مبيد قوارض أكثر حدة من المبيدات المتاحة حالياً. ومن الممكن في بعض الأحيان، اللجوء إلى تدخين الجحور، وبخاصة عندما تدعو الضرورة لمكافحة كل من الشيهم (*Hys-trix* sp.) والخلد (*Spalax* sp.) بطيئي التطور. وتناقش المقالة بشكل مقتضب متطلبات الارشاد والبحوث، وتبين أن التجارب الحديثة أشارت إلى أن الاهتمام بالنواحي التنظيمية قد يكون العامل الوحيد والأكثر فاعلية في انقاص عَيْث القوارض وأضرارها.

كلمات مفتاحية: قوارض، الشرق الأدنى.

المراجع

importance. Bulletin of the Biological Research Centre 12: 3 - 8. Baghdad, Iraq.

10. Krambias, AA. & A.H. Hoppe. 1984. Anticoagulant baiting as a new approach to rat control in Cyprus. Proceedings of a Conference on the Organisation and Practice of Vertebrate Pest Control. Imperial Chemical Industries PLC, Haslemere, England. 189 - 194.
11. Mohammad, A. H.H., T.M. Zaghloul and M. Zakaria (eds). 1983. **Recent advances in rodent control.** State of Kuwait, Ministry of Public Health. 226 pp. (in English and Arabic).
12. Osborn, D.J. and I. Helmy. 1980. The contemporary land mammals of Egypt. (including Sinai). Fieldiana Zoology. New Series, no. 5. Field Museum of Natural History, Chicago.
13. Richards, C.G.J. 1982. Methods for the control of mole-rats, *Spalax leucodon* in northern Syria. Tropical Pest Management 28: 37 - 41.
14. Spitz, F. 1985. Further development of the forecasting model for *Microtus arvalis*. Acta Zoology Fennica 173: 89 - 92.
15. Watson, J.S. 1951. **The rat problem in Cyprus.** Colonial Research Publication no. 9 HMSO, London. 66 pp.
16. Wolff, Y. 1977. The Levant vole, *Microtus guentheri:* economic importance and control. EPPO Bulletin 7: 277 - 281.
17. Yaman, I.K.A. 1975. Investigations on the house mouse, *Mus musculus praetextus* attacking corn in the field in Iraq. Unpublished typescript. 10 pp.

References

1. Bahgat, Amr. 1984. News about the egyptian-german field rat control project. EGFRCP, Documentation - Information Unit. Cairo. 47 pp.
2. Bernard, J. 1977. Damage caused by the rodents Gerbillidae to agriculture in North Africa and countries of the Middle East. EPPO Bulletin 7:283 - 296.
3. Bodenheimer, F.S. 1949. Probelms of vole populations in the Middle East: Report on the population dynamics of the Levant vole *(Microtus guentheri)*. Research Council of Israel. 77 pp.
4. Celenigil, F. (undated). New rodent control research and experiment in the management of irrigation systems in Turkey. Unpublished typescript.
5. EGERCP 1985. Information about the field rat control project. Arab Republic of Egypt, Ministry of Agriculture and Food Security, General Department for Rodent Control. Cairo. 23 pp.
6. Fulk, G. W., S.B. Lathiya & A.R. Khokhar. 1981. Rice-field rats of lower Sind: abundance, reproduction and diet. Journal of Zoology 193: 371 - 390.
7. Harrison, D.L. 1972. **The mammals of Arabia.** Ernest Benn, London: 670 pp.
8. Hopf, H.S., G.E.J. Morley & J.R.O. Humphries. 1976. **Rodent damage to growing crops and to farm and village storage in tropical and subtropical regions: results of a postal survey.** Centre for Overseas Pest Research. London. 115 pp.
9. Kadim, A.H. 1980. Geographical distribution of *Nesokia indica* and *Tatera indica* in Iraq and their economical