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Rodent Problems in Tropical Agriculture

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Introduction

Losses caused by rodents are often accepted as part of the normal run of events in agriculture. They are looked on as unavoidable and no effort is made to evaluate them, to identify the rodent responsible or to instigate control measures. By contrast, rodent problems in certain crops – particularly cash crops – have received a great deal of attention. Sugarcane, for instance, is attacked by rats practically wherever it is grown and a number of comprehensive studies of the economics of rodent control in canefields have been made. Coconuts are also highly susceptible to rodent attack and the problem has been tackled in several parts of the world. The only food crop that has received comparable attention is understandably rice, where catastrophic losses due to rats have occurred from time to time in parts of Asia.

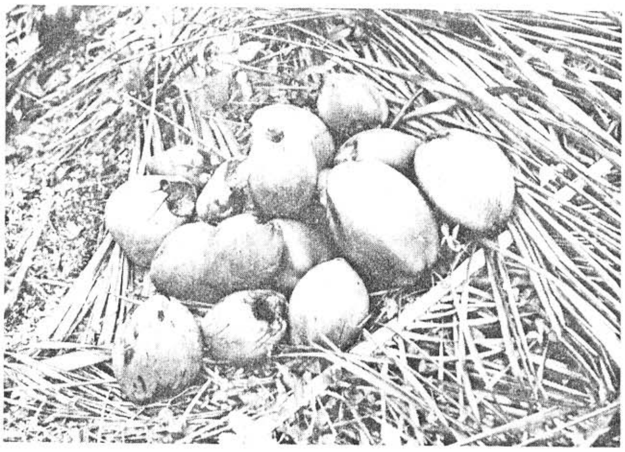

Fig. 1. Green coconuts holed by ship rats *(Rattus rattus)*. The nuts were collected from beneath one palm.

Fig. 2. A rat-damaged coconut sawn in half showing how the husk and shell have been penetrated, and how the rat has fed on about one-third of the 'jelly' layer. The point at which the rat ceased feeding on the 'jelly' was probably determined by the level of the 'water' within the nut while it was still on the palm.

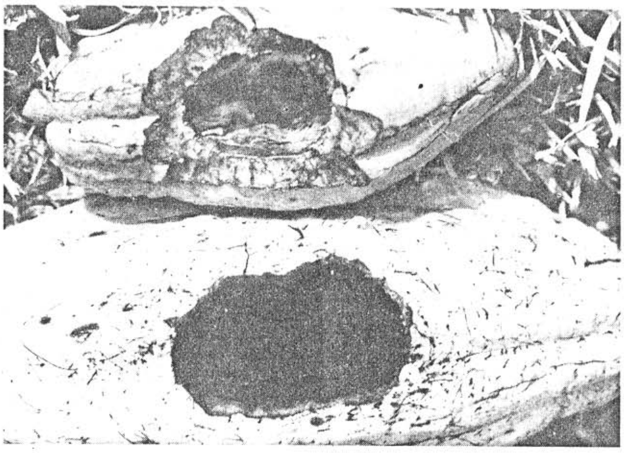

Fig. 3. Cocoa pods damaged by a rat, *Rattus rattus,* (above) and by a bird *Centurus radiolatus* (beneath). Claw marks made by the woodpecker are plainly visible on the lower pod and the edges of the hole do not show the characteristic gouge-like marks of rodent incisors that are evident on the upper pod.

Other thin-stemmed cereals such as wheat and barley are probably as susceptible as rice to rodent attack but less is known about the problem. Thick-stemmed cereals such as maize and sorghum are more resistant to rodent attack while they are maturing but severe losses sometimes occur at planting. Cocoa is a crop that is particularly susceptible to rodent damage; losses also occur in oil palms and even occasionally in coffee. In fact, almost any crop can be the target of rodent attack. Young soft woods planted at high altitude in the tropics are sometimes killed in large numbers by rodents and even such unlikely crops as tea and rubber are occasionally affected by the activities of burrowing rodents.

Throughout this diversity of rodent problems a few common factors emerge. Firstly, rodent damage is generally sporadic and localised; it may occur for several years at such a low level as to be unimportant and then suddenly flare up. Secondly, there is often an inverse relationship between rodent damage and field size due to the fact that rodents survive in field edges during the out-of-crop season. This of course does not apply to perennial crops such as coconuts and oil palm where the rodents live in the crop itself. It follows from this that large areas of monoculture with co-ordinated harvesting are less favourable to rodents than a diversified system with cropping throughout the year. Thirdly, good crop husbandry, particularly in respect of weed control, tends to limit the number of rodents that live in the crop.

Rodent damage

It is not within the scope of this article to catalogue the crops that are attacked by rodents. Rather, it is proposed to take as examples of rodent problems two widely grown crops, and to discuss in some detail the nature and extent of damage, without at this stage mentioning by name the species of rodents that cause losses. Sugarcane is taken as an example of a major cash crop and rice as an example of a major food crop.

(a) Sugarcane

Rodents gnaw the internodes of sugarcane and feed on the soft sugar-containing tissue within. When a choice is available, rodents tend to select the less fibrous cane varieties; this preference can be very noticeable in variety trials where several types of cane are grown in close proximity. There is also often a tendency for the smaller rodents that are cane pests (namely rats) to feed on canes that are of below-average thickness. Gnawing generally takes place near the base of a cane and even though only one or two internodes may be damaged, the sugar content of the cane quickly falls as a result of secondary damage by bacteria and fungi. Losses from rodent attack therefore considerably exceed the amount of cane that is actually eaten. Damage has also occasionally been reported to the apical buds of growing cane (4, 24).

Fig. 4. Part of a canefield devastated by rats *(Rattus norvegicus* and *R. rattus).* Damage to canes at some height above the ground, as seen here, commonly occurs in heavily attacked cane fields; in lightly attacked fields, most damage occurs close to ground level.

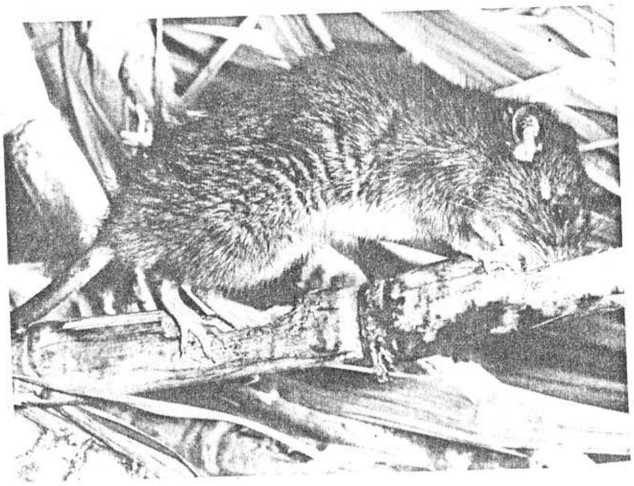

Fig. 5. A common rat *(Rattus norvegicus)* feeding on sugarcane.

Local losses to sugarcane can be very severe. Fields in which over 90% of the canes were damaged have been recorded in Hawaii (9) and Queensland (20). However, the proportion of canes damaged does not represent the overall loss since it has been shown that the amount of sugar extracted from mildly damaged canes is only about 15% less than that extracted from sound canes (9).

To estimate overall loss caused by rodents in economic terms requires many factors to be taken into consideration and few critical accounts have been published. Some of the more important estimates of losses have been summarised by Bates (4). He states that losses of up 21% in weight of cane and up to 15% in sucrose content have been demonstrated in Hawaii (25), Guyana (3) and Mexico (7). Further, a loss of £1¼ million has been reported in Queensland canefields over a 6-year period (30). Annually losses of about 4.5 and 2.5 million dollars have been reported respectively for Hawaii (16) and Puerto Rico (19). In one Jamaican estate an overall loss in potential yield of 5.4% was estimated (23) and in one year the loss in weight of cane due to rats in the island of Barbados was estimated at over 6% (32). Crop losses in the Philippines were estimated to vary between 4 and 15% over a 6-year period (1). According to Bates, it is generally agreed that most surveys tend to underestimate losses.

The figures quoted above show clearly the seriousness in economic terms of the problem of rodent damage to sugarcane. But there are reasons other than direct economic ones for controlling rats in canefields. It has been shown in Hawaii, Queensland and in the West Indies that the rat-transmitted disease, leptospirosis, is particularly prevalent amongst canefield workers. This is probably so for two reasons. Firstly, the causative organisms require moist conditions to survive outside the body of a host and surface moisture frequently persists in canefields for considerable periods. Secondly, to gain access to another host, man for example, the organisms generally need to come into contact with damaged skin and many varieties of cane have sufficiently sharp leaf edges and hairs to abraid or penetrate human skin. Thus, canefields with their often dense rat populations may provide near ideal conditions for the transmission of leptospirosis to men working there.

(b) Rice

Disastrous outbreaks of rats occurred in the rice-growing areas of the Philippines during the 1950s causing widespread food shortages and even serious famine in some areas (6). Rice is also attacked by rats on a large scale in Indonesia (12), Malaysia (35), Ceylon (11), Surinam (34) and probably many other areas for which published accounts are not readily available. The crop is damaged at all stages of growth from planting to harvest but is possibly most susceptible to rodent damage during the period of tillering until the grain has formed. During this period rats eat the hearts of the young stems discarding much of the outer tissue. It has been shown that a single rat can destroy as many as 100 stems of 4–6-week-old rice per night (12). Damage at this stage may thus be more serious than damage to maturing panicles, each of which may provide a meal for a rat.

Reliable estimates of the overall loss to growing rice caused by rodents are not available, but there is no doubt that losses are considerable in many rice-growing countries. For instance 60–80% of rice in affected areas is said to have been destroyed by rats in Indonesia during an outbreak in the early 1960s (15), and 80% of ricefields in Colombia are said to be affected by rats (17). Recent work in Malaysia has shown that growers may accept as normal a surprisingly high level of damage (35). In a trial of rodent control methods yields of 1200–1500 lb/ac (normal for the area) were raised to over 4000 lb/ac by systematic baiting. This indication of over 50% loss due to rodent damage in rice may not be atypical for West Malaysia where overall rice production has been estimated for FAO as under 2500 lb/ac.

Leptospirosis is an occupational disease of ricefield workers, as it is of canefield workers. Studies in Italy, Spain and Japan have shown a high incidence of the disease amongst labourers working in rice estates and a system of immunisation against the disease is operated in the Po valley (2). Little information is available about leptospirosis in tropical ricefields. This is probably because there are few organised labour forces from which the necessary data could be collected easily. There is, however, reason to suspect that leptospirosis, with its debilitating effects, is a common disease amongst rice farmers wherever rice fields are infested by rats.

Identifying the species responsible for damage

Statements can be found in the annual agricultural reports from tropical countries to the effect that 'rats' caused considerable losses to certain crops. Such statements usually appear at the end of a section of the report dealing with pests and diseases in which the various insect pests, identified by their full scientific names, are given prominence. Reading these reports gives rise to visions of over-worked agricultural entomologists, unwilling to spare time to investigate what they regard as intractable problems outside their particular discipline. Indeed this situation may have occurred not infrequently, since entomologists are often made responsible for rodent (and bird) problems in agriculture, for the simple reason that there is no-one else more appropriate. The result has been a general neglect of this type of agricultural pest. The neglect is not entirely unjustified since insects

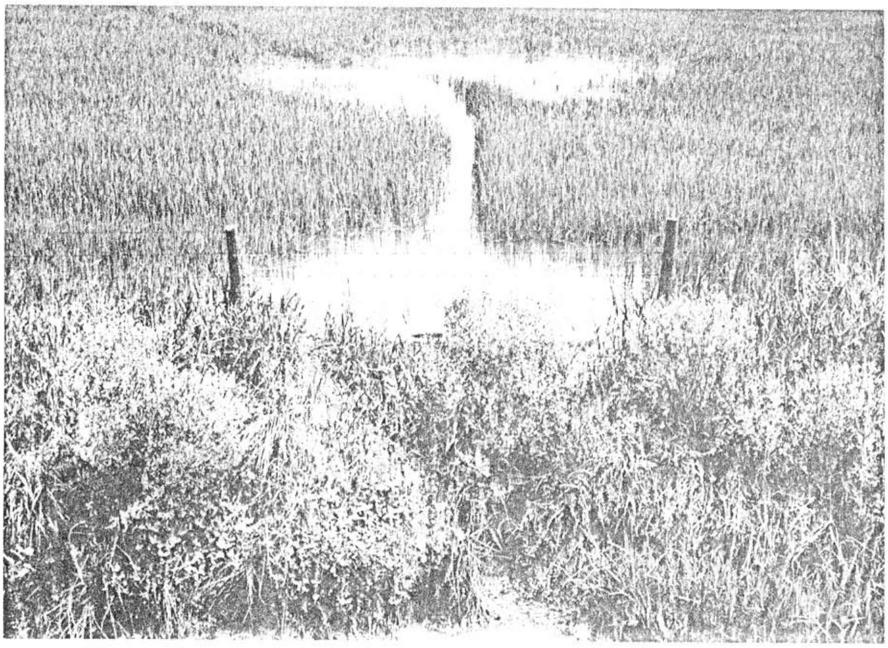

Fig. 6. Rice damaged by coypus *(Myocastor coypus)*, showing the channel used by these large aquatic rodents to reach their feeding area. (Photo: Roger D Nass; also appeared in *PANS Manual No. 3. Pest control in rice*, p 206.)

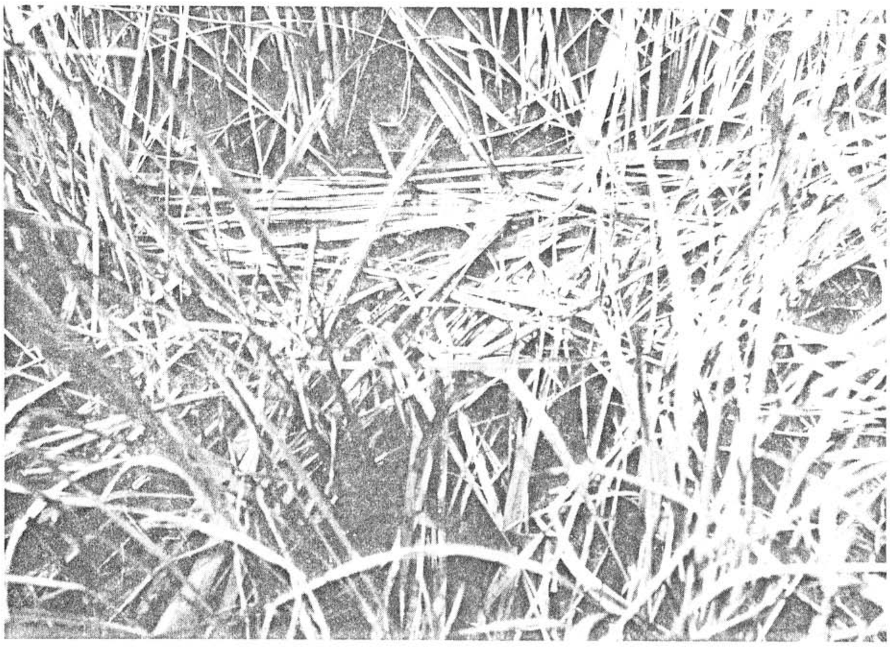

Fig. 7. A feeding platform of rice stems made by the lesser bandicoot rat, *Bandicota bengalensis.* (Photo: Henry Fernando; also appeared in *PANS Manual No. 3. Pest control in rice*, p 209.)

can generally cause far greater losses than vertebrates, but as the means of controlling insects improve, so justification for neglecting other sources of loss diminishes; thus the rodent pests of agriculture are now relatively more important than they used to be. To give entomologists their due, a number are turning their attention to rodent problems and making considerable headway. There is still a great deal to be learned, however, and information on many of the lesser rodent problems is scarce.

Even such basic information as the identity of the rodents causing crop losses is in a few instances unknown, or if it is known, it has not been published. This is partly because there is a widely held but mistaken belief that only rodent pests of any consequence are the common rats and mice that inhabit buildings and that therefore identification is unimportant. It is also because identifying the species of rodent responsible for crop damage is fraught with difficulties that are of a rather different nature than those encountered with insects. In the first place, the generally nocturnal and secretive habits of rodents and their mobility make it most unlikely that they will actually be seen damaging a crop, whereas many insect pests can be readily caught in the act of causing damage. Circumstantial evidence can be gathered by setting traps in the crop where damage is occurring, but it must be treated cautiously since several species may live in the crop and yet only one cause damage. Indirect clues can be used to narrow the field. The size of teeth marks on the crop can give some indication of the size of the rodent gnawing it, and the height of the damage above ground level can indicate whether a climbing rodent is involved. However, the surest indication of the species causing damage can be obtained through analysing the stomach contents of a sample of rodents trapped close to where crop damage is occurring. This procedure is not as time-consuming or difficult as it may appear and should be within the capabilities of a technician or field assistant with basic biological training.

Fig. 8. A pair of multimammate rats, *Praomys natalensis*. This species is one of the major rodent pests in Africa.

Having established which rodent, of possibly several kinds living in the crop, is responsible for damage, there remains the task of identifying it. Identification can be done on the spot using published keys which are available for several regions of the world: for example, Africa (8, 22, 27, 28, 29), India (10, 26), South Vietnam (33), Thailand (18), Malaya (13, 21). Other regions are covered rather less well, but there are some more specialised publications that provide identification keys for certain groups: for example South America (14) and Australia (31). The use of identification keys requires practice, and even with practice it is sometimes difficult to be certain of a rodent's identity without being able to compare it with specimens of similar, closely related species. It is therefore always advisable to have identifications confirmed by a reputable museum. Largely imagined difficulties in the preparation of specimens are probably partly responsible for the present lack of information about the species of rodents that attack crops. Entomologists or agronomists who have rodent problems may do nothing about identifying the pest because they feel that the preparation of specimens is time consuming and difficult, or they feel that the work is unpleasant. In fact, the skinning of most rodents can be accomplished easily and quickly once the technique has been mastered. Detailed instructions on the preparation of mammal specimens has been published by the British Museum (Natural History) (5).

Known rodent pests

Some rodent problems have been studied scientifically for many years and a great deal is known about the species causing damage and how to control it. Other problems have been tackled only recently. In compiling a list of tropical rodent pests (Table 1), use has been made of scientific publications describing both recent and older work, but species have been included in the table only if firstly, there seems no reason to doubt that they were identified correctly, and secondly, there were reports of widespread damage. A large number of rodent species will probably feed on crops causing sporadic damage, but only a limited number can be rated pests which regularly cause economically significant losses. The purpose of the table is therefore to list the established, well-known pests. No claims are laid to the table being comprehensive. Rather, it illustrates the paucity of information about rodent pests. For many countries there are no reports of rodent pests and yet crops susceptible to rodent attack are grown, and there seems little reason to doubt that losses due to rodents are sustained. As already mentioned, reports from other countries of rodents causing crop damage can be found, but without indication of the identity of the pest.

TABLE 1. THE ESTABLISHED RODENT PESTS OF MAJOR AGRICULTURAL CROPS IN THE TROPICS

Region	Pest species	Crops attacked*								
		R	W	M	Co	Cn	O	Cc	S	F
Australia	*Rattus conatus*								X	
	Melomys littoralis								X	
Pacific Islands	*R. exulans*					X		X	X	
	R. rattus					X		X	X	
	R. norvegicus								X	
S. E. Asia including Philippines and Taiwan	*R. argentiventer*	X								
	R. tiomanicus						X			
	R. mulleri							X		
	Sundasciurus hippurus							X		
	Callosciurus spp.							X		
	Hystrix brachyura						X			
	Bandicota nemorivaga								X	
	R. losea								X	
India	*Bandicota bengalensis*	X	X			X			X	
	Nesokia indica	X								
	Millardia meltada	X			X					
	Tatera indica	X								
	R. rattus					X				
Africa	*Praomys natalensis*		X	X	X					
	Arvicanthis niloticus		X	X						
	Rhabdomys pumilio		X							X
	Funisciuris spp.							X		
	Helioscuirus spp.							X		
	Cricetomys gambianus							X		
	Thryonomys swinderianus	X					X		X	
	Hystrix spp.								X	
Caribbean islands excluding Trinidad	*R. rattus*					X		X	X	
	R. norvegicus								X	
America	*Holochilus scuireus*	X						X		
	Sigmodon hispidus				X			X		
	Peromyscus spp.							X		
	Myocaster coypus	X								
	Rhipidomys couesi							X		

*R, rice; W, wheat; M, maize; Co, cotton; Cn, coconut; O, oil palm; Cc, cocoa; S, sugarcane; F, forestry.

Comment

This article has been written with a view to providing a very general account of the extent of rodent problems in tropical agriculture. No mention has so far been made of rodent control, and it is not proposed to embark on this subject here since to do so adequately would require very much more space. However, an article dealing with rodent problems cannot ignore so important a subject as control, and it is generally accepted that considerable progress has been made in controlling field rodents in the past 20 years. Much of this progress has been due to greater effort prompted by greater awareness of the losses caused by rodents. There have been few innovations as far as methods are concerned; large scale control has been, and still is, based almost entirely on poison baiting. The results of systematic baiting have often been very impressive initially but in some instances there has followed a period during which baiting has become slowly less effective. The capacity of rodents to adapt, either physiologically or behaviourally, to poisoning techniques makes it improbable that any one chemical control method will succeed indefinitely. Hence it appears that even where rodents are being controlled sucessfully by poisons, the search for other methods of control should be maintained; and where rodent problems are being tackled for the first time, some effort should be put into basic research rather than merely applying established poisoning techniques.

The Ministry of Agriculture's Pest Infestation Control Laboratory at Tolworth (PICL) has done a great deal of fundamental work on rodenticides and their application and has been at the forefront of investigations into the development in rodents of resistance to poisons. Most of this work has been concerned with species that are pests in Europe, nevertheless staff at the laboratory have built up considerable experience of rodent problems in the tropics. This experience results from requests for expert advice by international organisations such as FAO and WHO, but mainly by the Overseas Development Administration of the British Foreign and Commonwealth Office (ODA) and its precursors. There has been in existence for some time a standing arrangement between ODA and PICL whereby requests from governments of tropical countries for assistance in dealing with rodent problems are met by on-the-spot advice from members of the Laboratory's staff. In this way ODA funds have provided for investigations of a variety of rodent problems in several countries; to quote three examples, rodent problems have been tackled recently in coconuts in the South Pacific, in sugarcane in the West Indies and Guyana and in cereals in East Africa.

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