RAT CONTROL IN OIL PALMS AND RICE FIELDS

Brian Wood describes techniques being used to control rats in two major crops in SE Asia

Oil palms and rice are the two most widely grown crops in SE Asia, and both are subject to severe rat damage (Figure 1). The article describes the methods which have been developed in use to control these pests, in the context of later occurrence of anticoagulant resistance, appearance of new rat species, socio-economic changes and a trend toward non-chemical and non-proactive methods of control. Singleton *et al.* (1999) refer to this as a rare example of the wide application of measures derived from detailed ecological studies.

Oil palms

The rat species responsible for damage in oil palms is the wood rat (*Rattus tiomanicus*) which lives on the ground nesting in the piles of old fronds cut from palms, or in the crowns. It feeds on developing fruit bunches (Figure 2) and detached fruit that fall to the ground when ripe. Field studies show populations without control to be in the order of 200–600 per ha. From this, times consumption in captivity, losses in the region of 5% or more of the oil product are indicated.

Figure 2. **Damage to fruit bunches in the base of the oil palm crown.**

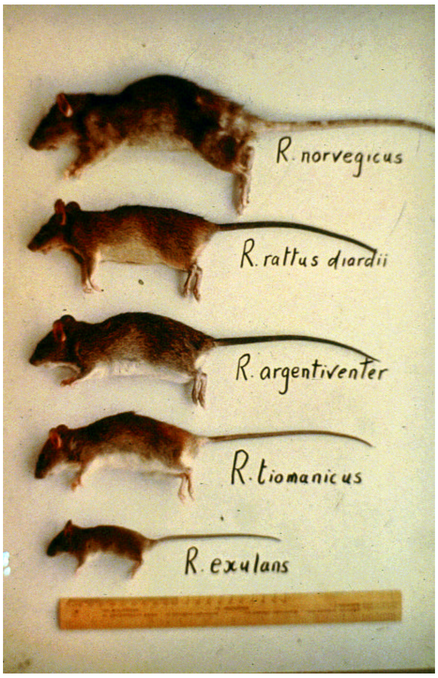

Figure 1. **Rat species that are pests (of the at least 18 *Rattus* or closely related species) in Malaysia.**

The replacement round baiting technique

The use of anticoagulants (warfarin) began in the 1950s and it was found, following a number of studies, that the best results were obtained with single baits of about 10–15 g, based on particulate maize, applied one per palm (about 150 per hectare) on a replacement round system (Figure 3). In this system, taken baits are replaced at about 4-day intervals until acceptance falls below 20%. This kills any rats needing extended dosage, and exposes any ‘shyer’ rats after any that may compete more effectively have died. The total amount of bait used is adjusted to population size.

In field use, the replacement round system typically needed about 4-6 rounds, totalling around 400-500 baits per ha. The best baits are wax-bound 2–2.5 cm cubes, which are reasonably durable and visible in the field. They have a few months shelf life, so can be made centrally, with economies of scale. A considerable industry has built up, and millions of baits are made and marketed in Malaysia. Long-term population ecology studies over 20 years showed that the best control was obtained by baiting progressively across the largest possible areas at one campaign (whole estates or even contiguous estates), and to do it every 6 months (Wood, 1984; Wood and Liau,1984).

Resistance

Resistance to warfarin and similar compounds is likely to arise eventually when they are used regularly. There was a wide range of individual warfarin tolerance 6 or 7 years

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Figure 3. **Rat taking a bait at a palm base. Note the detached fruitlets.**

after systematic control began, but no resistant populations. These appeared after about 15 years when, in 1982, there were places where bait acceptance continued indefinitely (Wood *et al.*, 1990)

Resistance spread and by 1989 there were three widely separated pockets. This led to the introduction of second generation anticoagulants (brodifacoum, bromadiolone and flocoumafen), which have a similar mechanism of action to warfarin, lowering the clotting ability of the blood, but which are effective at much smaller doses, and do not require chronic (multiple dose) feeding. Bromadiolone is chiefly used in baits manufactured for the replacement round system. These are more expensive than warfarin, and so better economy is achieved by reducing the first round to a bait every second palm. Commercial brodifacoum baits are smaller, for 'pulsed baiting' (*i.e.* application of up to 4 full rounds at 7-day intervals). Refusal of an active population to take baits at all has arisen at times and can be difficult to resolve. Approaches have included tounds of prebaiting without anticoagulants, and the use of alternative novel baits such as rhinoceros beetle grubs.

Rat species change

Until about 1983, *Rattus tiomanicus,* was the only rat species active in mature oil palms. Then in some localities, *R. rattus diardii*, (a subspecies of the ubiquitous black rat) (Figure 4) replaced it. It is now the common rat in several oil palm areas, rebounding after control (Liau *et al.*, 1993). The reasons remain speculative. A greater innate resistance to warfarin was discounted, and it could not be linked with any environmental change. The explanation appears to lie in some change in their relative competitive abilities, *e.g.* that rapid selection for warfarin resistance had otherwise weakened the genotype of *R. tiomanicus*. Alternatively, or additionally, elimination of *R. tiomanicus* allowed *R. rattus diardii* the opportunity to invade oil palm, become adapted to it, and so be more competitive in the crop. *R. rattus diardii* tends to occur in smaller numbers than *R. tiomanicus*, but individuals become bigger. This change is very intriguing biologically, but control technique is not much different.

Biological control

The barn owl (*Tyto alba*) builds up significant populations in oil palm estates if nesting boxes are provided. Many estates have done this, eschewing other forms of control. Visible rat damage seems to be less (Duckett and Karuppiah, 1990), but evidence on the effect on rat population size is presently inconclusive. Some planters suggest that rats actually became more of a problem after systematic control began. Certainly indigenous predators like snakes, monitor lizards, various mammale *etc.* do seem to disappear. A large-scale comparison is desirable.

Rats have numerous parasites; population levels of the parasites and their rat hosts vary in a series of interacting cycles. Acceptable bait might make the artificial maintenance of a disease organism at a high intensity a control possibility (Wood, 1985). One such 'biological rodenticide' is *Sarcocystis singaporensis*, a protozoan which alternates as a gut parasite of the reticulate python, passing back to rats which eat the faeces. It causes a debilitating muscle infection, lethal in cage trials. In the field weakened rats become easier prey, thus aiding the cycle; field trials show promise, (Jakel *et al.*, 1999). Other parasites deserve consideration, with due attention being paid to the risk of human infection.

Rice fields

Rice paddies in SE Asia have long been known to suffer heavy rat damage, the main culprit being the ricefield rat, *R. argentiventer*, although in its absence other species can do similar damage (Quick, 1990; Singleton *et al.*, 1999). This rat lives in burrows in surrounding vegetation between paddy seasons. As the rice begins to grow, rats move in and chop it down. As the stalks flower and fill, the increasing food source for rats supports a raised reproductive rate (a breeding season). This contrasts with oil palms, where the resident population reproduces at a more stable rate.

The replacement round baiting system proved to be very successful in rice paddies, leading to large increases in rice yield, from a range of 1.4–4.8 (average 2.5) t/ha (without rat control) to a range of 2.3–6.8 (average 4.4) t/ha (with rat control) (Figure 5). The pattern of improvement clearly showed the capability of rats to reduce yield below potential, and the economic benefits of control (Liau and Wood,

Figure 4. ***R. tiomanicus* and *R. rattus diardii.***

Figure 5. **Hollow bamboo tube, used for bait placement where there is risk of exposure of non-target species.**

1978). This control method has not, however, been widely adopted since farmers are used to free government distribution of acute poisons to make up their own bait, and they like to see dead rats, more likely to be left exposed with acute poisons. Financial constraints are such that they cannot or will not spend far in advance of return. Furthermore, they perceive that in the patchwork of ownership, one individual can do little alone, and that therefore if they do apply measures, those who do not will benefit equally.

Other control measures which are recommended include:

- Keeping bunds to the smallest needed for flood control, and non-paddy areas (gardens etc.) to the least possible. This minimises initial populations, and reduces their scope to invade and increase.
- Employing synchronised cropping across a locality so that they do not build up and move into new crop progressively.
- Using the trap barrier system (TBS) which protects paddies with a low fence, interspersed at intervals with holes into multiple traps (Figure 6).

For management, Singleton *et al.* (1999) suggests that keeping bund size to a minimum, using TBS in conjunction with planting an early 'trap crop' to reduce population pressure ahead of the main season.

Conclusions

In oil palms and rice fields, major economic benefits can arise from rat control. There is a clear lesson to continue to develop control measures through studies of population ecology. This has to be on-going to keep up with changes in both rat populations and the environment. Further, socio-economic changes can occur, in particular at present, labour is becoming a bigger proportion of baiting costs. Accordingly, progress in ecological management technique can be expected.

Figure 6. **Exclosures, similar to trap barrier system fences, but of very expensive construction for protection of high value plots – nurseries, trial plots *etc.***

Systematic anticoagulant baiting will continue to have a role in rat control in oil palms and rice fields. So far there is no evidence of physiological resistance to second generation anticoagulants. If it does occur the only route open at present is biological control – still not well researched. A necessary attribute for any new type of chemical is that it will not cause distress to the rat before the dose is lethal. To find such with acceptably low risk of side effects would be a tall order.

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Brian Wood worked from 1962 to 1990 for Malaysian plantation companies (oil palm, rubber, cocoa), becoming Director of Research, but maintaining his specialism as an entomologist. In the face of the damage being sustained from rats in oil palms, Brian became a 'ratologist', including involvement in commercial aspects of baiting. Since 1990, he has acted as an agricultural consultant, particularly in integrated pest management. He thanks Mr Chung Gait Fee of Ebor Research, Sime Darby Plantations, Kuala Lumpur, for valuable comments.

RODENTICIDE RESISTANCE GROUPS

Rodenticide Resistance Action Committee (RRAC)

The Rodenticide Resistance Action Committee (RRAC) is a working group within the framework of the Global Crop Protection Federation (GCPF). Participating companies include: AgrEvo, Bayer, Cyanamid, Lipha, Lipha Tech, Rentokil, Rhône-Poulenc, Sortex and Zeneca. Senior technical specialists, with specific expertise in rodenticides, represent their companies on the committee.

Objective

The objective of RRAC is to advise international agencies, government bodies, regulatory bodies and rodenticide users on technical matters relating to rodenticide resistance. It carries out this objective by:

- producing guidance leaflets for rodenticide users on the safe and effective use of rodenticide products
- organising seminars and conferences whereby industry members can meet and exchange ideas with experts from universities, governments and international organisations
- participating in trade exhibitions and other similar events
- sponsoring research projects on rodenticide resistance
- developing and advocating the use of effective resistance management strategies

For further information

See http://www.gcpf.org/rrac.html

Rodenticide Resistance Action Group (RRAG)

This recently established UK organisation, under the chairmanship of Professor Robert Smith from the Department of Biology at the University of Leicester, comprises representatives from the British Pest Control Association (BPCA), the Health and Safety Executive (HSE), rodenticide manufacturers, NPTA, independent consultants, the Central Science Laboratory (CSL), academic researchers, the National Farmersí Union (NFU) and English Nature.

Objectives

- to act as a central forum for exchange, interpretation and dissemination of accurate information on the extent and consequences of rodenticide resistance in the UK
- to identify research needs and to communicate them to appropriate agencies
- to establish methods of minimising the adverse effects of rodenticide resistance, including potential effects on health, food safety, environment, wildlife and economics
- to publish guidelines for farmers and pest control technicians
- to liaise with appropriate individuals and organisations in the UK and elsewhere, including the international Rodenticide Resistance Action Committee (RRAC)