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COVER
Japanese knotweed invading suburban England: will this pave the way for a breakthrough in classical biological control of weeds in Europe? (Photo: Dick Shaw/ CABI). See article on page 165.

The ECORAT project: developing ecologically-based rodent management for the southern African region

Dr Steven Belmain and co-authors*

Since the seminal book by Singleton *et al.* on ecologically-based rodent management (EBRM) published in 1999, the field of rodent management research has been re-invigorated to look beyond the use of rodenticides. Despite this post-rodenticide renaissance, rodents continue to be a growing pest problem. Research on the ecology of rodents, their impact on people's livelihoods and effective control is still very much required. Considering their importance as measured by their multiple impacts across health and agriculture, rodents continue to be a relatively neglected field of research, and research capacity on rodent biology and control remains woefully deficient in developed and developing countries alike. In this regard, transforming and applying scientific knowledge of EBRM into sustainable and cost-beneficial management strategies remains a high priority. The Ecorat project is contributing to the field of EBRM research by generating basic ecological knowledge and building research capacity, and then using these resources to implement EBRM in collaboration with African farming communities to provide practical pest management solutions.

Since January 2007, Ecorat has been carrying out many different research activities, some related to rodent ecology (e.g. population dynamics, habitat utilization), rodent biology (taxonomy, breeding), rodent–human interactions (disease risks, spatial proximity) and the social sciences (knowledge, attitudes and practices of agricultural communities with respect to rodents and their control, the pre-existing costs of rodent damage and the costs and benefits of rodent control). This multidisciplinary team of researchers works together within a consortium drawn from institutions in Namibia, South Africa, Swaziland and Tanzania, with central coordination provided by the Natural Resources Institute in the UK and an international panel of expert evaluators*.

Understanding the rodents

The Ecorat project is relatively unique in basing its research within rural agricultural communities, looking at all the problems pest rodents may cause to people's livelihoods. To do this, the scientific team works closely with farmers and households to understand rodent ecology within and around their households and cropping fields. Research methods such as habitat surveys using removal trapping, capture–mark–recapture grids using Sherman traps, and radio tracking individually tagged animals are being used to collect baseline ecological knowledge on the temporal and spatial dynamics of rodent populations within rural African farming communities in certain regions of Tanzania, Swaziland and Namibia. This work has shown us that rodent population dynamics can be extremely complex. Rural agricultural communities are fundamentally comprised of a mosaic of different habitats. For example, trapping rodents across different habitats (e.g. houses, peridomestic areas, public areas, crop fields, fallow areas) results in very different proportions of different rodent species in different localities. So although in a general sense, *Rattus rattus* tends to dominate inside people's homes and *Mastomys natalensis* dominates peridomestically, there is much potential for inter-species interactions and high spe-

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Habitat surveys are carried out in several different habitats found in rural African villages (e.g. farmer's fields, fallow land, houses, market areas). The animals captured are removed and processed to collect taxonomic, breeding and disease information which informs decision making when designing ecologically-based rodent management strategies (Steven Belmain/ University of Greenwich)

cies diversity within any given habitat. This is not only important in the context of designing spatially and temporally targeted rodent management, but also with regards to potential zoonotic disease transmission. Understanding this complexity of rodent populations within rural communities takes time, and Ecorat research on rodent ecology will continue for many months yet in order to capture the seasonal changes we expect in rodent breeding rates and abundance and the critical times when pre- and post-harvest agricultural damage is experienced.

Understanding the rodent managers

One of the big problems in developing better rodent management strategies is to understand their true impact on people's livelihoods. Although many farmers will understand that rodents are a problem and damage their field crops, stored food and personal possessions, awareness among farmers about the level and scope of damage is often underestimated. For example, rodents can transmit more than 60 different diseases, although the symptoms of many may be confused with other diseases about which awareness is higher (e.g. malaria). It is, therefore, important to raise awareness and generate accurate information about the multiple damages caused by rodents, producing information that correctly shows levels of loss and contamination, and disease risks. Providing people with the true cost of rodents on their livelihoods allows them to consider how much they can invest (traps, poisons, labour) in controlling rodents.

Community meetings, such as this one at a village in northern Namibia, are frequently held to bring Ecorat scientists and communities together. The community provides information on their problems experienced with rodent pests and the scientific staff explain something about current Ecorat research activities taking place in their community (Steven Belmain/University of Greenwich)

Rodents eat nearly all crops that people try to grow. This maize from a farmer's store in Tanzania has had the highly nutritious germ selectively removed by rats, making the grain useless as seed material for next year's cropping as well as reducing its nutritive quality if the remainder is consumed by people or livestock (Steven Belmain/University of Greenwich)

Understanding people's attitudes towards rats, the perceived problems and how they manage them is essential when considering how to use new ecological knowledge about rodents for more effective pest management. The Ecorat project team has collected information from farming households using questionnaires and group meetings to understand more about people's beliefs. For example, few small-scale farmers understand the different modes of action of acute and chronic rodent poisons, and will often choose cheap acute poisons as they find carcasses near the poison in the morning, which they rarely see when using chronic poisons because the rodents die much later, often back in their burrows. Small-scale farmers in Africa largely monitor efficacy of any rodent management activity through a 'body count' which can, unfortunately, be highly misleading, particularly if households engage in rodent control when rodent populations are already very high. Such misconstrued beliefs can lead to wrong pest management choices and wasted time and money. Understanding these human perceptions is very important for the design of EBRM as well as developing the training and knowledge transfer required within a community to more effectively manage its rodent pest problems.

EBRM interventions

Although effective rodent control methods exist, their poor application and adaptation to local situations often result in treatment failures, leading to apathy and widespread acceptance of rodent pests in the environment. Current rodent control practices are almost exclusively based on the use of rodenticides. Misuse of these poisons is unfortunately common in many African countries where highly dangerous and illegal poisons are used, which poses a threat to human health and environmental contamination. More importantly, misused rodenticides may not significantly reduce the rodent population, therefore having little impact on reducing the damage caused by rodents. Because rodenticides can be expensive and difficult to use safely, other rodent management methods involving trapping and environmental management can be more appropriate for the rural agricultural situations found in Africa.

Based on the information collected about rodents and rodent managers, the Ecorat project has recently begun an intervention programme in cooperation with communities that involves inten-

Tracking tiles are made using ordinary ceramic bathroom tiles which are blackened with soot using an oil lamp. The tracking tiles are then placed in people's homes and checked for signs of rodent activity as a way to monitor the impact of rodent management activities on the rodent population over time (Steven Belmain/University of Greenwich)

sively trapping rodents. Trapping is organized at the community level, with traps rotating around the community in order to share the costs. This ensures that the rodent population is reduced at a sufficiently large enough scale to reduce the effects of immigration back into the intervention zone. In addition to the trapping programme, environmental management activities to reduce rodent access to stored food, water and harbourage within communities are demonstrated. Monitoring the impact of the EBRM intervention takes place by firstly monitoring changes to the rodent population. This is done by measuring the relative abundance of rodents in the EBRM intervention villages in comparison with non-intervention villages nearby that are simply carrying on with their indigenous rodent management activities. This comparison is done with limited removal trapping surveys and non-invasive indicators such as the placement of tracking tiles to measure overall rodent activity levels within the communities.

Secondly, the Ecorat project is working with the communities to measure the impact of the EBRM intervention on levels of field crop and stored food damage and other observed effects (e.g. rat bites, damage to blankets). We hope that these activities carried out in partnership with the communities will convince them on the costs and benefits of EBRM and lead to sustainable changes in pest management practice.

Further information about the project can be found through the website: www.nri.org/ecorat

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Urban rodent management in a third-world city

A key concern with rodent infestations in dense urban settlements is the expected (but often unknown) human health risk. Informal settlements of the kind that have mushroomed in and around third-world cities appear particularly at risk because of inadequate sewage, housing and infrastructure.

A recent study in Durban, South Africa, was the first to investigate the risks from rodent zoonoses (for plague, leptospirosis and toxoplasmosis) in both formal (commercial, industrial, harbour and formal residential area) and informal (squatter camp) situations in a third-world city. Rodent control efforts in Durban, a city of three million inhabitants, traditionally target the central harbour (the busiest in Africa) and commercial districts of the city. However, rodent populations are known to be increasing in informal markets and the shack settlements that have sprung up throughout the wider municipal area over recent decades.

The study (part of the 'Ratzooman' – Rodent Zoonosis Management – Project: www.nri.org/ratzooman/) investigated (a) whether urban pest rodents pose real public health risks in both formal and informal sectors, (b) whether there are specific endemic disease areas ('hotspots') for rodents and humans and, if so, what the environmental and socioeconomic correlates of these are; and (c) the relative merits of different management interventions (derived from the 'Boston Model') to minimize the sanitary risk to humans.

The success of the Boston Model, a rodent management plan developed in and for a first-world city in the USA in the 1990s, is attributed to its centralized approach, well-defined responsibilities and firm accountability. Four components are key: (a) primary management function: biologists trained in the fields of rodent control, geographic information systems (GIS) and contract management; (b) municipal functions: enforcement of bylaws, refuse removal, environmental sanitation; (c) pest control contractors: baiting, trapping, monitoring; and (d) public participation championed by community leaders and non-governmental organizations: public outreach and education, community meetings, door-to-door visits, literature, recognition of cultural differences. Clearly some of these will be absent in some third-world city settlements, but the Durban study investigated how the model could be adapted for these circumstances.

Results of antibody/DNA testing of the six rodent species caught in live traps at 54 sites around Durban indicated no rodents were seropositive for plague, but nine Norway rats (4% of total rodent catch) were seropositive for toxoplasmosis and 22 (10%) for leptospirosis. Disease 'hotspots' were concentrated in the shack settlement of Cato Crest and the commercial district of Durban. Serology tests of humans living in Cato Crest showed 0% exposure to plague, 23% to leptospirosis and 35% to toxoplasmosis.

A socioeconomic survey of 90 households helped determine environmental and socioeconomic disease risk factors in Cato Crest. Based on the results, environmental hygiene and rodent trapping campaigns were launched in Cato Crest, with officials and the local community extensively involved in both from the outset. A committee was formed and funds committed to a multi-pronged community health awareness and action campaign. Educational brochures and questionnaires (in the local isiZulu language) about personal hygiene, rodent-borne diseases and other environmental health issues were distributed to all 5000 households in the settlement. This campaign culminated in a clean-up day in Cato Crest in June 2006 involving all municipal service departments and the local community. Following this, a year-long pilot study was initiated, employing local residents to distribute break-back rodent traps to 100 Cato Crest households at a time (moving the traps to new households on a monthly basis), teaching them to undertake intensive trapping and also to practise personal hygiene to minimize rodent contact and help break disease transmission routes.

The initiative owed much of its success to implementation of the principles inherent in the Boston Model, even though certain elements (e.g. sewer services, private pest controllers, neighborhood services) were absent. Crucially, the same principles that contributed to success in Boston were found in Cato Crest: a scientifically driven centralized approach, synergistic cooperation, and communication between scientists, city officials, vector-control specialists and the community.

Further information: Taylor, P.J., Arntzen, L., Hayter, M., Iles, M., Frean, J. and Belmain, S. (2008) Understanding and managing sanitary risks due to rodent zoonoses in an African city: beyond the Boston Model. *Integrative Zoology* 3, 38–50.

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A clean-up campaign supported by all sectors was a key element to improving rodent management in Cato Crest, Durban (Photo: Guy Redman/Durban Natural Science Museum)