

13. Rodents

13.1 Resistance to anticoagulants

13.1.1 Resistance in the brown rat

During 1999 a total of 548 brown rats (*R. norvegicus*) were received for anticoagulant resistance testing. New municipalities where resistance has been found are: coumatetralyl in Skjern (Jutland) and Stenlille (Zealand), and bromadiolone in Brøndby (Zealand).

J. Lodal

13.1.2 Population effects of anticoagulant rodenticide resistance in brown rats

Resistance to anticoagulant rodenticides has pleiotropic effects that can decrease the fitness of resistant rats compared to non-resistant rats when anticoagulants are no longer used. Thus, it can be hypothesized that resistance will disappear from the population if no anticoagulants are being used. In order to investigate this, a Ph.D. project was started in 1998 with experimental populations of resistant rats that were established with wild rats trapped in two localities in Denmark. These populations will be submitted to treatments with or without anticoagulant rodenticides, in order to investigate how the prevalence of resistance will change over time and how the resistance genes spread through the population.

Resistance in this project is determined by the use of the Blood Clotting Response (BCR) test. With microsatellite markers it will be possible to measure an individual's reproductive success as their contribution into next generation of rats can be traced, and thereby obtain a measurement of the individual fitness in relation to its state of resistance. Furthermore, we will measure changes of genetic composition due to the environmental selection over successive generations. All samples collected during 1999 from the four experimental populations are being typed with a total of 18 microsatellite markers in order to produce DNA profile of each individual rat. The molecular work is conducted at the DNA-laboratory, Department of Evolutionary Biology, Institute of Zoology, University of Copenhagen. The project will be running until August 2001.

A.-C. Heiberg

13.1.3 Implementing blood clotting response test for detection of anticoagulant rodenticide resistance

During 1999 a total of 161 rats were tested for bromadiolone resistance by means of the blood clotting response (BCR) test. Of these, 81 (40 females and 41 males) were then tested in a 0.005% feeding test in order to evaluate the power of the BCR test and finally to see if the BCR test will be able to replace the feeding test in most cases.

The BCR test is based on dosing of small amounts of anticoagulant together with menadione sodium bisulphite (MSB), a synthetic source of a vitamin k derivate, which can be utilised by resistant rats only. The animal's blood clotting time is measured before and after dosing the anticoagulant. Increase in clotting time indicates an effect on the rat by the anticoagulant poison, whereas an unchanged clotting time indicates that the animal has not been affected significantly. Such rats will be considered resistant.

Survival of BCR declared resistant rats in the feeding test was correlated to the percentage clotting activity (PCA) of the animals. A *T-test* revealed no statistical significant difference between mean PCA of rats surviving or dying in the feeding test ($p < 0.2085$). The data for males and females, respectively, show that

survivors' mean PCA did not differ from the PCA of the non-survivors (males, $p < 0,3940$; females, $p < 0,4282$), see Table 13a below.

The survival in the feeding test did not correlate with the BCR test. However, the survival rate in the feeding test is strongly influenced by the length of the test (six days), and thus the feeding test is most likely to underestimate the level of resistance as rats being heterozygous for the resistance genes will probably die in a feeding test. The heterozygous rats will be detected in the BCR as this test is more sensitive. A better correlation between the two tests will probably exist if the feeding periods are shortened to four days (H. J. Pelz, pers.com)

Some preliminary conclusion can be drawn from these experiments. All rats known to be susceptible (22 control rats were included, they do not appear in Table 13a) were identified as susceptibles in the BCR (all had a PCA below 10%), and all 22 rats died shortly after the BCR test due to anticoagulant poisoning. Thus truly susceptible rats are easily identified by the use of BCR. However, we were not able to distinguish between degrees of resistance using BCR, only to identify the individuals carrying one or two copies of the resistant gene. Compared to the feeding test, this gives an opportunity to detect resistance, before it becomes a control problem.

Table 13a: Mean PCA calculated using $PCA_4/PCA_0 \times 100$, where PCA_4 is the PCA after the administration of anticoagulant and PCA_0 before the administration.

	N	Mean PCA	SE	<i>p</i> (t-test SAS)
Females:				
Survivors	18	108.11	6.4	
<i>Non-survivors</i>	22	104.86	7.0	0.4282
Males:				
Survivors	22	90.50	4.92	
<i>Non-survivors</i>	19	84.10	6.42	0.3940
Total:				
Survivors	40	98.43	4.15	
<i>Non-survivors</i>	41	95.24	5.0	0.2085

A.-C. Heiberg

13.2 Other work on rodents and rodent management

13.2.1 Feeding decisions as an anti-predation strategy in the African multimammate rat

In an ongoing research project in Tanzania, populations of African *Mastomys* rats are submitted to different replicated predation treatments (predators excluded, predators allowed, and predators attracted). Any observed effects in that project could be due to direct effects of predation on survival, but also due to indirect effects caused by the rodents' individual reactions to the changed risk of predation. In order to investigate whether the differences in predation pressure are apparent to the individual rodents living in these areas, a number of experiments has been set up as an M.Sc. project.

In this project, the feeding decisions of the rodents are measured with a method known as the "giving-up-density"-method. For this method, a known amount of millet seeds was mixed with sand in a tray, and six trays were placed in each of the 10 study fields. Rodents that visit these trays during night were expected to search and remove seeds from the sand, until the density of the grains becomes so low that they no longer consider the profit of searching for more grains to balance the risk of doing so. The hypothesis was that

animals in the fields, from which predators were excluded, would continue searching for the seeds in the trays to a lower final density, than in the fields where predators could hunt. Simultaneously, a number of the seed trays was monitored by a video camera in order to observe difference in the feeding behaviour of the rodents. Data collection was carried out at the Sokoine University of Agriculture in Morogoro, Tanzania from October to December 1999.

K. Mohr

13.2.2 Population ecology of the African field rat *Mastomys natalensis*

S. Vibe-Petersen continued the data collection for the Ph.D. project "Predation pressure and population dynamics in African *Mastomys* rats: possibilities for integrated pest management?" at Sokoine University of Agriculture in Morogoro, Tanzania. The study began November 1997 and will terminate October 2000. *Mastomys* rats are common agricultural pest species in Sub-Saharan Africa. In an attempt to look for alternative methods of control than use of rodenticide, this study is a follow-up on previous results, which have indicated that predation may be an important mortality factor of the species. The aim of the study is to evaluate the effect of either attracting avian predators or excluding predators from maize-cultivated field plots of ½ ha (see also Danish Pest Infestation Laboratory, Annual Report 1998 for explanations on the set-up).

Preliminary analyses of the rodent CMR-data from the first trapping year indicate that the return rates of females in several months are lower in predator-attracted areas than in predator-excluded or control areas. This may indicate that females in predator-attracted areas have a lowered survival. Further, during the reproductive period it seems that reproducing females are trapped for a longer period in predator-excluded and control areas than in predator-attracted areas. Possibly this means that females in predator-attracted areas have a lowered reproduction. Analyses of frequency of raptor pellets have shown a clear correlation between pellet numbers and rodent population size. This suggests a numerical response of raptors to the rodent population.

Although there are some indications of an indirect effect of predators on the rodents, the rodent population dynamics still follows the usual seasonal variation that is known from literature, and no marked differences according to treatments of the plots are yet obvious. It is possible, however, that long-term exposure to increased predation risk may show a delayed effect in the rodent population dynamics and/or that the rodents are able to compensate for the increased predation pressure. Thus at present, the question of the effect of perch poles and nest boxes are still left open.

A second study, "Population dynamics of *Mastomys natalensis* in different habitats: an experimental and modelling study" was undertaken as a Ph.D. study at the University of Antwerp (Belgium) with supervision from DPIL. The population dynamics of these rats are investigated in capture-recapture set-ups on a 3 ha field-fallow mosaic and a 1 ha maize mosaic. Recolonization of maize fields after control is studied on a set of additional experimental maize fields. The field work continues with monthly captures until mid-2001.

H. Leirs and S. Vibe-Petersen

13.2.3 A population dynamics model for rodent management in Africa

Rodents of the genus *Mastomys* are common in sub-Saharan Africa. They are important pests in agriculture, both in field crops and in post-harvest storage, as well as in public health, carrying diseases like Lassa fever and plague. Their population dynamics is characterized by irregular large fluctuations, both intraannually and interannually. In order to organize rodent control more efficiently, it is necessary to understand how and why the population sizes change and, if possible, to predict them.

We used already available robust capture-mark-recapture (CMR) data from several localities in East Africa to analyse *Mastomys* demography in detail, using state-of-the-art multi-state CMR statistics. The obtained estimates were used to parameterize a population dynamics model, building on a model developed at DPIL before. The population dynamics model was tested for its sensitivity to variations in parameter values and predictions of the model were verified with observed rodent densities from several existing time series from Tanzania. In the near future, the model will be verified for other parts of East Africa.

In order to refine the parameters of the model for reproduction and early survival, a colony of *Mastomys natalensis* rats was established at DPIL, and information was collected about their reproductive output.

H. Leirs

13.2.4 Search for the natural reservoir of Marburg virus

In early 1999, in the region of Durba, Democratic Republic of the Congo, an outbreak occurred of a hemorrhagic fever. After identifying the cause of the disease as Marburg virus, a relative of Ebola virus, the World Health Organisation decided to send out a research equipe in May. In order to identify the still unknown natural reservoir of the virus, an Ecological Investigatory Team was established with participants from the National Institute of Virology, South Africa, Centers for Disease Control, USA, Institut Pasteur, France, and DPIL. The mission was to be based on the simple assumption that the majority of cases of Marburg disease were arising as primary infections in the Gorumbwa goldmine, and therefore likely reservoir hosts were to be sought in the mine and its immediate environments. The aim was to trap and sample potential vertebrate hosts (rodents, bats) found in and around the mine. In total, 165 specimens belonging to 14 species were collected, most of them bats. Laboratory investigation of the collected blood and tissue samples did, unfortunately, not reveal any indications of the virus.

H. Leirs

13.2.5 Effects of grazing on small mammals in wet meadows

Differences in vegetation structure affect living conditions for small mammals with respect to food quality and quantity, cover against predators, etc. In the framework of a large project to investigate the different grazing systems as a nature management strategy, DPIL and the Royal Veterinary and Agricultural University (Copenhagen) investigate the population ecology and behaviour of rodents under different grazing pressure. The experimental areas are situated in Fussingø, Jutland, and subject to different grazing and/or mowing intensity by sheep or cattle. On six of these areas, a capture-recapture study with monthly trapping was carried out in 1999. The data collection will continue for another year.

H. Leirs

13.2.6 Cable resistance to gnawing

A special cable type for use in structures where rats often occur was tested for resistance against being gnawed and damaged by brown rats. It was compared with a standard cable of the same diameter, about 14 mm. The cables were exposed to singly-caged rats in glass cages. The special cable showed a high degree of resistance to severe damage, whereas the standard cable in many cases was completely destroyed.

J. Lodal

13.2.7 Rat trap

At the request of a Danish inventor a prototype of a special trap for rats was tested in the laboratory. The aim of the test was - through studies of the reactions of the rats to the trap - to find out how to optimize the function of the trap.

J. Lodal