

11. Rodents

11.1 Efficacy and palatability testing

A new coumatetralyl paste formulation was after a series of tests recommended approved for rat control.

J. Lodal

11.2 Resistance to anticoagulants

11.2.1 Resistance in the brown rat

During 2000 a total of 493 brown rats (*Rattus norvegicus*) from 29 municipalities were received for anti-coagulant resistance testing. In addition to confirming resistance levels found in a number of municipalities previously, bromadiolone resistance was found for the first time in the municipality of Kjellerup (Jutland).

J. Lodal

11.2.2 Population effects of anticoagulant rodenticide resistance in brown rats

Data collection for the Ph.D. project "Population effects of anticoagulant rodenticide resistance in brown rats" was continued. The project was started in August 1998 and will be terminated in August 2001.

Rats resistant to anticoagulant rodenticides may show an increase in the requirement for dietary vitamin K in order to maintain a production of blood clotting factors preventing internal haemorrhages. The increase in the need for vitamin K may result in reduced fitness. It can thus be hypothesized that resistance will disappear from the population when anticoagulants are no longer present. In order to investigate this, experimental populations of rats were established with wild rats trapped in two localities in Denmark where bromadiolone resistance was known to exist. The populations will be submitted to treatments with or without the anticoagulant rodenticide: bromadiolone and changes in the prevalence of resistance in the populations will be monitored for a period of two years.

Resistance to bromadiolone is determined by the use of the Blood Clotting Response (BCR) test in order to identify all phenotypically-resistant rats. All resistant rats are additionally tested with the traditional non-choice feeding test.

By means of microsatellite markers it is possible to measure an individual's reproductive success as its contribution to next generation of rats can be traced, and thereby a measurement of the individual fitness in relation to its state of resistance is obtained. Furthermore we will measure changes in the genetic composition due to environmental selection over several generations. All rats from the four experimental populations are being typed for a total of 17 microsatellite markers in order to describe DNA profile of each individual rat. The molecular work is being conducted at the DNA-laboratory, Department of Evolutionary Biology, Institute of Zoology, University of Copenhagen.

A.-C. Heiberg

11.2.3 Vitamin K requirement in Danish anticoagulant-resistant Norway rats

Several strains of anticoagulant resistant rats in Britain have an increased need for vitamin K. The need cannot always be met by natural conditions, and this phenomenon may be useful in resistance management. An M.Sc. project was started in 2000 to investigate vitamin K requirements in anticoagulant resistant Norway rats in Denmark. Rats were sampled from different geographical localities and tested for resistance

to the anticoagulants warfarin and bromadiolone by means of blood clotting response tests. Vitamin K deficient diet was prepared, and rats were kept on the diet for 14 days. Response to the diet was observed as prolonged blood clotting times and reduced percent clotting activity (PCA), and vitamin K1 injections were given to investigate the dose level necessary to restore blood clotting function when the animal was depleted. Finally rats are submitted to a feeding test according to their level of resistance. The work continues and data analysis will start in the summer of 2001.

M. Drude Kjær Markussen

11.2.4 Genetic diversity in population of wild rats

In relation to the Ph.D project a master project was started in May 2000. By means of microsatellite markers genetic diversity is being investigated in 15 Danish populations of wild rats. Microsatellite markers have proven valuable in connection with questions on migratory patterns, population structures and degree of relatedness within populations. The project aims to examine the level of geographical differentiation between rat populations and the degree of differentiation within a restricted geographical range in order to elucidate migratory patterns and population substructures. The project will terminate in the summer of 2001.

A.-C. Heiberg

11.3 Other work on rodents and rodent management

11.3.1 Pest problems in organic pig production

Within the framework of the Research Programme for Organic Agriculture (FØJO), a knowledge synthesis was made up as a state of the art in organic pig production. DPIL participated in this work in order to evaluate which specific risks could rise due to pest problems under conditions of outdoors pig production and the limited possibilities for pest control in organic systems. The knowledge synthesis will be the basis for further research.

H. Leirs and J. Lodal

11.3.2 *Pneumocystis* in Danish brown rats

Pneumocystis infections occurring in wild brown rats (*Rattus norvegicus*) trapped in Denmark were studied in a collaborative study involving Molecular Infectious Diseases Group, Department of Paediatrics, Institute of Molecular Medicine, John Radcliffe Hospital, Oxford, United Kingdom, and Institute of Medical Microbiology and Immunology, University of Copenhagen, Copenhagen. The study focused on similarities and differences between human- and rat-derived *Pneumocystis carinii* organisms. Evidence for three novel formae speciales of rat-derived *P. carinii* was found. Furthermore, the study showed that human- and rat-derived *P. carinii* organisms are very different, not only in genetic composition but also in population structure and natural history.

J. Lodal

11.3.3 Hanta virus

Hanta virus has been found in Danish patients, and rodents act as reservoir for human infections. As part of a project with the aim of finding reservoir rodents in Europe, we collaborated with Heikki Henttonen from Vantaa Research Centre, Forest Research Institute, Vantaa, Finland, in trapping rodents for serum sampling and checking for antibodies to Hanta virus. The rodents (mice and voles) were trapped in Funen and in Jutland in areas where patients may have achieved their infections. Some rodents have been found positive to Hanta virus antibodies.

11.3.4 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 intra- 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 continued this work in a project, supported by Danida's Council for Development Research.

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 improve existing population dynamics models.

In order to refine the model's parameters for reproduction and early survival, reproductive data were collected from a colony of *Mastomys natalensis* rats maintained at DPIL. Survival of young in the population where they were born, was investigated in the field in Tanzania, partly by the use (unsuccessful) of a system with nestboxes, partly (and with success) by the maintaining of captured pregnant females in cages until the newborn young could be marked and then be returned to the field. These data are now under analysis.

The population dynamics model for *M. natalensis* rats was extended considerably by including AN economics component so that the model can be used to predict/simulate not only the population effects of rodent management, but also their effects on crop yield and ultimately farmers' income.

H. Leirs

11.3.5 STAPLERAT: Protecting staple crops in eastern Africa: integrated approaches for ecologically-based field rodent pest management

Staple crops in eastern Africa are subject to serious pre- and post-harvest pest damage. Major losses can be attributed to rats, making them in several places the most important pre-harvest pest species. Indiscriminate use of rodenticides is neither efficient nor sustainable, and there is a need for ecologically-based management strategies. The STAPLERAT-project (supported by EU 5FP) is investigating the needed biological information and collecting data on the economic aspects of damage and controls. Based on these data, tools for the organization and evaluation of management strategies will be developed:

Information about contribution of the ecological conditions to rodent problems yields the basis for an integrated approach. Population dynamic information will be elaborated into early-warning systems and bioeconomic decision making models.

A number of specific alternative approaches are being tested:

- repellent dressings to protect planted seeds
- biological control with predators
- use of agroforestry techniques to decrease a field's attractiveness to mole-rats

STAPLERAT is a collaborative project with different partners in Africa and Europe: DPIL, University of Antwerp, Belgium, University of Rome "La Sapienza", Italy, University of Oslo, Norway, Sokoine University of Agriculture, Morogoro, Tanzania, Rodent Control Center, Morogoro, Tanzania, Kenyatta University, Nairobi, Kenya, Addis Ababa University, Ethiopia and Mutanda Research Station, Solwezi, Zambia. DPIL co-ordinates the project, which started on 1 September 2000 and runs for three years.

H. Leirs

11.3.6 Effects of grazing on small mammals in wet meadows

Differences in vegetation structure affect the living conditions for small mammals with respect to food quality and quantity, cover against predators, etc. Since 1998 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) have investigated 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. The data collection was completed in 2000, and data analysis will be finalized in 2001.

Additional data on the movements of field voles under different grazing pressure were collected by radio-telemetry in the same areas, as part of an M.Sc. project.

H. Leirs

11.3.7 Behavioural effects in *Mastomys natalensis* rats under exposure to predator odour

An M.Sc. project was started to investigate changes in explorative behaviour of *Mastomys natalensis* rats in relation to predator odours. The odour medium was placed in test arenas, and the frequency and duration of visits to the arena by single rats were video-recorded for the next 24 hours. The tested odour media were faeces from cats that had fed on dead *Mastomys* rats, faeces from cats that had been fed fish and a control experiment in which no odour was used. The experiments will be completed with a neutral odour medium (rabbit faeces), and data analysis will be finalized in 2001.

H. H. Petersen

11.3.8 Feeding decisions as an anti-predation strategy in *Mastomys natalensis* rats

Observed effects of predation pressure in populations of rodents can be due to direct effects of predation on survival, but also due to indirect effects caused by the rodents' individual behaviour responses to different levels of predation risk. In order to investigate whether differences in predation pressure are apparent to the individual rodents living in an area, a number of experiments was carried out in 1999 in Tanzania in fields with manipulated predation pressure. The rodents' feeding decisions were measured by means of a method known as the "giving-up-density" method, and their foraging was recorded on video. The data were analysed in 2000, and the work will be completed in 2001.

K. Mohr

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

Data collection for the Ph.D. project "Predation pressure and population dynamics in African *Mastomys* rats: possibilities for integrated pest management?" was continued at Sokoine University of Agriculture in Morogoro, Tanzania. The study began in November 1997 and will evaluate the effects of different avian predation pressure on populations of the agricultural pest species *Mastomys natalensis* in Sub-Saharan Africa.

Analysis of the rodent CMR-data showed that the population growth during the increase phase was more rapid in the absence of predators. Otherwise, the dynamics patterns resembled each other in all open treatment plots. Fencing of the field plots reducing the dispersal of rodents changed the effect of predation on population growth and peak size. Maize yield was largest in predator-attracted areas, indicating that other factors than direct mortality by predators affected the rodent damage. Manipulation of predation pressure by

introducing perch poles and nest boxes does not affect rodent numbers directly, but may have an indirect beneficial effect on maize yield. Data analysis is ongoing.

S. Vibe-Petersen

11.3.10 Danish Mammal Atlas

A project aimed at mapping the distribution of Danish mammals was initiated in 2000. Zoological Museum of the University of Copenhagen and Natural History Museum, Århus, are responsible for the project. However, the project will be carried out in co-operation between researchers from the two museums and researchers from other research institutes, including DPIL. As part of the project the occurrence of rodent and shrew species on a small island, named Æbelø, situated north of Funen has been studied and published. Aage V. Jensen Charity Foundation sponsors the project.

J. Lodal