

## **13. Rodents**

### **13.1 Efficacy and palatability testing**

#### **13.1.1 Bromadiolone liquid poison**

As a continuation of tests carried out previously and briefly described in Annual Report 1997 two room tests were conducted with a new formulation of a bromadiolone liquid poison against brown rats (*Rattus norvegicus*). No rats died in the two groups of ten rats after a four-day test period with a choice between the bromadiolone poison and non-poisonous tap water. Based on the calculated theoretical amounts of bromadiolone consumed per kg body weight at least one rat should have died in one of the tests.

J. Lodal

#### **13.1.2 Alphachloralose**

At the request of a Danish company a new paste formulation of 4% alphachloralose was tested on house mice (*Mus musculus*). Single-cage choice tests with organic crushed wheat as non-poisonous alternative to the alphachloralose paste gave lower mortality when tested on *M. m. musculus* than on *M. m. domesticus*. Room tests with a similar choice gave only minor differences in mortality. The difference in reaction is now under further study. This paste formulation was approved for control of mice inside and around buildings.

J. Lodal

### **13.2 Resistance to anticoagulants**

#### **13.2.1 Resistance in the brown rat**

During 1998 about 1000 brown rats (*R. norvegicus*) were received for anticoagulant resistance testing. New municipalities where resistance has been found are: coumatetralyl in Præstø, Zealand, and difenacoum in

Vordingborg, Zealand. Decreased susceptibility to difenacoum was seen among rats from the municipality Nordborg in southern Jutland.

J. Lodal

### **13.2.2 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 and thereby its fitness in relation to its state of resistance and to estimate changes of genetic composition due to the environmental selection over successive generations. A preliminary screening identifying polymorphic microsatellite markers has been done. The molecular work is conducted at the DNA-laboratory, Department of Population Biology, University of Copenhagen.

A.-C. Heiberg

## **13.3 Other works on rodents and rodent management**

### **13.3.1 Field voles *Microtus agrestis* and predation**

Field work and data collection for the Ph.D. project "The effect of predation on field vole *Microtus agrestis* populations in fragmented forest habitats" was finished in the late spring of 1998. Twelve experimental trapping grids in young beech or oak forests have been the fundamental basis for the project. Four of the grids have been covered with net to exclude raptors, owls and foxes, four other grids were predator-enriched

by the setting up of perches and nest boxes for owls and kestrels, and the four remaining grids were left unmanipulated as control grids. Bank vole *Clethrionomys glareolus* and common shrew *Sorex araneus* have to some extent been incorporated in the study because they occurred in reasonable numbers and both species are relevant as prey items. As a supplement some laboratory experiments with voles and odours of predators formed part of the project too.

**Survival.** In response to predator exclusion the subadult winter survival in populations of *Microtus agrestis* increased in forest clearings. There were no significant results on adult survival in the reproductive season. The increased winter survival led to generally higher population sizes on predator exclusion grids, especially in the non-reproductive season. Throughout the year the relative changes in population sizes were density-dependent.

Winter survival was significantly correlated with both the relative change in population size and spring population size. Survival was not correlated with November population size, but together with immigration, which showed density dependence, it may shape the negative correlation between November population size and the relative change in population size. The results indicate that predation, though not the only factor of importance, has a major influence on survival, which, despite showing only weak signs of density dependence, is a key factor in shaping population size changes and spring population size.

Predator exclusion seems to have a positive influence on the proportion of females in the population over winter. Female proportion in spring was significantly positively correlated with survival. Spring weights on the other hand do not seem related to survival.

**Body weight.** The effect of predation risk on body weight in subadult *Microtus agrestis* was studied in the laboratory and in the field. The exposure of voles in the laboratory to faecal odours from domestic cat, captive fox and captive mink led to a larger decrease in individual body weight compared to control voles when the distance between cover and food bowl was short, despite equal intake of food in both groups of voles. An increase in the distance between cover and food bowl to 50 cm resulted in very low food intake in voles exposed to predator odour compared to control voles. In the field, voles from grids where mammalian and avian predators were excluded generally lost less or gained more weight in autumn and winter than voles from corresponding control grids. Despite

some variation in individual weight changes during autumn and winter voles from exclosures gained more weight than control voles in early spring immediately before the onset of reproduction. Mean weights throughout autumn, winter and spring were found to be affected not only by individual weight changes but also by immigration. When immigration was low, mean weights on predator exclusion grids were higher than on predated grids. Accordingly, the result of reduced predation risk in the laboratory as well as in the field seems to be higher body weight in the individual and often also in the population. In the field this was especially evident at the onset of breeding in spring, potentially resulting in a higher reproductive potential. To our knowledge this study is the first of its kind to show the same trend in weight development in the laboratory as well as in the field.

**Reproduction.** A reduction in predation in populations of *Microtus agrestis* in forest clearings led to earlier onset of reproduction on the predator exclusion grid at one site whereas there was no effect at another site. A possible connection between onset of reproduction and body weight was found.

A higher proportion of pregnant females was found on predator-excluded grids than on predated grids in spring. Mean litter size was almost similar on all grids. Litter size was positively correlated with body weight. There was no treatment effect on any reproductive parameter in spring that could not be ascribed to a treatment effect on body weight.

During summer, however, selective predation on pregnant females could be an explanation for the lower proportion of pregnant females found on a control grid compared to the neighbouring predator exclusion grid. Probably as a result of the higher proportion of pregnant females late summer recruitment of immatures and juveniles was higher on the predator-excluded grid.

**Forest habitat types.** It was also investigated how different habitat types in a Danish forest affected survival, body weight and reproduction of *Microtus agrestis*.

Three donor habitats and one reception habitat were distinguished. A fifth habitat included small patches of donor habitat, induced donor habitat and reception habitat in otherwise closed forest without undergrowth. Recorded movements of individual field voles indicated that one continuous population of field voles spanned over the three donor habitats whereas the patchy habitat and the reception habitat were isolated from the

donor habitats by habitat barriers. The three donor habitats were a perennial grassland, a young spruce plantation and a mature, open, mixed forest.

In the dry summer of 1997 population size and recruitment rate peaked earlier in the moist and shaded patchy habitat than in the perennial grassland where the food supply dried out.

In the donor habitats in the warm winter of 1997/98 the field voles in the perennial grassland gained more weight and reached higher mean weights than the voles in the mature forest, whereas these latter voles had a higher survival probability. The voles in the young spruce plantation took an intermediate position in both respects. It is suggested that predation causes the lower survival of the grassland voles, but that negative effects of predation on body weight are compensated for by a favourable food situation. In the mature forest low predation may have caused the higher survival probability. The reduction of negative effects on body weight from predation risk, however, could not compensate for a poor food supply.

The onset of reproduction happened earlier in the grassland than in the young spruce plantation and in the mature forest, probably because of higher body weights in the grassland.

**Bank voles.** The effect of predation and predation risk on survival, body weight development and microhabitat preferences of temporary non-breeding populations of bank voles *Clethrionomys glareolus* was investigated in two forest clearings in the autumn of 1996.

Female bank voles were found to be influenced to a higher degree than males. Female survival was higher on predator-excluded grids compared to predated grids, whereas there was no clear response in males.

Females also gained more weight on predator-excluded grids compared to both males on the same grids and females on predated grids. There was no clear treatment effect when mean body weights were compared in each trapping period. However, mean female body weights on net grids were significantly higher in November than in September. This was not the case on predated grids.

There was a clear treatment effect on female microhabitat preferences. On predated grids female bank voles were captured at trap stations with more

cover than females on net grids. A similar but less clear tendency was seen in males. On both net grids in both trapping periods female bank voles were trapped at trap stations with less cover than males, whereas the opposite was true for both predated grids in both trapping periods.

**Shrews.** In a predator exclusion experiment in the field only slight treatment effects were found on population size, mean body weights and microhabitat choice of common shrew *Sorex araneus*. However, changes in mean body weight were clearly affected by predation. Higher relative decreases in mean body weight with higher initial weights on non-excluded grids may reflect that heavy shrews reduce predation risk by inactivity thereby losing weight, whereas light weight shrews are forced to remain active. On predator exclusion grids there were higher relative decreases in mean body weight the lower the initial weights were. The mean body weight also had an effect on microhabitat choice. On non-excluded grids there was a negative correlation between cover and body weight, whereas the opposite was true for exclusion grids. Microhabitat choice was further and more clearly affected by the presence of microtines. On non-excluded grids high numbers of voles were correlated with low degree of cover for shrew captures. There were indications that shrews and voles avoid one another. Voles show increased preference for cover on non-excluded grids. This probably leads to less covered space available for shrews. On predator exclusion grids where voles show less preference for cover there was no correlation between degree of cover for shrew captures and vole numbers.

M. Carlsen and J. Lodal

### **13.3.2 Behavioural response of field voles under mustelid predation risk in the laboratory**

Several studies have tried to investigate the indirect influences of predator presence on prey animals. In this study we focused on the time budgets around feeding behaviour by observing the behaviour of 24 field voles *Microtus agrestis* (Linnaeus, 1761) in the laboratory, exposed to no odour, faeces from a least weasel *Mustela nivalis* (Linnaeus, 1766) and faeces from a domestic rabbit *Oryctolagus cuniculus* (Linnaeus, 1758). The voles showed a response when exposed to weasel odour, while exposure to rabbit odour did not cause any effects. The lack of a clear response to rabbit odour rules out neophobia as the underlying cause of the

behavioural changes. Voles exposed to weasel odour were more inactive, ate less of a high preference food which was placed far from the nestbox, displayed a smaller variation of behaviour types and were overall more abrupt in their actions. The study confirmed that the mere risk of predation affects voles' feeding behaviour. This may explain indirect effects of predation risk on other processes like reproduction.

This work resulted in an M.Sc.-degree for Thomas Bolbroe, University of Copenhagen.

T. Bolbroe

### **13.3.3 Population ecology of the African field rat *Mastomys natalensis***

The research on population ecology of *Mastomys natalensis* rats continued with the further analysis of earlier field data and the development of a population dynamics model. It was further intensified by the start-up of two Ph.D.-projects in Tanzania.

The Ph.D. project "Predation pressure and population dynamics in African *Mastomys* rats: possibilities for integrated pest management?" started in November 1997. Data collection is carried out at Sokoine University of Agriculture in Morogoro, Tanzania. Ten study fields are cultured as maize fields according to local custom. Each field plot of 0.5 ha has been ploughed and constructed according to one of the following predation manipulations:

- (1) Predators excluded (by nets)
- (2) Predators allowed (control)
- (3) Predators attracted (by perch poles and nest boxes)

To verify any masking effects of the treatment by rodent dispersal (i.e. immigrating and emigrating), the treatments are supplied to plots where the rodent populations are enclosed (migrations not allowed; closed population) as well as to open plots where the rodent populations have no physical barriers (migrations allowed; open population). For the areas with predator attraction, only open populations are used. All treatments are replicated.

Capture-recapture experiments on the rodent population have been carried out since March 1998. In the two predation areas, and in the two open control population areas, observations on birds of prey have been carried out twice during each capture-recapture session since the beginning of June 1998. Since the beginning of April 1998, owl pellets have been collected once a week under trees in the surroundings of the predation areas as well as under perch poles. Following harvest of maize, cob damage is estimated by weighing the total amount of shelled corn on each area. The project continues until the end of October 2000.

A second study, "Population dynamics of *Mastomys natalensis* in different habitats: an experimental and modelling study" is 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-2000.

H. Leirs and S. Vibe-Petersen

#### **13.3.4 Palatability and toxicity tests of fipronil as a systemic insecticide in a rodenticide bait for rat and flea control**

Vector/reservoir control in plague endemic areas must target rodents as well as their flea ectoparasites. Traditionally, insecticides are dusted before the application of rodenticides or an insecticide powder is applied in a bait box where rodents enter to reach the rodenticide. Both methods have their logistic problems. We investigated the possible use of fipronil as a systemic insecticide to be mixed in a anticoagulant rodenticide bait.

Three different concentrations of fipronil (0.05%, 0.005%, 0.0005%, with acetone as a solvent and 0.05% with propylen glycol as a solvent) and two control solutions (solvents only) were combined with a rodenticide bait consisting of crushed organic wheat and 0.005% bromadiolone. Each concentration was offered together with an unpoisoned alternative bait (crushed organic wheat) to ten singly caged *Rattus rattus*. One hundred rat fleas *Xenopsylla cheopis* were placed in each rat cage one day later.

Consumption of both choice baits was monitored daily for four days, after which the rats received unpoisoned standard food. Fleas were removed after six days and kept in a glass tube with sand; flea mortality was checked 24 and 48 hours later. Rodents were observed for 3 more weeks and rodent mortality was checked. All dead rats were autopsied for signs of anticoagulant poisoning.

Bait consumption was relatively low and an unsatisfactory rat mortality of around 50% only was obtained in all tests. The palatability of the bait, however, was not affected by the fipronil concentration although the solvents may have an effect. Flea mortality after 48 hours reached 100% at the highest fipronil concentrations and was still above 95% at the lowest concentration; in the control tests, the natural mortality was below 70%. In conclusion, fipronil has no bad effects on rodent bait palatability and is effective as a systemic insecticide to kill fleas. The bait base, however, has to be more attractive to roof rats in order to be useful in practice.

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### **13.3.5 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 started in June 1998. The data collection will continue for two years.

H. Leirs