RODENT RESEARCH

RODENT RESEARCH IS A BI-ANNUAL NEWSLETTER PRODUCED BY THE COMMUNITY ECOLOGY GROUP OF CSIRO SUSTAINABLE ECOSYSTEMS. THE COMMUNITY ECOLOGY GROUP AIMS TO FOSTER INTERNATIONAL LINKS BETWEEN SCIENTISTS, MANAGERS AND COMMUNICATORS INVOLVED IN PEST MANAGEMENT, RODENT CONSERVATION AND BASIC RESEARCH.

SUDAN

New Project on Taxonomy of Sudanese Rodents

Progressing towards a sustainable environment is one of the major challenges of this century, and sustainable resource use rests firmly on the maintenance of biological diversity. Thus taxonomy is a critical foundation of biology, and my research will focus on one small aspect of this larger problem, describing the diversity of rodents in the Sudan.

Rodent problems are very common in Sudan, both in agriculture and public health. Serious outbreaks were observed in 1976, 1984, and 1992. Rodents in the Sudan also carry serious diseases. These include Rift Valley Fever, Leishmaniasis, plague and leptospirosis. *Arvicanthis* spp. is possibly an important reservoir species for some of these human diseases. Therefore, from both the agricultural and medical points of view, it is important to review the taxonomy, evolution, and distribution of Sudanese Rodents.

This study will provide cyto-taxonomical data pertinent to the evolution, diversity and evolutionary biology of Sudanese rodents with the goals of improving rodent control and public health. The analysis may help identify ecological and geographic zones that are hotspots of rodent biodiversity.

The specific objectives of the study are:

1. To use a cytogenetics approach to define species of rodents from the Sudan and to explore patterns of geographic and non-geographic variation within and between species.

2. To discuss the relevance of combined data to theories of chromosomal speciation and to elucidate speciation mechanisms underlying the diversity of Sudanese rodents.
3. To search for cryptic and undescribed species.
4. To establish a chromosomal mapping for Sudanese rodents.

Environmental factors and the wide geographical distribution of many Sudanese rodents may affect their morphometric and meristic characters. Chromosomal analysis is a valuable tool to assess relationships between taxa, to identify undescribed species and to study processes of chromosomal speciation and evolution. Cytogenetics techniques are useful for the correct assignment of species, especially in cases where species are not well defined on morphological grounds. Karyotypes of rodents from Sudan will be described with a view to applying this knowledge to understand rodent diversity, evolution, and pest control management.

Classical comparative cytogenetics (studies which rely on conventional banding protocols) and mapping by fluorescence *in situ* hybridisation (FISH) will be used. Comparisons will be made of the genetic and chromosomal diversity of Sudan populations with those of the lower Nile valley and other parts of East and West Africa in order to define phylogenetic relationships among these populations.

This project will start mid-2004. The rodents collected will be preserved in the Sudan Natural History museum (Khartoum, Sudan) and the Museum National d'Histoire Naturelle (Paris, France).

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TANZANIA

Serengeti Biodiversity Program

Ecological Baselines are useful and important tools for monitoring changes imposed by humankind on the world. They are the insurance policy for future generations. Protected Areas play this role through necessity. The reason for baselines is that ecosystems change imperceptibly and without a reference point such changes go unnoticed until it is too late. Ecosystems can also change suddenly, and sometimes irreversibly. Therefore, we need to detect slow change before sudden large change occurs. To do this we use natural disturbances as experiments to understand how the system works.

The long-term research in Serengeti illustrates several aspects of this approach. We are monitoring various components of the biota including small mammals to understand how they respond to natural abiotic disturbances, such as weather and fire, and biotic disturbances,

Wildebeest on the Serengeti Plains.

namely grazing. The main disturbance from which we have learnt about most of the system is the change in the wildebeest population due to the removal of an exotic virus, rinderpest. This quasi-natural 'knock-out experiment', covering some 40 years, has shown us how the different components of the ecosystem are integrated. We compare these natural disturbances with those from human impacts, largely through agriculture.

It has been shown in agricultural areas of Tanzania that certain small mammals, particularly the multi-mammate rat (*Mastomys natalensis*), respond to seasonal rainfall by rapid increases in population (Leirs et al. 1997, Nature 389, 176). When rainfall is unusually high, the populations reach very high densities. We are monitoring this species, and several others in a natural habitat, the Serengeti savanna ecosystem, to see whether there are similar responses to rainfall as those recorded in agriculture. In Serengeti there are some 20 species of raptor and other bird groups that could feed upon rodents, and some of these (the black-shouldered kite, long-crested hawk-eagle, black-headed heron) are specialists on rodents. In addition, there are about 10 species of small carnivores that also eat rodents, and to these should be added several species of snakes. In all there may be as many as 40 species of predators feeding on these rodents: do they prevent or at least dampen rodent plagues relative to those outside the Serengeti Park in the agricultural areas? Bird transects show that 90% of the raptors drop out in agriculture, the carnivore densities show a similar decline, and though we do not have estimates of snake abundances we suspect these are also lower (humans do not like snakes).

We use live traps (Shermans) in four major habitats, baiting with a mixture of peanut butter, millet seed and dried sardine. The former attracts rodents, the latter shrews. Two days of prebaiting are followed by three of trapping. We place grids in pairs, one with a disturbance such as fire or grazing, the other nearby without the disturbance. There are two replicates of each. The native habitats are open long grassland, Lake Victoria flood plain, Acacia savanna and broadleaved Terminalia savanna. We trap twice a year, once at the beginning of the rains (November-January) and once at the end of the rains (May-June).

It is too early to present results, we have some four years of trapping so far. However, it is clear that we obtain an all-or-none effect. Many trapping sessions have no catches or 1-2 specimens at best. Less often we have an outbreak with every trap filled, sometimes 3 in a trap (we are not sure how they manage this). One of our difficulties is identification of species. We have collected some voucher specimens and have sent these to Herwig Leirs for identification (pending), and have taken hair samples from all caught animals. We will use the surface pattern of the hair as our method of identification once we have developed a key using the vouchers. This is our most difficult task. Any advice or help that we can get will be most welcome.

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CANADA

Rodent Pest Management Without Toxicants

Microtus montanus.

Populations of some species of voles (*Microtus* spp.) tend to have cyclic fluctuations in abundance every 3 to 5 years in northern latitudes. In years when voles are most abundant (peak years), they may feed on deciduous and coniferous seedlings planted on cutover and naturally disturbed lands in temperate and boreal forests. Damage primarily occurs during winter months when voles concentrate their feeding on the bark, vascular tissues, and roots of trees. The abundance of vole populations and degree of damage to newly planted trees is usually highest in early successional habitats that develop after forest harvesting and in old fields (perennial grasslands) undergoing afforestation. Such habitats are composed of grasses, herbs, and shrubs that provide food and cover for voles. In addition to potentially serious economic loss due to the costs of replanting, there are implications of regeneration delays that may limit the planting of native tree species in certain forest ecosystems.

Unattacked lodgepole pine seedling (left) and rodent damaged seedling (right).

Application of diversionary food is an alternative management practice that does not rely on a reduction in the target population. We tested two hypotheses that a granivorous diversionary food, sunflower seeds, would (1) reduce feeding damage to tree seedlings by montane voles (*M. montanus*) without enhancing abundance or other population attributes; and (2) enhance population dynamics of non-target, and potentially competitive, deer mice (*Peromyscus maniculatus*) and western harvest mice (*Reithrodontomys megalotis*) in old field habitats at Summerland, British Columbia, Canada. This granivorous diversionary food did not reduce feeding damage by voles to lodgepole pine (*Pinus contorta*) seedlings. The supply of sunflower seed was likely insufficient to divert voles from feeding on trees through the overwinter (5-6 months) period. The predicted increase in numbers of deer mice and western harvest mice appeared only as brief pulses of animals, and hence may not have increased the intensity of competition with voles.

A second diversionary food study was conducted with long-tailed voles (*M. longicaudus*), meadow voles (*M. pennsylvanicus*), and southern red-backed voles (*Clethrionomys gapperi*) in young lodgepole pine plantations in forested areas. Diversionary food was prepared in the form of "logs" composed of alfalfa pellets and bark mulch mixed with wax and sunflower oil. Mean percentage of pine seedlings eaten per vole was significantly reduced with bark mulch logs during a peak damage period in old field habitat. Alfalfa logs also tended to reduce seedling damage but only for the first month after placement. None of the diversionary foods tested had any effect on mean abundance of vole populations. In forest plantations, seedlings on control sites suffered mortality from vole feeding at levels 2.6 to 2.8 times higher than those on alfalfa and bark mulch sites. This difference was not statistically significant (P=0.09) but very likely was biologically significant in terms of seedling protection. This result was achieved with *Microtus* spp. on clearcut sites, but not on patch cut sites where red-backed voles were the most abundant microtine. The concept of seedling protection with these diversionary foods appears sound, but additional research is warranted.

Diversionary food logs.

Because of the close relationship between small weasels (*Mustela erminea* and *M. nivalis*) and voles, could the indirect effect of weasel scent disrupt vole populations and reduce their damage to forest plantations? Mean (n = 4) abundance of voles per ha was similar between control and treatment sites, ranging from 32 to 121 in controls and 37 to 118 in treatments. Montane voles declined by 17% to 36% on treatment sites during early summer when trappability of this species declined dramatically at Summerland. This pattern was not observed for meadow voles at a central interior site. Recruitment of new voles was generally similar between control and treatment sites. Weasel odor had no effect on reproduction, in terms of number of successful pregnancies and index of early juvenile survival, or on total survival, movements, or body mass of voles. Activity of small weasels appeared higher on treatment than control sites at the central interior site. Weasel odor did not reduce mortality of tree seedlings caused by vole feeding.

Our results demonstrate that by the time voles have reached high densities, it is too late to reduce numbers or curtail feeding damage, regardless of weasel odor-induced anti-predatory behavior or enhanced activity of predators. Application of weasel odor during the low phase of the vole population cycle would be a critical test of the hypothesis that small mustelids could lengthen the period of low numbers and potentially protect forest plantations from vole damage.

Further reading

Sullivan, T.P., D.S. Sullivan, D.G. Reid, and M.C. Leung. 2004. Weasels, voles, and trees: Influence of mustelid semiochemicals on vole populations and feeding damage. *Ecological Applications* (*In press*).

Sullivan, T.P. and D.S. Sullivan. 2004. Influence of a granivorous diversionary food on population dynamics of montane voles (*Microtus montanus*), deer mice (*Peromyscus maniculatus*), and western harvest mice (*Reithrodontomys megalotis*). *Crop Protection* 23: 191-200.

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Israel

The common kestrel: the diurnal partner to barn owls in biological pest control

Rodents constitute one of the most problematic pests to modern agriculture and are responsible for the destruction of 35% of the total world agricultural production. Farmers use rodenticides to control rodents although the effect is short-lived, the rodenticides require frequent reapplication, and usage leads to bait-shyness. Rodenticides also poison soil and water systems and have secondary health effects on humans and wildlife.

An environmentally friendly option, the use of barn owls as biological pest control of rodents, has been claimed to be successful in other ecosystems, however, good quantitative data are still lacking. In most environments, barn owls are small mammal specialists and studies have found that small mammals comprise more than

Female kestrel in nest box (Photo Motti Charter).

Barn owl with rodent (Photo Uria Shachak).

90% of their diet (Taylor, I., 1994, *Barn Owls: Predator-Prey Relationships and Conservation*. University Press, Cambridge, NY). However, the effectiveness of barn owls as a total solution to rodent control is limited due to their primarily nocturnal lifestyle and the fact that many rodent species are partially diurnal. The common kestrel (*Falco tinnunculus*) is a diurnal raptor that preys on rodents and nests in relatively high densities close to human habitation. Thus the diurnal kestrel is an ideal partner of the nocturnal barn owl in controlling rodents.

Kestrels are the most common raptor in Israel. They are generalist predators but prefer small mammals (mainly rodents). Kestrels lay between three to seven eggs per year. When voles are present, a pair of kestrels with young is capable of preying on twenty voles per day. When mammal numbers are low, kestrels may stay in the same location and switch to hunting alternative prey such as birds, insects, and lizards.

Test case in Israel

In 1983, barn owls were chosen to be used as pest control agents of rodents in Kibbutz Sde-Eliyahu (3 km^2), located in Bet-Shean Valley,

Kestrel young with rodent (Photo Motti Charter).

Israel. Barn owl nest boxes and hunting perches were erected in strategic locations in and around the fields and plantations and a stable barn owl population was quickly established. In 1997, 15 additional barn owl nest boxes were added to the 45 existing boxes. The barn owls did not respond to the extra nesting sites but for the first time kestrels began to occupy the boxes. An estimated 12-18 pairs of kestrels were already nesting naturally in date trees in the Kibbutz plantation. In 1998, 10 smaller nest boxes designed for kestrels were erected. Kestrels occupied the new boxes and continued to occupy some of the owl boxes. Since 1999 the kestrel population increased by an additional 8-12 laying pairs and the population of rodents in Kibbutz Sde Eliyahu has stayed at economically low numbers.

Female kestrel in nest box (Photo Yeshurun Plesser).

The decrease and stabilization of the rodent population came only after the increase in kestrel abundance.

During periods of rodent decline, a moderate sized kestrel population remains on their home ranges by switching to alternative prey, thus creating a continual predatory pressure on rodents and inhibiting rodent population growth. During rodent declines, more kestrel pairs may nest than barn owls pairs due to the owl's dependence on rodents. Once the rodent population starts to increase, kestrels switch their diet to primarily rodents and more barn owls start nesting, providing the needed pressure to control the rodents.

Barn owls and kestrels control rodents by causing direct mortality and behavioral changes to their prey (predatory avoidance, habitat selection, and foraging behavior). Rodents living in an environment with predators will forage less than

Kestrel nest box on date tree (Photo Motti Charter).

those in predator-free environments. In addition to barn owls and kestrels, other predators such as birds (storks, egrets, black kites) and snakes play an intricate role in controlling rodents and should all be protected. Irrigation also is used throughout Israel to flood fields and drown the rodent young in their burrows and force the adults out of their holes to be preyed upon by the many waiting predators. The hunting efficiency of raptors decreases as vegetation height increases so to combat vegetation growth in date plantations, Kibbutz Sde Eilyahu started placing herds of Donkeys to graze on the vegetation. The donkeys have proven cost effective and have successfully lowered the height of grass. The use of donkeys is spreading to other date plantations throughout Israel.

Acknowledgements

The biological pest control project in Israel is a joint venture led by Kibbutz Sde Eliyahu, the International Center for Study of Bird Migration, Latrun, the Israeli Ornithological Center, Tel Aviv University, Hebrew University in Jerusalem, and the International Ornithological Center of the Valleys, Kibbutz Kfar Ruppin. As of 2003, the project contains 209 barn owl nest boxes established in an area of approximately 7000 Ha.

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Donkeys (Photo Motti Charter).

Vole problem and management in Armenia

Armenia, a southwestern Asian country, experiences perennial and severe vole damage to agricultural crops. The common vole, *Microtus arvalis* and the social vole, *Microtus socialis*, are the major agricultural crop pests. Wheat and barley are the main cereal crops and are vulnerable to rodent attack. Voles also affect orchards with alfalfa grown between the trees. Only about 18% of Armenia is arable land and about 45% of the labour force is occupied in agriculture.

In 2003, nearly 80% of all the agricultural land surveyed showed signs of rodent damage and concern was expressed that rodent problems could become more severe in 2004. Due to the severity of the rodent problem, Dr. AMK Mohan Rao with the FAO of United Nations was requested to organize a national workshop on Rodent Pest Management at Tsakhkadzor on 8-10 December 2003. Sixteen scientists and rodent control officers attended the workshop and discussed control practices. The rodent control method currently used in Armenia is the spread of ethylphenacine, a USSR introduced indandione anticoagulant. It was generally agreed that baiting techniques require refinement and ecologically based rodent management techniques need to be encouraged. Data should be collected on the rodent population to allow possible forecasting of the rodent situation.

A "Training of Trainers" course on Rodent Pest Management was then organized for 15 extension and Plant Protection specialists at Yerevan on

12-18 December 2003. The basic methodology of the course was participatory and skill development. The skills developed included base line data collection through Knowledge, Attitudes and Practices (KAP) analysis; field sampling and rodent damage appraisal; and rodent population analyses.

The following recommendations were made for long-term effective vole management in the country:

- Organizations within the country need to collaborate and focus activities on ecologically based vole management.
- The Ministry of Agriculture may initiate appropriate action for systematic rodent monitoring throughout the country.
- The policy of using only ethylphenacin requires revision. Different rodenticides should be considered and tested.
- Extension personnel should be trained and fully qualified in rodent management by the end of March, 2004.
- Farmers' Field Schools may be considered in the vole-infested areas.
- The FAO of United Nations may consider extending technical assistance to the country.

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An officer trainee placing a bait station on the runway of vole burrow complex.

Pest and beneficial rodents in the Banaue rice terraces, Philippines

Over the past year a research team from the Philippines Rice Research Institute (PhilRice) led by Ravi Joshi and Evelyn Gergon, has been studying the impacts of rodents on rice crops in the rice terraces of Banaue, in northern Luzon. These spectacular terraces are thought to be over 2,000 years old and are often referred to as the eight wonder of the world. A member of the *Rattus rattus* complex is the major rodent pest and farmers rank rats amongst their top two pests. Preliminary findings also indicate that some of the native rodent species may be playing an important ecological service through eating the golden apple snail, an important pest of rice, and giant earthworms that are eroding some of the terraces.

Alex Stuart.

Rachel Miller.

There have been two recent international additions to the PhilRice rodent research team. Rachel Miller is an Australian Youth Ambassador

Banaue rice terraces.

for Development (AYAD) funded by the Australian Agency for International Development. Rachel arrived in the Philippines in late March 2004 to undertake a 10-month assignment. Alex Stuart is a MSc student from Reading University, UK. He arrived in the Philippines in April and will spend three months there. Rachel will examine the breeding ecology and habitat use of the main rodent pest species. Ravi Joshi and Grant Singleton (CSIRO) will supervise Rachel. Alex will examine the habitat use and diet of some of the native rodent species living in and around the rice terraces. Grant Singleton and Colin Prescott (Reading University) will supervise Alex.
Fotos available – rice terraces; Rachel Miller; Alex Stuart

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CONFERENCES

JAPAN

IX International Mammalogical Congress
July 31 - August 5, 2005 Sapporo, Japan

The IX International Mammalogical Congress (IMC 9), formerly International Theriological Congress (ITC), will be held in Sapporo, Japan in 2005. The congress will address aspects of research on mammalogy including conservation and management. The congress may also provide an appropriate opportunity for meeting of IUCN/SSC specialist groups. Please visit the congress website for more information (http://www.imc9.jp).

XIX International Congress of Zoology
August 23-27, 2004 Beijing, China

There will be a symposium devoted to RODENT ECOLOGY at the 19th International Congress of Zoology. The Rodent ecology symposium is convened by Nils Chr Stenseth (Norway), Grant Singleton (Australia) and Zhi-Bin Zhang (China). The call for abstracts has closed and there is an impressive line-up of presenters. These include Herwig Leirs and Stephen Davis (Belgium), Lyn Hinds and Tony Arthur (Australia), Zhang Zhibin, Hongjun Li and Xiao Zhi-Shu (China), Dale Nolte and Gary Witmer (USA), N.Yu. Feoktistova (Russia), L. K. Lin (Taiwan), Rhodes Makundi (Tanzania), V.R. Parshad (India) and Evelyn Gergon (Philippines). Please visit the congress website for more information: http://www.icz.ioz.ac.cn.

Recent Publications of the CSIRO Rodent Research Group

Arthur. A.D., Pech, R.P., Drew, A., Gifford, E., Henry, S., and McKeown, A. (2003). The effect of increased ground-level habitat complexity on mouse population dynamics. *Wildlife Research* 30: 565-572.

Davis, S., Akison L. K., Farroway L., Singleton G. R., and Leslie K. (2003). Abundance estimators and truth: accounting for individual heterogeneity in wild house mice. *Journal of Wildlife Management* 67: 634-645.

Davis, S., Leirs, H., Pech, R.P., Zhang, Z., and Stenseth, N.C. (2004). On the economic benefit of predicting rodent outbreaks in agricultural systems. *Crop Protection* 23: 305-314.

Jacob, J., Ylönen, H. and Singleton, G.R. (2004). Spatial distribution of feral house mice during a population eruption. *Ecoscience* 11: 16-22.

Mate, K. and Hinds, L.A. (2003). Contraceptive vaccine development. In *Reproductive Science and Integrated Conservation*, (Eds. W.V. Holt, A.R. Pickard, J.C. Rodger and D.E. Wildt), pp. 291-304, Cambridge University Press, Cambridge.

Singleton, G.R., Sudarmaji, Tuan, N.P., Sang, N.D., Huan, N.H., Brown, P.R. Jacob, J., Heong, K.L., and Escalada, M.M. (2003). Reduction in chemical use following integrated ecologically-based rodent management. *International Rice Research Notes* 28: 33-35.

Stokes, V.L., Pech, R.P., Banks, P., and Arthur, A.D. (2004). Foraging behaviour and habitat use by *Antechinus flavipes* and *Sminthopsis murina* (Marsupialia: Dasyuridae) in response to predation risk in eucalypt woodland. *Biological Conservation* 117: 331-342.

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