Population Dynamics – Session 1

Long-term dynamics of voles and lemmings in Finnish Lapland: importance of community approach

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Dynamics of voles and lemmings in northern Finnish Lapland have been monitored at Kilpisjärvi since late 1940s and at Pallasjärvi since 1970. A drastic change in the population dynamics took place in mid and late 1980s. Earlier "beautiful" cycles turned to primarily seasonal dynamics. This also included changes in the species composition of rodent communities. However, recently the cycle has returned! In the cyclic times, vole dynamics were characterized by synchronous cycles, particularly the deepest crash phase was synchronous in all sympatric species, though in the increase and peak phases some moderate inverse density changes were observed among competing species. The two main hypothesis put forward to explain the change are based on the role of intensive forestry in the taiga zone (decline in arboreal lichens as winter food for *Myodes glareolus*, and consequences for *Microtus agrestis* through shared predation), and climate change affecting the snow structure and subnivean space. During noncyclic times starting in mid 1980s, smaller and more agile *Myodes glareolus* and *Myodes rutilus* turned seasonal but maintained their earlier abundances. Larger and more clumsy species *Myodes rufocanus*, *Microtus agrestis*, *Microtus oeconomus* and *Lemmus lemmus* drastically declined in abundance. At more northern and altitudinally higher Kilpisjärvi the dynamic change took place a bit later, around 1990. Also here, the species with a larger body size becme more uncommon. Also some demographic features have changed. The decline in clumsy species with large body size refers to predation effects. This decline has taken place both in *Myodes rufocanus* and *Microtus agrestis* and *Microtus oeconomus*. It has taken place in all habitats, also in protected taiga regions, and also far (more than 100 km) from any forest management, possibly suggesting for the role of mobile predators and /or climate change.

Population Dynamics – Session 1

Rainfall and changing population dynamics during a long-term CMR study of *Mastomys natalensis* in Tanzania

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The multimammate mouse, *Mastomys natalensis*, is a common and widely distributed rodent in agriculture and peridomestic environments in most of Africa. It is a serious pest in cereal fields and causes devastating damage during outbreak years. Earlier work in Tanzania could link these outbreaks to unusually abundant early rainfall (in October-December) leading to aseasonal breeding resulting in an additional generation within a single year, causing a tenfold increase newly recruited individuals. After this initial work in the 1980s, we have carried out capture recapture studies in a permanent 3 ha study grid in Morogoro, Tanzania, since 1994. Every fourth week (sometimes more frequent), animals have been live trapped during three consecutive days, marked individually and released. So far, this has resulted in 321 trap sessions, and with in total 64,913 captures of 28,226 individual *Mastomys natalensis*. Over these almost 25 years, population dynamics continued to show a very regular seasonal pattern with interannual variation. However, outbreaks have become very rare, the amplitude of the fluctuations has become lower and the average abundance shows a decreasing trend. Breeding remained seasonal but the breeding season is shortened. The relation between October-December rainfall and outbreaks has become less clear. The changes seems to be linked to changes in rainfall. There has indeed been a decrease in annual precipitation over the whole period although the average amount of rainfall in October-December has remained similar. Apart from the decreasing total amount of rainfall, the temporal distribution of rainfall during the wet season seems to have changed. These changes did not happen gradually but started about 15 years ago with a second non-linear change around 2012. We investigate the relation between the changes in rainfall patterns and population dynamics and what the possible consequences could be.

Population Dynamics – Session 1

Transient and seasonal drivers of population demography and virus transmission in rodents

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Continuous wavelet transforms provide a means to identify common periodicities in noisy, non-stationary time series. This is particularly useful when modelling complex, non-linear relationships over a range of time scales, such as those commonly seen in population demography, disease and climate time series. Wavelet analysis can also be used to identify both consistent and transient relationships in noisy time series. Here, we use continuous wavelet transforms and coherency analysis to investigate population demography and arenavirus infection in rodents in relation to both global and local weather patterns. We show that while seroprevalence is related to rodent density, changes in both the intensity and variability of rainfall in our study region have differing consequences for density and seroprevalence. Finally, we detect phase shifts driven by changing weather patterns at higher resolutions than conventional methods of analysis would normally allow. These patterns are analysed within a Bayesian framework to identify relationships between transient climate drivers and rodent abundance and arenavirus infection while accounting for temporal correlation. Wavelet analysis can be used to detect high resolution, non-linear relationships between demography, transmission and changing climatic conditions in a strongly fluctuating rodent population.

Population Dynamics – Session 1

Population cycles in a hibernating rodent

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The common hamster (*Cricetus cricetus*) in Europe has become of high conservation concern since the 1960s when the western European populations began to decline. As a result, its distribution range was substantially reduced and become highly fragmented. Yet long-term studies of its demography are lacking so the pattern of its population dynamics is poorly understood. Hamsters are known to be among highly prolific rodents which can outbreak in some years. Unlike small annual voles, hamsters are much bigger (200–600 g) and biannual. Most individuals mature following the first hibernation when they are about one year of age. Adults can produce one to three litters of 4–6 offspring each. They rarely survive to breed following the second hibernation. We analyse the 16-year data on population density of hamsters in a natural population situated on the periphery of Olomouc, Czech Republic, collected from 2002 to 2017 using a capture-recapture approach. Besides the declining temporal trend, we observed large fluctuations around the trend indicating the presence of some periodicity in data. By applying autocorrelation function, we obtained weak evidence of 4-yr population cycles. However, partial autocorrelation function and autoregressive linear models confirmed that the dynamics is of order 2, suggesting that the hamsters do exhibit cyclic dynamics resulting from the delayed density-dependence in population growth rates. We also observed important characteristics proposed to define cyclic fluctuations biologically, such as the Chitty effect, summer decline or density-dependent productivity. We are confident that studying population dynamics in other rodents than voles may bring new perspective to population cycle research.

Population Dynamics – Session 1

Towards a metastability approach: outbreaks of mice in Australia

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Populations of mice in Australia keep low densities most of the time, but sudden population outbreaks cause important economic damages in cereal crops. The outbreaks of mice have irregular dynamics and so far no one has been able to find a satisfactory explanatory mechanism. The aim of this study was to identify which are the basic principles and mechanisms responsible for epidemic outbreaks in Walpeup, Victoria, using a time series from 1983 to 2004. We fitted two types of models, single species logistic growth including exogenous factors, focused on house mouse populations (*Mus musculus*), and predator-prey models with functional response focused on population of mice and generalist predators (*Elanus axillaris*). For the first approximation we used single species models with humidity, precipitation, evaporation, temperature and productivity of wheat crop as exogenous factors (alone and mixed), but none of the models accurately predicted the outbreaks. On the other hand, we evaluated the existence of alternative equilibrium points related with metastability, through phase portraits and stochastic simulations. The predator-prey approach explained transitional states between lower and high densities, allowing us to identify the mechanisms that generate the outbreaks and establish management measures in the future to reduce their economic impact.