University of West Hungary
Faculty of Forestry

Theses of doctoral (Ph.D.) dissertation

Ecological study of small mammal community in artificial reforestation

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1. Thesis statement and objectives

Protection of our environment and the conservation of the natural values have become fundamental elements of today's economic and social life. At the same time the preconditions to feasible protection are definitely the possibly most comprehensive exploration and the knowledge of all the processes surrounding us. The impacts of global environmental changes on the composition and dynamics of communities may be revealed only through long term researches.

The rate of degradedness of our forests is continuously increasing, the original habitats are fragmented to smaller territories, new habitat islands are being developed constantly among the forest fragments, and this mosaic like character determines the composition of the communities living in such areas.

Owing to its extended pine forests the Sopron-hills have suffered recurrent and severe damages caused by the bark beetles from time to time, leading to sanitation cuttings on expanded areas as of the end of the 1980s.

The regeneration time of new forest plantations following the clear cuts is long and during such periods the re-forested areas are characterised by typical temporary, or intermittent open habitat patches. These open cutting sites may provide intermittent habitats to communities that may not find optimal living space for themselves in the original stands, thus such final cuttings are expressly disadvantageous in terms of the forest (loss of the topsoil, erosion, slow regeneration, etc.) that may lead to the development of intermittent living spaces, that are to be considered specifically optimal to many plant and animal species.

In relation to the research of conservation biology and biodiversity, the survey of such ecological hot spots regarding individual species and groups of species both at regional and local level is of crucial importance. The quality of

the mentioned areas depends on their special structure and reserves, as well as on the interactions existing between the communities and populations.

The artificial forest plantation studied by the author is situated on one of the western points of the Sopron-hills and - in accordance with a preliminary survey embracing the whole area of the hills - it proved to be the most optimal cutting site in the region – with respect to the small mammal communities. With respect to the foregoing, the objectives of the dissertation are the following:

- To form a picture of the aforementioned intermittent habitats concerning their small mammal communities, the characteristics of their fauna, and to highlight the ecological functions of these patches, or possibly their roles as ecological stepping stones.

- To examine the genital and age composition of the individual species, the seasonal variations thereof, and the body weight development of the individuals as a function of time.

- To reveal the environmental factors affecting the individual populations, as well as the concrete impacts thereof on the dynamics of populations and on their patterns in space and time.

- To model the factors playing a role in the regulation of communities by means of multivariable statistical methods, the knowledge of which may be essential in assisting the efforts to protect the species and habitats.

- To survey the effects of the "live etiological factors" playing a role in the regulation of populations, and through this to form a judgement on the headcount regulating effect of such factors, which has been so far an undiscovered subject in the field of the ecological surveying of small mammals. The outcome of such surveys on the one hand may assist to gain a more comprehensive knowledge of the above mentioned complex processes, and on the other hand they may contribute to the mitigation of the rate of mortality caused by the later live-trapping studies.

2. Material and methods

Trapping methods and data collecting

For trapping the animals the author applied live-traps made of wood, and the author pursued the investigations on the designated sample site with 10x10 traps, located in a 10 m distance from one another, forming a trap-network on 1 ha in the new forest plantation located in the Sopron-hills. During the three years of the monitoring period the location of the traps was constant. Fat-bacon, carrot, and grain crops mixed with vegetable oil were used as bait. During the daytime the traps were activated, due to this, two checking a day and nine checking periodically were needed. The investigations were performed in all the three years of survey in eight, severally 5 night periods respectively, from April to November, thus the data of altogether 12 000 trapping-nights have been processed in the framework of this dissertation.

In the course of the surveys applying the CMR technique (catching-marking-re-catching) the trapped animals received individual marking that facilitated the manifold utilisation of the data. The gender (indicating the state of gravidity and lactation as well in the case of female individuals), the age, the weight, the essential dimensions of the body, the individual code of the trapped animals, as well as the trap number were recorded during the trapping process.

The animals found dead in the traps were dissected, in the course of which the external examination (the integument and the external apertures of the body) was performed then the abdominal cavity, the spleen, and the complete digestive tract, the genito-urinary tracts, the respiratory organs, the heart, and the kidneys were examined. The condition of the animals was judged by means of determining the volume of the adipose tissue around the kidneys. Samples were taken from the organs of the carcases showing changes and placed into 8% neutral formaldehyde solution. Bacterium samples were taken from the pharynx

cavity and the spleen to examine the bacterium cultures at 37°C temperature. The identification of the isolated bacteria to genus level was performed on the basis of the morphology, the growing and the coloration (Gram) of the bacterium bed.

Methods of data processing and assessment

The parameters of the animals trapped on the investigated are were recorded in a data base by the author, by means of the Windows Access program. The trapping parameters stored in the data base were analysed in accordance with Manly-Parr's Trapping Calendar method. On the basis of this assessment the minimum number alive (MNA) values were defined for the individual populations on a monthly basis. The percentage proportion of the insectivores (*Insectivora*) and rodents (*Rodentia*), as well as the percentage rate of the genus within the two mentioned orders were defined on every sampling site. For the characterisation of the small mammal community on the sample site the Shannon-Weaver's diversity was calculated on a yearly basis.

For the specification of the space-time pattern of the individual species, the author calculated the rate of aggregation of the individuals, determined by Lloyd's patchiness index. The affect of the species in the community to one another was characterised by means of the value of Metzgar index calculated for species-pairs, on the basis of the trap-usage, i.e. special overlapping values for the whole area of the quadrate. The data for the months and years characterised by aggregation were analysed by means of graphic diagrams perfectly illustrating the typical habitat preferences of diverse species.

The author used closed population models to correct the inaccuracy of MNA values underestimating the actual values of the populations by 15 to 20% on the basis of literary figures. On the contrary, the importance of the environmental factors playing roles actually in the regulation of populations, as

well as the impacts of such factors on the survival rate of individuals and the likelihood or probability of trapping thereof were examined through open population models, for the calculation of which the MARK program was applied.

The findings of the animals' anatomical dissecting were processed for each species, and such data were compared in the dissertation with the trend of the population dynamics of the species in question, examining by this means the headcount regulating role of the "live etiological factors".

3. Theses of the dissertation

1.) The cutting sites of the forests create intermittent living space for small mammal communities that would not find optimal and vital conditions in the original, closed stands. The mentioned cutting sites, as ecological stepping-stones ensure the continuity of spreading for several small mammal species occurring in Hungary. Such species are, for instance, the field vole (*Microtus agrestis*), the common vole (*Microtus arvalis*), the harvest mouse (*Micromys minutus*) or the bicoloured white-toothed shrew (*Crocidura leucodon*).

2.) The dissertation provides evidence for the fact that a stable stock of field vole (*Microtus agrestis*) live in the area of the Sopron-hills, in certain cases with an extremely high number of individuals, that presumably may be attributed to the spreading of the population in East Austria in eastern direction. The mentioned species occurs in the western cutting site of the hills. In the West-Hungarian region, the most wide-spread species of the new artificial forest plantations is the yellow-necked mouse (*Apodemus flavicollis*) being capable of sudden gradation. The headcount dynamics of the mentioned species has a determinant effect on the headcount of other species of the small mammal community living on the same area as the yellow-necked mouse.

3.) The author revealed that the body mass values of the small mammals living on the cutting sites, in the case of dominant species of the habitats, are principally influenced by the actual headcount of the own population of the particular species. Additionally, the volume of nutrition may also act as a restricting factor, but the effect of this latter is generally detectable only in the late autumn and winter months. At the same time, in the case of subdominant or rare species being sensitive to competition pressure (e.g. *Microtus agrestis*) a high rate of dominant species appears as restrictive factor, influencing negatively the body mass development of individuals.

4.) The dissertation highlights the fact that the aggregation of the individuals of certain species is inversely proportional with the number of individuals in a population. Exponential relation is observable between the two value lines. Such relation is determined by the author in the case of the yellow-necked mouse (*Apodemus flavicollis*), the field vole (*Microtus agrestis*), and the bank vole (*Clethrionomys glareolus*). The age distribution and genital proportion of the populations, however, indicate a seasonal balance on the cutting sites surveyed in the framework of this dissertation.

5.) By means of closed population models the author corrected the inaccuracies of "minimum known headcount of individuals". On the basis of observations, the author has defined the rate of underestimation of MNA values higher, namely 20 to 40%, compared to the literary data.

6.) Examining the trapping and survival probabilities of individuals by means of open population models the dissertation indicates that in the case of the small mammal species of cutting sites similar to the investigation area the probability of trapping and survival may be varied annually and per species, but it is true in all cases that the headcount of the dominant species highly influences the survival and trapping probabilities of individuals representing subdominant species, or species with less individual headcount. According to inspections surveying the variations of trapping probability (p) and survival rate (Φ) of each

gender (A) and age (S) groups of yellow-necked mouse (*Apodemus flavicollis*) in time, it may be stated that the survival and trapping probabilities of this species can be best characterised by the **Φ(., A, S), p(t, A, S)** model. The outcome indicates that the survival rate in the case of this species can be considered to be constant in time during the year although it depends on the age and gender of the individual. On the contrary the probability of trapping is varying in time, and additionally, it is different with respect to certain gender and age groups.

8.) It is stated in the dissertation that besides the competitive effect of the coexistent species, the predation impact on the changes in the population dynamics of small mammal communities as well as the environmental factors affecting them, the so-called *live etiological factors* also have stock regulating influence. Namely, in populations there exist *facultative pathogens* that cause sicknesses in the organisation of a healthy animal only if the population reaches the balance headcount (K) characterising the K-strategist species. However *obligate pathogens* need to be brought in the population in order that they may have an impact, but following their appearance they will surely cause diseases in all cases, if the density of population facilitates the infection.

9.) The author emphasises that for the purpose of nature conservation utmost care must be taken when trapping small mammal species to proper ventilation of the trap, as well as to carefully selecting the bait in order to prevent the death of protected species. The application of baits with high salt content must be avoided in the case of the protected sensitive shrew species, to avoid the risk of acute salt poisoning. According to the figures and data of the dissertation the due observation of the aforementioned recommendations may diminish the rate of unexpected mortality by 30 to 50%.

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