平成２２年度　環境科学院　修士論文内容の要旨

Modeling decision-making about roost selection in Fission-Fusion bat society
(離散―集合社会を形成するコウモリにおけるねぐら選択の数理モデル)

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Bat societies represent one of the most sophisticated ‘fission-fusion’ societies: social groups divide into small parties with several individuals, and fuse again to form a large group. How and why the fission-fusion patterns emerge in bat populations is still poorly understood. In this study, we developed a computational model about roost selection in bat populations to theoretically explore the mechanism and adaptive significance of fission-fusion behavior in bat populations by using indexes of fitness. In the model, we assumed followings: bat individuals disperse to inspect quality of potential roost they may switch. The bat brings new information about the quality of potential roost to her current roost, and shares the information with other members in the same colony. The inspection process includes noise that follow Gaussian distribution with mean of 0 and standard deviation of s. Each bat learns qualities of each potential roost by sharing information, and decides which roost they should switch by comparing these qualities. The important parameter is learning rate. If learning rate is high, bats use recent information and forget the past information quickly. In contrast, if learning rate is low, bats remember the past information as well as the recent information. We assume that bats enjoy high fitness when they are in a roost with a high quality. We classified patterns of group formation according to sub-colony density and mean sojourn time. The results of computer simulation showed that group division and aggregation frequently happen (fission-fusion behavior) when inspection error is large and learning rate is intermediate or small. All the members of group stay at the same roost (settlement pattern) when inspection error is small. Bats change their roost in synchronized manner with all of the group members (synchronized migration pattern) when both inspection error is large and learning rate is large. To assess how the patterns of roost selection affect the fitness of the bat colony, we incorporated the disease spreading dynamics into the original model by combining SIS (susceptible / infected / susceptible) model and learning model. When bat individuals are infected by disease, survival and birth rate decrease and overall fitness also decreases. The extent of fitness reduction due to disease infection is called cost of infection. We found that when the cost of infection was small, individuals in a settlement pattern attained the highest fitness because information exchange about roost quality is the most efficient in this grouping pattern. As the cost of infection increased, fitness of fission-fusion behavior exceeds the one of settlement pattern. This is because, in fission-fusion pattern, split into small groups effectively hampers disease spreading, and fusion into a large group enhances the quality of information exchange. From these results, we conclude that fission-fusion behavior improve the fitness of colony with a combination of benefit from information transfer about roost quality and cost derived from spread of infectious diseases.