学 位 論 文 要 旨

Evolutionary impact on Amami tip-nosed frog by an invasive predator mongoose and implication for the eradication project
外来捕食者マングースによるアマミハナサキガエルへの進化的影響と根絶事業への提言

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Human-caused disturbances degrade global biodiversity and one of the main drivers is biological invasions. It is well known that invasive species cause negative impact on native ecosystem while understanding of the impact and the eradication measures are still insufficient. It is necessary to progress the understandings about the impact by invasive species and develop the measures to eradicate the invasive species.

Most previous studies mainly focused on the impact on abundance and distribution of native species by invasive species, while it is gradually revealed that such a demographic impact can work as a natural selection and evolutionary change of native species can occur in rapid time scale. However there is few study reporting such an evolutionary impact on native species caused by invasive species. It is necessary for understanding a long-term effects by invasive species to reveal an evolutionary impact.

In 1979, 30 small Indian mongoose was introduced to Amami Island, southern Japan and decreased native biota seriously. In 2000, Ministry of the environment started eradication project of mongoose and successfully removed most of them. Owing to the project, native biota recovered. Because mongoose expanded concentrically and they did not spread whole island, spatial gradation of predation pressure by mongoose was emerged. I expected if strong predation pressure by mongoose caused evolutionary change in native species, I could detect them even after mongoose had been mostly removed. I examined whether trait change in behaviour (Flight Initiation Distance (FID): a measure of the anti-predator response (sensitivity to predator attack)), morphology (tibia length, thigh length) and performance (burst movement ability, endurance capacity) were explained by spatial gradation of past predation pressure by invasive mongoose. I used a spatial model based on generalized least-squares regression (GLS) methods to test the effects of various potential factors on each trait. The result in behaviour showed that FID of native frog increased with increasing the effect of mongoose, which represented that native frog got more sensitive under the effect of mongoose got stronger. The result in morphology showed that both tibia length and thigh length got longer with the effect of mongoose got stronger. The result in performance showed that burst movement ability did not change while endurance capacity got higher with the effect of mongoose got stronger. These results summarized that spatial heterogeneous behavior (anti-predator response), morphology (tibia length, thigh length) and performance (endurance capacity) of native frog can be explained by spatial gradation of past predation pressure by invasive mongoose.

Although I did not directly address whether the change in behaviour, morphology and performance were genetic or plastic, I believed that it was driven by genetic changes, I examined them well after the population size and distribution range of native frog had recovered (i.e. at least 5 years had passed after the mongoose density became extremely low). Thus these results showed that strong predation pressure by invasive mongoose worked as a natural selection and evolutionary impact on behaviour, morphology and performance of native frog have occurred. These results suggest that even if population size and distribution range of native species recovered owing to eradication project, evolutionary impact are likely to remain as trait change in behaviour, morphology and performance. It would be future studies examining how long these trait change persist, ecological meaning of these trait change in species (e.g. dispersal, food habit) and in community (e.g. cascade effects on lower trophic levels).

Though the eradication project successfully achieved extremely low mongoose density, eradication had not completed. Because it is generally difficult to capture animals in low density, effective capturing strategy is needed to complete the project. I examined what factors related to capture levels of invasive mongoose by Generalized linear models. I summarized that after achieving extremely low density of invasive mongoose, geographical condition and trapping bias of human accessibility can decrease the effectiveness of mongoose capturing. In final stage of the eradication project, trapping in strict geographical area would be needed to eradicate mongoose completely. It is important to conduct feedback management in response to mongoose population size, temporally and spatially.