Ground Beetle Communities and Urbanization

Subjects: Urban Studies
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Urbanization involves the profound alteration of original habitats and causes habitat loss and biodiversity decline. Urban areas and roads in land use mainly have a negative influence on ground beetles. Paddies, fields, parks and green spaces, and open space were positively correlated with species richness of forest species and large-sized species, and open space was positively correlated with species richness and the density of open land species. However, ground beetle communities in different areas of varying sizes did not group separately. These results suggest that changes in paddies, fields, parks and green spaces, forests, and open space associated with the expanding urban area and road greatly influenced species composition, and the community structure remained similar.

ground beetle urbanization land use urban green area GIS

1. Introduction

Urbanization drives global environmental changes and is one of the major anthropogenic activities that impacts biodiversity and ecosystem processes [1][2][3]. Currently, 55% of the global human population lives in urban areas, and this trend is expected to continue in the coming decades [4]. Urbanization has a significant impact on abiotic and biotic factors in nature and leads to substantial changes in natural habitats with profound effects on wildlife and their activity pattern, spatial distribution, phenology, productivity, and biotic interactions [5][6][7]. The diversity and community structure of wildlife will change significantly in urban habitats compared with rural ones [3][8][9][10].

Ground beetles are useful bio-indicators because they are sufficiently varied both taxonomically and ecologically, abundant, and sensitive to the anthropogenic effect [11][12]. Urbanization has a huge effect at various levels of the biological organization on ground beetles in urban habitats [13]. Ground beetles with large body sizes, predatory feeding habits, strict forest habitat requirements, and poor dispersal ability were most sensitive to urbanization [6]. Many studies have been conducted to clarify the relationships between ground beetle diversity and the effect of urbanization according to the urban–rural gradient [8][14][15].

There is a need for studies on the responses of ground beetle communities according to different areas and land use.

2. Response of Ground Beetle (*Coleoptera: Carabidae*) Communities to Effect of Urbanization in Southern Osaka

Unexpectedly, species richness, density, body size, habitat type, species diversity, and species evenness did not differ between the different urban green areas. Furthermore, the community structure of ground beetles was similar in different areas. It seems that ground beetle communities formed by the effect of urbanization may become similar regardless of area. Ishitani et al. [16] showed that in urban habitats, large-sized forest specialists may completely disappear, whereas small-sized forest specialists and medium-sized habitat generalists were in higher abundance. Fragmentation and isolation as well as lower habitat quality of remnant urban habitat patches may cause generalist species to increase [13]. Lee and Ishii [17] studied riverbank, urban park, rice paddy, and coppice remnants in southern Osaka and showed that forest specialist, open-habitat specialist, large-sized, and endemic species have been reduced by urbanization. In our study, four large-sized forest species (*Carabus yaconinus*, *Leptocarabus kumagaii*, *Haplochlaenius costiger*, and *Galerita orientalis*) were recorded. Ishitani et al. [16] considered *C. yaconinus* and *H. costiger* as forest generalists. *L. kumagaii* and *G. orientalis* might be forest generalists based on collected records such as riverbanks, paddy fields, and urban green areas around forests in previous studies [18][17][19]. Among three dominant species, *Synuchus nitidus* and *Dolichus halensis* were considered forest generalist and habitat generalist, respectively [17]. This result seems to be consistent with previous studies.

Remnant forests may be one of the reasons why ground beetle assemblages were similar regardless of area. Although SU was the smallest area in this study, 22 ground beetle species were recorded, and this value was higher than the average (20 species). SU is located near Hatadaimyou temple where there are remnant forests dominated by evergreen oaks (*Quercus* species). Forests associated with shrines and temples are recognized as important components of urban green spaces and can potentially function as a key role in ecosystem conservation in urban areas [20]. Although urban forests have less species richness and abundance and different species composition and dominant species compared with rural forest, they can provide habitats for wildlife and potentially be used as stepping stones in the urban green space network [20][21]. Connectivity for ground beetles in urban areas will be another important factor. Both UM and TA are located in landfill areas. However, species richness in UM was the highest, whereas that in TA was the lowest. UM is located near the mouth of Yamato River, whereas TA is connected to inland with two bridges. Yamato River is a class A river in the Kansai region and flows from Nara and Osaka Prefectures to the Osaka Bay [19]. Lee and Ishii [19] reported that 53 ground beetles were found in various places such as gravelly riverbeds, sand lands, and grassy riverbanks in Yamato River. Among ground beetles found in UM, 86% species composition was the same as that found by Lee and Ishii [19]. In addition, this result showed that *Carabus yaconinus* was collected in IZ, KU, and KM, which are connected to natural habitats. Lee and Ishii [17] reported that *Carabus yaconinus* was not found in urban parks which are separated from natural forests in southern Osaka. Lee and Kwon [22] suggested that short-winged *Carabidae* species, poor dispersers, disappear in fragmented forests. These species may not be able to disperse through corridors or stepping stones. Our results suggest that remnant forests and connectivity will contribute to keeping ground beetle diversity in the urban area.

Although there is no significant relationship between ground beetle communities and area, community indices were positively or negatively correlated with area. Among them, ground beetle species richness, species diversity, and species evenness showed positive correlations with area. Urban area and road were negatively correlated with species richness of all species, small-sized species, medium-sized species, large-sized species, open land species, and density of large-sized species and open land species, and species diversity and species evenness. Koivula and Vermeulen [23] showed that carabid populations isolated by highways were significantly affected by patch size, and forest carabids rarely cross roads. Keller and Largidèr [24] reported that the isolation caused by major roads has a significant impact on the genetic structure of ground beetle populations. Urbanization substantially influences all levels (species group, population, and community) of the biological organization of ground beetles living in urban green areas [13]. Our results were consistent with previous studies. However, there are no uniform patterns in year, field, park and green space, forest, or open space with community index. Future studies should increase the sample size to enhance the statistical rigor.

3. Conclusions

Our results suggest that there is no significant relationship between ground beetle communities and area. However, community indices were positively or negatively correlated with area. The changes in paddy, field, park and green space, forest, and open space associated with the increasing urban area and road greatly influenced species composition and the similar community structure remained. Remnant forests and connectivity were important factors to conserve ground beetle diversity in urban areas. The urban green space network will be essential for biodiversity conservation in an urban ecosystem. As cities expand, decision-makers should invest in preserving and restoring remnant habitats and their connectivity to the urban green space network.

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