The Fauna of Ground Beetles (Coleoptera: Carabidae) in Paddy Fields, Four Province, Korea

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Abstract: A total of 29 species belonging to 17 genera of 10 subfamilies were identified from 277 collected ground beetles in paddy fields. (Species richness was high in Harpalinae (9 species, 31.0%), Pterostichinae (8 species, 27.6%), Callistinae (4 species, 13.8%), Nebriinae (2 species, 6.9%), and other subfamilies (1 species, 3.4%). The subfamily Harpalinae had the most number of individuals (24.5%), followed by 63 Callistinae (22.7%), 59 Zabrinae (21.3%), and 48 Brachininae (17.3%). The dominant species was *Amara congrua* (59 individuals, 21.3%) and the subdominant species was *Chlaenius pallipes* (49 individuals, 17.7%). Between Site 4 (Chuncheon-city, Gangwon-do) and Site 5 (Gangneung-city, Chuncheon-city, Gangwon-do) and between Site 1 (Yuseong-gu, Daejeon metropolitan-city) and Site 2 (Danyang-gun, Chungcheongbuk-do) had the highest similarity in the result of cluster analysis using the surveyed ground beetles.

Keywords: Carabidae, Monitoring, Inventory, Diversity, Paddy Fields, Field

Introduction

A paddy field is a flooded parcel of arable land used for growing rice and other semi-aquatic crops. Paddy fields account for approximately 15% of the global arable land area (Huke and Huke, 1997, Maclean et al. 2002). In South Korea, paddy fields are the most common type of agricultural land, covering approximately 60% of all agricultural land (Do et al., 2011). Paddy fields provide forage, refuge, and a place for overwintering or estivation for many species, including soil macrofauna and microfauna, insects, and birds (Kato, 2001, Thomas et al., 2004, Katoh et al., 2009, Paik et al., 2009). Among these, ground beetles except Halpalinae and Zabrinae, are predaceous and a natural enemy of small-sized invertebrates including earthworms, aphids, moths and snails, that play a very important role in the ecosystem (Lövei and Sunderland, 1996; Holland, 2002) and this considers ground beetles an important natural enemy group in mountainous areas and agricultural environment (Kromp, 1999; Holland, 2002). More specifically, in wet habitats such as paddy fields, abandoned paddy fields, wet grasslands, riversides, and lowlands with different vegetation, lower soil pH, and higher soil moisture than surrounding areas, ground beetles can be characterized by species composition, food preference, and habitat selection (Hengeveld, 1987, Luff et al., 1989, Eyre et al., 1990, Do and Moon, 2002, Do et al., 2007). Some of these studies have examined the effectiveness of restoring abandoned paddy fields with respect to improved agricultural landscape biodiversity (Comín et al., 2001, Yamada et al., 2007, Uematsu et al., 2010). The study was performed to make specific inventories of ground beetles in paddy fields and to provide fundamental information and diversity on community structure of ground beetles.

Materials and Methods

Survey Sites and Collecting Method

Ground beetles mainly live on the surface of the paddy fields and pitfall traps are installed considering these features. There are 10 traps at 10 m interval for each and the top of the trap is placed at the same height of the surface of the paddy field. Transparent plastic bottles with 10.0 cm height, 7 cm diameter and 200 mL volume were used as traps and had plastic filters with 6 holes at 2 cm diameter to prevent from mid- and large-sized animals like rodents. Traps were filled with preservatives (50 mL, environmentally friendly antifreeze, Super-A Green, SK chemicals, Korea).
Pitfall traps were collected approximately every four weeks between May to July 2011. We surveyed at the following five sites according to the administrative district in Korea (Fig. 1);

1. Seongbuk-dong, Yuseong-gu, Daejeon metropolitan-city
2. Daedae-ri, Gagok-myeon, Danyang-gun, Chungcheongbuk-do
3. Sinsong-ri, Seocheon-eup, Seocheon-gun, Chungcheongnam-do
4. Yeochan-ri, Gujeong-myeon, Gangneung-city, Gangwon-do
5. Bangdong-ri, Seo-myeon, Chuncheon-city, Gangwon-do

**Identification**

Collected ground beetles were brought to the laboratory and dried, mounted, and identified to the species level under a dissecting microscope (Olympus, SZ40, ×20). Identification was performed according to Habu (1967, 1973, 1978), Kwon and Lee (1984), and Park and Paik (2001), Löbl and Smetana (2003), and Park (2004). The specimens examined were deposited in the J.Y. Park Collection (JYPC).

**Community structure analysis**

Pielou’s species diversity index (H', Pielou, 1969), McNaughton’s dominance index (DI, McNaughton, 1967), Margalef’s species richness index (RI, Margalef, 1958), Pielou’s species evenness index (EI, Pielou, 1975) and Jaccard’s similarity index (Jaccard, 1908) were calculated and the formulas are as follows:

\[ H' (\text{Species diversity index}) = - \sum \frac{n_i}{N} \log_2 \frac{n_i}{N} \]

\[ n_i \text{ means number of individuals at i-th species and } N \text{ means total number of individuals (Pielou, 1969).} \]

\[ DI (\text{Dominance index}) = \frac{n_1 + n_2}{N} \]

\[ n_1 \text{ means number of dominant species individuals, } n_2 \text{ means number of subdominant species individuals, } N \text{ means total number of individuals (McNaughton, 1967).} \]

\[ RI (\text{Species richness index}) = \frac{S - 1}{\ln(N)} \]

\[ S \text{ means total number of species and } N \text{ means total number of individuals (Margalef, 1958).} \]

\[ EI (\text{Evenness index}) = \frac{H'}{\log_2 S} \]

\[ H' \text{ means species diversity index and } S \text{ means total number of species (Pielou, 1975).} \]

**Results**

A total of 29 species belonging to ten subfamilies were identified from 277 collected ground beetles in paddy fields (Table 1). Nine species of Harpalinae recorded the highest number of subfamily species, followed by 8 Pterostichinae, 4 Callistinae, 2 Nebrinae and 1 other subfamily, respectively. The subfamily Harpalinae had the most number of individuals (24.5%), followed by 63 Callistinae (22.7%), 59 Zabrinae (21.3%), 48 Brachininae (17.3%), 19 Pterostichinae (6.9%), 8 Licininae (2.9%), Nebriinae (2.5%), 3 Patrobinae (1.1%) and 1 other subfamily (0.4%), respectively (Fig. 2, 3).

At the genus level, 5 species of Harpalus, 4 species of Chaenius, 2 species of Anisodactylus, Nebria, Colpodes and Pterostichus genus were collected. Also, the other 11 genera were for 1 species, respectively (Fig. 4). At the genus level, 63 individuals of Chaenius and 59 individuals of Amara genus were collected, followed by Pherosopsopus and Harpalus with 48 and 43, respectively (Fig. 5). The number of ground beetles species in each surveyed site were from 6 (Site 1, 3 Yuseong-gu, Daejeon metropolitan-city, Seocheon-gun, Chungcheongnam-do) to 12 (Site 2 Danyang-gun, Chuncheongbuk-do, Fig. 6). The dominant species was Amara congrua (59 individuals, 21.3%) and the subdominant species was Chaenius pallipes (49 individuals, 17.7%). The Dominance index (DI) for each sites were 0.45 to 0.88, and the average dominance index was in the order of St. 3 > St. 5 > St. 1 > St. 4 > St. 2, respectively.

The species diversity index (H') for each sites were 1.26...
to 2.98, and the average species diversity index was in the
order of St. 2> St. 4> St. 5> St. 1> St. 3, respectively.

The species richness index (R') for each sites were 1.23
to 2.64, and the average species diversity index was in the
order of St. 2> St. 4> St. 5> St. 1> St. 3, respectively.

The species evenness index (E') for each sites were 0.49
to 0.89, and the average species diversity index was in the
order of St. 4> St. 1> St. 2> St. 5> St. 3, respectively (Table
2).

Between Site 4 (Chuncheon-city, Gangwon-do) and Site
5 (Gangneung-city, Chuncheon-city, Gangwon-do) and between Site 1 (Yuseong-gu, Daejeon metropolitan-city) and Site 2 (Danyang-gun, Chungcheongbuk-do) had the similarity in the result of cluster analysis using the surveyed ground beetles (Fig. 7).

Acknowledgments

This study was supported by and carried out under the financial support of National Institute of Environmental Research (NIER).

References


Received: 8. Apr. 2013
Revised: 6. May 2013
Accepted: 7. May 2013