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Summer Dung Beetle (Coleoptera, Scarabaeidae) Fauna of Tohoku University Agricultural Farm, Northern Japan

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Abstract

The summer fauna of dung beetles in the Tohoku University Agricultural Farm in northern Honshu was studied by means of pitfall traps baited with fresh cow dung. A total of 149 individuals comprising five genera and ten species belonging to three subfamilies of Scarabaeidae were collected. The spatial distribution of each species is discussed in relation to vegetation types and microenvironmental open-shaded gradients.

Key Words: Dung beetle fauna, Tohoku, spatial distribution.

Introduction

The rich fauna of scarabaeid dung beetles in dung drops of large herbivorous mammals provides a suitable system for studies of interspecific competition and coexistence. Many attempts have been made to clarify the faunal composition and interspecific relationships of dung beetle populations in various parts of the world (Hanski 1980 a, b, 1983, Hanski and Koskela 1977, Holter 1982, Koskela 1979, Koskela and Hanski 1977, Landin 1961, Merrit and Anderson 1977, Peck and Forsyth 1982). In Japan, too, there are several reports dealing with the faunal composition of dung beetle populations (Goto 1957, Hayakawa 1977, Hosogi 1985, Mizuta 1975, Mizuta *et al.* 1972, Sakanoshita *et al.* 1979, Tani 1966, Togashi 1980, Yasuda 1984, Yoshida and Katakura 1985). As a supplement to these previous records, this paper describes the summer dung beetle fauna of the Tohoku University Agricultural Farm, Miyagi prefecture, northern Honshu, with reference to the spatial distribution of each beetle species.

Area Surveyed and Methods

A preliminary sampling of dung beetles in the Kitayama district of the Tohoku University Agricultural Farm was made in the summer of 1986. The Kitayama district is located 3 km northeast of Naruko (38°45′N, 140°45′E), Miyagi prefecture, northern Honshu, Japan. The district, on the eastern side of the Oou mountains, covers an area of 1,600 ha and ranges between elevations of 144 m and 622 m.

Temperate deciduous broad-leaved trees and some conifer trees dominate the slopes while pastures and grasslands cover the plateaux.

Beetles were collected in pitfall traps (215 ml polyethylene cups, 7 cm diameter, 9 cm deep) baited with approximately 50 g of fresh cow dung in the bottom. Four study stations were chosen in areas of different vegetation and elevation as follows:

A: Pasture (alt. 230 m) surrounded by crop fields situated near buildings of the experimental farm. Narrow shelter belts of Cryptomeria (*Cryptomeria japonica*) were adjacent to the pasture. Traps were settled in the pasture, a Cryptomeria belt and their boundary.

B: Hill grassland (alt. 570 m). Patches of trees (maples, oaks, etc.) accompanied by weigela (*Weigela hortensis*) and bracken (*Pteridium aquilium*) undergrowth were scattered among the grassland. Traps were set in the grassland, a tree patch and their boundary.

C: Marginal pine forest (alt. 540 m). An afforested pine forest (*Pinus densiflora*, 5–10 m high) between the hill grassland and the broad-leaved forest on the slope (approximately 700 m × 200 m wide). A thin tree canopy was accompanied by a dense undergrowth of mainly grass for cattle, with a mixture of bracken, weigela and other plants. Traps were set in open, semi-open and shaded sites.

D: Deciduous broad-leaved forest (alt. 550 m). A secondary forest of the Japanese beech (*Fagus crenata*) with a dense canopy and a thick litter layer, but sparse understory vegetation (mainly ferns and a poison ivy). A cutover, where young trees of Cryptomeria (ca. 50 cm high) were planted, was adjacent to the forest. Traps were settled in the forest, the cutover and their boundary.

Accordingly, the stations were chosen among grasslands (A and B), a marginal pine forest (C) and a broad-leaved forest (D). In all the stations, cows were pastured during the summer season. In each station (A–D), trap sites were settled in three different environments, namely, open, semi-open and shaded areas. At each site, five traps were installed at 1 m intervals. A total of 60 traps were thus set on August 6, 1986 and removed in the following afternoon. During the trapping period, the weather varied between cloudy and clear, and the air temperatures fluctuated between 21.3°C and 25.7°C. Additional random hand samplings were made near the trapping sites during the settlement and removal of the traps.

Results and Discussion

Species composition.

A total of 149 scarabaeid dung beetles comprising eight species in three subfamilies were collected by the pitfall traps. In addition, two species were collected by hand sampling. A list of the species abundance is show in Table 1. Based on the condition of the ovaries and the degree of cuticular wear, all species collected appeared to be reproductive period. New adults of *Aphodius sublimbatus* that are known to emerge in mid summer (Kiuchi 1979, Yoshida and Katakura 1985) were not collected. Hayakawa (1976, 1977), studying the phenologies of dung beetles in Iwate prefecture, northern Honshu, recorded a total of thirteen species

Table 1. The list of dung beetles collected by pitfall traps and hand sampling (asterisked) in the Tohoku University Agricultural Farm during August 6–7, 1986

Species	No. of individuals collected	Species	No. of individuals collected
Geotrupes auratus Motschulsky	22	*O. ater* Waterhouse	22
Copris acutidens Motschulsky*	1	*Aphodius haroldianus* Balthasar	14
Liatongus phanaeoides (Westwood)	13	*A. urostigma* Harold	4
Caccobius jessoensis Harold	61	*A. uniplagiatus* Waterhouse	4
Onthophagus lenzii Harold	9	*A. sublimbatus* (Motschulsky)*	10

in early August. Of those, the following seven species were also collected during this study: *Onthophagus ater, Liatongus phanaeoides, O. lenzii, A. uniplagiatus, A. urostigma, A. haroldianus, Caccobius jessoensis.* In addition, two species, *Copris acutidens* and *A. sublimbatus,* which, according to Hayakawa (1976, 1977) disappear by August in Iwate prefecture were collected in the Kitayama district.

Habitat preference.

Since some traps were damaged by cows and other vertebrates, probably foxes, the number of individuals per trap was calculated and used for a comparison between stations and between sites, instead of the total number of individuals of each species collected at each site (Table 1). The pattern of spatial distribution was examined in two dimensions: 1) Preference for macrohabitats (low altitude grassland, high altitude grassland, marginal forest and broad-leaved forest). 2) Preference for microhabitats (open, semi-open and shaded sites).

1) Preference for macrohabitat. The total number of individuals collected per trap was similar in the grasslands (A and B) and the marginal forest (C), (Table 2: $N_A=1.47$, $N_B=2.33$, $N_C=1.87$), whereas a considerably larger number were collected in the broad-leaved forest (D), ($N_D=5.46$). The species composition was different among stations. The pattern of spatial distribution of species with respect to the macrohabitats was divided into the following four types: a) Grassland species: *O. ater, O. lenzii, A. urostigma, A. uniplagiatus.* b) Marginal forest species: *Geotrupes auratus.* c) Forest species: *C. jessoensis, L. phanaeoides.* d) Eurytopic species: *A. haroldianus.*

2) Preference for microhabitat. The total number of beetles collected per trap was considerably larger in the open sites than in the semi-open and shaded sites (Table 2: $N_{Op}=4.67$, $N_{Sh}=2.15$, $N_{So}=1.80$). The microhabitat preference of each species was as follows: a) Open habitat species: *C. jessoensis, A. haroldianus, A. urostigma, A. uniplagiatus, O. lenzii.* b) Semi-open habitat species: *L. phanaeoides* c) Shaded habitat species: *O. ater, G. auratus.*

Interestingly, there seems to be little relationship between the preference for vegetation type and that for the open-shaded gradient (Table 3). For example, *C. jessoensis,* the most abundant of all species, was concentrated in a small open area surrounded by forest, while many *O. ater* were in a small shaded area in the

Table 2. The number of dung beetles per trap collected in various environments in the Tohoku University Agricultural Farm during August 6–7, 1986. Op: open. So: semi-open. Sh: shaded. A: Grassland (low altitude). B: Grassland (high altitude). C: Marginal pine forest. D: Secondary forest. Brackets: number of traps

Species	Macrohabitat				Microhabitat			Total
	A (15)	B (12)	C (15)	D (13)	Op (15)	So (20)	Sh (20)	per trap (55)
A. uniplagiatus	0.27	0.00	0.00	0.00	0.27	0.00	0.00	0.07
A. urostigma	0.27	0.00	0.00	0.00	0.27	0.00	0.00	0.07
O. lenzii	0.33	0.25	0.07	0.00	0.40	0.05	0.10	0.16
A. haroldianus	0.07	0.42	0.33	0.23	0.53	0.15	0.15	0.25
C. jessoensis	0.07	0.42	0.27	3.92	2.87	0.55	0.35	1.11
O. ater	0.47	0.92	0.13	0.15	0.13	0.30	0.70	0.40
G. auratus	0.00	0.25	1.00	0.31	0.07	0.25	0.80	0.40
L. phanaeoides	0.00	0.08	0.07	0.85	0.13	0.50	0.05	0.24
Total per trap	1.47	2.33	1.87	5.46	4.67	1.80	2.15	2.71

Table 3. The spatial distribution of dung beetles with respect to the open-shaded gradient and vegetation type in the Tohoku University Agricultural Farm in the summer of 1986

Vegetation type	Microhabitat		
	Open	Semi-open	Shaded
Grassland	*O. lenzii* *A. urostigma* *A. uniplagiatus*		*O. ater*
Marginal forest			*G. auratus*
Forest	*C. jessoensis*	*L. phanaeoides*	
Eurytopic	*A. haroldianus*		

grassland. It has been said that the distribution of dung beetles in the temperate zone is mainly determined by abiotic factors such as temperature and humidity (Landin 1961, Meritt and Anderson 1977), and the spatial patterns show no clear signs of competitive interactions (Holter 1982, Hanski 1980 a). Although preliminary in nature, the result presented here appear to support the view that the spatial distribution is determined by physical microenvironmental factors.

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