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Diversity and Abundance of Ground-beetles (Coleoptera) in Mt. Gabjangsan, Korea

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보행성 딱정벌레류의 다양성 및 풍부도에 관한 연구
-경북 상주시 갑장산-

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ABSTRACT

Diversity and altitudinal distribution of the ground-beetles including Silphidae were investigated on Mt. Gabjangsan, Sangju city, Korea. Of the collected 10 species belonging to 3 families, *Synuchus cycloderus* was the most abundant species and *S. nitidus* was the relatively more abundant than the other species. The highest number collected was at alt. 700 m. Simpson dominance index was 0.66 the highest at 700 m alt., whereas, 0.47 at alt. 800 m, was the lowest. The highest Simpson diversity index was noticed at alt. 800 m (0.53). Also, seasonal indices of diversity and dominance of Simpson and Menhinick index were provided.

Key words : Coleoptera, diversity, ground-beetles, Korea

INTRODUCTION

Ground-beetles are widely distributed in the zoogeographical region of the world. They are found under stones, logs, barks and debris, and most species move actively at night. Their constituent species are usually predacious on many kinds of terrestrial arthropods including insects, earthworm, slugs, and land snails. Most ground-beetle species collected by pitfall traps are endemic because they can not fly with vestigial hind wings (Kwon and Lee 1984, Park *et al.* 1997).

Many indices of insect diversity have been proposed (Pool 1974), and the diversity is most easily defined by the abundance and richness using these formulae. The insect diversity studies to find out at special regions and taxa have mainly been conducted by foreign scientists (Thiele 1977, Robert and Thompson 1977, Ishitani and Yano 1994, Ishitaniet *et al.* 1994). Recently, a few studies of ecological approaches on insect diversity were reported in Korea (Kim and Lee 1992, Kwon 1996, Park and Kwon 1996, Part *et al.* 1997).

This study, as a preliminary investigation of diversity or abundance, was conducted to provide the basic ecological information on ground-beetles at various altitudes in Mt. Gabjangsan, Sangju city, Korea.

MATERIALS AND METHODS

Seven sampling sites were chosen by altitudes from 200 m to 800 m in Mt. Gabjansan (alt. 805.7 m), Korea (Table 1, Fig. 1). Beetles were collected using pitfall traps, which are plastic cups of 7 cm in top diameter and 9.5 cm in height, from August 2 through October 31, 2001. Twenty cup traps were set at each site and the intervals between traps were about 10 m. The attractive bait materials in a cup were 10 ml sugar solution (90 ml of 99% saturated black sugar solution, 8ml of ethyl alchol and 2 ml of acetic acid).

Species diversity was calculated by Simpson diversity and Simpson dominance index and Menhinick index (Brewer *et al.* 1990). The formulae used were as follows:

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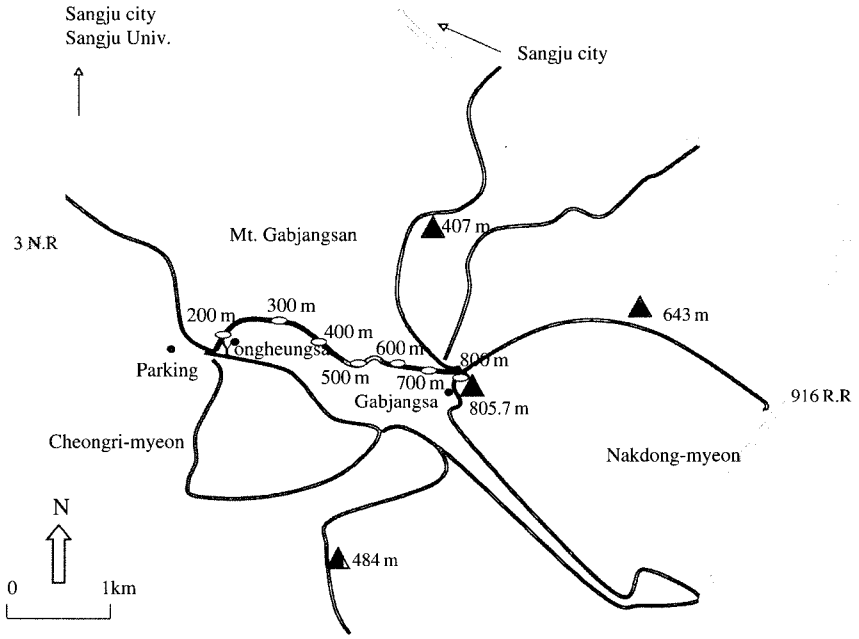

Fig. 1. The map of Mt. Gabjangsan (⬭: sites examined).

Table 1. Plantations and altitudes of sampling sites

Site No.	Plantation	Altitude (m)
1	Pinaceae+Fagaceae	200
2	Pinaceae+Fagaceae	300
3	Fagaceae	400
4	Fagaceae	500
5	Fagaceae	600
6	Fagaceae	700
7	Ericaceae	800

Simpson dominance index (C) = $\Sigma ni\,(ni-1/N(N-1))$

Simpson diversity index (Ds) = $1-\Sigma ni\,(ni-1/N(N-1))$

Menhinick index (SR) = $S/\sqrt{N}$

Dominance (D) = $ni/\sqrt{N}$, when ni is the proportion of the species in total sample, N is total number of individuals, and S is the number of species present.

RESULTS AND DISCUSSION

A total of 6,304 individuals were collected by pitfall traps during August to October, 2001 (Table 2). *Synuchus cyclo-derus* was the most numerous (68.7%, 4,332 ind.), and then *Synuchus nitidus*, the 2nd numerous (1,730 ind.). These two species are the first abundant group (A). The next abundant group (B), *Damaster jankowskii, Synuchus melantho, Nicrophorus* and *Synuchus arcuaticollis* were shown by the numbers from 31 ind. to 74 ind. The least abundant group (C)

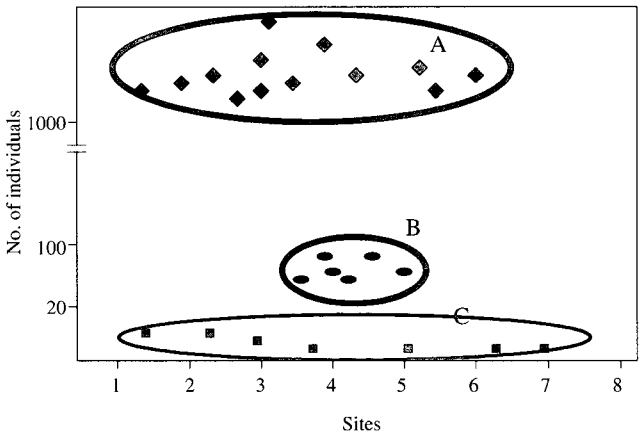

Fig. 2. Abundance grouping of ground-beetles according to different sites of Mt. Gabjangsan, Korea

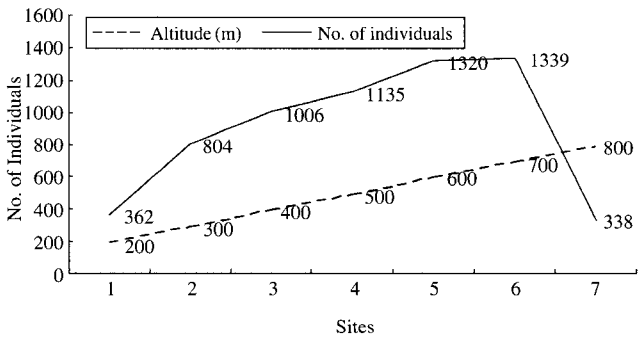

Fig. 3. Altitudinal sums of individuals of ground-beetles collected in Mt. Gabjangsan, Sangju, Korea.

Table 2. The seasonal and altitudinal distribution of beetles in Mt. Gabjangsan, Sangju, Korea, in 2001

Species	Season	Altitude (m)						
		200	300	400	500	600	700	800
Synuchus nitidus	Aug.	24	55	84	23	66	23	12
	Sep.	43	75	190	140	199	90	48
	Oct.	54	63	82	153	92	134	80
	Total	121	193	356	316	357	247	140
Synuchus cycloderus	Aug.	36	126	193	209	180	128	44
	Sep.	82	147	264	306	437	477	77
	Oct.	109	301	149	267	273	460	67
	Total	227	574	606	782	890	1065	188
Synuchus melantho	Aug.	0	0	2	0	6	0	0
	Sep.	0	1	16	14	26	0	0
	Oct.	0	1	0	0	0	0	1
	Total	0	2	18	14	32	0	1
Carabus smaragdinus	Aug.	4	4	0	0	0	4	0
	Sep.	0	2	0	0	0	0	0
	Oct.	0	0	0	0	2	0	0
	Total	4	6	0	0	2	4	0
Damaster jankowskii	Aug.	0	8	6	16	17	14	5
	Sep.	1	0	0	0	1	0	2
	Oct.	0	0	0	0	3	1	0
	Total	1	8	6	16	21	15	7
Synuchus arcuaticollis	Aug.	0	0	0	0	0	0	0
	Sep.	0	3	0	2	6	0	0
	Oct.	1	6	1	0	2	8	2
	Total	1	9	1	2	8	8	2
Nicrophorus quadripunctatus	Aug.	0	0	3	0	0	0	0
	Sep.	0	2	1	3	5	0	0
	Oct.	8	8	13	0	4	0	0
	Total	8	10	17	3	9	0	0
Nicrophorus maculifrons	Aug.	0	0	0	0	0	0	0
	Sep.	0	0	0	0	0	0	0
	Oct.	0	2	1	0	1	0	0
	Total	0	2	1	0	1	0	0
Chlaenius naeviger	Aug.	0	0	0	0	0	0	0
	Sep.	0	0	0	1	0	0	0
	Oct.	0	0	0	0	0	0	0
	Total	0	0	0	1	0	0	0
Lioptera erotyloides	Aug.	0	0	0	0	0	0	0
	Sep.	0	0	1	1	0	0	0
	Oct.	0	0	0	0	0	0	0
	Total	0	0	1	1	0	0	0

under 20 individuals comprised *Damaster smaragdinus, Nicrophorus maculifrons, Chlaenius naeviger* and *Lioptera erotyloides* (Fig. 2).

Until alt. 700 m, the number of individuals increased gradually from 362 ind. to 1339 ind., but at 800 m showed the least number of 338 ind. (Fig. 3). There are parking areas near alt. 200 m, and also the area of openly climbing start course are located at alt. 300 m, so that people's interference and pollutions may have influenced on the activities of beetles. As Dijk (1986) indicated, this different situation by each altitude is maybe caused by weather factors, age of the individuals, individual variability, availability of food, etc. In addition, it has been suggested that the activity in Carabidae be also influenced by the general habitat surrounding the trap and amount of moisture in the soil (Mitchell 1963, Park *et al.* 1997).

Species richness (*SR*) calculated by Menhinick index was 0.12, which is lowest among the Korean data examined. According to the present *SR* data, Mt. Gabjangsan showed

Table 3. Comparison of diversity and abundance of ground-beetles from the different regions in Korea

No. Species	Total individuals	SR[a]	D[b]	Period times	No. site	Habitat	Reference
24	15,692	0.19	0.92	1 year 12 times	16	Gwangneung	Kwon, 1996
7	559	0.30	0.52	1 year 12 times	9	Palgongsan	Kwon *et al.*, 1994
7	872	0.24	0.41	1 year 12 times	3	Palgongsan	Kim et Lee, 1992
9	1,060	0.28	0.45	1 year 12 times	5	Sobaeksan	Kim et Lee, 1992
7	947	0.23	0.66	1 year 12 times	8	Deokyusan	Park *et al.*, 1997
10	6,302	0.12	0.68	1 year 9 times	7	Gabjangsan	This study

[a]Menhinick index (SR) = $S/\sqrt{N}$
[b]Dominance (D) = ni/N

very poor species diversity compared to those of the former results. Dominance index (*D*) of 0.68 ranked 2nd because one species, *Synuchus cycloderus* was collected too numerously (more than 70% of the total collection) to affect the index of *D* of the data collected (Table 3).

As the comparative result of *SR* and *D* with other studies, the species diversity and environmental conditions of Mt. Ganbjansan were recognized low level because *SR* was the lowest and *D* was the secondly highest among the studies.

When calculated by the Simpson dominance method, the seasonal *C* value cannot be noticed among 3 seasons of August (0.55), September (0.54) and October (0.55). But there were differences in families' *C* value: Silphidae showed the highest (0.85), Carabidae, the second (0.70), and Harpalidae, the lowest (0.57), respectively. This situation means in the Silphidae only a few species were collected, and finally high *C* value of specific species or families means poor diversity or poor environmental factors (Brewer *et al.* 1990). Although numbers of individuals at alt. 700 m showed highest (1,339 ind.), 0.66 of *C* value means a low diversity of 1 or 2 species (Fig. 4).

Diversity index (*Ds*) and dominance index are closely related because these values always revealed oppositely (Price 1984). Generally, high *Ds* values mean too much different environmental factors existing at the examined sites. By contrast, high *C* values mean unique environmental factors exist, although numbers collected are limited to special species which are adapted to one simple factor, the species diversity and number of species are low.

The seasonal *Ds* value was very similar to each other; 0.45, 0.46 and 0.45, respectively, and Harpalidea was the highest value of 0.43 because of more species numbers (6 spp.) collected in Harpalidae. Altitudinal *Ds* value was the highest at 800 m, although that site is the smallest in the total number

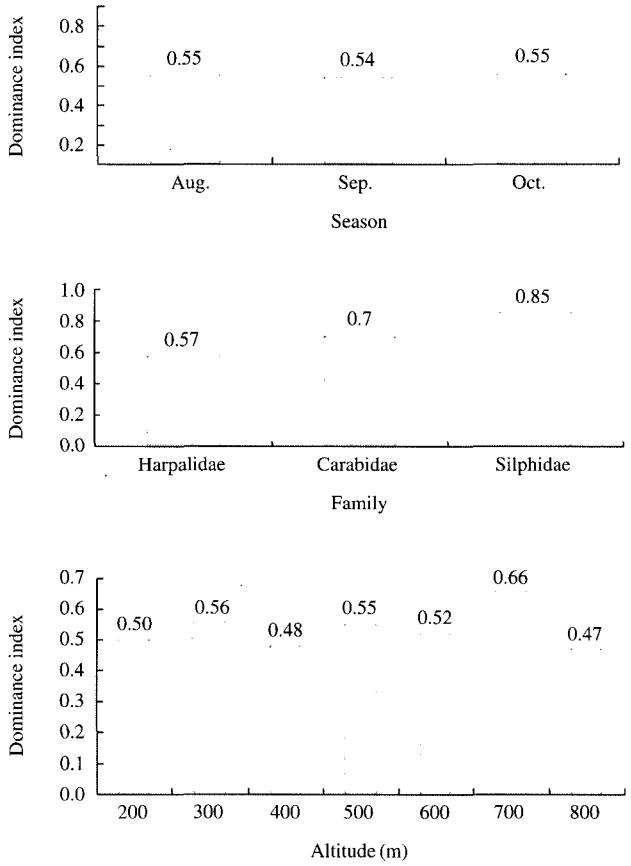

Fig. 4. The Simpson dominance index of ground-beetles collected in Mt. Gabjangsan, Sangju. Korea.

of special species in this study. *S. cycloderus* and *S. nitidus* occupied this site at lower percentages relatively than other sites, which may influence on calculating the index (Fig. 5).

In conclusion, there were 98% of 10 species within harpalids beetles. Among them, *S. cycloderus* was most abundant. Then, *S. nitidus* was more abundant than other species. Simpson dominance index was 0.66 the highest at alt. 700 m,

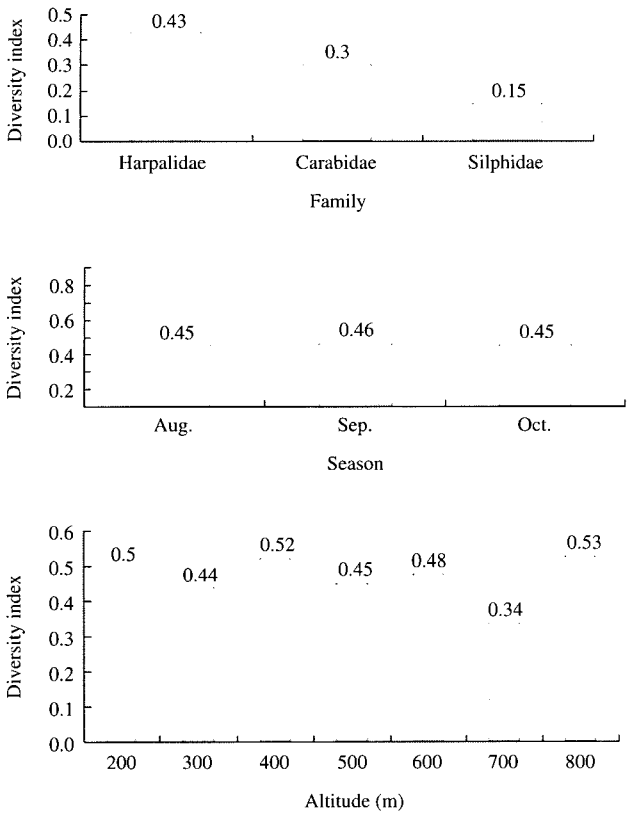

Fig. 5. The Simpson diversity index of ground-beetles collected in Mt. Gabjangsan, Sangju, Korea.

whereas, 0.47 at alt. 800 m, the lowest. However, Simpson diversity index was the highest at alt. 800 m of 0.53. Seasonal simpson diversity indices were from 0.45 to 0.46 in which the difference was not recognized from August to October, 2001. However, the differences of diversity indices among the three families were revealed, 0.43 of Harpalidae, 0.30 of Carabidae and 0.15 of Silphidae.

적 요

상주시에 위치한 갑장산(805.7 m)을 대상으로 고도 200 m부터 800 m까지 100 m 간격으로 7개의 시험구를 설정하여 2001년 8월부터 2001년 10월까지 당밀을 이용한 pitfall trap를 설치하여 고도별, 계절별 다양도 및 우점도 지수를 알아보았다. 그 결과 먼지벌레과, 딱정벌레과 그리고 송장벌레과에 속한 곤충들이 채집되었고, 전체 6,304개체 중 먼지벌레과가 6,163개체로 98% 이상을 차지하였다. 고도 200 m부터 700 m까지 점차적인 개체수의 증가추세를 보이다가 800 m에서 급격하게 감소하였다. 고도 700 m에서 심슨의 우점도지수는 0.66으로 가장 높게 나타났으며, 800 m에서 0.47로 가장 낮게 나났다. 반면 심슨의 다양도 지수는 800 m에서 0.53으로 가장 높게 나타났다. 계절별 우점도 및 다양도 지수는 0.54에서 0.55로 큰 차이를 발견할 수 없었으며, 과 별 다양도지수는 먼지벌레과에서 가장 높았다.

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