

## Diversity and Abundance of Ground-beetles (Coleoptera : Carabidae) in Mt. Tōgyusan, Korea

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### ABSTRACT

Diversity or richness and altitudinal distribution of subtribe Carabinae were investigated on Mt. Tōgyusan in Korea. Of the collected seven species belonging to 4 genera, *Carabus sternbergi* was the most abundant and *Leptocarabus semiopacus* and *L. seishinensis* were relatively abundant than the other species. Although species diversity and species richness indices were higher at the crown site than those at lower sites, more individuals were found at low sites. There were relatively more females.

**Key words** : Diversity, Coleoptera, Carabinae, Tōgyusan, Korea

### INTRODUCTION

The carabid beetles are widely distributed across the zoogeographical region of the world. Found under stones, logs, barks and debris, most species move actively at night. They often hibernate as adults with one generation per year in Korea. Their constituent species are essentially predacious on many kinds of terrestrial arthropods including insects, earthworm, slugs and land snails. Most species are endemic because with vestigial hind wings, they can not fly (Kwon and

Lee 1984). A considerable number of the species being particularly malacophagous in their choice of food, have the morphological specialization to survive through stenocephalism or macrocephalism (Ishikawa 1978). The stenocephalic species has a fore body so narrowly elongated that in preying on a snail, it inserts its slender head into the shell. On the other hand, the macrocephalic species, disproportionately, enlarged head preys on a snail by breaking with its strong mandibles the shell.

Many indices of diversity have been proposed

(Poole 1974), and the diversity is most easily defined by use of one of these formulae. The studies on diversity or abundance of ground-beetles were mainly conducted outside the country (Thiele 1977, Robert and Thompson 1977, Ishitani and Yano 1994, Ishitani *et al.* 1994). Recently, a few ecological studies on ground-beetles were carried out in Korea (Kim and Lee 1992, Kwon 1996, Park and Kwon 1996).

This study, as a primitive investigation of diversity or abundance, was conducted to collect basic ecological information on ground-beetles at various altitudes in Mt. Tōgyusan, southern part of Korea.

**MATERIALS AND METHODS**

Eight sampling sites were chosen from Mt. Tōgyusan (1614m), South Korea (Table 1, Fig. 1). The materials were collected by pitfall traps on mid-June and mid-September, 1991, and then they were exposed for 7 days. The trap was a plastic cup of 7cm in top diameter and 9.5cm in height. Ten cups at each site were buried about 8-10m intervals between each trap. Each trap contained 10ml sugar solution (90ml of 99% saturated black sugar solution, 8ml of ethyl alcohol and 2ml of acetic acid) as an attractive agent. In this investigation, only species of subtribe Carabina were collected and calculated.

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

Simpson dominance index

$$(C) = \sum ni(ni-1) / N(N-1)$$

Simpson diversity index

$$(Ds) = 1 - \sum ni(ni-1) / N(N-1)$$

Shannon-Wiener index

$$(H') = - \sum pi \log pi$$

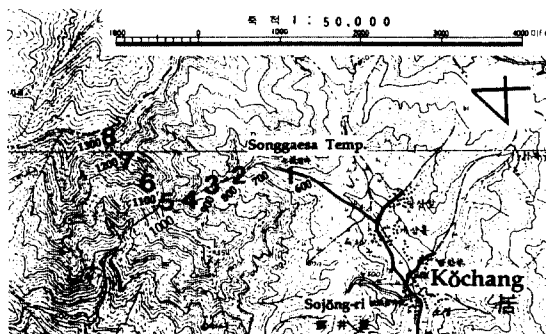
Menhinick index (SR) =  $S / \sqrt{N}$

Dominance (D) =  $ni / N$

$ni$  and  $pi$  are the proportion of the  $i$ th species in total sample,  $N$  is total individuals and  $S$  is number of species present.

**Table 1. Environmental factors at sampling sites.**

| site | Plantation | Altitude | Direction | Slope |
|------|------------|----------|-----------|-------|
| 1    | nature     | 600m     | south     | >5°   |
| 2    | "          | 700m     | "         | "     |
| 3    | "          | 800m     | "         | "     |
| 4    | "          | 900m     | "         | "     |
| 5    | "          | 1000m    | "         | <10°  |
| 6    | "          | 1100m    | "         | >10°  |
| 7    | "          | 1200m    | "         | "     |
| 8    | "          | 1300m    | "         | "     |



**Fig. 1. The map of sampling sites, southern part of Mt. Tōgyusan, Korea (1991).**

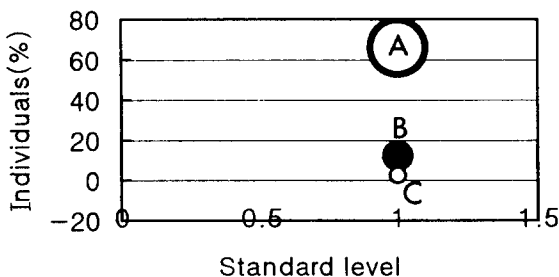
**RESULTS AND DISCUSSION**

A total of 947 individuals belonging to subtribe Carabina were collected (Table 2). Of the total individuals, 66 percent was composed of *Carabus sternbergi*. *Leptocarabus semiopacus* and *L. seishinensis* were relatively more abundant than other species. One individual of *Damaster mirabilissimus kana*, trapped at high altitude, is a

rare species in Korea. *C. sternbergi*, common species, was most abundant in Korea (Kim and Lee 1992, Kwon 1996, Kwon *et al.* 1994). The collected 7 species were categorized into 3 groups of richness. Group A included most of *C. sternbergi* and Group B consisted of *Leptocarabus seishinensis* and *L. semiopacus*, and finally, *Damaster jankowskii*, *D. mirabilissimus kana*, *D. smaragdiinus branickii* and *Tomocarabus fraterculus* were grouped to C (Fig. 2).

**Table 2. Numbers of carabina beetles collected in Mt. Tögyusan on 1991**  
(site number same as in Table 1).

| Species                          | No. of individuals | site           |
|----------------------------------|--------------------|----------------|
| <i>Corabus sternbergi</i>        | 625                | all sites      |
| <i>Damaster jankowskii</i>       | 27                 | 1,2,3,5,6,7,8  |
| <i>D. mirabilissimus kana</i>    | 1                  | 8              |
| <i>D. smaragdiinus branickii</i> | 12                 | 1,2,3,5,6,7,8, |
| <i>Leptocarabus seishinensis</i> | 117                | 1,2,3,4,5,6,8  |
| <i>L. semiopacus</i>             | 130                | 1,2,3,4,5,7,8  |
| <i>Tomocarabus fraterculus</i>   | 35                 | 2,3,4,5,7,8    |



**Fig. 2. Total distribution of Carabina collected in Mt. Tögyusan, Korea (1991).**

**Table 3. Comparison of diversity and abundance examined from the different regions in Korea.**

| No. of Species | Total individuals | SR <sup>a</sup> | D <sup>b</sup> | Period times <sup>c</sup> | site | Habitat              | Reference               |
|----------------|-------------------|-----------------|----------------|---------------------------|------|----------------------|-------------------------|
| 24             | 15,629            | 0.19            | 0.92           | 1 year 12 times           | 16   | Kwangnung Ex. Forest | Kwon 1996               |
| 7              | 559               | 0.30            | 0.52           | 1 year 3 times            | 9    | Mt. P'alongsan       | Kwon <i>et al.</i> 1994 |
| 7              | 872               | 0.24            | 0.41           | 1 year 7 times            | 3    | Mt. P'alongsan       | Kim and Lee 1992        |
| 9              | 1,060             | 0.28            | 0.45           | 1 year 7 times            | 5    | Mt. Sobaeksan        | Kim and Lee 1992        |
| 7              | 947               | 0.23            | 0.66           | 1 year 2 times            | 8    | Mt. Tögyusan         | this study              |

<sup>a</sup> Menhinick index (SR) =  $S/\sqrt{N}$  (N is total individuals, S is number of species present)

<sup>b</sup> Dominance (D) =  $ni/N$  (*ni* is the proportion of the *i*th species in total sample)

<sup>c</sup> No. of occasions the species was collected within period

Species richness (SR), as indicated by Menhinick index, was 0.23, which is very similar to 0.25 of average of Korean data examined. Dominance index (D) at 0.66 is higher than the average value of 0.56 (Table 3).

Calculated through Simpson dominance method, the C value at site 6 (1100m) and that at site 2 (700m) were relatively high. The values of sites 8 (1300m) and 5 (1000m), state 0.265 and 0.309 respectively, indicated that these sites (5 and 8) are in more advanced for adaptation than other sites (Brewer *et al.* 1990). Similar to C value, the Simpson diversity index (Ds) at sites 5 and 8 were more diverse than at other sites (Table 4).

**Table 4. Diversity and dominance of Simpson index.**

| Index                                | Site | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     |
|--------------------------------------|------|-------|-------|-------|-------|-------|-------|-------|-------|
| simpson dominance (C <sup>a</sup> )  |      | 0.511 | 0.628 | 0.537 | 0.411 | 0.309 | 0.749 | 0.440 | 0.265 |
| Sompson diversity (Ds <sup>b</sup> ) |      | 0.489 | 0.372 | 0.467 | 0.589 | 0.691 | 0.251 | 0.560 | 0.735 |

<sup>a</sup> Simpson dominance index (C) =  $\sum ni(ni-1)/N(N-1)$

<sup>b</sup> Simpson diversity index (Ds) =  $1 - \sum ni(ni-1)/N(N-1)$  (N is total individuals, *ni* is the proportion of the *i*th species in total sample)

High diversity at sites 5 and 8 was believed to be due to environmental factors. As Van Dijk (1986) indicated, this status is maybe caused by weather factor, age of the individuals, individual variability and availability of food, etc. In addition, it has been suggested that the activity in Carabidae is also influenced by the general habitat surrounding the trap and the amount of moisture in the soil (Mitchell 1963). In relation to C and Ds values alone, site 5 included a lot of broad-leaf trees, fertile soil and long valley with clean water and site 8 contained a large grassland, a suitable setting for ground-beetles to live and to adapt themselves in.

Shannon-Wiener index(H') is usually obtained by the result of information theory based on uncertainty conception. Although higher diversity makes higher uncertainty, it is one of the most commonly used indices (Price 1984). In this study, H' value, similar to C and Ds values, was high at sites 8 and 5, while, site 6(1100m) had the lowest species diversity. (Fig. 3).

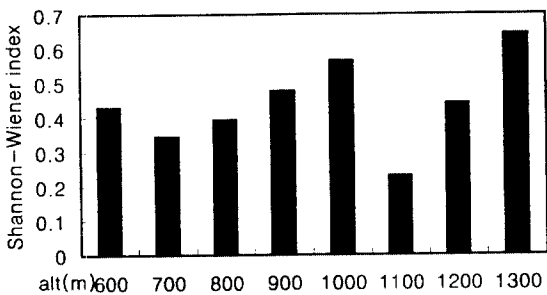


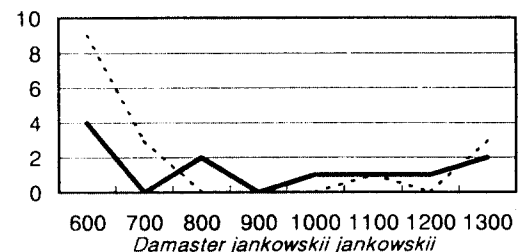
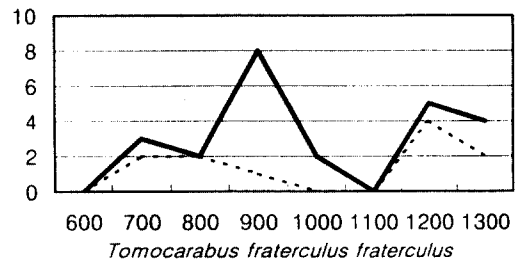
Fig. 3. The Shannon-Wiener index of Carabina in Mt. Tōgyusan, Korea (1991).

The altitudinal occurrence of ground-beetles is shown in Fig. 4. There is a differential sexual ratio, with females being more numerous at 60.1% than males at 39.9%. Thiele(1977) explained this biased ratio by assuming that there are no sexual difference in the attraction to formal (attractant), that is to say that the males are probably better able to climb out of the traps ; their being usually smaller and being

equipped with bristles on the anterior tarsals facilitate their climbing. Besides, this ratio seemed to be related with the instinct of preservation of the species (Kim and Lee 1992). *Carabus sternbergi* occurred throughout the sites regardless of male and female. This species was mostly collected below 1000m, and numerously caught from 600m to 800m. Similar to *C. sternbergi*, *Leptocarabus seishinensis* and *L. semiopacus* were abundantly and evenly collected from 600m to 1000m. *Damaster jankowskii* and *D. smaragdiinus branickii* were low in density throughout the sites. In case of *Tomocarabus fraterculus*, no individuals were collected at 600m and 1100m, however at other sites, they occurred relatively uniform.

The least occurrence was found at site 6, a situation believed to be due to its being rocky and to the prevalence of numerous groups of *Lophatherum* sp. It is usually regarded that an area teeming with *Lophatherum* sp. is unsuitable for carabid-beetles to live in.

Although more diversified species occurred at sites 5 and 8, more individuals were collected low altitudes (sites 1, 2, 3 and 4)



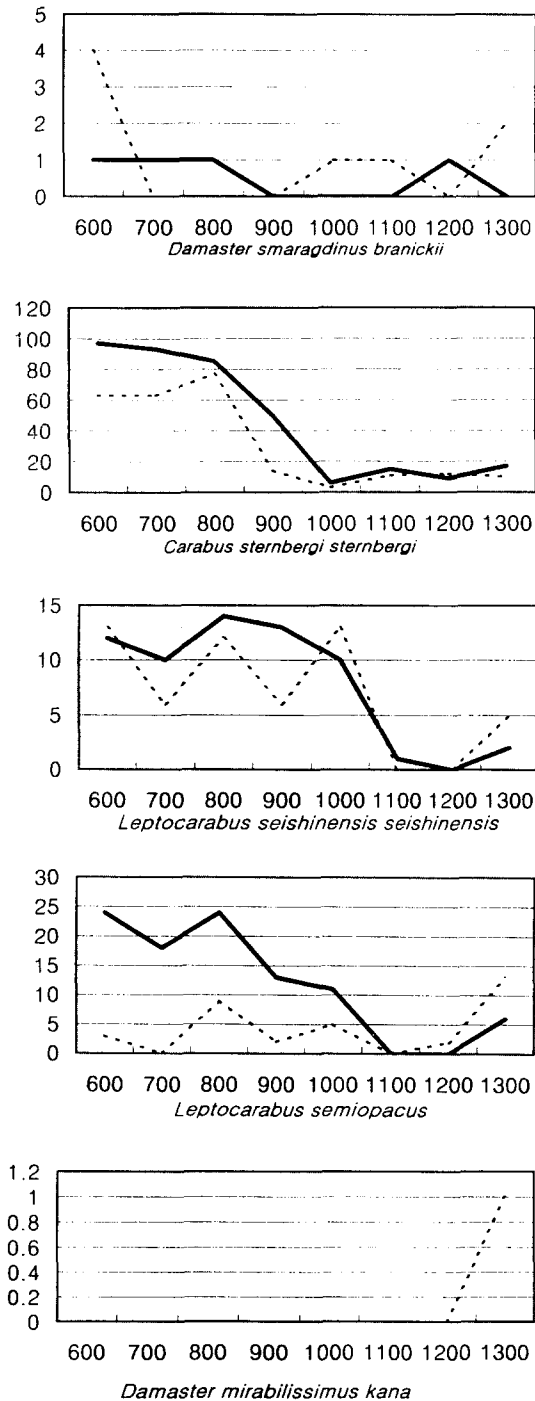


Fig. 4. Altitudinal distribution of Carabina collected in Mt. Togyusan, Korea on 1991 (X bar : altitudes, Y bar: individuals, --- : male, — : female).

적 요

덕유산 남쪽 지역을 대상으로 고도별로 600m부터 1300m의 정상부 까지 100m 간격으로 8개의 정점을 선정하여 딱정벌레아족의 종다양도 및 분포 상황 등을 국내자료와 비교 조사하였다. 총 7종이 채집되었고 그 중에서 우리딱정벌레가 66%로서 가장 풍부한 우점도 지수를 나타내었다. 반면에 덕유멋조롱딱정벌레는 단지 1개체만이 최고 고도에서 채집되었다. 종다양도지수에서는 1,000m와 1,300m 지역에서 가장 높게 나타났으며, 암컷이 수컷보다 높게 채집되었다. 우리나라에서 연구된 다른 지역과 비교 해 본 결과, 딱정벌레의 경우 거의 비슷한 경향으로 다양도 및 풍부도 지수가 나타났다.

검색어 : 다양성, 풍부도, 딱정벌레아과, 덕유산

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