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Ground Beetles on Mt. Usu Six Years after the 1977-78 Eruptions[1)]

Ryoichi B. Kuranishi, Seigo Higashi, Hiroaki Sato and Hiromi Fukuda

Department of Biosystem Management, Division of Environmental Conservation, Graduate School of Environmental Science, Hokkaido University, Sapporo, 060 Japan

Abstract

A survey was made of the ground beetles on and around Mt. Usu which had suffered vegetational damage from volcanic eruptions in 1977-78. A total of 2,485 specimens of 29 species were collected, primarily *Silpha perforata venatoria*, *Pterostichus thunbergi*, *Chlaenius pallipes* and *Pterostichus subovatus*. On the somma surrounding O-usu, *Polygonum sachalinense* communities provided the appropriate habitat for many species including forest species such as *Pterostichus subovatus* and *Leptocarabus opaculus* in the spring and summer, though these species nearly disappeared in the autumn when herbs were defoliated. In the grasslands and sometimes even in the bare ground around Ko-usu, dead trees blown down by the latest eruptions offered a refuge for the forest species.

Key Words: Ground beetle, Refaunation, Mt. Usu, Habitat preference.

1. Introduction

An active volcano, Mt. Usu, which erupted in 1977-78, has provided a useful field for several studies of vegetational and faunal recovery after the complete destruction of the ecosystem (e. g., Ota and Ito, 1980 ; Rivière. 1982 ; Ito and Haruki, 1984 ; Toda, 1985). In one study, a comprehensive survey of insects was made in 1984. Samplings of moths (Sato et al., 1985), ants (Higashi et al., 1985), drosophilid flies (Toda and Fukuda, 1985) and bees (Okazaki et al., 1986) already proved that the refaunation of insects was in rapid progress even in the completely deforested areas. In this paper, fifth report of the comprehensive survey, we will discuss the recovery of ground beetles based on their habitat preference.

Before going further, we wish to express our sincere gratitude to Prof. K. Ito and Dr. M. Haruki, Graduate School of Environmental Science, Hokkaido University, for their valuable advice on the vegetation of Mt. Usu. Cordial thanks are also due to Messrs. H. Sugawara and K. Okazaki of our laboratory for their assistance in the comprehensive survey made in 1984.

1) Entomological and ecological surveys on Mt. Usu in 1984. V.

2. Study Area and Methods

In the mountaintop area, samplings were taken mainly around O-usu (Ka, Kb and So in Figure 1), and Ko-usu (Kc to Kg in Figure 1). The topography and research sections (I-VIII) of the somma (So) are given in Figure 2: Section I, with two trap stations in a grove of *Sorbus commixta* and *Acer mono* on the outer slope of the somma; Section II, with one station on the top of the somma, which was sparsely covered with *Poa annua, Trifolium repens, Artemisia japonica, Elaeagnus umbellata* and so on; Section III, with one station on the middle of the inner slope, where there was a small patch of *Polygonum sachalinense*; Section IV, with one station on the base of the somma, densely covered with *P. sachalinense*; Section V, with two stations densely covered with *P. sachalinense* and *Petasites japonicus* var. *giganteus*; Section VI, with four stations, which formed a transitional section toward the crater basin, densely covered with *Polygonum sachalinense, Petasites japonicus* var. *giganteus*, and *Equisetum arvense*; Section VII, with five stations, which was in the crater basin with the occasional presence of *Polygonum sachalinense* and *Petasites japonicus* var. *giganteus*; Section VIII, with four stations, where many volcanic rocks were scattered. There was a density

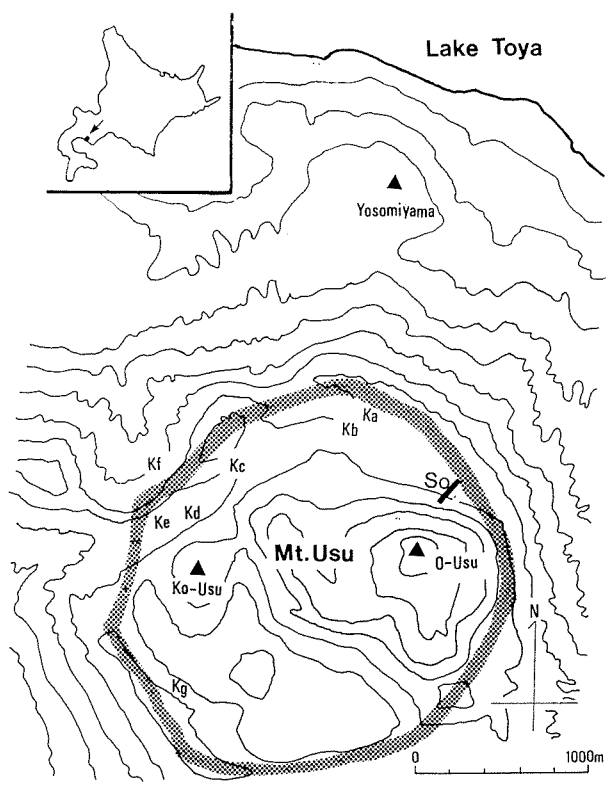

Figure 1. Areas surveyed. Ka, Kb and So: a somma surrounding O-usu, Kc to Kg: open land around Ko-usu.

of standing and fallen dead trees from sections II to VI but a sparsity of dead trees in sections I, VII and VIII.

Around Ko-usu, samplings were taken in four grassland areas and three areas of bare ground by setting 14 trap stations (cf. Figure 1): Ka with two stations: a debris barrier covered with *Trifolium repens*; Kb with two stations: bare ground near an inactive crater containing a temporary pool at present; Kc with two stations: bare ground where volcanic steam was sometimes emitted and the ground was hot; Kd with three stations: bare ground sparsely covered with dead trees; Ke with two stations: a grassland of *Artemisia montana*; Kf with two stations: a newly planted turf to protect the slope from erosion; Kg with one station: a

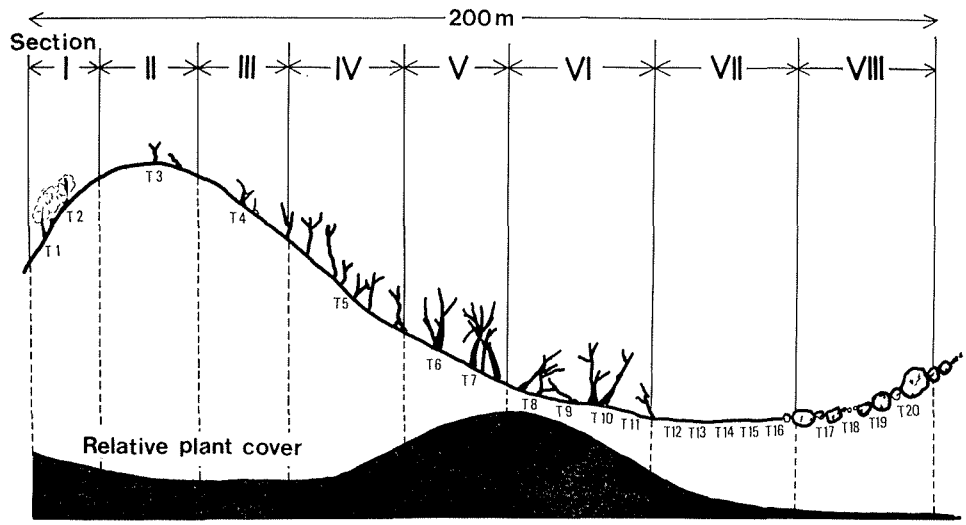

Figure 2. Topography and habitat situation on the somma of O-usu (So).

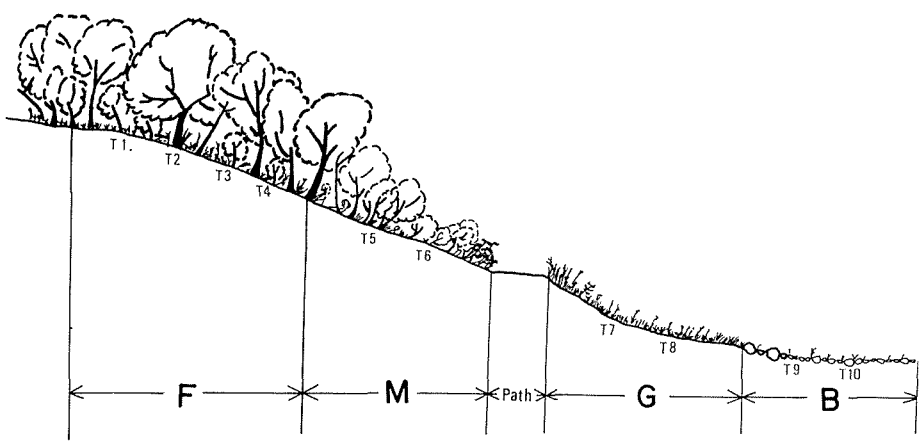

Figure 3. Vegetational profile on Yosomiyama.

F: forest of *Populus maximowiczii* and *Betula maximowicziana*, M: forest margine, G: grassland, B: bare ground, T1 to T10: trap stations.

grassland of *A. montana* near the margin of *Betula ermanii* forest.

A control survey was made on Yosomiyama where the vegetation was not seriously damaged by the latest eruptions (Takahata, 1980). Ten trap stations were chosen from *Populus maximowiczii* and *Betula maximowicziana* forest to bare ground (Figure 3).

The survey was made three times: June 15 to 18 (spring), July 31 to August 3 (summer), and September 8 to 12 (autumn) in 1984. At each trap station, five pit-fall traps of 210 cc volume, 6.5 cm caliber and 9 cm deep were arranged in a row at 1 m intervals.

3. Results and Discussion

In total, 2,485 specimens of 29 species were collected in the present survey. In the following list, the scientific name, full total, seasonal total (Sp: June 15–18; Sm: July 31-Aug. 3; Au: Sep. 8–12) and, in parentheses, the number of specimens collected at each sampling site are given for each species. Ka to Kg were localities around Ko-usu (Figure 1); I to VIII were sections on a somma surrounding O-usu (Figure 2); F, M, G and B were forest, forest margin, grassland and bare ground on Yosomiyama, respectively (Figure 3). The number of specimens was omitted when only one specimen was collected.

Family **CARABIDAE**

1. *Carabus granulatus yezoensis* Bates. 16: Sm 11 (V, VI 2, Ke 2, Kf 2, Kg 4), Au 5 (Kg 5)
2. *C. japonicus* Motschulsky. 28: Sp 11 (IV, Kd, Ke, F 2, M 6), Sm 15 (V, VI 2, Ke, F 10, G), Au 2 (M 2)
3. *Leptocarabus arboreus arboreus* (Lewis). 6: Sm 3 (V 3), Au 3 (Ka 3)
4. *L. opaculus* (Putzeys). 89: Sp 32 (I 17, VI 10, VIII, F 4), Sm 21 (I 5, V 5, VI 10, Ka), Au 36 (I 3, II 2, IV 2, V 10, VI 3, Ka 6, Kg 4, F, M 5)
5. *Hemicarabus tuberculosus* (Dejean et Boisduval). 4: Sm 3 (Ke 3), Au 1 (Ke)
6. *Damaster gehinii* (Fairmaire). 4: Sp 1 (V), Sm 2 (IV, Ka), Au 1 (VI)
7. *D. blaptoides rugipennis* (Motschulsky). 8: Sp 4 (I, IV, V, Kd), Sm 4 (IV, V 2, VI)
8. *Bembidion popii captivorum* Netolitzky. 9: Sp 6 (VI, Ka, Kb 4), Sm 2 (Kb 2), Au 1 (Ka)
9. *B.* sp. 72: Sp 15 (I, III, VI, VII 7, VIII 5), Sm 57 (VII 25, VIII 2, Kb 2, Kc 25, Kd 3)
10. *Pterostichus planicollis* (Motschulsky). 81: Sp 9 (VI, Ka, Ke 3, G 2, B 2), Sm 70 (VI, VII, Kb 2, Ke 22, M, G 4, B 39), Au 2 (Ke, G)
11. *P. samurai* (Lutshnik). 12: Sp 1 (Ke), Sm 11 (I, IV, VI, Ke 7, Kg)
12. *P. haptoderoides japanensis* Lutshnik. 130: Sp 99 (V 12, VI 28, VII 2, VIII 2, Kd 2, Ke 48, G 5), Sm 26 (II, IV, VIII, Kb, Ke 15, Kf 3, Kg, G, B 2), Au 5 (II 2, V, VI, Ke)

13. *P. subovatus* (Motschulsky). 807 : Sp 291 (I 13, III 3, IV 5, V 28, VI 114, VII 6, VIII 24, Ka 33, Kb 3, Kd 9, Ke 19, Kf 27, G 7), Sm 501 (I 10, III 2, IV 5, V 76, VI 129, VII 4, VIII 30, Ka 12, Kb 4, Kc 2, Kd 116, Ke 73, Kf 5, Kg 5, F 24, G 4), Au 15 (V 2, VI, VIII 4, Ka 3, Kd, Ke 2, F 2)
14. *P. leptis* Bates. 4 : Sp 1 (G), Sm 3 (IV, G 2)
15. *P. thunbergi* Morawitz. 162 : Sp 39 (F 38, M), Sm 102 (VI, Kd, Kf, Kg 16, F 78, M 2 G 3), Au 21 (F 18, M 2, G)
16. *P. prolongatus* Morawitz. 64 : Sp 60 (F 41, M 19), Su 4 (F 4)
17. *P. microcephalus* (Motschulsky). 215 : Sp 121 (I, III, IV 2, V 15, VI 41, VII 3, VIII 2, Ka 17, Kb, Kd 5, Ke 8, Kf 9, G 5, B 11), Sm 90 (I 2, II, III 2, IV 7, V 4, VI 25, VIII 4, Ka, Kb 7, Kd 6, Ke 23, Kg 2, G 3, B 3), Au 4 (III, IV, Ke, M)
18. *Platynus impressus* (Panzer). 77 : Sp 36 (V, VI 8, VIII, Ka 11, Kb 8, Ke, B 6), Sm 40 (VI 8, VII, Ka, Kb 6, Kc, Kd 13, G 5, B 5), Au 1 (Kg)
19. *P.* sp. 1 : Sp 1 (Kb)
20. *Synuchus nitidus* (Motschulsky). 3 : Su 3 (M 3)
21. *S. melantho* (Bates). 78 : Sp 17 (Ka 4, Kd, Ke, F, M 8, G 2), Sm 10 (I 3, V, Kg 5, F), Au 51 (III, V 2, VI 5, VIII 11, Kd 3, Ke 5, Kg 4, M 20)
22. *Amara chalcophaea* Bates. 5 : Au 5 (II, VIII, Kd, Ke, G)
23. *Harpalus* sp. 1. 3 : Au 3 (M 3)
24. *H.* sp. 2. 1 : Sm 1 (G)
25. *Chlaenius pallipes* Gebler. 317 : Sp 153 (V, VI 16, Ka 18, Kf, F 12, M 52, B 53), Sm 145 (VI 46, Ka 5, Kb 14, Ke 4, Kf 4, Kg 13, F, M 10, G 42, B 6), Au 19 (VI 2, Ka 6, M 10, B)
26. *C. micans* (Fabricius). 22 : Sp 1 (M), Sm 20 (Ka 2, Ke 3, Kf 10, G 2, B 3), Au 1 (Ke)

Family **SILPHIDAE**

27. *Nicrophorus quadripunctatus* Kraatz. 2 : Sm 2 (Kg 2)
28. *Silpha perforata venatoria* Harold. 242 : Sp 127 (Ke, F 87, M 39), Sm 99 (VI, Ka 3, Ke 4, Kf 5, Kg 23, F 61, M 2), Au 16 (Ka, Kf 2, Kg 8, M 5)
29. *Eusilpha japonica* (Motshulsky). 23 : Sp 3 (F, M 2), Sm 16 (Kg 8, F 7, G), Au 4 KG 2, F, G)

The ground beetles collected on Yosomiyama totaled 815 specimens of 19 species which could be grouped into three classes by mean sample size per species (815/19=43) and the number of trap stations (10). The three classes were rare, common and dominant species, the sample size of which were 1 to 9, 10 to 42 and more than 42 specimens, respectively. The habitat overlap among the 12 common and dominant species was calculated using SR (Janssen, 1975), resulting in six types of habitat preference by setting up the similarity level at SR=0.2 (Figure 4) : Type A, *Silpha perforata venatoria, Pterostichus thunbergi, P. subovatus* and *P. prolongatus*, which preferred the forest interior ; Type B, *Carabus japonicus,*

L. opaculus and *Eusilpha japonica*, which were collected mainly in the forest and occasionally in grassland areas ; Type C, *Synuchus melantho*, which preferred the forest margin ; Type D, *Chlaenius pallipes*, which was distributed from the forest margin to areas of bare ground ; Type E, *Pterostichus microcephalus* and *Platynus impressus* which were collected in grassland and bare ground areas with occasional occurrence at the forest margin ; Type F, *Pterostichus planicollis*, which preferred only open habitats (Figure 5).

In the summit area the ground beetles totaled 1,670 specimens of 25 species with the following species prevailing : *Pterostichus subovatus*, *P. microcephalus*, *P. haptoderoides japanenis* and *Chlaenius pallipes*. As compared with the results

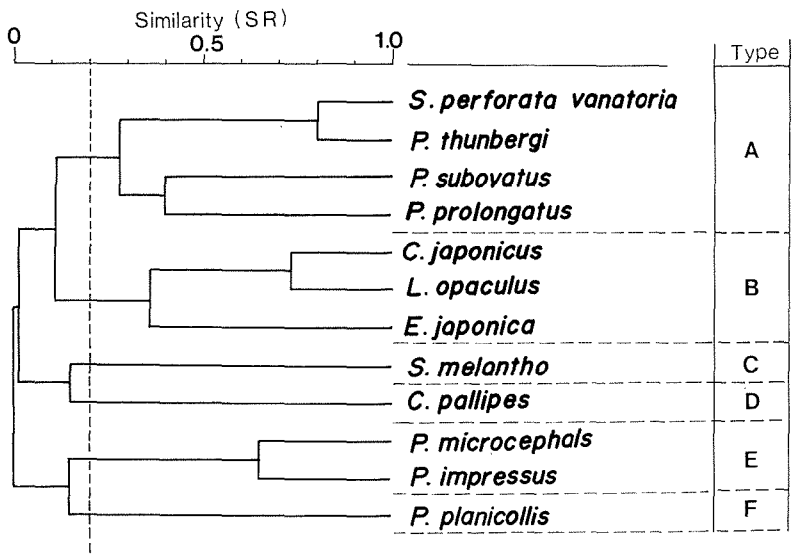

Figure 4. Clustering of ground beetles, based on habitat overlap among the 12 common or dominant species collected on Yosomiyama.

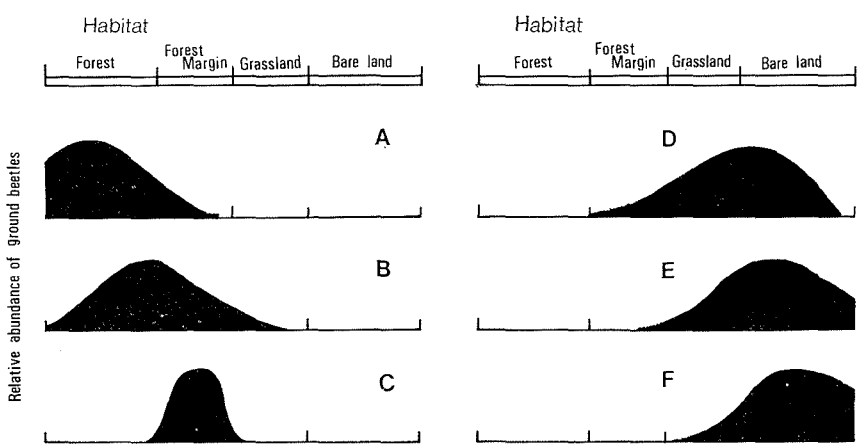

Figure 5. Six types of habitat preference.

Table 1. Effects of potential dominancy in colonizing the mountaintop area.

	Dominant	Common	Rare
Yosomiyama	5	7	7
Mountaintop area	4 (80%)	7 (100%)	4 (57%)

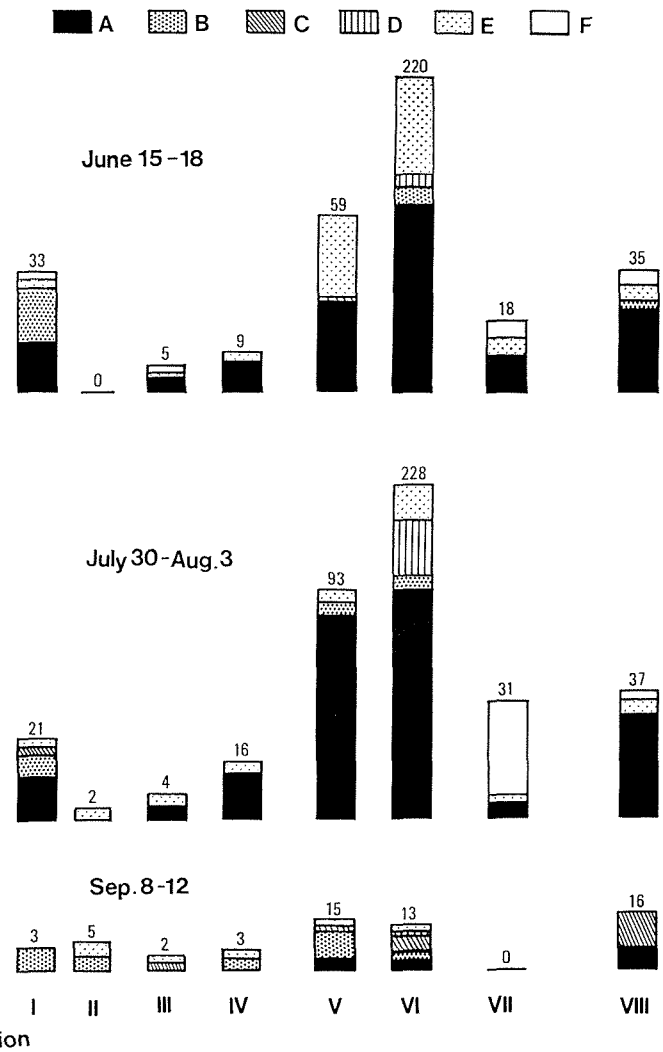

Figure 6. Ground beetles collected along the research section developed on the somma of O-usu. Density of ground beetles per one trap station was given on the top of bars. Habitat preference of each species was decided, on the basis of the control survey, Katakura and Fukuda (1975), Higashi et al. (1983, 1984) and Katakura and Ueno (1985). For types of habitat preference (A–F), see Figure 5.

of Sakagami et al. (1980), who had reported 10 species surviving in the mountaintop area soon after the 1977-78 eruptions, there was a significant scarcity of *Pterostichus thunbergi*, probably due to the destruction of their favorite habitats. Table 1 shows the effect of potential dominancy in colonizing the mountaintop area. The species already inhabiting this area constituted 92% of the dominant and common species, but only 57% of the rare species, which suggests that high dominancy provides more frequent opportunities for each species to immigrate into the deforested area, similar to the pattern found in ants reported by Higashi et al. (1985).

Along the research section developed from the somma to the crater basin of O-usu, 868 specimens of 20 species were collected (Figure 6). In the spring when clumps of *Polygonum sachalinense* and *Petasites japonicus* var. *giganteus* were already growing, many beetles of types A and B (*Pterostichus subovatus* and *Leptocarabus opaculus*) and E (*P. microcephalus* and *P. impressus*) coinhabited the sections V and VI, while the upper parts of the inner slope, i. e. sections II to IV, had few beetles. In a grove on the outer slope, section I, forest species of types A (*P. subovatus*) and B (*L. opaculus*) were dominant. The bare sections VII and VIII were sparsely inhabited even by forest species of type A (*P. subovatus*). In the summer when the research section was in full-bloom, the herb communities, sections V and VI, were dominated by the species of type A (*P. subovatus*) while sections II to IV still had few beetles, as in the spring. A grove in section I was mainly inhabited by *P. subovatus* (type A) and *L. opaculus* (type B), but the section VII by *Bembidion* sp. of type F. Interestingly, the section VIII was rather abundant in *P.*

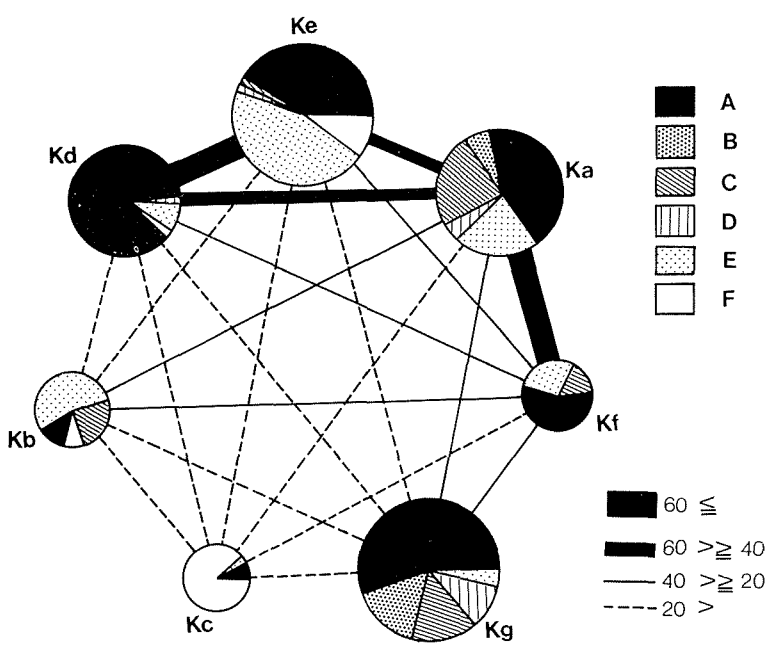

Figure 7. Faunal similarities among the seven sampling localities around Ko-usu. Relative sample size is shown by the size of circles. SR×100 is used for similarity index. For A to F, see Figure 5.

subovatus of forest type A, partly because the number of rocks scattered in this section offered refuge to this forest species immigrating from the herb communities. In the autumn, when the herbs were almost completely defoliated, there were few beetles in any section, mainly because the forest species lost their favorite habitats.

Around Ko-usu, 802 specimens of 24 species were collected. Faunal similarities among the seven localities surveyed were examined using Janssen's SR index (1975) (Figure 7). Three areas of bare ground, i. e. Kb, Kc, Kd, were faunally dissimilar to each other, mainly because the beetles were almost completely defaunated in Kb and Kg. The fauna of Kd was rather similar to that of a neighboring grassland area, Ke (SR=0.66), probably because the number of dead trees scattered in Kd provided enough refuge to the forest species *P. subovatus* which usually inhabited the dead trees of Ke but sometimes emigrated to Kd. Among four grassland areas, Ka, Ke and Kg were rich but Kf was poor in beetles. However, the faunae in Kf, Ka and Ke were very similar to each other, all being dominated by the forest species *P. subovatus*, which probably inhabited dead trees. Another grassland area, Kg, was also dominated by the species of type A but faunally dissimilar to other localities, because this grassland was adjacent to a forest of *Betula ermanii* and the forest beetles such as *S. perforata venatoria* and *P. subovatus* frequently foraged into this grassland area.

4. Conclusion

The mountaintop area which had been almost completely deforested by the 1977–78 eruptions was already inhabited not only by open land beetles but also by forest beetles, because the clumps of *Polygonum sachalinense*, *Petasites japonicus* var. *giganteus* and *Artemisia montana* provided the appropriate habitats to the forest beetles. The moldering trees also offered the resources necessary to those beetles.

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