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Faunal Makeup and Distribution of Ground Beetles in Kushiro City and its Vicinity, Northern Japan

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Abstract

Surveys of ground beetles were made in eastern Hokkaido from May to September, 1981. Following the previous paper which reported the results obtained at a dairy village Bekkai (Higashi *et al.*, 1983), we took up the faunal makeup and the distribution of ground beetles in an industrial fishery city Kushiro and its vicinity in the present paper.

Key words: Human impact, Index of Whittaker, Faunal makeup, Ground beetles, Kushiro, Overlap of distribution.

Introduction

As a part of "Interdisciplinary Studies on the Land Development and the Environmental Change[1)]" which was made from 1979 to 1981 jointly by scientists of the Graduate School of Environmental Science, Hokkaido University, faunal and floral surveys were carried out in eastern Hokkaido. Since involving different kinds of districts such as dairy villages, fishery harbors and industrial cities, this region is useful to study the effects of the various human impacts on the biotic environment.

In the previous paper (Higashi *et al.*, 1983), we reported the faunal makeup and distribution of ground beetles at a dairy village Bekkai where the human activities had not quite disturbed the community of those insects. As a second report of the series, the present paper takes up ground beetles obtained in an industrial and fishery city Kushiro and the vicinity.

Before going further, the authors wish to express their sincere thanks to Dr. Haruo Katakura, Faculty of Science, Hokkaido University, and to Mr. Toshinobu Matsumoto, Tokyo Agricultural University, for their useful advice on the identification of the ground beetles.

1) This research was supported by Grant-in-Aid for Special Studies from the Ministry of Education.

Study Area and Methods

Kushiro City lies on the center of the Kushiro Plain which forms a part of eastern margin of Hokkaido (Fig. 1). According to Kojima (1979), Kushiro City and its vicinity vegetationally belong to a nemoral *Acer mono* zone dominated by *Acer mono, Betula platyphylla* var. *japonica, Kalopanax pictus, Quercus mongolica* var. *grosseserrata, Tilia japonica, Ulmus davidiana* var. *japonica* and so on. Fig. 2 gives the climatic conditions of Kushiro City from May to September in 1981.

Nine localities were chosen for the survey (Fig. 1). Environmental conditions of those localities are summarized in Table 1. Flora of each locality is presented with dominant plants as follows:

Mitsuura

A coast covered with communities of *Sasa apoiensis* and *Quercus mongolica* var. *grosseserrata*. Forest: shrub layer (2 to 8 m high), *Quercus mongolica* var. *grosseserrata*; herbaceous layer (below 2 m), *Osmundastrum cinnamomeum* var. *fokiense, Aruncus dioicus* var. *tenuifolius, Carex breviculmis, Schisandra chinensis, Cardamine leucantha*. Grassland: *Calamagrostis langsdorffii, Sasa apoiensis, Carex leucochlora, Sanguisorba tenuifola* var. *alba, Anaphalis magaritacea* var. *angustior*.

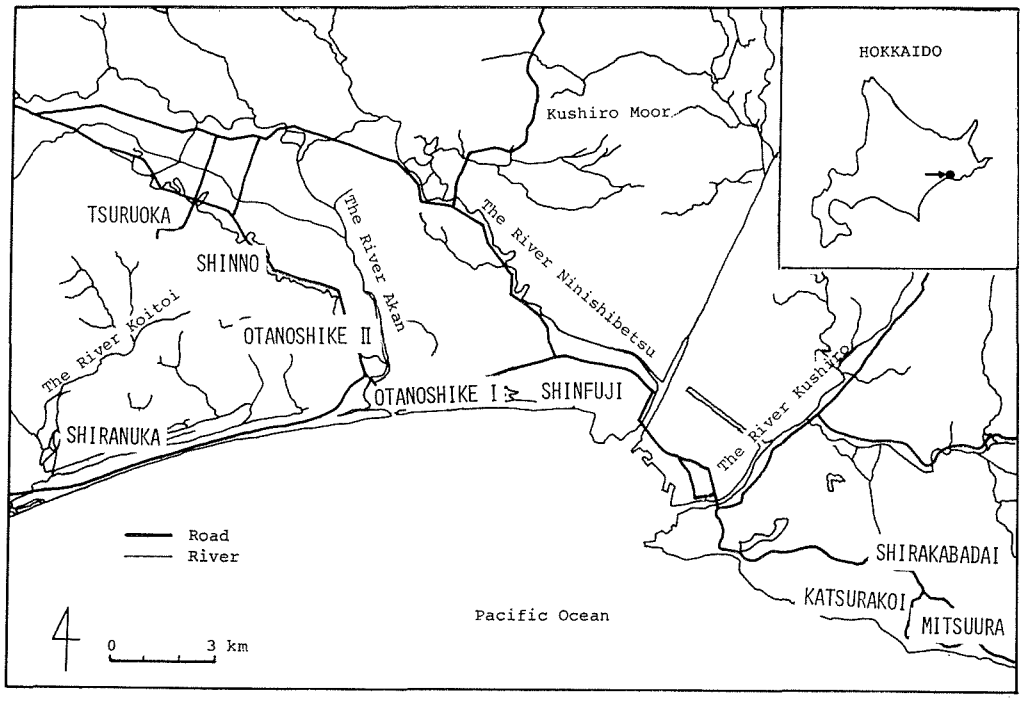

Fig. 1. Location and topography of the study area. Nine localities surveyed are presented.

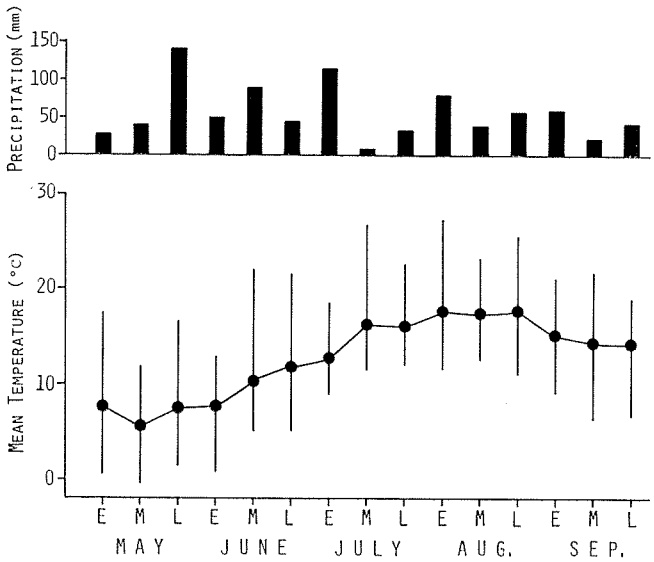

Fig. 2. Mean temperature with range and precipitation in Kushiro City from May to September, 1981 (cited from the Monthly Weather Report from Hokkaido Meteorological Observatory). E, the first third of each month; M, the second third; L, the last third.

Table 1. Environmental situation of localities surveyed. In each category of environmental condition, ⧺ and − are the highest and the lowest levels respectively. Other marks mean the relative situations compared with those two extremes.

	Urbanization	Industrialization	Farmland exploitation	Dune	Soil humidity
Mitsuura	−	−	−	+	−
Katsurakoi	−	−	+	+	−
Shirakabadai	+	−	+	−	−
Shinfuji	⧺	⧺	−	⧺	−
Otanoshike I	⧺	⧺	+	⧺	+
Otanoshike II	⧺	⧺	⧺	−	+
Shinno	−	−	⧺	−	⧺
Tsuruoka	−	−	−	−	−
Shiranuka	−	+	+	⧺	⧺

Katsurakoi

A small fishery village involoving some patches of windbreak forests. Forest: shrub layer, *Quercus mongolica* var. *grosseserrata*, *Acer mono* var. *glabrum*; herbaceous layer, *Sasa apoiensis*, *Rhus ambigua*, *Thalictrum kemense* var. *hypoleucum*, *Celastrus orbiculatus*, *Carex breviculmis*. Grassland: *Trifolium pratense*, *Oenothera erythrosepala*, *Artemisia montana*, *Cicuta virosa* var. *nipponica*, *Trifolium repens*.

Shirakabadai

Eastern margin of residence sections close to the underdeveloped areas of Kushiro City. Forest : shrub layer, *Quercus mongolica* var. *grosseserrata, Fraxinus mandshurica* var. *japonica, Acer mono* var. *glabrum ;* herbaceous layer, *Sasa apoiensis, Euonymus sieboldanus, Rhus ambigua, Schisandra chinensis, Artemisia montana.* Grassland : *Petasites japonicus* var. *giganteus, Trifolium pratense, Dactylis glomerata, Artemisia montana, Amphicarpaea trisperma.*

Shinfuji

The most urbanized one among nine localities surveyed, where many fish processing facilities are in operation. There is no forest. Grassland : *Polygonatum humile, Calamagrostis langsdorffii, Poa pratensis, Artemisia japonica, Achillea alpina* var. *angustifolia.* Dune : *Elymus mollis, Carex caryophyllea* var. *microtrica, Calamagrostis epigeios, Miscanthus sinensis, Galium verum* var. *trachycarpum.*

Otanoshike I

Around a paper mill manufactory poluting the environments with smoke and wastes. There is an arboretum of willows, which forms a hedge of the manufactory. Arboretum : shrub layer, *Salix sachalinensis, S. hultenii* var. *angustifolia, S. subfragilis, Alnus hirsuta* var. *sibirica* ; herbaceous layer, *Agrostis alba, Dactylis glomerata, Geum japonicum, Salix subfragilis, Geranium thunbergii.* Grassland : *Cirsium setosum, Dactylis glomerata, Artemisia montana, Calamagrostis langsdorffii, Rudbeckia serotina.* Dune : *Carex caryophyllea* var. *microtrica, Calamagrostis epigeios, Miscanthus sinensis, Artemisia stelleriana, A. montana.*

Otanoshike II

Around Kushiro Stockbreeding Center which is about 1.5 km apart from Otanoshike I. Southeast wind frequently brings much smoke from the paper mill manufactory to this locality. There is a small coniferous plantation in the premises of K. S. C. Forest : sub-tree layer (8 to 15 m high), *Picea jezoensis, Fraxinus mandshurica* var. *japonica* ; shrub layer, *Euonymus sieboldianus* ; herbaceous layer, *Calamagrostis langsdorffii, Cacalia hastata* var. *orientalis, Urtica platyphylla, Carex lyngbyei, Agrimonia japonica.* Grassland : *Phragmites australis, Carex lyngbyei, Thalictrum kemense* var. *hypoleucum, Vicia cracca, Stellaria monosperma* var. *japonica.*

Shinno

Farmlands expand in this locality with few houses. There are plantatoin of *Larix kaempferi* and of *Ulmus japonica* along a tributary of the River Akan. Plantation : shrub layer, *Larix kaempferi* ; herbaceous layer, *Carex thunbergii, Calamagrostis langsdorffii, Equisetum arvense, Geum aleppicum, Rubus idaeus* var. *aculeatissimus.* Broad-leaves : sub-tree layer, *Ulmus japonica* ; shrub layer, *Euonymus sieboldianus, Salix sachalinensis* ; herbaceous layer, *Pachysandra terminalis, Urtica platyphylla, Carex lyngbyei, Calamagrostis langsdorffii, Chamaele*

decumbens.

Tsuruoka

The most underdeveloped one among nine localities surveyed. Forest: subtree layer, *Ulmus japonica*; shrub layer, *Alnus hirsuta* var. *sibirica, Sambucus sieboldiana* var. *miquelii, Salix hultenii* var. *angustifolia*; herbaceous layer, *Petasites japonicus* var. *giganteus, Aralia cordata, Calamagrostis langsdorffii, Ranunculus japonicus, Urtica platyphylla.* Grassland: *Lespedeza bicolor, Artemisia montana, Carex lyngbyei, Achillea alpina* var. *angustifolia, Agrimonia japonica.*

Shiranuka

This locality involves marshy grounds along the River Koitoi. Forest: shrub layer, *Betula platyphylla* var. *japonica*; herbaceous layer, *Osmundastrum cinnamomeum* var. *fokiense, Schisandra chinensis, Iris ensata* var. *spontanea, Rhus ambigua, Carex breviculmis.* Grassland: *Phragmites australis, Carex lyngbyei, Osmundastrum cinnamomeum* var. *fokiense, Carex breviculmis, Lycopus maackianus.* Dune: *Miscanthus sinensis, Elymus mollis, Artemisia japonica, Moehringia lateriflora, Calamagrostis epigeios.*

In total 38 trap stations were chosen in those localities. At each station five pitfall traps of 210 cc volume, 6.5 cm caliber and 9 cm deep were linearly arranged at 1 m intervals. The sampling was made on May 19 to 22, June 24 to 27, July 22 to 25, August 27 to 30 and September 19 to 22 in 1981.

Results and Discussion

Faunal makeup: The species of Carabidae, Harpalidae, Silphidae, Catopidae, Geotrupidae, Tenebrionidae, Meloidae and Scaritidae were identified in the present research. The following list represents the scientific name, full total, monthly total and, in parentheses, the number of individuals captured at each trap station for each species. The monthly number was omitted when only one specimen was collected. Symbols of sampling localities and habitats are as follows: MI, Mitsuura; KA, Katsurakoi; SK, Shirakabadai; SF, Shinfuji; OI, Otanoshike I; OII, Otanoshike II; SN, Shinno; TU, Tsuruoka; SR, Shiranuka; B, bare land; G, grassland; Di, deciduous broad-leaved forest; Dm, its margin; Dg, dune grassland; Db, dune bare land; Pi, forest of *Picea jezoensis*; Pm, its margin; L, forest of *Larix leptolepis.*

Family CARABIDAE

1. *Carabus conciliator hokkaidensis* Lapouge 97: V 22 (MI-Dm 3, KA-Dm, Di, SK-B, Dm 3, Di, OI-Dg, TU-Dm 6, Di 5), VI 50 (MI-Dm 4, Di 3, KA-B, G 3, Dm, Di, SK-G, Dm 9, Di 6, SF-Dg 3, TU-Dm 12, Di 7), VII 10 (MI-Dm 2, Di, KA-Dm, Di, SK-Di, OI-Db, TU-Di 3), VIII 12 (MI-Dm 5, Di 3, KA-Dm, SK-G, Di, TU-Dm), IX 3 (KA-B, SK-G, Dm).
2. *C. maeander paludis* Gehin 13: V 9 (OI-B 4, TU-G 2, Dm, SR-Dm, Di), VI 3 (OI-B 3), IX (OI-G).
3. *C. granulatus yezoensis* Bates 73: VI 12 (MI-Dm, KA-G 3, Di, SK-Dm, Di,

TU-G, Dm 3, Di), VII 42 (MI-Dm 11, Di 7, KA-G 2, Dm, Di 3, SK-Dm 5, Di 4, TU-Dm 7, Di 2), VIII 18 (MI-Dm 2, KA-Dm 3, Di, SK-Dm 4, Di, TU-G, Dm 3, Di 2, SR-G), IX (SK-Dm).

4. *C. opaculus* Putzeys 55 : VI 4 (MI-Dm, SK-G, Dm, TU-Di), VII 9 (TU-Dm, SR-G 2, Dm 4, Di 2), VIII 21 (OII-Pm, TU-Dm 7, Di 3, SR-B 3, G 6, Di), IX 21 (SK-Di 5, OII-Pi 3, TU-B 3, SR-B 8, Di 2).
5. *C. arboreus* Lewis 2 : VIII 2 (TU-Dm, Di).
6. *Hemicarabus tuberculosus* Dejean et Boisduval 17 : V 6 (SK-Dm, SR-Db 5), VI 7 (SR-Di, Dg, 4, Db 2), VII 2 (MI-B, SK-G), VIII (SK-B), IX (SK-B).
7. *Procrustes aino* Rost 2 : VIII 2 (MI-Dm, SK-G).
8. *Cychrus morawitzi* Gehin 3 : VIII 3 (MI-Dm, Di, TU-Dm).
9. *Damaster blaptoides rugipennis* Motschulsky 2 : VI (SR-Dg), VII (OI-Dg).

Family HARPALIDAE

10. *Poecilus caerulescens* L. 192 : V 50 (MI-G, Dm 6, Di, KA-B 2, Dm 11, Di, SK-Dm 4, Di 3, SF-G 5, Db, OI-G 7, OII-B 8), VI 86 (MI-B 4, G 6, KA-B 3, G 30, Dm, SK-B 2, G 8, Dm 5, OI-B 3, OI-G, TU-B 6, TU-G 12, SR-B, G 4), VII 45 (MI-B, G 4, KA-B, G 6, SK-G, Dm, SF-G 4, OI-B 6, S 7, OII-B 5, G, TU-B 3, G, SR-B, SR-S 3), VIII 11 (MI-B, KA-G, SF-B 2, G, OI-G, TU-B 3, G, SR-G).
11. *P. fortipes* Chaudoir 17 : VI 5 (SF-G 3, Db, SR-Db), VII 10 (SK-G, SF-Db, OI-Db 5, SN-Di, SR-Db 2), VIII 2 (OI-Db, OII-B).
12. *Agonum impressum* Panzer 86 : V 26 (OI-B 13, G 5, Dm, SR-B 4, G 2, Db), VI 52 (OI-B 51, Dg), VII 4 (OI-Db, OII-B, G, SR-Db), VIII 1 (OI-Db), IX 3 (OI-B, G 2).
13. *A. charillum yezoanum* Nakane 1 : IX (OII-Pi).
14. *A.* sp. 1 : V (SF-G).
15. *Amara chalcites* Dejean 12 : V 2 (SF-Db, TU-B), VI 8 (KA-Dm, SK-G, OI-G, Di, SR-Db 4), VII 2 (OI-B, Dm).
16. *Am. communis* Panzer 126 : V 33 (MI-Dm, KA-G 7, Dm 2, SK-G, SF-G 3, OI-B, Di 2, Db, OII-B, SR-B 8, G, Dm, Dg 2, Db 2), VI 62 (MI-G 2m KA-G 3, SK-G 15, SF-G, Dg 2, OI-G, Dm, Di 19, OII-B, G 8, TU-B, G, SR-Di 3, Dg 3, Db), VII 24 (MI-G, KA-G 3, SK-B, G 6, SF-B, G 2, TU-G 3, Dm 3, SR-Di, Dg 2, Db), VIII 5 (MI-G, SK-G, OII-B, G, TU-B), IX 2 (OI-G, OII-Pm).
17. *Am. chalcophae* Bates 83 : V 4 (OI-Db 4), VI 3 (KA-B, SR-Db 2), IX 76 (MI-B 18, G, KA-B 38, SK-Dm, OI-Db 9m SR-B 4, Db 5).
18. *Am. tibialis* Paykull 14 : VI 3 (SR-Db 3), VII 11 (SK-G 4, SF-Dg, OI-Dm 2, Di 2, TU-Dm 2).
19. *Am.* sp. 3 : V 1 (SF-G), VI 2 (OI-Dg, SR-Dm).
20. *Pterostichus haptoderoides japanensis* Lutshnik 51 : V 12 (KA-B 2, SK-B 3, OI-B 5, G 2), VI 33 (MI-G 2, KA-B, G 7, SK-G 5, SF-B, G 3, SF-Db, OI-Dm, TU-B 2, G 8, Dm, SR-Db), VII 6 (MI-G 3, SK-B, G, SF-G).
21. *Pt. neglectus* Morawitz 7 : V 7 (MI-Dm, KA-Di 2, SK-Dm 2, Di, TU-Di).

22. *Pt. thunbergi* Morawitz 28 : V 13 (SK-G, Dm 3, TU-G 3, Dm 4, Di 2), VI 10 (MI-Dm, KA-Dm 2, Di, SK-Di, TU-Dm 4, Di), VII 5 (MI-Di, SK-Dm, TU-Dm 2, Di).
23. *Pt. adstrictus* Eschscholtz 62 : V 20 (MI-Dm, Di 2, KA-Di, SK-Dm 5, Di 1, TU-B 2, Dm 5, Di 3), VI 24 (MI-Dm, Di 5, KA-G, Di 6, SK-Dm, Di 4, TU-Dm 3, Di 3), VII 11 (MI-Dm, Di 2, KA-G, Dm, Di 3, SK-Di, TU-Di 2), VIII 7 (MI-Di 2, KA-Dm, Di, SK-Di, TU-Di 2).
24. *Pt. microcephalus* Motschulsky 18 : V 6 (KA-G, SF-G 3, SR-G 2), VI 10 (MI-B, KA-G 2, SK-G 3, Dm 2, Di, TU-Dm), VII 1 (OI-B), IX 1 (SK-Dm).
25. *Pt. orientalis* Motschulsky 72 : VI 25 (MI-Dm 2, Di 6, SK-Dm 9, Di 3, TU-G, Dm 3, Di), VII 31 (MI-Dm 6, KA-G, Dm 4, Di 4, SK-G, Dm 6, Di 5, TU-Dm 3, Di 1), VIII 14 (MI-Dm, KA-Dm 3, Di, SK-Dm, Di, TU-G, Dm 3, Di 3), IX 2 (SK-Dm 2).
26. *Pt. sulcitarsis* Morawitz 11 : VI 5 (MI-Di, KA-Dm, OI-Dg 3), VII 4 (OI-Db 2, SR-B, Db), VIII 1 (SK-G), IX 1 (SR-Db).
27. *Pt. rotundangulus* Morawitz 2 : V 1 (SR-B), VII 1 (SR-G).
28. *Pt. subovatus* Motschulsky 22 : V 4 (SK-B 2, Dm 2), VI 5 (MI-Dm 2, KA-B, G, TU-B), VII 12 (MI-Dm, Di, KA-Dm 3, SK-Di 2, TU-Dm 4, Di), IX 1 (MI-Dm).
29. *Pt. prolongatus* Morawitz 1 : VIII (SR-G).
30. *Pt. leptis* Bates 1 : VIII (OI-Db).
31. *Bembidion poppii captivorum* Netolitzky 10 : V 5 (SK-G, OI-B, Db, SN-Di 2), VI 3 (KA-G, SK-G 2), VII 1 (SK-G), IX 1 (MI-G).
32. *B. morawitzi* Csiki 1 : VII 1 (SR-G).
33. *B. fasciatum* Motschulsky 4 : VI 3 (OI-B 3), IX 1 (OI-B).
34. *Chlaenius pallipes* Gebler 111 : V 15 (MI-B, G, Dm 4, OI-B, OII-G 2, TU-B 2, G 2, Dm, SR-G), VI 37 (MI-G 4, KA-G 9, SK-G 8, Dm 11, OI-B, TU-B, G 2, Dm), VII 37 (MI-B, G 5, Dm 2, KA-B, G 4, SK-B 4, G 8, SF-G 3, OI-Db, TU-B, G 4, Dm, SR-B, G). VIII 10 (MI-Dm 3, KA-G 3, SK-G, TU-G 2, Dm), IX 12 (MI-G 4, Dm 2, SK-B, Dm 4, TU-Dm).
35. *Platynus subovatus* Putzeys 2 : VI 1 (SK-Dm), VII 1 (TU-Dm).
36. *Anisodactylus signatus* Panzer 1 : VII (SK-B).
37. *Harpalus quadripunctatus ainus* Habu et Baba 8 : VII 1 (MI-Dm), VIII 7 (MI-G, SK-B 4, TU-Dm, SR-G).
38. *H. platynotus* Bates 17 : VIII 17 (SF-B 4, Db 8, OI-Db 4, SR-Db).
39. *Panagaeus robustus* Morawitz 22 : VI 2 (TU-G, SR-Dg), VII 20 (OI-Dg 4, SR-G 6, SR-Dg 3, SR-Db 7).
40. *Stenolophus propinguus* Morawitz 5 : V 2 (OI-Dg 2), VI 3 (MI-G, TU-G, SR-Dg).
41. *Synuchus melantho* Bates 33 : VIII 8 (MI-Dm 3, Di, KA-B, SK-Di, TU-Dm, Di), IX 25 (KA-B, Dm 9, Di, SK-B, Dm 7, Di, SN-Di 2, TU-Dm 2, Di).
42. *S. arcuaticollis* Motschulsky 2 : VII (TU-G), IX (OI-Dg).
43. *S. cycloderus* Bates 3 : IX 3 (KA-Dm, TU-Di, SR-B).

44. *Craspedonotus tibialis* Schaum 4 : VIII 2 (OI-Db 2), IX 2 (MI-G, OI-Db),
45. *Ophonus sinicus* Hope 8 : VI 2 (MI-Di, KA-Dm), VII 1 (TU-B), IX 5 (OI-Dg, Db 4).
46. *O. ussuriensis* Chaudoir 1 : VII (MI-G).
47. *O. capito* Morawitz 1 : VIII (TU-Dm).
48. *O. griseus* Panzer 1 : IX (OI-B).
49. *Bradytus simplicidens* Morawitz 31 : VII 4 (SF-B 2, OI-Db 2), VIII 27 (KA-B, SK-B, SF-B 3, Db 2, OI-Db 14, SR-Db 6).
50. *B. macros* Bates 3 : VII (SK-B), VIII 2 (TU-B 2).
51. *Trichotichnus congruus* Morawitz 1 : V (SF-Dg).
52. *T. longitarsis* Morawitz 4 : VIII 4 (TU-Dm 4).
53. *Lachnolebia cribricollis* Morawitz 2 : V (KA-G), VI (MI-G).
54. *Cymindis yokoyamai* Nakane 7 : VII (OI-Db), VIII 5 (OI-Db, SR-Db 4), IX (OI-Db).
55. *Calathus halensis* Schaller 10 : VIII 8 (KA-B 3, G, SF-Db 2, TU-B, G), IX 2 (SF-Db, OI-Db).

Family SILPHIDAE

56. *Silpha perforata venatoria* Harold 328 : V 37 (MI-G, Dm, Di 4, KA-Dm 3, SK-B, G 2, Di, SF-Dg 3, OI-G 6, Db 3, OII-G 3, SN-L, TU-G 6, Dm 2), VI 124 (MI-B, Dm 3, Di 7, KA-G 26, Dm 11, Di 8, SK-Dm 7, Di 9, SF-G, Dg, OI-G 3, Dg 9, OII-G 9, SN-Di 2, TU-Dm 5, Di 6, SR-B 4, G, Di, Dg 7, Db 3), VII 85 (MI-B, Dm 6, Di 3, KA-G 8, Dm 5, Di 4, SK-G 4, Dm 2, Di 2, SF-G 3, Dg, OI-G 2, Dg 5, Db 7, OII-Pm, TU-G, Dm 4, Di, SR-B 2, G 6, Dg 4, Db 13), VIII 49 (MI-B, Dm 10, Di 5, KA-Dm 3, Di 2, SK-B, Dm 2, Di 2, OI-G, Dm 2, Db 2, OII-B, TU-B, Dm 5, Di 3, SR-G 2, Dg 5, Db), IX 33 (MI-G, SK-Dm 5, SF-G 3, OI-G 5, Dg 2, Db 2, OII-B 2, G, Pm 6, Pi, SR-B, Dg, Db 3).
57. *Phosphuga atrata* L. 11 : VI 4 (MI-Di. SK-Dm, OI-G, OII-G), VII 4 (MI-Di, SK-Dm, TU-Dm, SR-B), VIII 3 (MI-Di, TU-G. Di).

Family CATOPIDAE

58. *Catops* sp. 2 : VI (SN-Di), IX (OII-Pm).

Family GEOTRUPIDAE

59. *Geotrupes laevistriatus* Motschulsky 48 : VI 9 (MI-Di, KA-Dm 2, Di, SK-Di, TU-Dm 3, Di), VII 15 (MI-Dm 4, KA-G, Di 2, SK-Dm, Di 2, TU-G, Dm, Di 3), VIII 11 (MI-Di, KA-G, Di 2, SK-Dm 3, Di, TU-Dm 2, Di), IX 13 (MI-Di, KA-G, Di, SK-Dm 2, Di 4, SN-Di 2, TU-Dm, Di).

Family TENEBRIONIDAE

60. *Phaleromela subhumeralis* Marseul 94 : V 57 (SF-Db 48, OI-Db 9), VI 37 (SF-Db 37).
61. *Gonocephalum recticolle* Motschulsky 74 : VI 35 (SF-G 2, Db 13, OI-Db 11, SR-Db 9), VII 35 (SF-Db 11, OI-Db 16, SR-Db 8), VIII 4 (SF-Db 2, OII-B,

SR-Db).

62. *G. japanum* Motschulsky 14 : VI 9 (MI-B, KA-B 3, G, SK-B 4), VII 4 (KA-B 3, OI-Db), IX (SR-Db).
63. *G. persimile* Lewis 1 : VII (OI-Db).
64. *Stenophanes rubripennis* Marseul 1 : IX (MI-B).

Family MELOIDAE

65. *Meloë corvinus* Marseul 1 : VI (OII-B).

Family SCARITIDAE

66. *Clivina vulgivaga* Boheman 2 : VI (SK-G), VIII (SF-B).
67. *Dyschirius glypturus* Bates 1 : VIII (OII-B).

In total 1943 individuals of 67 species were obtained. Table 2 gives the faunal comparison of seven common families between Kushiro and Bekkai (Higashi *et al.*, 1983). Out of 70 species discovered in the two areas combined, 40 species were common to both areas. The common ones occupied 89% of all species in Bekkai but 62% in Kushiro, which means that the most species of Bekkai were discovered in Kushiro, too, but Kushiro was inhabited by many specific species. The species found only in Kushiro were most abundant in Harpalidae, of which the following species were dominant: *Amara chalcophae, A. tibialis, Harpalus platynotus, Calathus halensis, Cymindis yokoyamai.* They frequently inhabited the localities such as Shinfuji and Otanoshike. These localities are always exposed to severe human impacts which are nearly absent in Bekkai.

Overlap of distribution among dominant species: An index of Wittaker (1952) was used to represent the distribution overlap among dominant species:

$$DO = \sum_i \min(P_{ai}, P_{bi}) \times 100$$

where P_{ai} and P_{bi} are relative frequencies of species a and b, respectively, at trap station i.

As in Bekkai (Higashi *et al.*, 1983), most of the *DO*s were less than 30% in

Table 2. Faunal comparison of ground beetles between Bekkai (Higashi *et al.*, 1983) and Kushiro, in which the number of species is given.

Family	Bekkai	Kushiro	Common to both areas
Carabidae	8	9	7
Harpalidae	30	46	28
Silphidae	2	2	2
Catopidae	1	1	0
Geotrupidae	1	1	1
Tenebrionidae	2	5	2
Meloidae	1	1	0
Total	45	65	40

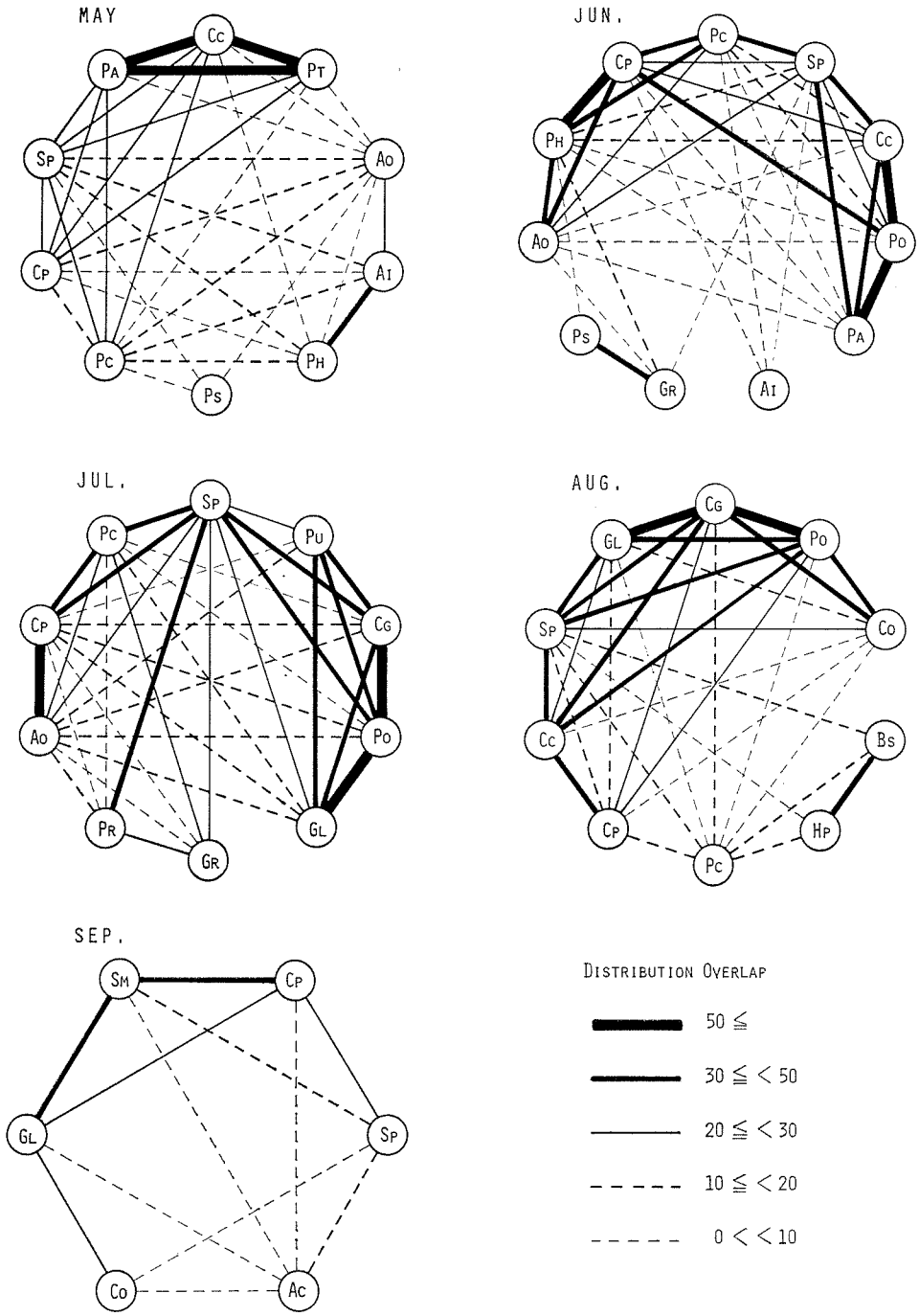

Fig. 3. Distribution overlap among dominant species in each month.
AC, *Amara chalcophae*; AI, *Agonum impressum*; AO, *Amara communis*; BS, *Bradytus simplicidens*; CC, *Carabus conciliator hokkaidensis*; CG, *C. granulatus yezoensis*; CO, *C. opaculus*; CP, *Chlaenius pallipes*; GL, *Geotrupes laevistriatus*; GR, *Gonocephalum recticolle*; HP, *Harpalus platynotus*; PA, *Pterostichus adstrictus*; PC, *Poecilus caerulescens*; PH, *Pterostichus haptoderoides*; PO, *P. orientalis*; PR, *Panagaeus robustus*; PS, *Phaleromela subhumeralis*; PT, *Pterostichus thumbergi*; PU, *P. subovatus*; SM, *Synuchus melantho*; SP, *Silpha perforata venatoria*.

the spring and the autumn (Fig. 3), each species showing peculiar distribution pattern. In the summer, however, their cohabitation occurred frequently, and the dominant species could be grouped into several types based on their habitat preference. In July there were four types as follows. 1. Openland species: *Poecilus caerulescens, Chlaenius pallipes, Amara communis.* 2. Sylvan species: *Pterostichus subovatus, P. orientalis, Carabus granulatus yezoensis, Geotrupes laevistriatus.* 3. Dune species: *Gonocephalum recticolle.* 4. Eurytopic species: *Silpha perforata venatoria.* As considered in the previous paper (Higashi *et al.*, 1983), the clear separation of the four types in the summer should be due to the culmination of tree foliages which induces the maximum difference of environmental conditions between the forests and the open habitats.

Clustering of trap stations: The Whittaker's index mentioned was used to represent the faunal similarities among trap stations, too:

$$\mathrm{PS} = \sum_{a} \min (P_{ai}, P_{aj})$$

in which P_{ai} and P_{aj} were relative frequencies of species a at trap stations i and j respectively. The cluster analysis of the trap stations was adopted to the data of July (Fig. 4), because each species distinctly realized its habitat preference in this season as mentioned above. The clustering was made with the average-linkage method of Davis (1963) and the clustering limit was fixed at PS=0.2 for types and at PS=0.38 for groups in accordance with Howard-Williams and Walker (1974) who set up the clustering limit at a glacis point on the curve of the relation between

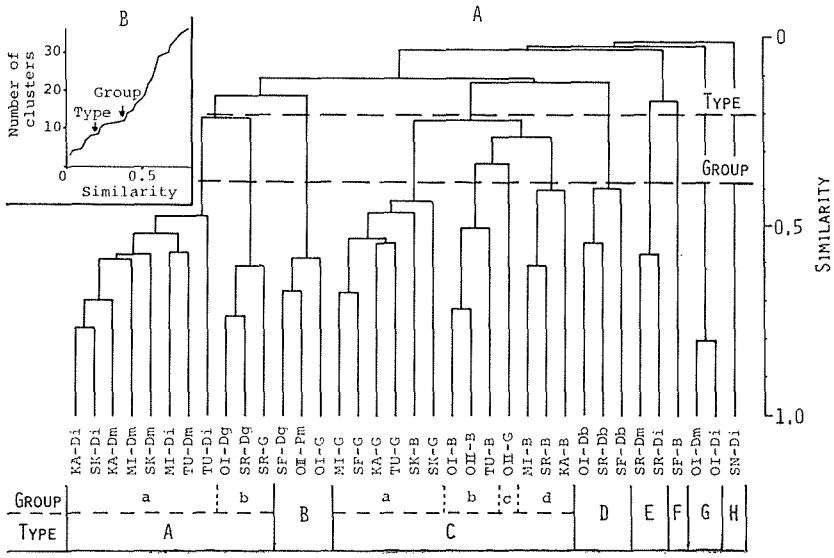

Fig. 4. Cluster analysis of the data obtained in July.

A. Clustering of trap stations with the average-linkage method (Davis, 1963). A similarity index PS (Weittaker, 1952) was used. B. Selection of clustering limit for types and groups, in accordance with Howard-Williams and Walker (1974). The clustering limit was fixed at PS=0.2f or types and at PS=0.38 for groups.

the similarity level and the cluster abundance (Fig. 4 B). The trap stations were clustered as follows:

Type A: This type was subdivided into two groups. Group Aa involved the inside and the margin of the forests at Mitsuura, Katsurakoi, Shirakabadai and Tsuruoka where the human impacts were not so serious as in other localities (Table 1). Predominant beetles were *Carabus granulatus yezoensis*, *Silpha perforata venatoria* and *Pterostichus orientalis*. Group Ab involved grasslands on or around the dunes of Otanoshike I and Shiranuka which were dominated by *Panagaeus robustus* and *Silpha perforata venatoria*. The groups Aa and Ab were commonly inhabited only by a eurytopic species *Silpha perforata venatoria*, and they were clustered with each other at a low similarity level of PS=0.21.

Type B: A grassland of Otanoshike I, a forest margin of Otanoshike II and a dune grassland of Shinfuji. These localities were heavily urbanized and industrialized, and the ground beetle communities were almost defaunated except for occasional occurrence of *Silpha perforata venatoria*.

Type C: Most of the grasslands and the bare lands belonged to this type. There were four groups. Most grasslands belonged to Ca but bare lands formed two groups Cb and Cd. Cb consisted of the bare lands in Otanoshike I, Otanoshike II and Tsuruoka, which were almost monopolized by *Poecilus caerulescens*. Cd involved the bare lands of Mitsuura, Shiranuka and Katsurakoi which were dominated by *Chlaenius pallipes* as well as *Poecilus caerulescens*. Cc was composed of a poor fauna grassland in Otanoshike II.

Type D: Aphytal dunes, predominantly inhabited by *Gonocephalum recticolle*.

Type E: A wetland forest of *Betula platyphylla* var. *japonica* and its margin in Shiranuka, occupied by *Carabus opaculus*.

Type F: A bare land in Shinfuji, inhabited by only two species *Bradytus simplicidens* and *Amara communis*.

Type G: An arboretum of willows and its margin in Otanoshike I, occupied by *Amara tibialis*.

Type H: A riverside forest of *Ulmus japonica* in Shinno, where only *Poecilus fortipes* was discovered.

The forests and their margins of underdeveloped localities formed a group Ab but those of developed localities belonged to other types. This means that the sylvan communities of the ground beetles are heavily disturbed and almost defaunated by the urbanization and the industrialization. On the other hand, the grasslands and the bare lands of developed localities made up a type C jointly with those of underdeveloped ones, which suggests that those open habitats have been exposed to the human impacts more or less and the urbanization and the industrialization hardly produce a new community there. The communities on dunes were also similar among any localities, probably because the dunes have always been laid to the stress of coastal conditions and the human impacts can hardly reform the dune communities of ground beetles.

Summary

1. In total 67 species of 34 genera were obtained, including the following predominant species: *Carabus conciliater hokkaidehsis, C. granulatus yezoensis, C. opaculus* (Carabidae); *Poecilus caerulescens, Agonum impressum, Amara communis, A. chalcophae, Pterostichus haptoderoides japanensis, P. adstrictus, P. orientalis, Chlaenius pallipes* (Harpalidae); *Silpha perforata venatoria* (Silphidae); *Geotrupes laevistriatus* (Geotrupidae); *Phaleromela subhumeralis, Genocephalum recticolle* (Tenebrionidae).

2. Out of them 27 species had not been discovered in Bekkai. Many of them inhabited the urban and industrial environments which were absent in Bekkai.

3. The habitat preference of each species was distinctly realized in the summer, probably because the culmination of tree foliages induced the maximum difference of environmental conditions between the forests and the open habitats in this season.

4. The urbanization and the industrialization heavily disturbed and nearly defaunated the sylvan communities, while the openland communities were not reformed by those human impacts.

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