Korean J Biol Sci 1: 305-311, 1997

Conservation of Dermaptera in Youngnam Region I. Choosing Priority Area by Taxonomic Root Weighting and Distribution Analysis

Il-Byong Yoon[1] and Tae-Young Moon*

[1]Department of Biology, Korea University, Seoul 136-701, Korea;
Department of Biology, Kosin University, Pusan 606-701, Korea

Key Words:
Dermaptera distribution
Taxonomic root weighting
Priority conservation area

Dermaptera was investigated, examined and reviewed in taxonomy and for distribution in Youngnam region. Based on the data, the local species groups were measured to choose priority-conservation-area by taxonomic root weighting and distribution analysis at 232 geographical conservation units. Eleven species belonging to 4 families and 8 genera were recorded mounting up to 68.75% of species diversity known in Korea. Found remarkably were the rare and endangered *Challia fletcheri* Burr at Sobaek Mountain National Park, and unusually *Anisolabis maritima* (Bonelli) in Taegu, *Euborellia pallipes* (Shiraki) at Island Geoje and *E. plebeja* (Dohrn) at Hwanho near Pohang. The highest species diversity was found at the temple Huibang area at Sobaek Mountain National Park with 8 species, which was measured also as the primary priority-conservation-area with 83.41% of accumulated taxonomic root weighting indices in percentage. Geoje and Hwanho both measured as 12.18% of accumulated taxonomic root weighting index in percentage and complimentary to Sobaek Mountain National Park but supporting 5 and 3 species, respectively. The priority goes to the geographical conservation unit supporting higher species richness between two geographical conservation units in comparison. By the rule, the second priority-conservation-area should be Geoje and the third Hwanho. It is, thus, demonstrated how 11 species can be all conserved by choosing 3 priority-conservation-areas out of 232 geographical conservation units to maintain maximum species in minimum areas.

Insects are an animal group left far from conservation priority in Korea. Although a small number of butterflies and beetles have been concerned from the aesthetic point of view (Korea Ministry of Environment, 1994), it may be better to be counted as a starting point to conserve enormous diversity of the insect class. It is true indeed that insects have been declining rapidly at the level of individual species or local fauna during last two decades (Moon et al., 1992; Moon and Kim, 1995). In particular, the situations are found worse among primitive, minor, neglected or pest taxa, that eventually has seriously declined or may have disappeared even before being described in taxonomy.

Dermaptera is one of the most neglected insects and some species have been often eliminated as household pests for no reasons other than their disgusting appearance from anthropocentric bias. However, Dermaptera is an old taxa of insects retaining many characters found in the fossil species from Jurassic strata (Rodendorf, 1962). It was, therefore, suggested that Dermaptera may provide various clues to reconstruct the uncertain part of the phylogeny between Plecopteroid and Orthopteroid insects (Hennig, 1981; Sakai, 1995). They were also known as predators on small insects but more important as saprophagous insects attending to all stages of decomposition of animal carrions. Therefore, the value of Dermaptera conservation may be recognized for taxonomic and ecological importance, adding to their own rights for natural existence (Nash, 1989; Collin and Thomas, 1991).

There were efforts to study the taxonomy of Dermaptera in South Korea (Kim and Moon, 1985; Moon and Kim, 1991; Moon, 1993). However, there has been no further studies on intraspecific dynamics, local distribution, and ecology. It is, therefore, important in the first place to investigate local distribution to conserve them, as the modern strategies for wildlife conservation require the target objects be defined in taxonomy and distribution (McNeely et al., 1990).

In a such context, Youngnam region was chosen as a pilot-study area, because it is a region separated

* To whom correspondence should be addressed.
Tel: 82-51-400-2320, Fax: 82-51-403-5911

geographically by Mts. Taebaek and Sobaek from other parts of Korean peninsula. Such geographical division was also demonstrated to be appropriate for studying the relationship between vegetation and climate in the region (Yim and Kira, 1975, 1976).

We examined the specimens collected from Youngnam region, which are available from Korean institutes, to reveal the pattern of distributions of Dermaptera species in the region and to test the tactics for maximum conservation in minimum areas.

Materials and Methods

A series of taxonomic and ecological information related to Youngnam region was retrieved from DermaData which is a comprehensive database for Dermaptera accumulated by one (TYM) of us since 1983. The data included common species listed in various faunistic reports on Youngnam region (Kamizo, 1934; Yoon and Nam, 1978; Nam and Kim, 1983; Kim et al., 1985; Yoon et al., 1990; Kim and Park, 1991; Park et al., 1993; Moon and Kim, 1995). Based on the retrieved data, we examined, if we had not examined recent samples or in case the data were in doubt, those from Youngnam region amongst the specimens deposited largely at Korean Entomological Institute, Kosin, Sungshin, Youngnam, Gyeongsang, Kyungbuk and Andong Universities, Forest Research Institute, Pohang Primary School and other institutes. Taxonomy for the local fauna was discussed in part elsewhere recently (Moon and Lee, 1995; Moon and Lee, 1995; Moon and Park, 1995). Therefore, we summarized only the skeleton of local fauna and explained a few species still in confusion. Amongst various phylogenetic trees produced by the method of Wiley et al. (1991) to measure taxonomic rootness and relatedness between the species, the most concise topology was chosen among those emphasizing the relationships between male genitalia

A map was produced to measure the distribution of each species, and to delimit a conservation unit. Youngnam region was divided into 232 geographical conservation units (GCUs) of which a unit represents a 1/25,000 scale map of the National Ordinance Survey of Korea. But the Island Ullungdo was not included because it is too far and different from Youngnam region in biogeography, although it is included administratively in the region. Each GCUs can be indicated in the relevant grid references by combination of the horizontal and vertical codes(*rf.* Fig. 1).

The details of sites sampled and recorded for each species are not described in full due to the enormous size of data, but they can be accessed roughly through GCUs in Fig. 2 and would be provided in text on request. We tried to visit as many GCUs as possible, particularly when there had been no records or any doubtful results. However, the nature parks i.e. Sobaek, Jiri and Chuwang Mountain National Parks (SMNP, JMNP, CMNP), and Gaji Mountain Provincial Park were the most important places investigated.

Based on the tree topology chosen and distribution analyses, primary and complimentary taxonomic root weightings (TRWs) were carried out following Vane-Wright et al. (1991) and Moon et al. (1992). Finally, priorities were evaluated to decide the Priority-Conservation-Areas (PCAs) between the GCUs supporting higher species richness. The taxonomic root weighting was demonstrated as a quantitative way of measuring the priorities between various implications of local diversities based on taxonomic and distributional data (Williams et al., 1991).

Results

The records were available at 125 GCUs either through visitings or from retrieved data, while neither samples nor records were obtained at 30 GCUs visited. Seventy seven GCUs have neither recorded any species nor were visited. Consequently, 155 GCUs were investigated and 77 remained vacant for future study amongst 232 GCUs produced.

Examined and reviewed are 11 species of Dermaptera belonging to 4 families 8 genera; that is, *Challia fletcheri* Burr, *Anisolabis maritima* (Bonelli), *Gonolabis marginalis* (Dohrn), *Euborellia annulipes* (Lucas), *E. pallipes*

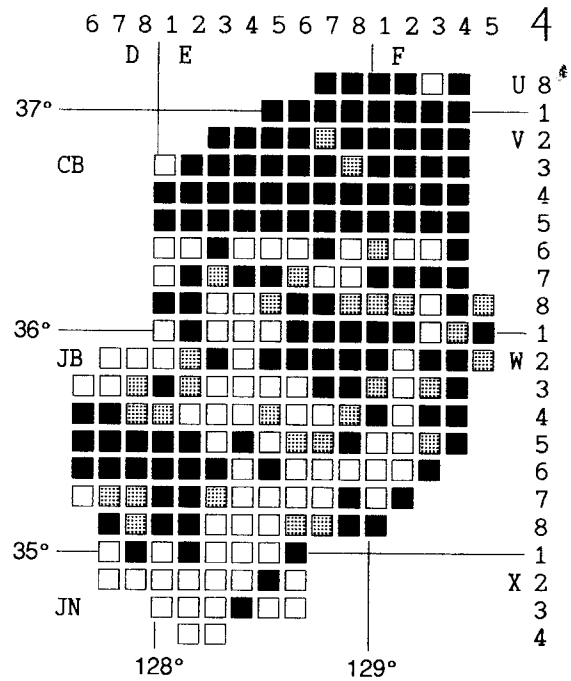

Fig. 1. GCUs investigated and confirmed distribution of Dermaptera in Youngnam region. CB, Chungchungbuk-do; JB, Cheollabuk-do; JN, Cheullanam-do; ■ Areas recorded Dermaptera; ▨ Areas visited but no records; □ Areas not visited and no records; E3V2, Dongno; E4V2, Seokmak; F3V1, Hawon; F4V1, Uljin; E2V3, Hokye; F2V5, Cheongsong; E1V7, Kimcheon; F4V8, Hwanho; E5W2, Taegu; E6W2, Kyeungsan; D6W4, Hamyang; D8W5, Sancheong; E8W8, Dadae; F1W8, Pusan; E5X2, Geoje.

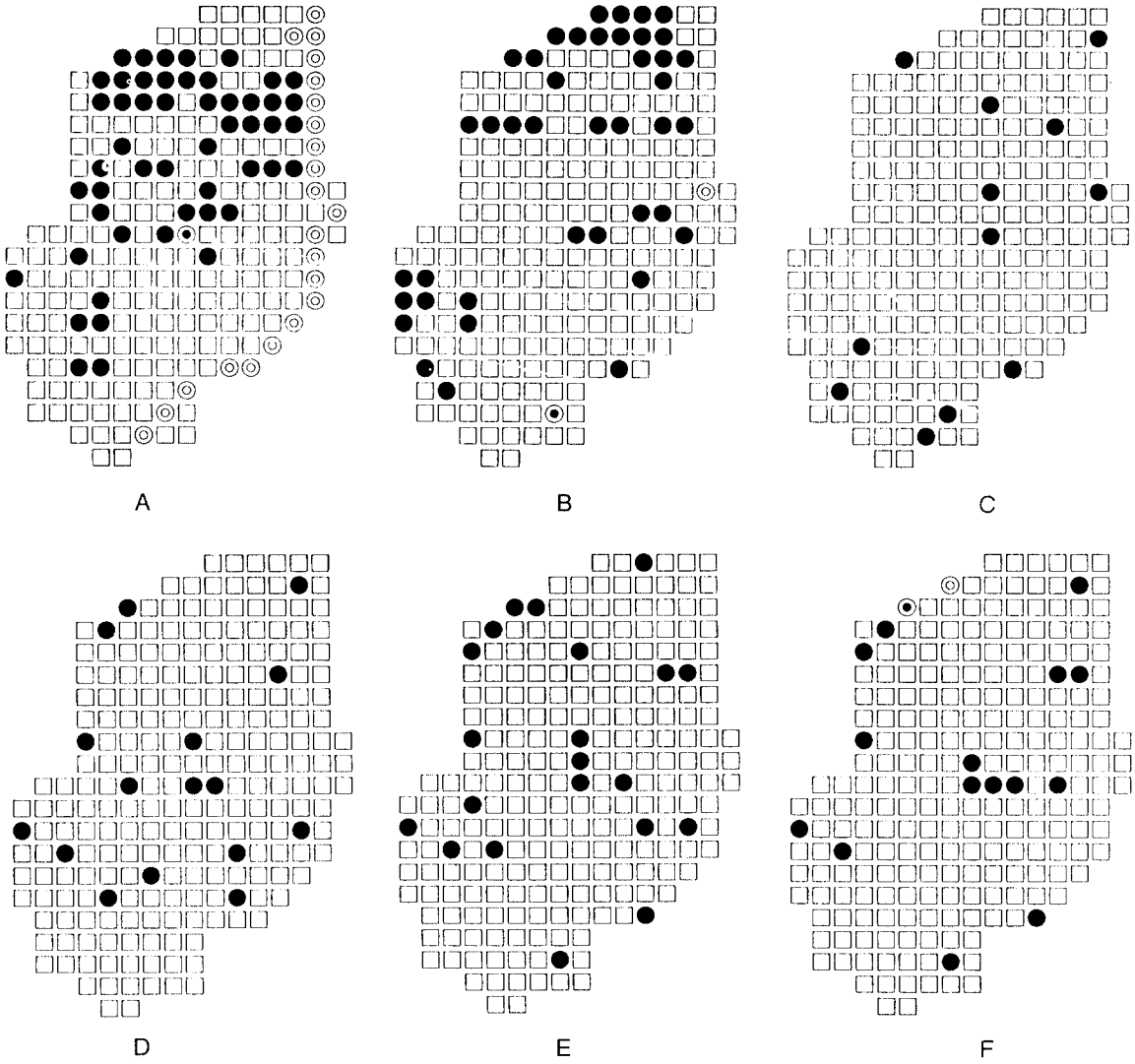

Fig. 2. Distribution of Dermaptera in Youngnam region (*ref.* Fig. 1). A, *Anisolabis maritima* (Bonelli) ( ), *Gonolabis marginalis* (Dohrn) (●), Both Species (◉). B, *Euborellia annulipes* (Lucas) (●), *Euborellia pallipes* (Shiraki) (◉), *Euborellia plebeja* (Dohrn) ( ). C, *Labidura riparia japonica* (De Haan) (●). D, *Timomenus komarowi* (Semenov) (●). E, *Anechra japonica* (Bormans) (●). F, *Forficula scudderi* Bormans (●), *Forficula vicaria* Semenov (◉), *Challia fletcheri* Burr ( ).

(Shiraki), *E. plebeja* (Dohrn), *Labidura riparia* japonica (De Haan), *Timomenus komarowi* (Semenov), *Anechura japonica* (Bormans), *Forficula vicaria* Semenov and *F. scudderi* Bormans.

C. fletcheri is among the most primitive Dermaptera, but has been declining seriously to the endangered status (Yoon and Moon, 1996). In Youngnam region, it has been recorded twice in 1982 and 1994 only at SMNP. The GCU was indicated as Dongno (E3V2) near Danyang in Fig. 2F. Otherwise, the species was found intermittently at Mts. Kounbong, Seorak, Jeombong, and Baekun in South Korea (Moon and Kim, 1985), while it was collected at Mts. Myohyang, Suyoung and Kumgang in North Korea (Moon, unpublished data). It was recorded once from northeast China and the Ryukyu islands in Japan (Steinmann, 1989), but there has been no further records in the countries for many years.

A. maritima is particularly abundant at rocky shores, old ports, and islands, feeding usually on small invertebrates and meats of animal carrions left by tides. In Youngnam region, it was once recorded from Taegu (E5W2) which is inland urban (Kamizo, 1934). The record has not left any voucher specimens and had been doubted for long. However, it was possible to find a few recent specimens from Taegu at the collection of Youngnam University (Moon and Lee, 1995). Furthermore, the additional records were present from Bulyoung Valley indicated as Hawon (F4V1) in Fig. 2A, as though the valley is not far from the East Sea of Korea. The dispersal is, nevertheless, still unusual and suspected artificial and accidental by fish

marketings or other ways, because there has been no more specimens that might imply any established populations of the species. Otherwise, the species has been always recorded at coastal areas in Youngnam region.

G. marginalis is a common species appearing widely from human residence, gardens, and parks to mountains of considerable altitude in Youngnam region. *G. marginalis* may be an inland substitute with the equal ecological niche as *A. maritima* possessed at coastal areas. They are almost similar to each other in their size and habits for intraspecific cannibalism, hostile predation to small invertebrates, and being saprophagous on animal carrions. However, geographical partitions for distribution between two species can be clearly noticed in Fig. 2A. *G. marginalis* occurs often together with *E. annulipes* locally, although it has not yet expanded into urban areas as actively as *E. annulipes*. Noticeably *G. marginalis* preys on and, hence may substitute with a superior ecological niche to *E. annulipes*, when they encounter at cramped spaces as under garbage disposal bins, flat-bottom rocks or decaying woods.

E. annulipes, E. pallipes and *E. plebeja* are among the relatively small earwigs in Anisolabididae. It is difficult in fact to distinguish a species between them particularly during immature stages. Taxonomic and diagnostic keys between the species are available respectively (Moon and Kim, 1985; Moon and Park, 1995). *E. annulipes* is a small and common species, that occupies a wide range of habitats, particularly abundant intruding into man-made environment. It spreads successfully in urban areas through ventilator-tunnels and drainpipes at apartments and tree lawns. *E. annulipes* is carnivorous essentially feeding on small insects. It is, however, also attracted to discarded pieces of meat usually available at slaughterhouses, around restaurants and market places, while it may cause serious damages on stored products like as potatoes and pollen. *E. pallipes* and *E. plebeja* were recently recorded respectively at Island Geoje (E5X2) (Moon and Park, 1995) and at Mt. Ouyun between Pohang (F3V8) and Hwanho (F4V8) (Moon and Lee, 1995). They are rare and unknown in ecology. It is hard in fact to find any evidence that *E. pallipes* and *E. plebeja* are native to Korea upon reviewing their records and distribution (Fig. 2B). We suspect them accidental to Korea for their unusual pattern of distribution limited to the areas along coast or at ports.

L. riparia japonica was recorded largely at waterside sandy banks or grasslands. Therefore, many populations were collected at riverside sands along Bulyoung Valley between Hawon (F3V1) and Uljin (F4V1), at sand deposits along the River Nakdong to Island Eulsuk at Dadae (E8W8), at Island Geoje (E5X2) and Bijin (E4X4) (Fig. 2C). It was often recorded at the places covered with cement and asphalt beneath which soil has, however, remained sandy. It digs a hole under sands where eggs and larvae are bred, and preys on small insects and animal carrions.

Forficulidae recorded in Youngnam region are all characteristic species representing the far-east Palaearctics. *T. komarowi* was found at the areas with remaining vegetation where it lives mostly on trees and hardly comes down to the surface (Fig. 2D). *A. japonica* is common in most types of vegetations from tall-tufted grasslands to forested hills and deep mountains (Fig. 2E). Although polymorphic *A. japonica* were often confused locally with *A. quelparta* Okamoto and *A. harmandi* Burr, they have not been detected in Youngnam region so far (e.g. Yoon et al., 1990=*A. harmandi*; Kim and Park, 1991=*A. harmandi*, *A. quelparta*, *Labias curvicauda*; Park et al., 1993=*A. harmandi*). *A. japonica* feeds on small insects and their eggs or cocoons, but females used to feed on pollen before laying eggs. Females lay eggs in the soils under fallen leaves and practise maternal cares in subsociality.

F. vicaria is a species distinguished by the *F. auricularia* typed forceps which are unique in Korea. It was found only at SMNP (E3V2) in Youngnam region (Fig. 2F). *F. scudderi* is the biggest earwigs in Youngnam region. It has been found generally at littered soils, and under broad leaves of trees. It was often found together with *A. japonica* in same areas, but competitions or predations between them seem to be avoided using different habitats. *A. japonica* lives mostly on twigs of various trees and hardly comes down to soil except for breeding and escaping from danger, while *F. scudderi* lives generally on surface ground in group (Fig. 2F). *F. mikado* recorded previously in Youngnam region are the misidentification of *F. scudderi* (Kim and Park, 1991=*F. mikado*), that were the phenotypes expressing cyclolabic forms of *F. scudderi*.

Based on the taxonomic data and tree topology, TRW indices (TRWI) were calculated for 11 species in Table 1. *C. fletcheri* received 7.04 of TRWI that was evaluated for its taxonomic plesiomorphies, while *E. pallipes* and *E. plebeja* were both fallen to 1.00 of

Table 1. Taxonomic and ecological data for Dermaptera conservation in Youngnam region

Species	TRWI	OTRW	PT	Remarks
Challia fletcheri	7.04	1		Endemic. forest. endangered (Yoon and Moon. 1996)
Anisolabis maritima	1.76	3		Cosmopolitan. coastal. common (Moon and Kim. 1985)
Gonolabis marginalis	1.41	4		Oriental. seminatural. common (ibid.)
Euborellia annulipes	1.17	5		Cosmopolitan. urban. common. pest (ibid.)
E. pallipes	1	6		Far-east palaearctic. seminatural. rare (ibid.)
E. plebeja	1	6		Oriental. rare. introduced?. (Moon and Lee. 1995)
Labidura riparia	2.35	2		Cosmopolitan. waterside. sandy. common
Forficula vicaria	1.41	3		East palaearctic. forest. rare (Moon and Kim.1985)
F. scudderi	1.41	3		Palaearctic. forest. common. (ibid.)
Anechura japonica	1.76	3		Far-east palaearctic. forest. common (Moon.1985)
Timomenus komarowi	2.35	2		Far-east palaearctic. forest. canopy. common (ibid)

TRWI, taxonomic root weighting Indices; OTRW, orders of rootness for each species by TRWI; PT, phylogenetic trees.

TRWI that also reflects their mediocrity in taxonomic rootness. The values of TRWIs also satisfied reasonably to appreciate indirectly the ecological status of each species in this study, although TRW was not designed to measure the ecological qualities of species. It was, therefore, not weighted more in different methods either for the rarity of *C. fletcheri* or for the suspected status of *E. pallipes* and *E. plebeja* in Youngnam region.

The GCU with the highest species richness was on Dongno (E5V1) covering SMNP, where 8 species were recorded. In particular, the slope Temple Huibang standing on supported a rare and endangered species *C. fletcheri*, which was the heaviest valued factor to make SMNP to be the primary PCA. It made Sŏkmak (E4V2) to be dumped, which has 4 species overlapping with those of Dongno (E3V2) in their species composition.

The second group was found at the GCUs of Cheongsong (F2V5) including a main part of CMNP and Taegu (E5W2) both with 6 species. The third group of GCUs was found at Hamyang (D6W4) part of JMNP and Island Geoje (E5X2) with 5 species each. The fourth group of GCUs was those with 4 species as Hokye (E2V3) including Munkyoung Saejae Provincial Park, Kimcheon (E1V8) represented by Temple Jikgi, and Koungsan (E7W2) largely around Youngnam University. Fifths are Hawon (F3V1) represented by Bulyoung Valley, Hwanho (F4V8) near Pohang, Sancheong (D8W5) slope of JMNP, Busan (F1W8), and Dadae (E8W8) respectively in various combinations of 3 different species as seen in Table 2. Otherwise, the GCUs recorded 1 or 2 species as were indicated in Fig. 3. They supported only *A. maritima* at coastal areas, or often *E. annulipes* and *G. marginalis* at inland areas.

The local sums of TRWI were tabulated to evaluate the scores between GCUs with higher species richness in Table 2 (cf. Fig. 3). Applying TRW, Dongno (E5V1) was chosen as the primary PCA with accumulated TRWI in percentage (ATRWIP) of 83.41%. However, Dongno supported only 8 out of 11 species recorded in Youngnam region. Therefore, we tried to find complimentary areas to Dongno among remaining areas. By measuring complementarity, Geoje and Hwanho were chosen as the second PCAs both with 12.18% of the complimentary ATRWIP but supporting respectively 5 and 3 species. In the cases of equal values of TRWI, it should be reasonable that the priority goes to the GCU supporting higher species richness between GCUs on comparison. By the rule, the second PCA should be Geoje (E5X2), and the third Hwanho (F4V8) as indicated in Table 2 and Fig. 3.

In this way, it was demonstrated that 11 species recorded in Youngnam region can be all conserved in minimum areas by choosing only 3 out of 232 GCUs indicated in Fig. 3.

Discussion

There are various points of view for conservation of insects. However, based on the result we provided, the conservation value of Dermaptera may be considered from 3 points of view; evolutionary value, rarity and decline.

On evolutionary value, different species reflect an expression of different histories of their own evolution. Particularly in aspects of morphology and behavioral ecology, the Dermaptera are inactive insects essentially due to various limiting factors as apterism, negative phototaxis, nocturnae, hygrokinesis, thigmotropism and subsocialism (Kim and Moon, 1985). The dispersal is, therefore, likely to have progressed slowly from tropical regions to Korea, accepting the hypothesis of Gondwanaland as the possible origin of Dermaptera (Popham, 1963, 1996). In the other hand, although the southern end of Youngnam region has relatively moderate climate in Korean peninsula, it still has winter which has forced Dermaptera to survive through facul-

Table 2. Choosing priority-conservation-areas by taxonomic root weightings and complementarities between the areas with higher Dermaptera species richness in Youngnam region

Species	1	2	3	4	5	6	7	8	9	10	11	12	13
Challia fletcheri	+												
Anisolabis maritima			+		+				+	+		+	+
Gonolabis marginalis	+	+	+	+		+	+						
Euborellia annulipes	+	+	+	+				+					+
E. pallipes					+								
E. plebeja										+			
Labidura riparia	+	+			+			+		+			+
Forficula vicaria	+												
F. scudderi	+	+	+	+	+	+	+	+	+		+	+	
Anechura japonica	+	+	+	+	+	+	+				+	+	
Timomenus komarowi	+	+	+	+		+	+	+	+		+		
NLS	8	6	6	5	5	4	4	4	3	3	3	3	3
∑ TRWI	18.90	10.45	9.86	8.10	8.28	6.93	6.93	7.28	5.52	5.11	5.52	4.93	5.28
PDS	83.41	46.12	43.51	35.75	36.54	30.58	30.58	32.13	24.36	22.55	24.36	21.76	23.30
PDR	—	—	7.76	—	12.18	—	—	—	7.76	12.18	—	7.76	7.76
Priorities	1st	—	—	—	2nd	—	—	—	—	3rd	—	—	—

NLS, number of local species; ∑ TRWI, local sum of taxonomic root weighting indices; PDS, percentage diversity scores for each 13 areas; PDR. percentage diversity scores for remaining 12 areas as complimentary to that in the highest scored area; 1, Dongno; 2, Cheongsong; 3, Taegu; 4, Hamyang; 5, Geoje; 6, Munkyoung; 7, Kimcheon; 8, Kyoungsan; 9, Hawon; 10, Hwanho; 11. Sancheong; 12, Pusan; 13, Dadae.

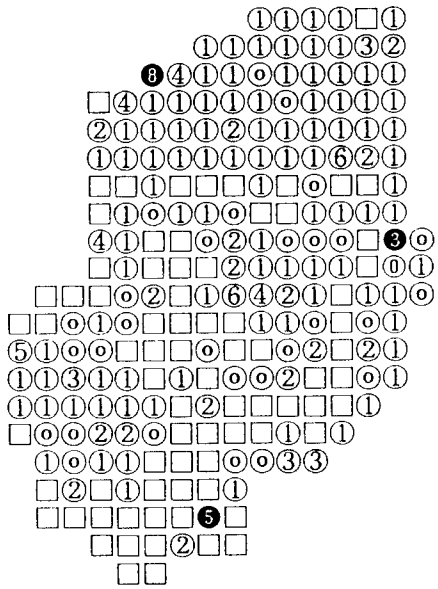

Fig. 3. Dermaplera species richness at geographical conservation units in Youngnam region (*ref.* Fig. 1). The circled numbers are the number of species recorded at the relevant units; ❽, Dongno as the fist priority-conservation-area (PCA); ❺, Geoje as the second PCA; ❸, Hwanho as the third one.

tative hibernation. Korea, therefore, is not likely to be the region suitable for Dermaptera with tropical origin (Richard and Davies, 1977). In deliberation of such passive dispersal and climatological biogeography, Dermaptera is a typical case of insect evolution adapted to a cold temperate region through slow dispersal rates although it could be not quite successful to flourish the diversity. Therefore, Dermaptera in Korea may be one of regional communities of the insects characteristic to the far-east Palaearctics, and then Youngnam region would be a community representing the Korean fauna in species diversity.

On rarity, it can be understood to incorporate both abundance and distribution of a species, either as presence or absence or as some relative or absolute measurement of either or both. In such a term, it should be pointed out first that Dermaptera is a minor group of 19 species belonging to 10 genera of 5 families (Moon, 1994), and then 11 species belonging to 8 genera of 4 families and in Youngnam region. Within the poor diversity, Dermaptera has 3 attributes of rarity by habitat specificity, geographical range, and population size. The distribution of Dermaptera can be clearly specified (rf. Fig. 2). *A. maritima* and *L. riparia japonica* limit their habitats respectively to coastal and sandy areas, and the species in Forficulidae, in a more collective sense, largely in wild or semi-natural forests. In geographical range, most species are in low density and wide spread distribution while *C. fletcheri* is in low density and extremely limited distribution. Naturally, the population sizes are not found in a large number of individuals in general. In fact, the densities were found mostly low at the areal size of the geographical conservation units we adapted.

The rarity of individual species may be linked to the uniqueness of local fauna at the level of regional community. Many species and their local compositions we discussed here are typical but special to the far-east Palaearctics. However, they are moderately different from those of the region covering the Japan Islands, Ryukyu Archipelago and Taiwan but very different from other parts of the world in species composition. Except cosmopolitan species *A. maritima* and *E. annulipes,* most species are those usually limited to distribution in temperate or subtropical zones. *C. fletcheri* and *F. vicaria* are the species endemic to far-east Palaearctics and retaining taxonomic plesiomorphies. *L. riparia japonica, A. japonica* and *F. scudderi* are the representative species of the northern temperate Palaearctics. *G. marginalis, E. pallipes, E. plebeja* and *T. komarowi* have relatively oriental components in their distribution. Therefore, both the species and species composition are characteristic to the far-east Palaearctics. The fact may well support the necessity and value of conservation for Dermaptera fauna in Youngnam region.

On decline, the decline of living organisms is in fact a worldwide phenomenon. However, insects have declined, in many cases by habitat destruction rather than intrinsic factors, toward extinction even before being known to science, which is different from many vertebrates recorded and then had declined even in care. It seems that a main reason for declining of Dermaptera is that the soil ecosystem has been destroyed and disappeared by covering with asphalt and cement.

As far as conservation is concerned in practice, Dongno having been chosen as the primary PCA might be able to support Dermapteran diversity continuously without serious difficulties. Because most parts of the area have been already included within the range of SMNP and protected by the relevant laws for many years, although various conflicts were emerged by local residents during recent several years. Careful management, however, should be required to conserve the habitats intact by remaining weeds, fallen leaves, decaying woods, sand piles, scattered stones, waste patches of lands and if possible, even animal carrions. Such efforts to maintain the habitats may be tedious but should be important not only for Dermaptera but also for various insects and the other living organisms chained each other, although it may look untidy in national parks.

However, the GCU covering Geoje and Pohang should be found as relevant strategies to conserve the meaningless-looking-earwigs particularly in the areas developed for heavy industries. It should be of a prime interest to investigate the local continuity of *E. pallipes* at Geoje and to confirm the established populations of *E. plebeja* at Hwanho of which the ecosystem has

been strongly affected by industrial expansion and urbanization of Pohang for many years.

As we demonstrated through mapping, it should be useful to prepare the detailed distribution map of species richness for a first approximation for identification, for choosing PCAs and possibly other land use, and for decision toward conservation of biodiversity (Scott et al., 1993; Conroy and Noon, 1996). The test method to choose PCAs by adopting TRW is likely to be a tool for such requirements, at least in establishing priority-areas, for wildlife conservation in dilemma in which maximum diversity has to be conserved in minimum areas due to limited cost (Kirkpatrick, 1983).

Acknowledgments

TYM wishes to express his cordial gratitude to Emeritus Professor Seiroku Sakai (Daito Bunka University) for the photographed data for *Challia fletcheri* Burr and to Dr. Gy. Sziraki (Hungarian Natural History Museum) for his kindness to lend North Korean materials used for comparison and distribution analysis. We are also grateful to two anonymous reviewers for helpful suggestions. This paper was supported by Non-directed Research Fund, Korea Research Foundation, 1993-1994.

References

Collins NM and Thomas JA (1991) The Conservation of Insects and Their Habitats, Academic Press, London, pp 1-450.

Conroy MJ and Noon BR (1996) Mapping of species richness for conservation of biological diversity: conceptual and methodological issues. *Ecol Appl* 6: 763-773.

Hennig W (1981) Insect phylogeny, *Translated and Edited by* Pont AC, and Schlee D (eds), John Wiley and Sons, Chicester, Vol 22, pp 1-514.

Kamizo J (1934) Miscellaneous Korean Dermaptera. *J Chosen Nat Hist Soc* 19: 176-178.

Kim CH and Park JS (1991) A Report on the Insect Fauna of Mt. Jiri. Kyungsang Namdo Centre for Nature Study, Jinju, pp 122.

Kim CW, Lee CE, Park HC, Nam SH, and Kwon YJ (1985) Insect fauna in the area of Mt. Chuwang in summer season, *Rep Korean Asso Conser Nat* 23: 93-110.

Kim CW and Moon TY (1985) A taxonomic revision of Korean Dermaptera. *Entomol Res Bull Korea Enotomol Inst* 11:37-59.

Kirkpatrick JB (1983) An iterative methods for establishing priorities for the selection of nature reserves: an example from tasmania. *Biol Conserv* 25: 127-134.

Korea Ministry of Environment (1994) Coloured Guide for Specified Wild Animals and Plants in Korea. Korea Ministry of Environment, Seoul.

McNeely JA, Miller KR, Reid WV, Mittermeier RA, and Werner TB (1990) Conserving the World's Biological Diversity. IUCN, WRI, CI, WWF-US and The World Bank, Washington, DC, pp 1-193.

Moon TY (1993) *Gonolabis distincta* (Nishikawa): new to Korea (Anisolabididae, Dermaptera). *Korean J Entomol* 23: 273-276.

Moon TY (1994) Order 13. Dermaptera. In: The Entomological Society of Korea and Korean Society of Applied Entomology (eds), Check List of Insects from Korea. Kon-Kuk University Press, Seoul, pp 47.

Moon TY and Lee JE (1995) Systematics and distribution of insects in Kyoungsangbukdo. I. Dermaptera. *Ann Rep Inst Bas Sci Andong Univ* 6: 75-86.

Moon TY and Lee JW (1995) Systematics of Dermaptera deposited at the Youngnam University. *Ann Rep Inst Bas Sci Youngnam Univ* 15: 273-283.

Moon TY and Kim CW (1985) A review of the far-east Palaearctic genus *Challia* Burr, including a new species *Challia kyusani* sp. nov. *Korean J Entomol* 15: 55-60.

Moon TY and Kim CW (1991) Catalogue of Korean Dermaptera. *Entomol Res Bull Korea Enotomol Inst* 17: 67-79.

Moon TY, Kim JK, and Yoon IB (1992) Towards diversity conservation of vespine wasps in Korea. *Entomol Res Bull Korea Enotomol Inst* 18: 63-69.

Moon TY and Kim KM (1995) Measurement and conservation of insect fauna at Sobaek Mountain National Park (Orthoptera, Hemiptera, Homoptera and Minor Taxa). *Rep Korean Asso Conserv Nat* 33: 221-236.

Moon TY and Park JS (1995) Priority conservation areas for Dermaptera in Kyoungsangnamdo Province by taxonomic root weighting and distribution analysis. *Rep Agric Res Inst Gyongsang Univ* 29: 65-76.

Nam SH and Kim ML (1983) On the relation between the insects and forest-types of Piagol Valley in Mt. Chiri. *Rep KACN* 21: 123-136.

Nash RF (1989) The Rights of Nature. The University of Wisconsin Press, London, pp 1-290.

Park JS Ku DS, and Han KD (1993) Insect fauna of Mt. Jiri-Hamyanggun and Baemsagol. *Rep Korean Asso Conserv Nat* 31: 153-218.

Popham EJ (1963) The geographical distribution of the Dermaptera. *Entomologist* 96: 131-144.

Popham EJ (1996) The geographical distribution of Dermaptera with reference to their classification. In: XX International Congress of Entomology: Proceedings of Taxonomy of Dermaptera. Firenze, pp 196-214.

Richard OW and Davies RG (1977) Order 11, Dermaptera (earwigs), In: Imms' General Textbook of Entomology, Classification and Biology (10th ed), Chapman and Hall, London, Vol 2, pp 572-582.

Rodendorf BB (1962) Arthropoda-Tracheata and Chelicerata, In: Textbook of Palaeontology, a Textbook for Palaeontologists and Geologists of the USSR, Academy of Sciences of the USSR, Moscow, Vol 9, pp 1-561.

Sakai S (1995) A basic survey for integrated taxonomy of the Dermaptera of the world. In: Dermapterorum Catalogus XXVII and Iconographia XI, Tokyo, pp 6176-7097.

Scott JM, Davis F, Csuti B, Noss R, Butterfield B, Groves C, Anderson H, Caicco S, D'Erchia Edwards TC, Jr, Ulliman J, and Wright RG (1993) Gap analysis: a geographic approach to protection of biological diversity. *Wild Monog* 123: 1-41.

Steinmann H (1989) World Catalogue of Dermaptera, Series Entomologica 43. Kluwer Academic Publisher, Dordrecht and Budapest, pp 1-900.

Vane-Wright RI, Humphries CJ, and Williams PH (1991) What to protect? - systematics and the agony of choice. *Biol Conserv* 55: 235-254.

Williams PH, Humphries CJ, and Vane-Wright RI (1991) Measuring biodiversity: taxonomic relatedness for conservation priorities. *Aust Syst Bot* 4: 665-679.

Wiley EO, Siegel-Causey D, Brooks DR, and Funk VA (1991) The Compleat Cladist: A Primer of Phylgenetic Procedures. The University of Kansas Museum of Natural History, Special Publication No. 19, pp 1-158.

Yim YJ and Kira T (1975) Distribution of forest vegetation and climate in the Korean peninsula. I. Distribution of some indices of thermal climate. *Jpn J Ecol,* 25: 77-88.

Yim YJ and Kira T (1976) Distribution of forest vegetation and climate in the Korean peninsula. II. Distribution of climatic humidity/aridity. *Jpn J Ecol* 26: 157-164.

Yoon IB and Moon TY (1996) Distribution and habitats of the rare and endangered *Challia fletcheri* Burr. *Korean J Entomol* 26: 403-409.

Yoon IB and Nam SH (1978) Insect fauna of remote islands from Geoje Is. in summer seasons. *Rep Korean Asso Conserv Nat* 14: 75-91.

Yoon IB, Park HC, Han KD, and Kim CS (1990) A faunistic study of terrestrial insects in Kayasan National Park. *Rep Korean Asso Conserv Nat* 28: 99-128.

[Received January 4, 1997; accepted March 20, 1997]