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Insect Fauna of Adjacent Areas of DMZ in Korea

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ABSTRACT: Insect fauna in adjacent areas of Demilitarized Zone (DMZ) in Korea was surveyed seasonally in 2001～2003. The survey area was divided into 3 regions (eastern mountain, middle inland, and western coastal regions) in accordance with administrative districts and topography. Sampling methods such as sweeping, sieving, beating, brushing and suction were used depending on the environmental and military conditions. Total 361 genera and 437 species of 116 families belonging to 14 orders were identified. Among these, 46 species were new to insect fauna of DMZ areas. Species richness was the highest in the eastern mountain region. Numbers of habitat-common and -specific species were 96 (22%) and 195 (47.2%), respectively. The insect species community similarity was highest (0.64) between eastern mountain region and western coastal region. Insect orders showing high species richness were Coleoptera (38.9%), Lepidoptera (19.2%), Orthoptera (9.4%), and Hemiptera (9.2%). These results will be useful information for study of history on the change of insect fauna and future conservation in DMZ areas.

Key words: DMZ, Fauna, Insect, Korea

INTRODUCTION

Demilitarized Zone (DMZ) was established on July 27 in 1953 resulting from the Armistice Agreement between United Nations and North Korea. It is 2 km distance to the north and south from the Military Demarcation Line (MDL) and its area is about 99,144 ha. MDL (155 miles) traverses the Korea peninsula from Gyodong island in west to Goseong in east. Civil Control Line (CCL) area (231,405 ha) which has many types of ecosystems was also established for the purpose of protection of military installations and national security. Since humans access to these areas have been strictly restricted for past 5 decades, natural ecosystems in DMZ and CCL are thought to be conserved better than any other places in the world.

For this reason, many researches of diverse taxa including insects in DMZ areas have been conducted. The survey of insects in DMZ areas was first conducted in Mt. Geumgang by Tsunamoto (1926). Since then many faunistic and taxonomic reports have been published (Kim and Kim 1972, Kim et al. 1974, Nam and Kim 1981, Kim and Nam 1981, An et al. 1985, Yoon and Park 1985, Park and Park 1987, Park 1987, Lee and Ryu 1989, Lee and Suh 1991, Park and Yoon 1991, Lee et al. 1992, Kim and Ryu 1992, Kim et al. 1992, Park and Shin 1995, Shin et al. 1996, Korea Forest Research Institute 2000). It is necessary to monitor insect fauna in DMZ areas in a regular basis for developing blueprints of conservation of biological resources and environment in DMZ.

This study was conducted to survey the fauna of insect and their distributions to provide useful insect inventory in adjacent areas of DMZ during 2001～2003.

MATERIALS AND METHODS

Study Areas

The study areas were CCL which is adjacent areas of DMZ, southern part of MDL (Fig. 1). The survey area was divided into 3 main regions according to the administrative districts and geographical characteristics: eastern mountain, middle inland, and western coastal regions. The survey in 2001 was conducted in 5 eastern mountain areas located in Gangwon-do. They were lakes, dams, and high mountains, which typically characterize the survey area. The 10 selected survey areas in 2002 were located in mid-part of the CCL area, from north-western part of Gangwon-do to north-eastern part of Gyeonggi-do. They were mostly low elevated areas consisting of plains, farm lands, small mountains, bogs, and reservoirs. In 2003, seven areas were selected from the western coastal region. The areas were mostly consisted of islands, farm lands, estuary areas, and low elevated hillocks. Table 1 shows geographic information about survey sites and their habitat types.

Insect Survey

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Fig. 1. A map of main surveyed areas (1 Goseong-gun, 2 Inje-gun, 3 Yanggu-gun, 4 Whachun-gun, 5 Cheorwon-gun, 6 Yonchon-gun, 7 Paju-si, 8 Gimpo-si, 9 Incheon Metropolitan city).

Table 1. Habitual characteristics of studied areas in DMZ areas

Main regions	Surveyed sites	Longitude	Latitude	Habitat types
Eastern mountain region	Mt. Gunbong , Goseong-gun, Gangwon-do	128° 22' 17"	38° 23' 28"	Mountain
	Sadang-gol, Yanggu-gun, Gangwon-do	127° 54' 30"	38° 16' 16"	Valley
	Lake Paro, Yanggu-gun, Gangwon-do	127° 46' 25"	38° 05' 45"	Lake
	Peace Dam, Hwachon-gun, Gangwon-do	127° 50' 48"	38° 12' 21"	Dam
	Buk-Myeon, Injegun, Gangwon-do	127° 12' 23"	38° 07' 18"	Hillock
Middle inland region	Togyo reservoir, Cheorwon-gun, Gangwon-do	127° 17' 30"	38° 16' 20"	Reservoir
	Mt. Daesung, Cheorwon-gun, Gangwon-do	127° 35' 18"	38° 11' 47"	Mountain
	Mt. Godae, Cheorwon-gun, Gangwon-do	127° 08' 42"	38° 12' 33"	Mountain
	Wasu-ri, Cheorwon-gun, Gangwon-do	127° 27' 05"	38° 14' 34"	Hillock
	Mt. Yawoel, Yonchon-gun, Gyeonggi-do	127° 06' 32"	38° 14' 09"	Mountain
	Jeongok-ri, Yonchon-gun, Gyeonggi-do	127° 04' 17"	38° 02' 35"	Bog
	Baekhak reservoir, Yonchon-gun, Gyeonggi-do	126° 55' 36"	38° 01' 45"	Reservoir
	Pk. Guksa, Yonchon-gun, Gyeonggi-do	126° 53' 05"	37° 57' 22"	Peak
	Mt. Jangmyeong, Paju-si, Gyeonggi-do	126° 44' 09"	37° 45' 02"	Mountain
	Mt. Wollong, Paju-si, Gyeonggi-do	126° 46' 52"	37° 47' 54"	Mountain
Western coastal region	Jangdan pennynsula, Paju-si, Gyeonggi-do	126° 44' 30"	37° 50' 50"	Estuary
	Mt. Mani, Ganghwa-gun, Incheon Metropolitan city	127° 25' 19"	37° 37' 44"	Mountain
	Seokmo Isl., Ganghwa-gun, Incheon Metropolitan city	126° 21' 36"	37° 40' 02"	Island
	Pk. Aegi, Gimpo-si, Gyeonggi-do	126° 35' 32"	37° 44' 49"	Peak
	Mt. Munsu, Gimpo-si, Gyeonggi-do	126° 32' 03"	37° 44' 46"	Mountain
	Wolgot-myeon, Gimpo-si, Gyeonggi-do	126° 33' 14"	37° 42' 49"	Farmland
	Haengju mountain fortress, Goyang-si, Gyeonggi-do	126° 49' 36"	37° 35' 46"	Hillock

The survey for insects was carried out 4 times a year, spring (April), summer (June～August), fall (September～October) and winter (November～December) in 2001～2003. Since many parts of the study areas were mine fields and military operational areas, collection methods were strictly restricted. Sweeping, sieving, beating, brushing and suction methods were used depending on the conditions. For some insects, identification was made on site with their external features. However, for most of insects collected were reserved in 75% alcohol or made as dry specimens, and then identified to the species level under dissecting microscope in the laboratory. The order of insect orders was followed according to the Check list of insects from Korea (The Entomological Society of Korea and the Korean Society of Applied Entomology 1994) and families, genera and species were arranged by alphabetically. The voucher specimens were deposited in Insect Ecology Laboratory in Seoul National University in Korea.

Data Analysis

The similarity between sampling sites was calculated by Sorenson coefficient (Sorenson 1948) based on species presence-absence using software program Species Diversity and Richness (SDR ver. 3, Pisces conservation 2003).

$$S_{ij} = \frac{2a}{2a+b+c}$$

Where, a is the number of species which are present in both samples; *b* is the number of species present in sample *i* but absent from sample *j*; *c* is the number of species present in sample *j* but absent from sample *i*.

RESULTS

Total 361 genera and 437 species of 116 families belonging to 14 orders were identified (Tables 2 and 3). Among these, 46 species were new to insect fauna of DMZ areas. Species richness was highest in the eastern mountain region even though the number of survey sites was less than other regions (Table 4).

Habitat-common species which were found in 3 regions were 96 species (22% of total) and habitat-specific species which were found only in one region were 195 species (44.6%). Among these, 92 species (47.2%) were founded only in the eastern mountain region. Habitat specialists in the middle inland and western coastal regions were 69 and 34 species, respectably. The commonness between eastern mountain region-middle inland region, eastern mountain region-western coastal region, and western coastal region-middle inland region by similarity index were 0.55, 0.64 and 0.52, respectably. Insect orders showing high species richness were Coleoptera (38.9% of total), Lepidoptera (19.2%), Orthoptera (9.4%) and Hemiptera (9.2%) (Table 4).

DISCUSSION

Many researches discover hundreds of new risky species annually, adding to our knowledge of nature. Often, natural inventories can help to guide effective allocation of scarce conservation resources and management of them. Biological inventory provides important biodiversity information and prescribes management that maintains or enhances native biological diversity in addition to protecting ecosystems and conserving their productivity. Many projects and programs in DMZ areas have been conducted for field surveys of rare plants, animals and many other taxonomic groups including insects of conservational concern, and habitat reservation for outstanding natural features. In spite of these efforts, there are many problems in compiling natural heritages synthetically in these areas because field access is severely restricted because of military and political situations and physical limitations such as mine fields.

Korean ministry of environment specified 5 insect species as the first class endangered wild species and 15 insect species as the second class. Among them, *Aporia crataegi* (Lepidoptera, Pieridae), *Challia fletcheri* (Dermaptera, Pygidicranidae), *Protantigius superans* and *Spindasis takanonis* (Lepidoptera, Lycaenidae), *Fabriciana nerippe* (Lepidoptera, Nymphalidae), and *Gymnopleurus mopsus* and *Copris tripartitus* (Coleoptera, Scarabaeidae) have been known to distribute in DMZ areas, though they were not found in our survey. Shin et al. (1996) and Korea Forest Research Institute (2000) explored eastern mountain areas in which rare insect species were distributed and asserted that these areas had conservational values. Most of previous insect survey studies in DMZ areas (Kim et al. 1974, Kim and Nam 1981, Park and Park 1987, Park 1987, Kim and Ryu 1992, Kim et al. 1992, Lee et al. 1992, Shin et al. 1996, Korea Forest Research Institute 2000) were focused on the areas which have conservational value and were actually limited to adjacent areas of DMZ because of the problems as stated above. Thus, the insect fauna of DMZ itself could only be inferred via those from its adjacent areas. Also, many previous taxonomic works were conducted according to taxonomists' own interests using the specimens deposited in universities and national research institutes (Kim and Kim 1972, Nam and Kim 1981, An et al. 1985, Yoon and Park 1985, Lee and Ryu 1989, Lee and Suh 1991, Park and Yoon 1991, Park and Shin 1995). In this regard, our results are difficult to compare exactly with previous reports. Of DMZ insect fauna studies, Shin et al. (1996), KFRI (2000), and our study were the most intensively surveyed ones. As far as the range of areas and diversity of habitat types were concerned, our study covered the most widely. The most recent previous survey (KFRI 2000) reported 314 insect

Table 2. Insect list and their distribution in surveyed areas

Orders	Families	Species	E	M	W
Odonata	Coenagrionidae	*Ischnura asiatica* (Brauer, 1865)	+	+	
	Lestidae	*Indolestes peregrinus* (Ris, 1916)	+	+	
	Libellulidae	*Crocothemis servilia* (Drury, 1770)		+	
		Orthetrum albistylum (Sélys, 1848)		+	
		Pantala flavescens (Fabricius, 1798)	+	+	
		Sympetrum depressiusculum (Sélys, 1841)	+		
		Sympetrum eroticum (Sélys, 1883)		+	
		Sympetrum infuscatum (Sélys, 1883)		+	
		Sympetrum pedemontanum elatum (Sélys, 1872)		+	
	Platycnemididae	*Platycnemis phyllopoda* (Djakonov, 1926)	+		
Blattaria	Blattellidae	*Blatella germanica* Linnaeus, 1767	+		+
	Blattidae	*Periplaneta fulginosa* (Serville, 1839)	+		+
		Periplaneta japonica (Karny, 1908)		+	
Mantodea	Mantidae	*Tenodera aridifolia* (Stoll, 1813)	+	+	+
		Tenodera sinensis (Saussure, 1842)	+	+	+
Isoptera	Rhinotermitidae	*Reticulitermes speratus* (Kolbe, 1885)			+
Dermaptera	Forficulidae	*Anechura japonica* (Bormans, 1880)	+	+	+
		Forficula scudderi Bormans, 1880	+	+	+
		Timomenus komarowi (Semenov, 1901)	+	+	+
Orthoptera	Gryllidae	*Dianemobius flavoantennalis* (Shiraki, 1911)		+	
		Loxoblemmus arietulus (Saussure, 1877)	+		+
		Paratrigonidium bifasciatum (Shiraki, 1911)	+		
		Polionemobius mikado (Shiraki, 1913)	+		
		Teleogryllus emma (Ohmschi & Mat-summura, 1951)	+	+	+
		Velarifictorus micado (Saussure, 1877)		+	
	Gryllotalpidae	*Gryllotalpa orientalis* (Burmeister, 1839)	+		+
	Oecanthidae	*Oecanthus indicus* (Saussure, 1878)	+	+	+
	Pyrgomorphidae	*Acrida cinerea* (Thunberg, 1815)	+	+	+
		Aiolopus thalassinus (Fabricius, 1798)	+		
		Anapodisma miramae (Dovnar-Zapolskij, 1933)	+	+	+
		Arcyptera coreana (Shiraki, 1930)	+	+	+
		Atractomorpha lata (Motschulsky, 1866)	+	+	+
		Calliptamus abbreviatus (Ikonnikov, 1913)		+	+
		Chorthippus schmidti (Ikonnikov, 1913)	+	+	
		Eirenephilus longipennis (Shiraki, 1910)	+	+	+
		Gastrimargus marmoratus (Thunberg, 1815)		+	+

Table 2. Continued

Orders	Families	Species	E	M	W
		Locusta migratoria (Linnaeus, 1758)	+		+
		Mecostethus alliaceus (Germar, 1817)	+	+	
		Mongolotettix japonicus (Bolivar, 1898)			+
		Oedaleus infernalis (Saussure, 1884)	+	+	+
		Ognevia sergii (Ikonnikov, 1911)		+	
		Oxya chinensis (Thunberg, 1815)		+	
		Podismopsis genicularibus (Shiraki, 1910)	+		
		Shirakiacris shirakii (Bolivar, 1914)	+	+	+
		Stethophyma magister (Rehn, 1902)			+
		Trilophidia annulata (Thunberg, 1815)	+		+
	Tetrigidae	*Criotettix japonicus* (de Haan, 1842)			+
		Euparatettix insularis (Bey-Bienko, 1951)			+
		Tetrix japonica (Bolivar, 1887)	+	+	+
	Tettigoniidae	*Conocephalus gladiatus* (Redtenbacher, 1891)	+	+	+
		Ducetia japonica (Thunberg, 1815)	+		
		Gampsocleis sedakovi obscura (Walker, 1869)	+	+	+
		Gampsocleis ussuriensis (Adelung, 1910)	+	+	+
		Hexacentrus unicolor (Serville, 1839)	+		+
		Metrioptera bonneti (Bolivar, 1890)			+
		Paratlanticus ussuriensis (Uvarov, 1926)	+		
		Phaneroptera falcata (Poda, 1761)	+	+	+
		Phaneroptera nigroantennata (Brunner von Wattenwyl, 1878)	+	+	+
		Ruspolia lineosa (Walker, 1869)	+		
	Tridactylidae	*Xya japonica* (de Haan, 1842)		+	
Phasmida	Phasmatidae	*Phraortes elongatus* (Thunberg, 1815)	+		
Hemiptera	Acanthosomatidae	*Sastragala esakii* (Hasegawa, 1959)		+	
	Alydidae	*Riptortus clavatus* (Thunberg, 1783)		+	
	Coreidae	*Cletus schmidti* (Kiritschenko, 1916)	+		
		Homoeocerus dilatatus (Horvath, 1879)		+	
		Hygia lativentris (Motschulsky, 1866)		+	
		Molipteryx fuliginosa (Uhler, 1860)		+	
	Cydnidae	*Macroscytus japonensis* (Scott, 1874)		+	
	Lygaeidae	*Geocoris varius* (Uhler, 1860)		+	
		Pachygrontha antennata (Uhler, 1860)		+	
		Panaorus albomaculatus (Scott, 1874)		+	
		Panaorus japonicus (Stål, 1874)	+		

Table 2. Continued

Orders	Families	Species	E	M	W
	Miridae	*Adelphocoris suturalis* (Yakovlev, 1882)	+		
		Adelphocoris triannulatus (Stål, 1858)	+	+	+
		Eurystylus coelestialium (Kirkaldy, 1902)	+	+	
		Trigonotylus coelestialium (Kirkaldy, 1902)		+	
	Nabidae	*Himacerus apterus* (Fabricus, 1798)	+		
		Nabis stenoferus (Hsiao, 1965)		+	
	Pentatomidae	*Aelia fieberi* (Scott, 1874)		+	+
		Carbula humerigera (Uhler, 1860)	+		
		Carbula putoni (Jakovlev, 1876)	+		+
		Dolycoris baccarum (Linnaeus, 1758)	+	+	+
		Eurydema gebleri (Kolenati, 1856)	+		
		Eysarcoris aeneus (Scopoli, 1863)			+
		Graphosoma rubrolineatum (Westwood, 1873)			+
		Halyomorpha halys (Stål, 1855)	+		
		Homalogonia obtusa (Walker, 1868)	+		+
		Lelia decempunctata (Motschulsky, 1859)	+		
		Menida violacea (Motschulsky, 1861)	+		
		Nezara antennata (Scott, 1874)		+	
		Palomena angulosa (Motschulsky, 1861)		+	
		Pentatoma japonica (Distant, 1882)	+		
		Pentatoma rufipes (Linnaeus, 1758)	+		
		Pentatoma semiannulata (Motschulsky, 1859)	+		
		Picromerus lewisi (Scott, 1874)	+		
		Plautia stali (Scott, 1874)	+		
	Phyllocephalidae	*Gonopsis affinis* (Uhler, 1860)		+	
	Plataspididae	*Coptosoma bifarium* (Montandon, 1896)	+		+
	Reduviidae	*Sphedanolestes impressicollis* (Stål, 1861)		+	+
	Rophalidae	*Stictopleurus crassicornis* (Linnaeus, 1758)		+	
	Scutelleridae	*Poecilocoris lewisi* (Distant, 1883)	+		
Homoptera	Cicadellidae	*Bothrogonia japonica* (Ishihara, 1962)		+	
	Cicadidae	*Cicadella viridis* (Linnaeus, 1758)		+	
		Meimuna opalifera (Walker, 1850)			+
		Ricania taeniata (Stål, 1870)		+	
	Derbidae	*Diostrombus politus* (Uhler, 1896)		+	
	Dictyopharidae	*Dictyophara patruelis* (Stal, 1859)		+	
Neuroptera	Ascalaphidae	*Ascalaphus sibiricus* (Eversmann, 1852)			+

Table 2. Continued

Orders	Families	Species	E	M	W
	Chrysopidae	*Chrysopa septempunctata* (Wesmael, 1841)		+	
	Myrmeleontidae	*Hagenomyia micans* (MacLachlan, 1875)	+		+
Coleoptera	Anthribidae	*Exechesops leucopis* (Jordan, 1928)	+		
	Aphodiidae	*Aphodius (Phaeaphodius) rectus* (Motschulsky, 1866)			+
	Attelabidae	*Apoderus jekelii* (Roelofs, 1874)	+	+	
		Apoderus (Leptapoderus) balteatus (Roelofs, 1874)	+		
		Apoderus erythropterus (Gmelin, 1790)	+	+	+
		Aspidobyctiscus lacunipennis (Jekel, 1860)	+	+	
		Cycnotrachelus coloratus (Faust, 1882)	+		
		Euops (Synaptops) punctatostriatus (Motschulsky, 1860)	+	+	
		Mechoris (Cyllorhynchites) ursulus (Roelofs, 1874)			+
		Paracentrocorynus nigricollis (Roelofs, 1874)	+		
		Paracycnotrachelus longiceps (Motschulsky, 1860)	+	+	+
	Bruchidae	*Callosobruchus chinensis* (Linnaeus, 1758)		+	
	Buprestidae	*Agrilus tibialis* (Lewis, 1893)	+	+	+
		Buprestis haemorrhoidalis (Herbst, 1780)	+		
		Trachys minuta (Linnaeus, 1758)		+	
		Trachys variolaris (Saunders, 1873)	+		
	Carabidae	*Anisodactylus signatus* (Panzer, 1797)	+		+
		Carabus (Coptolabrus) jankowskii (Oberthür, 1883)	+		
		Carabus (Coptolabrus) smaragdinus (Fischer-Waldheim, 1823)	+		
		Chlaenius costiger (Chaucdoir, 1856)		+	
		Chlaenius micans (Fabricius, 1792)	+		
		Chlaenius posticalis (Motschulsky, 1853)		+	
		Cymindis daimio (Bates, 1873)		+	
		Dolichus halensis (Schaller, 1783)		+	+
		Harpalus sinicus (Hope, 1845)	+		
		Pheropsophus javanus (Dejean, 1825)		+	
		Pheropsophus jessoensis (Morawitz, 1862)		+	+
		Synuchus cycloderus (Bates, 1883)		+	
		Synuchus melantho (Bates, 1883)		+	
		Trigonognatha coreana (Tschitscherine, 1895)	+		
	Cephaloidae	*Cephaloon pallens* (Motschulsky, 1860)	+		
	Cerambycidae	*Agapanthia pilicornis* (Fabricius, 1787)	+	+	+
		Agapanthia villosoviridescens (De Geer, 1775)	+	+	
		Amarysius altajensis (Lexmann, 1770)	+		+

Table 2. Continued

Orders	Families	Species	E	M	W
		Amarysius sanguinipennis (Blessig, 1872)	+		+
		Anastrangalia scotodes (Batten, 1873)	+		+
		Anoplophora malasiaca (Thomson, 1865)	+	+	
		Asemum striatum (Linnaeus, 1758)	+		
		Asias halodendri (Pallas, 1776)		+	+
		Chlorophorus diadema (Motschulsky, 1853)	+		+
		Corymbia rubra (Linnaeus, 1758)	+	+	+
		Lamiomimus gottschei (Kolbe, 1886)			+
		Leptura aethiops (Poda, 1761)	+		
		Leptura arcuata (Panzer, 1795)	+		
		Massicus raddei (Blessig et Solsky, 1872)	+		+
		Megopis sinica (White, 1853)			+
		Mesosa myops (Dalman, 1817)		+	
		Moechotypa diphysis (Pascoe, 1871)	+	+	+
		Oberea depressa (Gebler, 1825)	+		
		Oberea fuscipennis (Chevrolat, 1852)	+		
		Oberea inclusa (Pascoe, 1858)			+
		Phytoecia rufiventris (Gautier, 1873)	+		+
		Polyzonus fasciatus (Fabricius, 1781)	+	+	+
		Pyrestes haematicus (Pascoe, 1857)	+		+
		Spondylis buprestoides (Linnaeus, 1758)	+		
		Thyestilla gebleri (Faldermann, 1835)	+	+	+
		Xylotrechus chinensis (Chevrolat, 1852)	+		
	Cetoniidae	*Clinterocera obsoleta* (Fairmaire, 1878)	+	+	
		Eucetonia pilifera (Motschulsky, 1860)	+		
		Gametis jucunda (Faldermann, 1835)	+	+	+
		Glycyphna fulvistemma (Motschulsky, 1860)	+		
		Protaetia brevitarsis seulensis (Kolbe, 1886)		+	+
		Protaetia orientalis (Gory et Percheron, 1833)	+		
		Trichius succinctus (Pallas, 1781)	+	+	+
	Chrysomelidae	*Aulacophora indica* (Gmelin, 1790)		+	
		Basilepta fulvipes (Motschulsky, 1860)	+	+	+
		Cassida nebulosa (Linnaeus, 1758)	+	+	+
		Chrysochus chinensis (Baly, 1859)		+	+
		Chrysolina aurichalcea (Gebler, 1825)	+	+	+
		Chrysolina exanthematica (Wiedemann, 1821)			+

Table 2. Continued

Orders	Families	Species	E	M	W
		Chrysolina virgata (Motschulsky, 1860)	+	+	+
		Clythraxeloma cyanipennis (Kraatz, 1879)			+
		Clytra (Clytra) arida (Weise, 1889)		+	+
		Colasposoma dauricum (Mannerheim, 1849)	+	+	+
		Dactylispa angulosa (Solsky, 1871)	+	+	
		Galerucella grisescens (Joannis, 1866)	+		+
		Lema diversa (Baly, 1873)	+	+	
		Linaeidea adamsi (Baly, 1879)		+	+
		Longitarsus (Longitarsus) succineus (Faudras, 1860)	+	+	+
		Nonarthra cyaneum (Baly, 1862)	+	+	+
		Ophraella communa (LeSage, 1986)		+	
		Physosmaragdina nigrifrons (Hope, 1842)		+	
		Plagiodera versicolora (Laicharting, 1781)	+	+	+
		Smaragdina semiaurantiaca (Fairmaire, 1888)	+		+
		Temnaspis nankinea (Pic, 1914)			+
		Thlaspida cribrosa (Boheman, 1855)	+	+	
		Thlaspida lewisii (Baly, 1874)	+		+
		Zeugophora (Pedrillia) bicolor (Kraatz, 1879)	+		
	Cicindelidae	*Cicindela chinensis* (De Geer, 1774)	+		
		Cicindela gemmata (Faldermann, 1848)	+	+	+
	Cleridae	*Opilo carinatus* (Lewis, 1892)		+	
		Thanasimus lewisi (Jacobson, 1912)	+		
	Coccinellidae	*Aiolocaria hexaspilota* (Hope, 1831)	+	+	+
		Anatis halonis (Lewis, 1896)	+		
		Chilocorus kuwanae (Silvestri, 1909)	+		+
		Coccinella septempunctata (Linnaeus, 1758)	+	+	+
		Harmonia axyridis (Pallas, 1773)	+	+	+
		Henosepilachna vigintioctomaculata (Motschulsky, 1857)	+	+	+
		Hippodamia (Hippodamia) tredecimpunctata (Linnaeus, 1758)			+
		Propylea japonica (Thunberg, 1781)	+	+	+
		Scymnus (Neopullus) babai (Sasaji, 1971)			+
		Vibidia duodecimguttata (Poda, 1761)	+		
	Curculionidae	*Anthonomus bisignifer* (Schenkling, 1934)	+		+
		Baris deplanata (Roelofs, 1875)	+		
		Baris dispilota (Solsky, 1870)	+	+	
		Curculio dentipes (Roelofs, 1874)	+	+	+

Table 2. Continued

Orders	Families	Species	E	M	W
		Enaptorrhinus granulatus Pascoe, 1881	+	+	+
		Episomus turritus (Gyllenhal, 1833)	+	+	+
		Eugnathus distinctus Roelofs, 1873	+		+
		Hylobitelus haroldi (Faust, 1882)			+
		Lixus impressiventris Roelofs, 1873	+	+	+
		Ornatalcides (Mesalcidodes) trifidus (Pascoe, 1870)	+	+	+
		Pseudocneorhinus bifasciatus Roelofs, 1879			+
		Pseudocneorhinus setosus Roelofs, 1879	+		+
		Rhynchaenus sanguinipes Roelofs, 1874			+
	Elateridae	*Agrypnus binodulus* (Motschulsky, 1861)		+	
		Ectinus sericeus Candeze, 1878	+		
		Spheniscosomus restrictus Candeze, 1865		+	
	Geotrupidae	*Geotrupes auratus* Motschulsky, 1857	+		
	Helodidae	*Scirtes japonicus* Kiesenwetter, 1874			+
	Helotidae	*Helota fulviventris* Kolbe, 1886			+
	Lagriidae	*Luprops orientalis* (Motschulsky, 1868)	+		
	Lampyridae	*Pyrocoelia rufa* Olivier, 1886	+		
	Lucanidae	*Lucanus maculifemoratus dybowskyi* Parry, 1873	+	+	
		Macrodorcas rectus (Motschulsky, 1857)			+
		Nipponodorcus rubrofemoratus (Snellen von Vollenhoven, 1865)	+		
		Prismognathus dauricus (Motschulsky, 1860)	+		
		Prosopocoilus inclinatus (Motschulsky, 1857)	+		+
		Serrongnathus platymelus castanicolor Motschulsky, 1861	+		+
	Lycidae	*Dictyopterus aurora* (Herbst, 1789)	+		
		Macrolycus flabellatus Motschulsky, 1860	+		
	Meloidae	*Epicauta chinensis taishoensis* (Lewis, 1879)	+		+
		Lytta (Lytta) caraganae Pallas, 1781	+		+
		Schroetteria polita (Gebler, 1830)	+		+
	Melolonthidae	*Apogonia cupreoviridis* Kolbe, 1886		+	+
		Ectinohoplia rufipes (Motschulsky, 1860)	+		
		Gastroserica herzi (Heyden, 1887)	+		+
		Heptophylla picea Motschulsky 1855		+	
		Holotrichia diomphalia (Batten, 1895)	+		+
		Holotrichia morosa Waterhouse, 1875			+
		Maladera holosericea (Scopoli, 1772)		+	+

Table 2. Continued

Orders	Families	Species	E	M	W
		Melolontha incana (Motschulsky, 1853)			+
	Mordellidae	*Mordella brachyura* (Mulsant, 1856)			
		Mordellistena comes (Marseul, 1876)	+		
	Oedemeridae	*Chrysanthia integricollis* (Heyden, 1886)	+		
		Nacerdes (Xanthochroa) waterhousei (Harold, 1875)	+		
	hynchophoridae	*Sipalinus gigas* (Fabricius, 1775)	+		
	Rutelidae	*Adoretus tenuimaculatus* (Waterhouse, 1875)	+	+	+
		Anomala chamaeleon (Fairmaire, 1887)		+	+
		Anomala daimiana (Harold, 1877)			+
		Anomala (Anomala) rufocuprea (Motschulsky, 1860)	+		
		Blitopertha (Exomala) pallidipennis (Reitter, 1903)	+		+
		Mimela holosericea (Fabricius, 1789)	+		
		Mimela splendens (Gyllenhal, 1817)		+	+
		Mimela testaceipes (Motschulsky, 1860)	+	+	+
		Popillia atrocoerulea (Bates, 1888)		+	+
		Popillia indigonacea (Motschulsky, 1853)	+		+
		Proagopertha pubicollis (Waterhouse, 1875)			+
	Scarabaeidae	*Liatongus phanaeoides* (Westwood, 1839)	+		+
		Onthophagus (Gibbonthophagus) atripennis (Waterhouse, 1875)	+		+
		Onthophagus (Phanaeomorphus) fodiens (Waterhouse, 1875)	+		+
		Onthophagus lenzii (Harold, 1874)			+
		Sisyphus schaefferi (Linnaeus, 1758)	+		
	Silphidae	*Nicrophorus quadripunctatus* (Kraatz, 1877)	+		
		Silpha perforata (Gebler, 1832)	+		
	Staphylinidae	*Paederus fuscipes* (Curtis, 1826)	+		
	Tenebrionidae	*Misolampidius tentyrioides* (Solsky, 1875)	+		
		Pedinus strigosus (Faldermann, 1835)			
		Plesiophthalmus spectabilis (Harold, 1875)			
	Trogossitidae	*Leperina squamulosa* (Gebler, 1830)	+		+
Hymenoptera	Anthophoridae	*Tetralonia nipponensis* (Perez, 1911)		+	
		Xylocopa appendiculata circumvolans (Smith, 1873)		+	
	Apidae	*Apis indica* (Fabricius, 1793)	+	+	
		Apis mellifera (Linnaeus, 1758)	+	+	+
		Bombus hypocrita sapporensis (Cockerell, 1911)	+	+	
		Bombus ignitus (Smith, 1869)	+	+	
		Bombus koreanus (Skorikov, 1933)	+	+	

Table 2. Continued

Orders	Families	Species	E	M	W
	Argidae	*Arge pagana pagana* (Panzer, 1798)	+	+	
		Arge similis (Vollenhoven, 1860)		+	
	Colletidae	*Colletes collaris* (Dours, 1872)	+	+	
	Eumenidae	*Eumenes micado* (Cameron, 1904)	+	+	
		Eumenes punctatus (Saussure, 1852)	+	+	
		Orumenes decorata (Smith, 1852)		+	
	Formicidae	*Camponotus japonicus* (Mayr, 1866)	+		
		Formica japonica (Emery, 1925)	+	+	
		Tetramoirum caespitum (Linnaeus, 1758)	+		
	Ichneumonidae	*Charops bicolor* (Szepligeti, 1906)	+		
		Dictyonotus purpurascens (Smith, 1874)			+
	Megachilidae	*Megachile nipponica* (Cockerell, 1914)		+	
	Scoliidae	*Campsomeriella annulata* (Fabricius, 1793)		+	
		Mecacampsomeris prismatica (Smith, 1855)	+	+	
		Scolia nobilis (Saussure, 1858)		+	
	Sphecoidae	*Ammophila infesta* (Smith, 1873)		+	
		Cerceris hortivaga (Kohl, 1880)	+	+	
		Sphex occitanicus (Lepeletier et Serville, 1828)		+	
		Sphex subfuscatus (Dahlbom, 1845)		+	
	Tenthredinidae	*Athalia japonica* (Klug, 1815)	+		
		Athalia proxima (Klug, 1815)	+		
		Dolerus ephippiatus (F. Smith, 1874)	+		
		Rhogogaster opacella (Mocsáry, 1909)	+		
	Vespidae	*Parapolybia varia* (Fabricius, 1787)	+	+	
		Polistes chinensis antennalis (Pérez, 1905)	+	+	
		Polistes jadwigae (Dalla Torre, 1904)		+	
		Polistes japonicus (Saussure, 1858)	+		
		Polistes mandarinus (Saussure et Geer, 1853)	+	+	
		Polistes snelleni (Saussure, 1862)	+	+	
		Vespa crabro flavofasciata (Cameron, 1903)	+	+	
		Vespa mandarina (Smith, 1852)		+	
		Vespa simillima simillima (Smith, 1868)	+	+	
		Vespula flaviceps lewisii (Cameron, 1903)	+	+	
Diptera	Asilidae	*Cophinopoda chinensis* (Fabricus, 1794)		+	
		Machimus scutellaris (Coquillett, 1898)	+	+	+
		Neoitamus angusticornis (Loew, 1858)	+	+	

Table 2. Continued

Orders	Families	Species	E	M	W
		Philonicus albiceps (Meigen, 1820)	+	+	
		Promachus yesonicus (Bigot, 1887)	+	+	
	Bibionidae	*Bibio tenebrosus* (Coquillett, 1898)		+	
		Plecia adiastola (Hardy et Takahashi, 1960)	+		
	Bombyliidae	*Bombylius major* (Linnaeus, 1758)		+	
		Bombylius shibakawae (Matsumura, 1916)	+		
		Systropus nitobei (Matsumura, 1916)	+	+	
	Calliphoridae	*Aldrichina grahami* (Aldrich, 1930)	+		
		Calliphora lata (Coquillett, 1898)	+	+	
		Hemipyrellia ligurriens (Wiedemann, 1830)	+		
		Lucilia ampullacea (Villeneuve, 1922)		+	
	Sarcophagidae	*Bellieria melanura* (Meigen, 1826)			+
		Sarcophaga (Kramerea) schuetzei (Kramer, 1909)	+	+	
	Scathophagidae	*Scatophaga stercoraria* (Linnaeus, 1758)		+	+
	Stratiomyidae	*Ptecticus tenebrifer* (Walker, 1849)		+	
	Syrphidae	*Chrysotoxum shirakii* (Matsumura, 1931)	+	+	
		Episyrphus balteatus (De Geer, 1776)	+	+	+
		Eristalis arbustorum (Linnaeus, 1758)		+	
		Eristalis cerealis (Fabricius, 1805)	+	+	
		Eristalis (Eristalis) tenax (Linnaeus, 1758)	+	+	+
		Eupeodes (Metasyrphus) nitens (Zetterstedt, 1843)	+	+	
		Sphaerophoria menthastri (Linnaeus, 1758)	+	+	+
		Volucella jeddona (Bigot, 1875)	+		
		Volucella tabanoides (Motschulsky, 1859)	+	+	
	Tabanidae	*Tabanus chrysurus* (Loew, 1858)		+	
	Tachinidae	*Tachina* (*Servillia*) *lueola* (Coquillett, 1898)	+	+	
		Tachina (*Eudoromyia*) *nupta* (Rondani, 1859)	+	+	
	Tipulidae	*Ctenophora* (*Dictenophora*) *pictipennis fasciata* (Coquillett, 1898)	+		
		Tipula (Yamatopitula) patagiata (Alexander, 1924)		+	
		Tipula taikun (Alexander, 1921)		+	
Lepidoptera	Arctiidae	*Hyphantria cunea* (Drury, 1773)	+	+	+
		Spilosoma lubricipeda (Linnaeus, 1758)	+	+	+
		Spilosoma niveum (Ménétriès, 1859)	+		+
	Cambidae	*Cnaphalocrocis medinalis* (Guenée, 1854)	+		+
		Maruca vitrata (Fabricius, 1787)	+	+	+
	Ctenuchidae	*Amata fortunei* (Orza, 1869)	+		

Table 2. Continued

Orders	Families	Species	E	M	W
		Amata germana (Felder et Felder, 1862)	+		+
	Geometridae	*Cystidia stratonice* (Stoll, 1872)	+		+
	Hesperiidae	*Daimio tethys* (Menetries, 1857)	+	+	+
		Erynnis montanus (Bremer, 1861)	+	+	+
		Lobocla bifasciata (Bremer et Grey, 1852)	+	+	+
		Ochlodes venata (Bremer et Grey, 1853)	+	+	+
		Pyrgus maculatus (Bremer et Grey, 1853)	+	+	+
	Lasiocampidae	*Dendrolimus spectabilis* (Butler, 1877)	+		+
	Libytheidae	*Libythea celtis* (Laicharting, 1782)	+		+
	Limacodidae	*Monema flavescens* (Walker, 1855)	+		+
	Lycaenidae	*Callophrys frivaldszkyi* (Kindernann in Lederer, 1853)	+	+	+
		Celastrina argiolus (Linnaeus, 1758)	+	+	+
		Everes argiades (Pallas, 1771)	+	+	+
		Lycaena phlaeas chinensis (Felder, 1862)	+	+	+
		Pseudozizeeria maha (Kollar, 1884)	+		+
		Rapala caerulea (Bremer et Grey, 1851)	+	+	+
	Lymantriidae	*Euproctis similis* (Fuessly, 1775)	+		+
		Euproctis subflava (Bremer, 1864)	+		+
		Lymantria dispar (Linnaeus, 1758)	+		+
		Lymantria mathura (Moore, 1865)	+		
		Lymantria monacha (Linnaeus, 1758)			+
	Notodontidae	*Uropyia meticulodina* (Oberthür, 1884)	+		+
	Nymphalidae	*Apatura metis* (Freyer, 1829)	+		+
		Araschnia burejana (Bremer, 1861)	+		
		Argyronome laodice (Pallas, 1771)	+	+	+
		Cyntia cardui (Linnaeus, 1758)	+	+	+
		Damora sagana (Doubleday, 1847)	+		+
		Hestina assimilis (Linnaeus, 1758)	+	+	+
		Kaniska canace (Linnaeus, 1763)	+	+	+
		Limenitis doerriesi (Staudinger, 1892)	+	+	+
		Limenitis sydyi (Lederer, 1853)	+	+	+
		Neptis alwina (Bremer et Grey, 1862)	+	+	+
		Neptis pryeri (Butler, 1871)	+	+	+
		Neptis sappho (Pallas, 1771)	+	+	+
		Polygonia c-aureum (Linnaeus, 1758)	+	+	+
		Vanessa indica (Herbst, 1794)	+	+	+

Table 2. Continued

Orders	Families	Species	E	M	W
	Papilionidae	*Atrophaneura alcinous* (Klug, 1836)	+	+	+
		Papilio bianor (Cramer, 1777)	+	+	+
		Papilio machaon (Linnaeus, 1758)	+	+	+
		Papilio macilentus (Janson, 1877)	+	+	+
		Papilio xuthus (Linnaeus, 1767)	+	+	+
		Parnassius stubbendorfii (Menetries, 1849)	+	+	+
	Pieridae	*Anthocharis scolymus* (Butler, 1866)	+	+	+
		Colias erate (Esper, 1805)	+	+	+
		Gonepteryx rhamni (Linnaeus, 1758)	+	+	+
		Leptidea amurensis (Menetries, 1859)	+	+	+
		Pieris canidia (Sparrman, 1768)	+	+	+
		Pieris melete (Menetries, 1857)	+	+	+
		Pieris rapae (Linnaeus, 1758)	+	+	+
	Psychidae	*Eumeta minuscula* (Butler, 1881)	+		
	Pyralidae	*Angerona prunaria* (Linnaeus, 1758)	+		+
		Herpetogramma luctuosalis (Guenée, 1854)	+		+
		Heterarmia charon (Butler, 1878)	+		+
		Hymenia recurvalis (Fabricius, 1775)	+	+	
		Ostrinia furnacalis (Guenée, 1854)	+		+
	Saturniidae	*Antheraea yamamai* (Guérin-Méneville, 1861)	+		+
		Dictyoploca japonica (Moore, 1862)	+		+
	Satyridae	*Coenonympha hero* (Linnaeus, 1761)	+	+	+
		Coenonympha oedippus (Fabricius, 1787)	+	+	+
		Lasiommata deidamia (Motschulsky, 1860)	+	+	+
		Lethe marginalis (Motschulsky, 1860)	+	+	+
		Melanargia epimede (Staudinger, 1887)	+		+
		Minois dryas (Scopoli, 1763)	+	+	+
		Mycalesis francisca (Cramer, 1780)	+	+	+
		Ypthima argus (Butler, 1866)	+	+	+
		Ypthima motschulskyi (Bremer et Gray, 1853)	+	+	+
	Sesiidae	*Paranthrene regalis* (Butler, 1878)		+	
	Sphingidae	*Agrius convolvuli* (Linnaeus, 1758)	+		+
		Clanis bilineata (Walker, 1866)	+		+
		Macroglossum stellaparum (Linnaeus, 1758)	+		+
		Marumba gaschkewitschii (Bremer et Grey, 1853)	+		+
		Pergesa elpenor (Linnaeus, 1758)	+		+

Table 2. Continued

Orders	Families	Species	E	M	W
		Rhagastis mongoliana (Butler, 1875)	+		+
	Thyrididae	*Rhodoneura vittula* (Guenée, 1877)	+		+
	Tortricidae	*Adoxophyes orana* (Fischer von Röslerstamm, 1834)	+		
	Zygaenidae	*Chalcosia remota* (Walker, 1854)	+		+
		Illiberis tenuis (Butler, 1877)	+		+

E, eastern mountain region; M, middle inland region; W, western coastal region.

Table 3. Synopsis of composition according to insect taxa

Orders	Families	Genera	Species
Odonata	4	7	10
Blattaria	2	2	3
Mantodea	1	1	2
Isoptera	1	1	1
Dermaptera	1	3	3
Orthoptera	7	39	41
Phasmida	1	1	1
Hemiptera	13	34	40
Homoptera	4	6	6
Neuroptera	3	3	3
Coleoptera	33	141	170
Hymenoptera	12	27	40
Diptera	11	26	33
Lepidoptera	23	70	84
Total	116	361	437

Table 4. Insect composition of 3 main regions

Regions	Orders	Families	Genera	Species
Eastern mountain region	12	91	267	313
Middle inland region	12	77	233	239
Western coastal region	12	61	198	224

species of 48 families belonging to 3 orders, Hemiptera, Coleoptera and Lepidoptera while current survey reported 437 insect species and of them, merely 145 species were the same as in KFRI (2000). This difference might be, in part, due to differences in survey areas between two studies. On the contrary, 352 species were the same between our study and Shin et al. (1996). Eastern mountain area was highest in the species richness than other areas, indicating that eastern mountain area seemed to provide insects with more favorable condition such as plentiful and diverse plantation, and geographical features composed of many types of retreats and habitats. Also, this result corresponded to previous reports (Shin et al. 1996, KFRI 2000). Lower levels in development in this region than in other regions might also contributed to higher insect species richness. The fact that eastern mountain area had more habitat specialist species than other areas may also agree with these explanantion.

That Coleoptera, Lepidoptera, Orthoptera and Hemiptera were abundant in DMZ areas was relatively consistent with the insect fauna in Korea. Other taxa such as Blattaria, Mantodea, Dermaptera and Phasmida were found with less than 10 species in our survey, but they should not be underestimated considering their ecological roles in nature. They are considered to be more important for evaluation of healthiness of the ecosystem. The numbers of species of this orders found in our study were small, but were the highest compared to previous DMZ insect fauna studies.

Despite the limitations for DMZ fauna studies as described earlier, our study in three regions in DMZ was carried out during the same seasons, though each region was surveyed in different years, and covered other sites which were not surveyed before. The insect list of this study added 46 species newly to DMZ fauna and could be valuable for understanding insect fauna, history of change of insect community and their distributions in DMZ areas. Although our study was the most recently conducted and a highly intensive one covering from east to west in DMZ areas, inherent limitations due to military and political situations restricted more intensive and comprehensive faunistic study and our study was no exception. To construct more comprehensive and useful biological data base for biological conservation and natural heritage management plans for DMZ areas, long-term and ecological functional as well as species inventory studies should be conducted with careful experimental designs, sampling plans, and more importantly thorough examination and solutions for DMZ area accessability.

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