

# A Survey on Insect Diversity of Mulyeongari-Oreum Wetland, on Jeju Island, South Korea<sup>1a</sup>

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## 제주도 물영아리오름 습지의 곤충다양성에 관한 연구<sup>1a</sup>

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### ABSTRACT

The purpose of this study is to identify insects inhabiting Mulyeongari-Oreum wetland and to provide basic information for conservation of wetlands. As a result, a total 229 species, 73 families, 9 orders of insects were collected: 136 species, 39 families, 6 orders from Mulyeongari-Oreum Wetland and 121 species, 52 families, 9 orders from Mt. Sooryeong. Of the 229 species of insects investigated, *Copris tripartitus* Waterhouse, an endangered species of wildlife fauna in Korea, was found with many individuals. Also, *Lychnuris rufa*(Olivier), having a narrow habitat near unpolluted water and mountains, was also recorded with 3 individuals and then should be considered as a protected species in Wetlands. To identify the community structure of moth on Mulyeongari-Oreum wetland, a light trap was examined and a total 76 species of moths were collected. Total dominant species was *Hydrillodes morosa*(Butler) with index of 0.12 and the species diversity on the moth community from survey area was the highest in July with index of 3.42.

**KEY WORDS: INSECT DIVERSITY, MULYEONGARI-OREUM WETLAND, RAMSAR CONVENTION**

### 요 약

본 논문은 물영아리오름 습지에 서식하는 곤충류를 파악하여 습지 보전에 대한 기초적인 정보를 제공하고자 실시되었다. 조사결과 총 9목 73과 229종이 조사되었으며, 물영아리오름 습지는 6목 39과 136종, 수령산은 9목 52과 121종이 조사되었다. 조사된 229종의 곤충류 중 멸종위기종인 애기뿔소똥구리가 포함되었다. 또한 오염되지 않은 습한 산 주위에서 주로 서식하는 늦반딧불이가 3개체 조사되었으며 이는 청정지역임을 나타내는 대표적인 종으로 습지에서 보호되어야 할 가치가 있는 것으로 판단된다. 또한 물영아리오름 습지의 나방류 확인을 위해 야간 유인등 조사를 실시하였으며 조사 결과 총 76종이 조사되었다. 넓은떠담혹수염나방이 0.12의 우점도 지수로 전체 우점종으로 조사되었으며, 종다양

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도는 7월 조사에서 3.42로 가장 높게 나타났다.

주요어: 곤충다양성, 물영아리오름 습지, 람사르 협약

## INTRODUCTION

Although wetlands occupy only about 4% of the total surface of the earth(Hunter *et al.*, 2002), they are recognized to have significant functions of high value. With this recognition, people came to have interest in and to pay attention to the preservation of wetlands, with results such as the Ramsar Convention. Wetlands are defined as those with high water content in the soil(Gove, 1969). They are known to have high primary productivity and to have critical roles in the life cycles of many aquatic species, many of which are economically important(National Research Council, 1992). They also serve life support functions including adjustment of water flow and storage of excesses, mitigating damage by floods. In addition, plant and bacterial species of wetlands serve to remove contaminants from circulating water and thus improve water quality(National Research Council, 1992). In the Wetlands Conservation Act of Korea, they are defined as inland and coastal land which is permanently or temporarily covered with fresh water, brackish water or salt water(Lee *et al.*, 2003).

Mulyeongari-Oreum Wetland is located in Sumang-ri, Namwon-eup, Seogwipo-si, Jeju-do, South Korea. It is classified as inland wetland, specifically forest wetland, and more specifically basin wetland(Kwon, 2006). It was designated as a Wetlands Conservation Area in December, 2000 by the Ministry of Environment and registered as the fifth Ramsar Wetland in Korea in October, 2006. Based on its geographical condition, within the secluded mountaintop crater of Mt. Sooryeong, it is considered an independent ecosystem. There are always some wet parts in the wetland all year round, although conditions within specific areas vary according to the season. The natural environment of the area is excellent, with abundant vegetation that provides a variety of microhabitats. It is considered to have high conservational value.

Regarding the insects of the Mulyeongari-Oreum Wetland, Cho and Kim(1988a) and Cha(1999) reported 41

species and 26 species, respectively, for a total of 47 species up to now. These surveys were performed before the existence of the Ramsar Convention. From this perspective, this survey is highly meaningful in that it is the first survey since the Ramsar Convention. There are other surveys on the other Ramsar Registered Wetlands in Korea such as the High Moor, Yonneup of Mr. Daeam(Kim and Jung, 2007), Upo Wetland(Lee and Oh, 2006), Muljangori-oreum Wetland(Cho and Kim, 1998a; Jung, 2001), Moojehineup(Lee, 1997; Cho and Kim, 1998b; Do *et al.*, 2002; Lee and Lee, 2006), Jangdo Island High Moor(Kim, 2004; Paek and Song, 2007) and Du-ung Wetland(Cho and Kim, 2002).

This survey of the insects inhabiting Mulyeongari-Oreum Wetland and its supporting area on Mt. Sooryeong was performed to provide basic information for preservation and recovery of Mulyeongari-Oreum Wetland as part of the Mulyeongari-Oreum Wetland Precision Survey Project by the Ministry of Environment.

## MATERIALS AND METHODS

### 1. Place and Time of Survey

Surveys were performed separately in Mulyeongari-Oreum Wetland(N: 33° 22' 57", E: 126° 42' 42") and its supporting area on Mt. Sooryeong(N: 33° 21' 21", E: 126° 41' 11")(Figure 1). They were performed three times: April 28 to 30, July 17 to 19 and September 30 to October 2, for a total of nine days, in 2008. All specimens are preserved in the laboratory of animal taxonomy and ecology in Daejeon University.

### 2. Method of Survey and Analysis

As insects have diversified habitats and behavioral habits, we used as many different collection methods as possible, according to the characteristics of the adults of each taxonomic group. For daytime collection, searching, sweeping and beating were adopted and qualitative

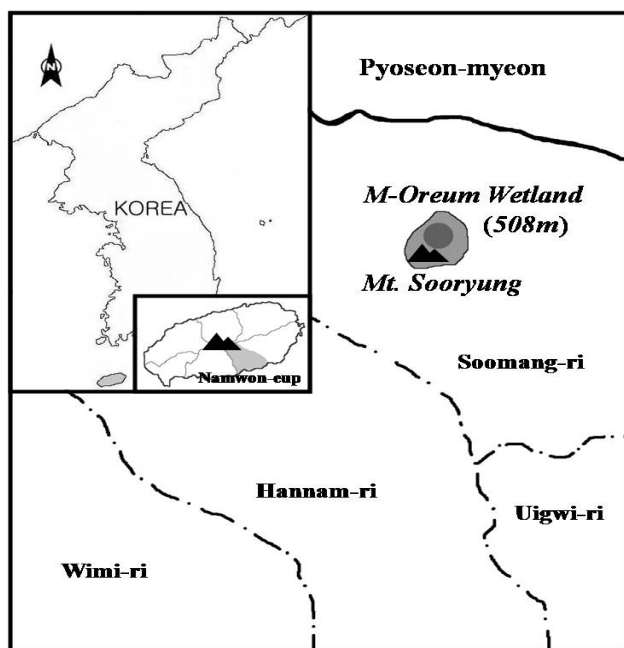


Figure 1. Survey area

surveys were done for various taxonomic groups. At night, to identify the community of moths, light trap quantitative surveys were done seasonally from 20:00 to 24:00 hours, to make three times in total. Additionally, to make a qualitative survey of the ground beetles in the wetland, pitfall trap was performed using silkworm pupae.

The insects collected in the field were temporarily anesthetized and then transported to the laboratory. Some were made into dried specimens and the others were made into immersion specimens in 70% ethanol. The collected insects were classified based on the previous literature and articles, and followed the classification scheme in "Checklist of Insects from Korea(1994)".

Moths were analyzed using dominance index and diversity index. For dominance index, McNaughton's

formula(1967) was used. For diversity index, Shannon-Weaver Diversity(1949) was used to create a baseline for comparison in the future.

## RESULTS AND DISCUSSION

### 1. Total Taxonomic Groups

From the surveys, a total of 483 individuals belonging to 136 species, 39 families and 6 orders of adult insects were collected from Mulyeongari-Oreum Wetland and a total of 283 individuals, belonging to 121 species, 52 families and 9 orders of insects were collected from Mt. Sooryeong. The most species were reported in July for both Mulyeongari-Oreum Wetland and Mt. Sooryeong, 74 species and 77 species, respectively. In April, relatively smaller number of species were reported, 46 species and 18 species respectively(Table 1).

In the earlier Mulyeongari-Oreum Wetland surveys, Cho and Kim(1998a) reported 41 species, 22 families in 5 orders, while Cha(1999) reported 26 species, 14 families in 5 orders, for a total of 47 reported species. A considerable number of the reported insects were aquatic(18 species, approximately 40%) and the surveys were somewhat biased toward certain taxonomic groups because of the characteristics of the wetland. However, in this survey we were able to add approximately 90 species using the seasonal surveys in spring, summer and autumn and through a wider variety of collection methods for Lepidoptera and Coleoptera. Additionally, Mt. Sooryeong, which has not been surveyed before, and which has significant meaning in biology and ecology as it supports and nurtures Mulyeongari-Oreum Wetland was included in this survey. In Muljangori-Oreum, another Ramsar Wetland on Jeju Island, Cho and Kim(1998a) reported 31 species, 20

Table 1. Species composition of investigated areas

Site	Season	Order	Family	Species	Individuals
Mulyeongari-Oreum Wetland	April	4	16	46	157
	July	5	23	74	197
	October	4	22	49	129
	Total	6	39	136	483
Mt. Sooryeong	April	3	7	18	15
	July	8	38	77	153
	October	9	31	60	115
	Total	9	52	121	283

families in 7 orders and Jung(2001) reported 182 species, 72 families in 11 orders. In the High Moor, Yongneup of Mt. Daeam, Kim and Jung(2007) reported 220 species, 62 families in 11 orders. Kim(2004) and Paek and Song(2007) reported 126 species, 60 families in 15 orders and 308 species, 102 families in 15 orders respectively in Jangdo Island High Moor. Cho and Kim(2002) reported 81 species, 43 families in 11 orders in Du-ung Wetland area and Lee and Oh(2006) reported 121 species, 18 families in 9 orders in Upo Wetland area. Additionally, Lee(1997) reported 60 species, 40 families in 8 orders, Do *et al.*(2002) reported 124 species, 60 families in 11 orders and Lee and Lee(2006) reported 34 species, 22 families in 10 orders terrestrial insects in Moojehineup area. In particular, in Muljangori Wetland, the High Moor, Yongneup of Mt. Daeam and Jangdo Island High Moor various insects were reported as 182 species, 220 species

and 308 species respectively.

Muljangori Wetland(63 ha) and the High Moor, Yongneup(106 ha) of Mt. Daeam have lower insect diversity per unit than Mulyeongari-Oreum Wetland because they are relatively wider than Mulyeongari-Oreum Wetland(31 ha). Jangdo Island High Moor(9 ha) showed high level of insect diversity per unit reporting more species than Mulyeongari-Oreum Wetland although it is no more than a third of Mulyeongari-Oreum Wetland in size. However, Jangdo Island High Moor survey result included 126 literature species and the survey area was wide because wide area around the wetland was included in the survey. It is judged that the 229 species which come from Mulyeongari-Oreum Wetland and its neighboring ecosystem in Mt. Sooryeong can compete with other wetlands considering the aforementioned reasons(Table 2).

Table 2. Insect diversity of registered Ramsar wetlands in South Korea

Wetlands (Area, ha)	Investigated results		
	Cho and Kim (1998a)	Jung(2001)	
Muljangori-Oreum Wetland (63)	31 species, 20 families in 7 orders	182 species, 72 families in 11 orders	
High Moor, Yongneup of Mt. Daeam (106)	Kim and Jung (2007) 220 species, 62 families in 11 orders		
Jangdo Island High Moor (9)	Kim (2004) 126 species, 60 families in 15 orders	Paek and Song (2007) 308 species, 102 families in 15 orders	
Du-ung Wetland (6)	Cho and Kim (2002) 81 species, 43 families in 11 orders		
Upo Wetland (854)	Lee and Oh (2006) 121 species, 18 families in 9 orders		
Moojehineup (4)	Lee (1997) 60 species, 40 families in 8 orders	Do <i>et al.</i> (2002) 124 species, 60 families in 11 orders	Lee and Lee (2006) 34 species, 22 families in 10 orders
Mulyeongari-Oreum Wetland (31)	Cho and Kim (1998a) 41 species, 22 families in 5 orders	Cha (1999) 26 species, 14 families in 5 orders	This study (2008) 136 species, 39 families in 6 orders

## 2. Taxonomic Composition

Looking at the appearance ratio by order, members of Lepidoptera and Coleoptera made up approximately two thirds of total species as 106 species(46%) and 45 species (20%), respectively. The next orders are Hymenoptera (11%) with 25 species, Hemiptera(8%) with 19 species, and Diptera(6%) with 13 species. By survey place, in Mulyeongari-Oreum Wetland the order of species was reported as Lepidoptera 77 species(57%), Coleoptera 31 species(23%), Hymenoptera 15 species(11%). In Mt. Sooryeong, the same order was reported as Lepidoptera 42 species(35%), Coleoptera 19 species(16%), Hymenoptera 17 species(14%)(Table 3).

It is thought that the reasons why members of Lepidoptera and Coleoptera were absolutely dominant in the survey are because they are large taxonomic groups and because the methods used to collect the insects, Light Trap and Pitfall Trap, favored collection of these kinds of insects. Cho and Kim(1998) and Cha(1999) used relatively simple collection methods such as air net and sweeping the water weed field for adult aquatic insects. As a result, in their surveys, not even a single species of Lepidoptera, Hymenoptera or Diptera was reported. Most

of the specimens they collected were members of Coleoptera(28 species, 60%), Hemiptera(8 Species, 17%), and Odonata(4 species, 8%).

## 3. Moth Community Analysis

For the moth community analysis of the Mulyeongari-Oreum Wetland, the highest species diversity index occurred in July(3.42) and the lowest in April(2.49). The dominant species was *Hydrillodes morosa*(Butler) with dominance index of 0.12(Table 4).

The species diversity index ranged from 2.49 to 3.42. This was relatively lower than general survey results. One reason many kinds of moths were not reported may have been because light from the light trap was obstructed by the trees with same height as Mulyeongari-Oreum Wetland is located in a deep crater. Additionally, on the interior slope, broad-leaved forest trees such as *Carpinus laxiflora* (Siebold & Zucc.) Blume, *Cornus kousa* F.Buerger ex Miquel, *Styrax japonicus* Siebold & Zucc. and *Neolitsea sericea*(Blume) Koidz. were dominant, while on the exterior slope, there was an artificial plantation of trees such as *Cryptomeria japonica*(L.f.) D.Don and *Pinus thunbergii* Parl.. Therefore, it is possible that the food plants of the

Table 3. Number of families and species within the orders collected in investigated areas

Order	Mulyeongari-Oreum Wetland		Mt. Sooryeong		Total	
	Families	Species	Families	Species	Families	Species
Odonata	0	0	2	6	2	6
Mantodea	0	0	1	2	1	2
Orthoptera	0	0	6	10	6	10
Hemiptera	3	11	7	9	8	19
Homoptera	1	1	3	3	3	3
Coleoptera	16	31	10	19	20	45
Hymenoptera	3	15	5	17	6	25
Diptera	1	1	7	13	7	13
Lepidoptera	15	77	11	42	20	106
Total	39	136	52	121	73	229

Table 4. Seasonal community analysis of moths collected from Mulyeongari-Oreum Wetland

Season	Dominant Species	Dominance Index	Species Diversity Index
April	<i>Odontopera arida</i> (Butler)	0.21	2.49
July	<i>Hydrillodes morosa</i> (Butler)	0.19	3.42
October	<i>Neocifuna jankowskii</i> (Oberthür)	0.19	2.94
Total	<i>Hydrillodes morosa</i> (Butler)	0.12	

moths were restricted in that area. *Hydrillodes morosa*(Butler) was the dominant species not only in July but also in total, and appeared from May till August. It is a general species distributed all over Korea. *Odontopera arida*(Butler) is also a general species appearing from May to June and from August to September. On the other hand, *Neocifuna jankowskii*(Oberthür) appears once a year from July to September. Although they are species with not many individuals, they were dominant in the Autumn survey. The food plants for those three species are unknown(Kim *et al.*, 1983; Shin *et al.*, 1983; Shin, 2001).

#### 4. Protected Species

No species registered on the IUCN Red List were collected in this area. However, 37 species of protected species were reported, including *Copris tripartitus* Waterhouse which falls under the Second Grade of endangered species of wildlife fauna and flora in Korea. In the Mulyeongari-Oreum Wetland, 12 species were reported such as 8 specific species, 3 approved species for delivering overseas and 1 endangered species. In Mt. Sooryeong, 25 species such as 5 endemic species, 19 specific species and 1 endangered species were reported. Cho and Kim(1998a) and Cha (1999) reported 7 and 5 protected species respectively including *Lethocerus deyrollei*(Vuillefroy) and *C. tripartitus* Waterhouse(Figure 2, Table 5).

In our survey, many more protected species were reported compared to previous surveys. However, the second grade endangered species, *L. deyrollei*(Vuillefroy) was not reported in this survey because our survey focused on terrestrial insects and did not make separate surveys of benthic macroinvertebrates and aquatic insects. The *C.*

*tripartitus* Waterhouse was first reported by Cha(1999) and confirmed in this survey in 2008. This means that the habitat has been preserved well for nearly ten years and that conditions favor *C. tripartitus* Waterhouse habitation as cow and horse dung is very abundant. Although *L. deyrollei*(Vuillefroy) has not been reported in this survey, in 2008, as well as 1998 to 1999, it was reported in two places near Dongbaekdongsan(Mt.) which is near Mulyeongari-Oreum Wetland. Considering that, it is highly probable that they still inhabit this area. As they are a protected species being endangered, continuous and precise monitoring should be performed. In the nighttime light trap survey, *Lychnuris rufa*(Olivier) was identified. Thus, it seems that two kinds of fireflies inhabit this area with *Luciola lateralis* Motshulsky which was identified by hearing from local residents.



Figure 2. *Copris tripartitus* Waterhouse, the Second Grade of Endangered Species in Korea, collected from Mulyeongari-Oreum Wetland and Mt. Sooryeong in 2008

Table 5. Legally protected species collected from Mulyeongari-Oreum Wetland and Mt. Sooryeong

Investigated areas	Endemic species	Specific species	Species Approved for Overseas Delivery	Endangered species	Total
Literature					
Mulyeongari-Oreum Wetland (2008)		8	3	1 <i>Copris tripartitus</i> Waterhouse	12
Cho and Kim (1998)	2	3	1	1 <i>Lethocerus deyrollei</i> (Vuillefroy)	7
Cha (1999)	1	2		2 <i>Lethocerus deyrollei</i> (Vuillefroy), <i>Copris tripartitus</i> Waterhouse	5
Mt. Sooryeong (2008)	5	19		1 <i>Copris tripartitus</i> Waterhouse	25

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Appendix 1. (Continued)

Scientific name	Korean name	April		July		October		Cho & Kim (1998a)	Cha (1999)
		MOW	MS	MOW	MS	MOW	MS		
<i>Neolethaeus dallasi</i> (Scott)	달라시긴노린재			2					
<b>Family Alydidae</b>	<b>호리허리노린재과</b>								
<i>Riptortus clavatus</i> (Thunberg)	톱다리개미허리노린재				1				
<b>Family Lygaeidae</b>	<b>알노린재과</b>								
<i>Coptosoma bifarium</i> Montandon	알노린재				5				
<b>Family Acanthosomatidae</b>	<b>빨노린재과</b>								
<i>Acanthosoma forficula</i> Jakovlev	녹색가위빨노린재					2			
<i>Acanthosoma haemorrhoidale</i> (Linné)	빨노린재					3			
<i>Acanthosoma labiduroides</i> Jakovlev	긴가위빨노린재			5		2			
<i>Elasmostethus interstinctus</i> (Linné)	진얼룩빨노린재					1			
<i>Elasmucha putoni</i> Scott	푸토니빨노린재			2					
<b>Family Phyllocephalidae</b>	<b>역새노린재과</b>								
<i>Gonopsis affinis</i> (Uhler)	역새노린재						1		
<b>Family Pentatomidae</b>	<b>노린재과</b>								
<i>Carbula putoni</i> (Jakovlev)	가시노린재				1	2			
<i>Lelia decempunctata</i> (Motschulsky)	열점박이노린재					1			
<i>Halyomorpha halys</i> (Stal)	썩덩나무노린재				1				
<i>Nezara antennata</i> Scott	풀색노린재					3			
<i>Palomena angulosa</i> (Motschulsky)	북방풀노린재				1				
<i>Plautia stali</i> Scott	갈색날개노린재			13		2			
<b>Order Homoptera</b>	<b>매미목</b>								
<b>Family Cercopidae</b>	<b>쥐머리거품벌레과</b>								
<i>Eoscartopsis assimilis</i> (Uhler)	쥐머리거품벌레				3				
<b>Family Cicadellidae</b>	<b>매미충과</b>								
<i>Bothrogonia japonica</i> Ishihara	끝검은말매미충					25	o	o	
<b>Family Aphrophoridae</b>	<b>거품벌레과</b>								
<i>Aphrophora maritima</i> (Matsumura)	갈잎거품벌레						o		
<b>Family Delphacidae</b>	<b>멸구과</b>								
<i>Sogatella furcifera</i> (Horváth)	흰등멸구						o		
<b>Family Cicadidae</b>	<b>매미과</b>								
<i>Graptosaltria nigrofusca</i> (Motschulsky)	유지매미			2	1				
<b>Order Coleoptera</b>	<b>딱정벌레목</b>								
<b>Family Carabidae</b>	<b>딱정벌레과</b>								
<i>Carabus (Parhomopterus) sternbergi sternbergi</i> Roeschke	우리딱정벌레	20		2					
<i>Carabus (Isiocarabus) fiduciarius saishutoicus</i> Csiki	제주왕딱정벌레	15		3			o		
<i>Carabus (Parhomopterus) sternbergi touzalini</i> Lapouge	제주우리딱정벌레						o		
<i>Nebria (Orientonebria) chinensis chinensis</i> Bates	중국먼지벌레	1				9			
<b>Family Harpalidae</b>	<b>먼지벌레과</b>								
<i>Dolichus halensis</i> (Schaller)	등빨간먼지벌레	1							
<i>Colpodes (Eucolpodes) japonicus</i> (Motschulsky)	일본줄납작먼지벌레						o		
<i>Harpalus (Pseudoophonus) vicarius</i> Harold	북방머리먼지벌레						o		
<i>Oxycentrus argutoroides</i> (Bates)	긴머리먼지벌레	1					o		
<i>Dischissus mirandus</i> Bates	큰털보먼지벌레	1					o		
<i>Scarites (Parallelomorpha) terricola pacificus</i> Bates	긴조롱막먼지벌레						o		
<i>Galerita (Galerita) orientalis</i> Schmidt-Goebel	목가는먼지벌레	2							
<b>Family Brachinidae</b>	<b>폭탄먼지벌레과</b>								
<i>Pheropsophus javanus</i> (Dejean)	남방폭탄먼지벌레	10		1					
<i>Pheropsophus jessoensis</i> Morawitz	폭탄먼지벌레	36		5		13			
<b>Family Noteridae</b>	<b>자색물방개과</b>								
<i>Noterus japonicus</i> Sharp	자색물방개						o	o	
<i>Canthydrus politus</i> (Sharp)	노랑머물방개						o	o	
<b>Family Cicindelidae</b>	<b>길앞잡이과</b>								
<i>Cicindela (Myriochile) specularis</i> Chaudoir	쇠길앞잡이				5	2			
<b>Family Dytiscidae</b>	<b>물방개과</b>								
<i>Hydaticus conspersus</i> Regimbart		1							
<i>Cybister (Meganectes) brevis</i> Aube	검정물방개	3					o	o	
<i>Laccophilus difficilis</i> Sharp	무늬깨알물방개						o	o	
<i>Agabus browni</i> Kamiya	큰땅콩물방개						o	o	

Appendix 1. (Continued)

Scientific name	Korean name	April		July		October		Cho & Kim (1998a)	Cha (1999)
		MOW	MS	MOW	MS	MOW	MS		
<i>Agabus congener</i> (Thunberg)	북쪽땅콩물방개							○	○
<i>Hydaticus (Hydaticus) bowringi</i> Clark	줄무늬물방개							○	○
<i>Hydaticus</i> sp.	알물방개류							○	○
<b>Family Gyrinidae</b>	<b>물맴이과</b>								
<i>Gyrinus (Gyrinus) gestroi</i> Régimbart	참물맴이							○	○
<b>Family Hydrophilidae</b>	<b>물맹맹이과</b>								
<i>Sternolophus (Sternolophus) rufipes</i> Fabricius	애물맹맹이							○	○
<b>Family Staphylinidae</b>	<b>반날개과</b>								
<i>Stenus (Hypostenus) cicindeloides</i> (Schaller)	북방알락딱부리반날개							○	
<i>Stenus (Nestus) melanarius verecundus</i> Sharp	좁딱부리반날개							○	
<i>Lathrobium dignum</i> Sharp	홍딱지개미반날개							○	
<b>Family Silphidae</b>	<b>송장벌레과</b>								
<i>Nicrophorus (Nicrophorus) quadripunctatus</i> Kraatz	넙적박이송장벌레						1		
<i>Necrodes asiaticus</i> Portevin	큰수증다리송장벌레				1				
<b>Family Staphylinidae</b>	<b>반날개과</b>								
<i>Stenus</i> sp. 1		5							
<i>Ocypus</i> sp. 1		2							
<b>Family Helodidae</b>	<b>알꽃벼룩과</b>								
<i>Scirtes japonicus</i> Kiesenwetter	알꽃벼룩	2						○	
<b>Family Lucanidae</b>	<b>사슴벌레과</b>								
<i>Serrognathus platymelus castanicolor</i> Motschulsky	넙적사슴벌레				1				
<b>Family Scarabaeidae</b>	<b>소똥구리과</b>								
<i>Scarabaeus typhon</i> (Fischer-Waldheim)	뿔소똥구리				1				○
<i>Copris tripartitus</i> Waterhouse	애기뿔소똥구리	1		2	7	10	5		○
<i>Onthophagus (Strandius) lenzii</i> Harold	렌지소똥풍뎅이								○
<i>Onthophagus (Phanaeomorpha) fodiens</i> Waterhouse	모가슴소똥풍뎅이								○
<b>Family Aphodiidae</b>	<b>똥풍뎅이과</b>								
<i>Aphodius (Aphodius) elegans</i> Allibert	큰점박이똥풍뎅이						1		○
<b>Family Melolonthidae</b>	<b>검정똥풍뎅이과</b>								
<i>Holotrichia diomphalia</i> (Bates)	참검정똥풍뎅이		1						
<b>Family Rutelidae</b>	<b>풍뎅이과</b>								
<i>Adoretus tenuimaculatus</i> Waterhouse	주둥무늬차색풍뎅이						1		
<i>Anomala albopilosa</i> Hope	청동풍뎅이				26				
<i>Bifurcanomala aulax</i> Wiedemann	흙줄풍뎅이				2				
<i>Popillia quadriguttata quadriguttata</i> (Fabricius)	녹색똥풍뎅이					18	8		
<b>Family Cetoniidae</b>	<b>꽃무지과</b>								
<i>Protaetia brevitarsis seulensis</i> (Kolbe)	흰점박이꽃무지					1	1		
<b>Family Elateridae</b>	<b>방아벌레과</b>								
<i>Pectocera fortunei</i> Candéze	왕빛살방아벌레				1	2	2		
<b>Family Lampyridae</b>	<b>반딧불이과</b>								
<i>Lychmurus rufa</i> (Olivier)	늦반딧불이						3		
<b>Family Coccinellidae</b>	<b>무당벌레과</b>								
<i>Anatis halonis</i> Lewis	달무리무당벌레					3			
<i>Coccinella (Coccinella) septempunctat</i> Linné	칠성무당벌레					1			
<i>Harmonia axyridis</i> (Pallas)	무당벌레				2		1	2	
<i>Propylea japonica</i> (Thunberg)	꼬마남생이무당벌레				1	3		1	
<b>Family Cerambycidae</b>	<b>하늘소과</b>								
<i>Spondylis buprestoides</i> (Linné)	검정하늘소				1				
<i>Leptura arcuata</i> Panzer	긴알락꽃하늘소					1			
<i>Agapanthia pilicornis</i> (Fabricius)	남색초원하늘소					1			
<i>Anoplophora malasiaca</i> (Thomson)	알락하늘소					2			
<i>Massicus raddei</i> (Blessig)	하늘소					1			
<b>Family Chrysomelidae</b>	<b>잎벌레과</b>								
<i>Liliocercis (Liliocercis) ruficollis</i> (Baly)	고려긴가슴잎벌레					2			
<i>Galerucella grisescens</i> (Joannis)	딸기잎벌레	9							
<i>Galerucella nipponensis</i> (Laboissiere)	일본잎벌레								○
<i>Lema (Lema) coronata</i> Baly	가시다리큰벼잎벌레								○
<i>Altica caerulescens</i> (Baly)	발리잎벌레						2		

Appendix 1. (Continued)

Scientific name	Korean name	April		July		October		Cho & Kim (1998a)	Cha (1999)
		MOW	MS	MOW	MS	MOW	MS		
<i>Batophila acutangula</i> Heikertinger	콩알벼룩잎벌레	17							
<i>Chaetocnema (Chaetocnema) ingenua</i> (Baly)	두줄털다리벼룩잎벌레	4							
<i>Sphaeroderma placidum</i> Harold					2				
<b>Family Anthribidae</b>	<b>소마구미과</b>								
<i>Tropideres naevulus</i> Faust	날개떡소마구미	1							
<b>Order Hymenoptera</b>	<b>벌목</b>								
<b>Family Ichneumonidae</b>	<b>맷시벌과</b>								
<i>Pimpla luctuosa</i> Smith							1		
Ophioninae sp.						4			
<i>Trogus bicolor</i> Radoszkowski	두색맷시벌					1			
<i>Alomyini</i> sp.							1		
<b>Family Scoliidae</b>	<b>배벌과</b>								
<i>Campsomeris (Megacampsemeris) prismatica</i> Smith	금태줄배벌					1			
<b>Family Formicidae</b>	<b>개미과</b>								
<i>Camponotus kiusuensis</i> Santsch	갈색발왕개미	+							
<i>Camponotus vitosus</i> Kim et Kim	제주왕개미	+							
<i>Crematogaster matsumurai</i> Forel	마쓰무라밀들이개미	++							
<i>Crematogaster osakensis</i> Forel	노랑밀들이개미	+++	+++	+++	+++	+++	+++		
<i>Formica japonica</i> Motschulsky	곰개미	+++	+	+++	+	+++			
<i>Lasius flavus</i> (Fabricius)	황개미			+					
<i>Lasius hayashi</i> Yamauchi et Hayashida	하야시털개미	++	++					+	
<i>Lasius japonicus</i> (Latreille)	고동털개미	++	+						
<i>Myrmecina nipponica</i> Wheeler	가시방패개미		+						
<i>Pachycondyla javana</i> Mayr	일본침개미		+						
<i>Paratrechina flavipes</i> (Smith)	스미스개미	++	++	++	++	++	++		
<i>Pheidole fevida</i> (Smith)	극동흑개미	++	++	++	++	++	++		
<i>Tetramorium tsusimae</i> (Linné)	주름개미	+	++	+	++		++		
<i>Vollenhovia emeryi</i> Wheeler	에메리개미	+							
<i>Camponotus (Camponotus) japonicus</i> Mayr	일본왕개미						+		
<i>Camponotus (Camponotus) obscuripes</i> Mayr	홍가슴개미						+		
<b>Family Pompilidae</b>	<b>대모벌과</b>								
<i>Cyphononyx dorsalis</i> (Lepeletier)	대모벌					2			
<b>Family Sphecoidae</b>	<b>구멍벌과</b>								
<i>Psen affinis</i> Gussakovskij	구사코브스키포마구멍벌						1		
<b>Family Apidae</b>	<b>꿀벌과</b>								
<i>Ceratina japonica</i> Cockerell	일본광채꽃벌						2		
<i>Apis mellifera</i> Linné	양봉꿀벌				2				
<b>Order Diptera</b>	<b>파리목</b>								
<b>Family Stratiomyidae</b>	<b>동애등애과</b>								
<i>Hermetia illucens</i> (Linnaeus)	아메리카동애등애						1		
<b>Family Asilidae</b>	<b>파리매과</b>								
<i>Promachus yesonicus</i> Bigot	파리매				1				
<b>Family Dolichopodidae</b>	<b>장다리파리과</b>								
<i>Mesorhaga nebulosa</i> (Matsumura)	얼룩장다리파리				1				
<b>Family Syrphidae</b>	<b>꽃등애과</b>								
<i>Episyrphus balteatus</i> (de Geer)	호리꽃등애						1		
<i>Betasyrphus serarius</i> (Wiedemann)	검정넓적꽃등애				2				
<i>Sphaerophoria menthastri</i> (Linné)	꼬마꽃등애				3				
<i>Melanostoma mellinum</i> (Linné)	광불이꽃등애				1				
<i>Paragus haemorrhous</i> Meigen	고려꽃등애						3		
<i>Helophilus (Helophilus) virgatus</i> Coquillett	수중다리꽃등애	1					1		
<b>Family Platystomatidae</b>	<b>알락파리과</b>								
<i>Rivellia alini</i> Enderlein	알린콩알락파리				5				
<b>Family Muscidae</b>	<b>집파리과</b>								
<i>Musca domestica</i> (Linné)	집파리						2		
<b>Family Tachinidae</b>	<b>기생파리과</b>								
<i>Tachina nupta</i> (Rondani)	등줄기생파리						1		
<i>Cylindromyia (Cylindromyia) brassicaria</i> (Fabricius)	표주박기생파리						1		

Appendix 1. (Continued)

Scientific name	Korean name	April		July		October		Cho & Kim (1998a)	Cha (1999)
		MOW	MS	MOW	MS	MOW	MS		
<b>Order Lepidoptera</b>		<b>나비목</b>							
<b>Family Tortricidae</b>		<b>잎말이나방목</b>							
<i>Archips audax</i> Razowski	뒷노랑잎말이나방						2		
<b>Family Pyralidae</b>		<b>명나방목</b>							
<i>Bradina geminalis</i> Caradja	외줄들명나방			5					
<i>Charema noctescens</i> Moore	노랑다리들명나방			1					
<i>Cnaphalocrocis medinalis</i> (Guenée)	흑명나방			2					
<i>Herpetogramma luctuosalis</i> (Guenée)	포도들명나방			2					
<i>Palpita inusitata</i> Butler	애기흰들명나방					1			
<i>Palpita nigropunctalis</i> (Bremer)	수수꽃다리명나방	1				2			
<i>Hymenia recurvalis</i> (Fabricius)	흰띠명나방	1							
<i>Lamoria glaucalis</i> Caradja	앞붉은부채명나방			6					
<i>Craneophora ficki</i> (Christoph)	줄보라집명나방			3					
<i>Teliphasa amica</i> (Butler)	흰무늬집명나방			5					
<i>Orthaga achatina</i> Butler	갈색집명나방			1					
<i>Endotricha consocia</i> (Butler)	큰홍색뾰족명나방			3					
<i>Maruca testulalis</i> Geyer	콩명나방						3		
<b>Family Thyrididae</b>		<b>창나방목</b>							
<i>Striglina cancellata</i> (Christoph)	창나방			1					
<b>Family Limacodidae</b>		<b>췌기나방목</b>							
<i>Austrapoda dentata</i> (Oberthür)	흰점췌기나방			1					
<i>Narosa fulgens</i> (Leech)	꼬마얼룩무늬췌기나방			1					
<i>Phlossa conjuncta</i> (Walker)	남방췌기나방			1					
<b>Family Drepanidae</b>		<b>갈고리나방목</b>							
<i>Auzata nigrata</i> Park et Shin	얼룩갈고리나방		1						
<i>Deroca inconclusa</i> (Walker)	남방흰갈고리나방						3		
<b>Family Thyatiridae</b>		<b>뾰족날개나방목</b>							
<i>Habrosyne aurorina</i> (Butler)	애기담홍뾰족날개나방			2	2				
<i>Thyatira batis</i> (Linné)	무늬뾰족날개나방			2	1				
<b>Family Cyliidiidae</b>		<b>왕갈고리나방목</b>							
<i>Cyclidia substigmatica</i> (Hübner)	왕갈고리나방				1				
<b>Family Geometridae</b>		<b>자나방목</b>							
<i>Geometra dieckmanni</i> Graeser	흰줄푸른자나방				1				
<i>Ecliptopera umbrosaria</i> (Motschulsky)	큰톱날물결자나방			1	1				
<i>Eulithis fabiolaria</i> (Oberthür)	무늬박이흰물결자나방						1		
<i>Gandaritis fixseni</i> (Bremer)	큰노랑물결자나방				1				
<i>Heterophleps confusa</i> (Wileman)	애기담홍물결자나방			2	1				
<i>Amraica superans</i> (Butler)	노박덩굴가자나방				1				
<i>Ascotis selenaria</i> (Denis et Schiffmüller)	네눈썹가자나방	1		1	2		2		
<i>Chiasmia cinerearia</i> (Bremer et Grey)	줄마디가자나방			1					
<i>Corymica specularia</i> (Moore)	큰노랑애기가자나방						2		
<i>Hypephyra terrosa</i> Butler	뒷노랑뾰족가자나방			1					
<i>Ectropis excellens</i> (Butler)	줄고운가자나방			3					
<i>Fascellina chromataria</i> Walker	갈고리가자나방			2					
<i>Heterolocha aristonaria</i> (Walker)	뒷분홍가자나방						1		
<i>Hypomecis punctinalis</i> (Scopoli)	네눈가자나방	1		1					
<i>Menophra atrilineata</i> (Butler)	뿔나무가자나방	1	1	1					
<i>Menophra senilis</i> (Butler)	먹그림가자나방	1		9					
<i>Ninodes splendens</i> (Butler)	보라애기가자나방			1					
<i>Obeidia tigrata</i> (Guenée)	노랑날개무늬가자나방			1	1				
<i>Nothomiza aureolaria</i> Inoue	앞노랑가자나방						1		
<i>Odontopera arida</i> (Butler)	남방갈고리가자나방	5	3						
<i>Chiasmia normata</i> (Alphéraky)	고운날개가자나방	1		1					
<i>Ourapteryx maculicaudaria</i> (Motschulsky)	흰제비가자나방			1			1		
<i>Pareclipsis gracilis</i> (Butler)	끝짧은노랑가자나방			4			4		
<i>Zethenia rufescentaria</i> Motschulsky	솔밭가자나방	4	5						
<i>Alcis angulifera</i> (Butler)	털뿔가자나방						5		
<b>Family Lasiocampidae</b>		<b>솔나방목</b>							

Appendix 1. (Continued)

Scientific name	Korean name	April		July		October		Cho & Kim (1998a)	Cha (1999)
		MOW	MS	MOW	MS	MOW	MS		
<i>Dendrolimus spectabilis</i> (Butler)	솔나방			1					
<b>Family Bombycidae</b>	<b>누에나방과</b>								
<i>Bombyx mandarina</i> (Moore)	멧누에나방					1			
<b>Family Sphingidae</b>	<b>박각시과</b>								
<i>Ambulyx japonica</i> (Rothschild)	갈고리박각시	1							
<i>Callambulyx tatarinovii</i> (Bremer et Grey)	녹색박각시				2				
<i>Anuga multiplicans</i> Walker	애물결박각시				1				
<i>Dolbina tancrei</i> Staudinger	물결박각시		1						
<i>Marumba gaschkewitschii</i> (Bremer et Grey)	분홍등줄박각시			1					
<i>Marumba spectabilis</i> (Butler)	제주등줄박각시				3				
<i>Acosmeryx naga</i> (Moore)	포도박각시	1	1						
<i>Macroglossum saga</i> Butler	검정꼬리박각시					1			
<i>Rhagastis mongoliana</i> (Butler)	우단박각시				4				
<b>Family Notodontidae</b>	<b>재주나방과</b>								
<i>Quadricalcarifera cyanea</i> (Leech)	때죽나무재주나방	1							
<b>Family Lymantriidae</b>	<b>독나방과</b>								
<i>Neocifuna jankowskii</i> (Oberthür)	갈색독나방					11			
<b>Family Arctiidae</b>	<b>불나방과</b>								
<i>Mitochondria miniata</i> (Forester)	주홍테불나방				2				
<i>pilarctia seriatopunctata</i> Motschulsky	줄점불나방				5				
<b>Family Noctuidae</b>	<b>밤나방과</b>								
<i>Agrotis tokionis</i> Butler	숫검은밤나방					2			
<i>Sineugraphe exusta</i> (Butler)	쌍검은밤나방					1			
<i>Hadena rivularis</i> (Fabricius)	출현무늬밤나방					3			
<i>Xestia stupenda</i> (Butler)	앞노랑점밤나방					4			
<i>Pseudaletia separata</i> (Walker)	멸강나방			1					
<i>Callopietria repleta</i> Walker	얼룩어린밤나방					1			
<i>Cosmia achatina</i> Butler	제주꼬마밤나방			1					
<i>Ctenoplusia (Acanthoplusia) agnata</i> (Staudinger)	콩은무늬밤나방			2		2			
<i>Ercheia niveostrigata</i> Warren	청백무늬밤나방			6					
<i>Metopta rectifasciata</i> (Ménétrières)	흰줄태극나방	2			4				
<i>Spirama helicina</i> (Hübner)	톱니태극나방			1					
<i>Anomis mesogona</i> (Walker)	무궁화잎밤나방	1	1			1			
<i>Oraesia emarginata</i> (Fabricius)	작은갈고리밤나방					1			
<i>Hypersynpoides astrigera</i> (Butler)	흰별밤나방			1					
<i>Hypena trigonalis</i> (Guenée)	대만수염나방			1					
<i>Simplicia niphona</i> (Butler)	골은머수염나방			1		2			
<i>Hypena amica</i> (Butler)	뒷노랑수염나방			1					
<i>Herminia tarsicrinalis</i> (Knoch)	갈색줄수염나방			1					
<i>Hydrillodes morosa</i> (Butler)	넓은머슴수염나방	2		23					
<i>Macdunnoughia confusa</i> (Stephens)	국화는무늬밤나방					1			
<b>Family Hesperidae</b>	<b>팔랑나비과</b>								
<i>Pyrgus maculatus</i> (Bremer et Grey)	흰점팔랑나비				1				
<i>Daimio tethys</i> (Ménétrières)	왕자팔랑나비			3		2			
<i>Erynnis montanus</i> (Bremer)	멧팔랑나비			2					
<i>Parnara gutata</i> (Bremer et Grey)	줄점팔랑나비			2		1			
<i>Pelopidas mathias</i> (Fabricius)	제주꼬마팔랑나비					1			
<b>Family Papilionidae</b>	<b>호랑나비과</b>								
<i>Graphium sarpedon</i> (Linné)	청띠제비나비				2	1			
<i>Papilio xuthus</i> Linné	호랑나비			1		1			
<i>Papilio bianor</i> Cramer	제비나비			7					
<b>Family Pieridae</b>	<b>흰나비과</b>								
<i>Artogeia melete</i> (Ménétrières)	큰줄흰나비			3		1			
<i>Artogeia rapae</i> (Linné)	배추흰나비			2		2			
<i>Colias erate</i> (Esper)	노랑나비			2		2			
<i>Eurema hecabe</i> (Linné)	남방노랑나비			1		4			
<i>Eurema laeta</i> (Boisduval)	극남노랑나비					1			

## Appendix 1. (Continued)

Scientific name	Korean name	April		July		October		Cho & Kim (1998a)	Cha (1999)
		MOW	MS	MOW	MS	MOW	MS		
<b>Family Lycaenidae</b>		<b>부전나비과</b>							
<i>Lycaena phlaeas</i> (Linné)	작은주홍부전나비				1		2		
<i>Pseudozizeeria maha</i> (Kollar)	남방부전나비				2				
<b>Family Nymphalidae</b>		<b>네발나비과</b>							
<i>Neptis sappho</i> (Pallas)	애기세줄나비				6		1		
<i>Argyronome laodice</i> (Pallas)	흰줄표범나비						1		
<i>Damora sagana</i> (Doubleday)	암검은표범나비						1		
<i>Polygonia c-aureum</i> (Linné)	네발나비		1		3		5		
<i>Melanargia epimede</i> (Staudinger)	조흰뺨눈나비				1				
<i>Minois dryas</i> (Scopoli)	굴뚝나비				2		1		
<i>Ypthima motschulskyi</i> (Bremer et Grey)	물결나비				1		2		
<i>Mycalesis francisca</i> (Cramer)	부처사촌나비				1		1		

Note: 1. MOW, Mulyeong-Oreum Wetland; MS, Mt. Sooryeong

2. The number of ants is not counted in this study due to too many individuals;

+, under individuals 30; ++, individuals between 30 and 50; +++, over individuals 100