

## A Faunistic Study of Insects of Uninhabited Islands in the Docho-myeon, Sinan-gun, Jeollanam-do, Korea<sup>1</sup>

Youngho Cho<sup>2a</sup>, Youngjin Kim<sup>2a</sup>, Heon-Myoung Lim<sup>3</sup>, Yong-Gu Han<sup>3</sup>, Min-Joo Choi<sup>2</sup>, Sang-Ho Nam<sup>2\*</sup>

### 전라남도 신안군 도초면 일대 무인도서의 곤충상<sup>1</sup>

조영호<sup>2a</sup> · 김영진<sup>2a</sup> · 임헌명<sup>3</sup> · 한용구<sup>3</sup> · 최민주<sup>2</sup> · 남상호<sup>2\*</sup>

#### ABSTRACT

Shinan-gun in Jeollanam-do has 1,004 islands which is the biggest number in the whole country. As most of the islands in Korea are secluded from the mainland or other islands, biological surveys are very important for the biogeographical perspective. Especially, the species diversity of insecta on an island plays an important role in the food stability of top predators, including birds. This study provides baseline academic resources for the preservation and management of uninhabited islands by providing information about the status of insects on the uninhabited islands in Docho-myeon, Jeollanam-do, Korea. As far as the appearance aspects of the insects in 28 uninhabited islands were 921 individuals, 122 species, 60 families or 12 orders. Ga Island showed the highest appearance as 32 species, 22 families or 9 orders. Appearance of specific insects was investigated unknown species: 1 species, southern characteristic species: 3 species, coastal dune species: 1 species, climate-sensitive indicator species: 1 species

**KEY WORDS:** *INSECT FAUNA, SOUTHERN CHARACTERISTIC SPECIES, COASTAL SPECIES, CLIMATE-SENSITIVE INDICATOR SPECIES*

#### 요 약

전라남도 신안군은 전국에서 가장 많은 총 1004개의 도서가 위치하고 있다. 이처럼 국내 대부분 섬들은 일정한 지역에 밀집이 되어있으나 각각의 섬들은 육지 또는 타도와 격리되어 있기 때문에 생물상의 조사는 생물지리학적으로 매우 중요하다. 특히 섬 생태계에서 곤충류의 종다양성은 조류를 포함한 상위포식자의 생태계 먹이 안정성에 매우 중요한 역할을 한다고 볼 수 있다. 본 연구는 전라남도 신안군 도초면 일대 28개 무인도서의 곤충상을 확인하여 무인도서의 보존 및 관리방안 설정에 따른 기초자료를 제공하고자 한다. 조사된 28개 무인도서의 곤충류 출현 양상은 총 12목 60과 122종 921개체가 조사되었으며 가도에서 9목 22과 32종으로 가장 높게 나타났다. 특정 곤충종의 출현 현황은 국내 미기록 1종, 남방계 특성종 3종, 해안사구 지표종 1종, 기후변화 지표종 1종이 조사되었다.

주요어: 곤충상, 남방계 특성종, 해안사구 지표종, 기후변화 지표종

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2 대전대학교 생명과학과 Dept. of Biology, Daejeon University, Daejeon(300-716), Korea(themoth@dju.kr)

3 국립환경과학원 National Institute of Environment Research, Incheon(404-708), Korea

a These authors contributed equally to this paper

\* 교신저자 Corresponding author(shnam@dju.kr)

## INTRODUCTION

South Korea is surrounded by seas on three sides containing a total of 3,358 islands, of which 482 are inhabited and 2,876 are uninhabited islands (85.65%). Most of the islands are concentrated in west and south coasts (1,744 islands off Jeollanam-do and 484 islands off Gyeongsangnam-do). Especially Shinan-gun has 1,004 islands (72 inhabited 932 uninhabited) which is the biggest number in the whole country. Furthermore, Docho-myeon in Shinan-gun has 62 islands (4 inhabited, 58 uninhabited) most of which are located in Dadohae Marine National Park(MMAF, 2007). As most of the islands in Korea are secluded from the mainland or other islands, biological surveys are very important for the biogeographical perspective(Kim and Lee, 1979). Chilbal, Gugul and Chilsan Islands became natural preserves as they are breeding places of marine birds(CHA, 2009). Out of the aforementioned marine birds, *Apus pacificus*, *Larus crassirostris* and *Egretta eulophotes* take Insecta as their source of protein. In particular, *A. pacificus* is known to eat flying insects including those within the orders Homoptera, Coleoptera, Hymenoptera and Lepidoptera(Gang, 1962; Yoon, 1996; Lee *et al.*, 2000). Therefore, the species diversity of insecta on an island plays an important role in the food stability of top predators, including birds. Additionally, as it is difficult for the insects to move to other regions, they can often be differentiated to subspecies when they are located in secluded areas. All this means that they have very important significance in that they allow us to observe long-term changes, for example, those related to climate change. However, recently even uninhabited islands which used to be less impacted by external forces, and whose original ecosystem and geographical landscapes used to be well preserved, reckless grazing, fishing and other damage now threaten the habitats of various biological species. Accordingly, this study provides baseline academic resources for the preservation and management of uninhabited islands by providing information about the status of insects on the uninhabited islands in Docho-myeon, South Korea.

## MATERIALS AND METHODS

### 1. Survey areas

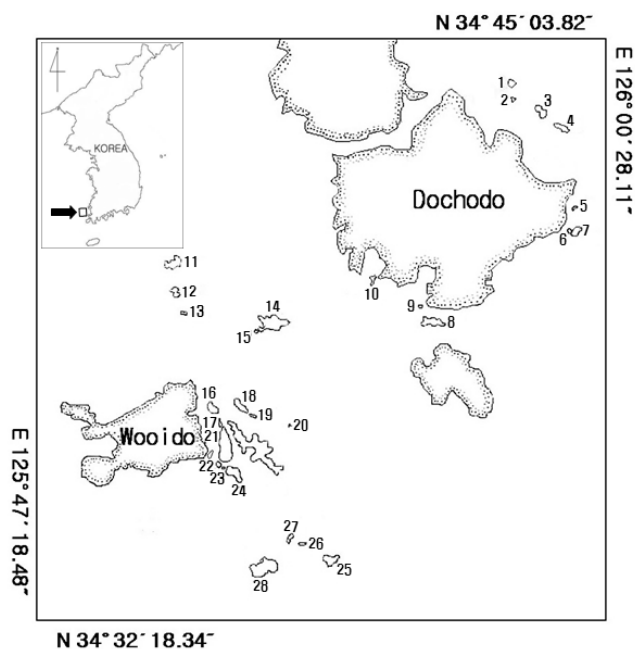


Figure 1. Survey Islands in Docho-myeon, Shinan-gun, Jeollanam-do

(1. Umul, 2. Baekkgaeayak, 3. Oegaeyak, 4. Mal, 5. Maesil, 6. Migi\_1, 7. Migi, 8. Meonge, 9. Nongganbawi, 10. Ttandae, 11. Seokhwang, 12. Ru, 13. Soru, 14. Gyeongchi, 15. Tokki, 16. Ga, 17. Song, 18. Baek, 19. Jakeunhui, 20. Mo, 21. Ttanmok, 22. Seung, 23. Hang, 24. Hwa, 25. Bi, 26. Cheong, 27. No, 28. Juk)

This survey includes work performed on 28 uninhabited Islands located in Docho-myeon, Shinan-gun, Jeollanam-do(Figure 1).

### 2. Survey methods

The surveys were performed three times from August to October when the insect species diversity is the highest, but excluding days with bad weather such as high wind and rain. However surveys of uninhabited islands are also affected by the weather because ships must be used to transports the workers. Because of the tidal effects and the unique landscape of each island, it was often difficult to get from the transport ships to the islands. Depending on the size of each island, it took from one to four hours to survey terrestrial insects on each island. To collect terrestrial insects, we used air nets for flying insects, and sweeping and beating methods where insects were not visible because of dense herbaceous plants. The adult

insects collected were made into dried specimens, which were then identified. The specimens were stored in the Insect Specimen Room of the Animal and Ecology laboratory at Daejeon University, Daejeon, South Korea. The insect list was made based on the Checklist of Insects from Korea(1994).

## RESULTS AND DISCUSSION

### 1. Appearance of the insects in uninhabited islands

As far as the appearance aspects of the insects in 28 uninhabited islands is concerned, Ga Island showed the highest appearance as 32 species, 22 families or 9 orders. The order of the islands are Mal Island as 31 species, 23 families or 11 orders, Seokhwang Island as 28 species, 26 families or 8 orders, Baik Island and Hwa Island as 23 species, 14 families or 8 orders and as 23 species, 9 families or 7 orders respectively, Bi Island and Migi Island as 22 species, 17 families or 8 orders and as 22 species, 19 families or 7 orders respectively and then Umul Island, Gyeongchi Island and Juk Island as 21 species, 16 families or 8 orders, as 21 species, 16 families or 6 orders and as 21 species, 16 families or 5 orders respectively(Table 1).

Ga Island has abundant flora and a well-developed evergreen broad-leaved forest such as *Machilus thunbergii* and *Celtis sinensis* communities. Compared to other islands, it has very stable habitats for the insects there. Additionally, as underground water flows nearby, it is highly favorable for various aquatic insects to inhabit the area. As it is adjacent to an inhabited island named Ui, there may be frequent movement of insects between the two islands and high populations of insects that could be used as food sources by the upper level predators.

As aforementioned, most of 28 islands in this survey with dense insect populations have well developed evergreen broad-leaved forest in the warm temperate region, and the *Pinus thunbergii* community frequently found on islands. As herbaceous plants such as the *Miscanthus sinensis* and *Imperata cylindrica* communities are dense under the trees, the insects living on herbaceous plants, such as *Parnara guttata* eating Cyperaceae, *Ossoides lineatus* and *Mimophantia maritima* occur in high numbers. The average area of the ten islands with high species density was 83,525m<sup>2</sup>. This is bigger than the average area of the 28

Table 1. Composition of insect fauna on uninhabited islands

Islands	Orders	Families	Species
Umul	8	16	21
Baekkgaeyak	6	8	8
Oegaeyak	6	8	12
Mal	11	23	31
Maesil	5	7	8
Migi_1	2	2	2
Migi	7	19	22
Meonge	5	8	9
Nongganbawi	2	3	3
Ttandae	6	11	12
Seokhwang	8	26	28
Ru	4	9	10
Soru	5	9	9
Gyeongchi	6	16	21
Tokki	2	3	3
Ga	9	22	32
Song	9	16	19
Baek	8	14	23
Jakeunhui	3	4	5
Mo	5	8	8
Ttanmok	4	7	10
Seung	3	6	6
Hang	2	3	5
Hwa	7	9	23
Bi	8	17	22
Cheong	7	11	11
No	3	6	7
Juk	5	16	21

islands (48,079m<sup>2</sup>). This is consistent with the Equilibrium Theory by MacArthur and Wilson(1967) which points out the correlation between the size of islands and the number of species found on them. In other words, as the area of the island increases, the habitats become more diversified because of heterogeneity of geography and geology, which leads to an increase in the number of species. In particular, this is supported by research on Lepidoptera, which is a macro taxonomic group used as an indicator to identify the effects on ecosystems because 120,000 species have already been reported throughout the world and taxonomic and ecological research on them has been widely performed (Kitching *et al.*, 2000; Summerville *et al.*, 2001; Summerville and Crist, 2002). The most influential factors on Lepidoptera on islands have been reported to be the composition of plant species and the size of the island

(Reed, 1985; Choi and Shin, 1993; Dennis and Shreeve, 1997; Choi, 2000).

## 2. Comparison of insects fauna around the islands

The terrestrial insects identified in 28 uninhabited islands were 921 individuals, 122 species, 60 families or 12 orders. Up to now, the insects reported in southwest islands in Korea are 15 species in Docho Island, an inhabited island, 60 species in Bigeum Island and Ui Island, and 23 species in Chilbal Island in Shinan-gun by Kim and Lee(1979), 30 species in Imja Island, 10 species in Ji Island, 2 species in Jeung Island and 13 species in Maehwa Island by Jung and Lee(1997), 25 species in Chilbal Island by Nam(2002), 573 species in Jin Island by Sohn *et al.*(2005), 339 species and 563 species in Aphae Island by Lim(2007, 2009), 423 species in Bigeum

Island and Docho Island and Ui Island and Daeya Island and Gwanmae Island and Sin Island by KNPS(Table 2).

Jin Island showed an unusually high number of species because the figure reported is the summary of all the research on Lepidoptera of that island. Additionally, although Jin-do used to be a true island, it is now connected to the mainland by a causeway, and two-way movement of insects is now frequent. In the case of Aphae Island, the high number reported is the result of studies on the moth fauna. It showed high species density because Aphae Island is very near the mainlan, only 8km from Mokpo city. Furthermore this research was not a conventional fragmentary study, but included multiple surveys performed more than once a month. Additionally, in Maehwa Island, Aphae-myeon, Shinan-gun, Cheonnam, *Fabriciana nerippe* which is a second grade endangered wild species designated by the Ministry of Environment, was reported by Cheong and Lee(1997).

Table 2. Insect faunas of around islands in Sinan-gun, Jeollanam-do, Korea

	Islands	Orders	Families	Species
	Docho	6	12	15
Kim and Lee(1979)	Bigeum	6	26	60
	Ui	7	39	60
	Chilbal	8	15	23
	Imja	5	17	30
Cheong and Lee(1997)	Ji	2	4	10
	Jeung	2	2	2
	Maehwa	1	4	13
Nam <i>et al.</i> (2002)	Chilbal	8	19	25
Sohn <i>et al.</i> (2005)	Jin	1	37	573
Lim(2007)	Aphae	1	16	339
Lim(2009)	Aphae	1	18	563
KNPS (2009)	Docho, Bigeum, Ui Daya, Sin, Gwanmae	13	88	423

## 3. Appearance of specific insects

Appearance of specific insects was investigated unknown species: 1 species, southern characteristic species: 3 species, coastal dune species: 1 species, climate-sensitive indicator species: 1 species(Table 3).

### 1) Unknown Species

*Grammodes geometrica* (Fabricius) (Noctuidae, Lepidoptera) inhabit China, Japan, India, region of the Mediterranean and Australia(Rose, 2002). It was identified in Jakeunhi Island in this survey. It has a wingspan of approximately 42mm, brown thread-shaped antennae and light brown body color. On the fore-wings there are black triangles on a brown base, with two white bands in the middle of the triangle. The hind wings are dark brown and there is white fur on the termen. This species is a

Table 3. Appearance of specific insects of particular interest by island

	Scientific name	Islands
Unknown species	<i>Grammodes geometrica</i> (Fabricius)	Jakeunhui
	<i>Cantao ocellatus</i> (Thunberg)	Hwa
Southern characteristic species	<i>Graphium sarpedon</i> (Linné)	Gyeongchi, Bi, Juk, Ga, Seung, Hwa
	<i>Papilio protenor</i> Cramer	Gyeongchi, Bi, Ttanmok
Coastal dune species	<i>Scepticus uniformis</i> Kono	Migi
Climate-sensitive indicator species	<i>Eurema hecabe</i> (Linné)	Migi, Mal, Gyeongchi

polyphagous insect eating *Phyllanthus*, *Sapium*, *Ricinus* of Euphorbiaceae, *Cistus* of Cistaceae, *Diospyros* of Ebenaceae, *Oryza* of Gramineae, *Polygonum* of Polygonaceae, *Ziziphus* of Rhamnaceae, *Tamarix* of Tamaricaceae and *Cirtus reticulata* Blanco which is a famous fruit belonging to Rutaceae and is known as Mandarin in Korea (Koshino, 1999; Robinson *et al.*, 2001; Aran *et al.*, 2005). As there is no record regarding this species in Korea, it is judged an unrecorded species.

## 2) Southern Characteristic Species

### (1) *Cantao ocellatus* (Thunberg)

*C. ocellatus* (Thunberg) was collected on Hwa Island in this survey. This species is common and frequently observed in Japan. Only a few individuals have been collected on Jeju Island and the south coast of Korea. *Mallotus japonicus* is known as its host plant. They usually compose a community and live in the community. It is an insect with strong maternal instinct and stays around her eggs until they are hatched (An, 2010). It is a rather large species among the insects of Hemiptera. It has splendid body color and the black on its body has many variations. The ecological information of this species is not well known. Further researches are needed as to why it has been identified only in the southern parts of the Korean Peninsula.

### (2) *Graphium sarpedon* (Linné)

*G. sarpedon* (Linné) is a butterfly (Papilionidae). Only species has been found in Korea, while more than 102 species are reported as *Graphium* genus in the world. They occur on southwest islands including Jeju Island and Uleung Island in South Korea. Overseas, they occur mostly in Asia, Oceania and Africa (Saigusa *et al.*, 1981; Kim, 2002). In this survey there were collected on Gyeongchi, Bi, Juk, Ga, Seung and Hwa Islands. The host plants of *G. sarpedon* are *Machilus thunbergii* and *Cinnamomum camphora* of Lauraceae, and *Aucuba japonica* of Cornaceae, which occur in evergreen broad-leaved forests distribute along the southern coast and islands. Therefore, it can be said that the habitat of *G. sarpedon* is somewhat restricted. However, outbreaks of *G. sarpedon* occurs twice to four times a year according to its region (Joo *et al.*, 2002; Kim, 2002). Yukawa (2000) recorded that this species can change the times of outbreak and that its geographical distribution pattern is affected

by global warming. Thus, as this species inhabits the southern part of Korea only at present, it can be used as an indicator species for estimating change in the weather.

### (3) *Papilio protenor* Cramer

Four subspecies of the butterfly *P. protenor* (Papilionidae) are known in Korea while more than 210 species within the genus *Papilio* are known in the world. They are normally observed on Jeju Island, as well as the south and west coast of Korea. Individuals moving in from original habitats are occasionally observed in the southern part of Korea and middle of the Korean Peninsula (Kim, 2002; Paek and Shin, 2010). In this survey they were identified in Gyeongchi, Bi and Ddanmok Islands. *P. xuthus* is a polyphagous insect which has diversified host plants such as *Zanthoxylum schinifolium*, *Phellodendron amurense*, *Z. piperitum*, *Poncirus trifoliata*, *Citrus junos*, *Z. ailanthoides*, and *Dichroa febrifuga* of Rutaceae, *Lia kiusiana* of Tiliaceae, and *Clerodendrum trichotomum* of Verbenaceae.

## 3) Coastal dune species

*Scepticus uniformis* (Kono) is beetle genus of *Scepticus* (Coleoptera). Three species of this genus are known in Korea. *Secepticus* genus includes species having special habitats in the sand on islands and coastal dunes. However they showed variation in density according to the place of collection. It is known that its density has something to do with the distribution of specific plants rather than the habitats themselves (Kim, 1981). Bigot (1971) reported this species as the basic species in coastal dunes in work on the coastal ecology by habitats in Camargue Region, France. *S. uniformis* is a species with extraordinary habitats such as coastal dunes and the changes in the coastal dunes resulting from environmental effects and human damages could cause extinction of the species.

## 4) Climate-sensitive indicator species

*Eurema hecabe* (Linné) is a butterfly (Coliadinae, Pieridae). Eleven species within four genera of them are known in Korea. They are distributed in the area below 37°, particularly Uleung Island and the Taean Peninsula on the west coast of Korea. Overseas they occur widely in Southern China, Taiwan, Japan, Australia and Africa. The host plants of *E. hecabe* are known as *Lespedeza cuneata*, *L. pilosa*, *L. bicolor*, *L. virgata*, *Albizia julibrissin*, *Cassia obtusifolia*, *Caesalpinia decapetala*, *Cassia minosoides*, *L.*

*cyrtobotrya* falling under Leguminosae(Sohn and Park, 1993; Joo *et al.*, 2002; Kim, 2002). This species is a CBIS(Climate-sensitive Biological Indicator Species) designated by the Korean Ministry of Environment in 2010. It inhabits the southern part of Korea including Jeju Island, Cheollanam-do and Gyeongsangnam-do. It seems that their habitats has expanded to islands off Gyeonggi-do and the eastern part of Gangwon-do. However, Choi(2011) reported that they have been constantly identified in some parts of Gyeonggi-do and Gangwon-do since the 1960s. It seems that the eligibility of *E. hecabe* to be a CBIS should be reconsidered.

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Appendix 1. (Continued)

Scientific name	Korean name	Umu. Bae. Oeg. Mal. Mae. Mig. Mi.	Meo. Non. Tta. Seo. Ru. Sor. Gye. Tok. Ga. Son. Ba. Jak. Mo. Ti. Sou. Han. Hwa. Bi. Che. No. Juk
<i>Spirama retorta</i> (Clerck)	태극나방	1	
<i>Mocis annetta</i> (Butler)	구름무늬밤나방		1
<i>Oraesia emarginata</i> (Fabricius)	작은갈고리밤나방		1
<i>Spodoptera litura</i> (Fabricius)	담배저세미나방	1	
<i>Ctenoplustia (Acanthoplustia) agnata</i> (Staudinger)	붉은무늬밤나방	1	
<i>Grammodes geometrica</i> (Fabricius)	국명미정		1
Family Hesperidae	팔랑나비과		
<i>Daimito tethys</i> (Ménétriés)	왕자팔랑나비	1	1
<i>Aeronaachus inachus</i> (Ménétriés)	파리팔랑나비	1	1
<i>Parnara guttata</i> (Bremer et Grey)	출진팔랑나비	5	6
<i>Potanthus flavum</i> (Murray)	황알락팔랑나비	3	2
Family Papilionidae	호랑나비과		
<i>Graphium sarpedon</i> (Linné)	청미제비나비	10	5
<i>Papilio machaon</i> Linné	산호랑나비	2	10
<i>Papilio protenor</i> Cramer	남방제비나비	1	1
<i>Papilio xuthus</i> Linné	호랑나비	1	1
Family Pieridae	흰나비과		
<i>Artogeia melite</i> (Ménétriés)	큰줄흰나비	1	2
<i>Colias erate</i> (Esper)	노랑나비	1	
<i>Eurema hecabe</i> (Linné)	남방노랑나비	2	3
Family Lycaenidae	부진나비과		
<i>Celastrina argiolus</i> (Linné)	푸른부진나비	1	2
<i>Everes argiades</i> (Pallas)	암막부진나비	1	1
<i>Tongeia fischeri</i> (Evermann)	먹부진나비	1	1
<i>Pseudozizeeria maha</i> (Kollar)	남방부진나비	1	1
Family Nymphalidae	네발나비과		
<i>Argyronome laodice</i> (Pallas)	흰줄표범나비	1	1
<i>Cynthia cardui</i> (Linné)	작은핏쟁이나비	1	1
<i>Polygonia c-aureum</i> (Linné)	네발나비	1	
<i>Vanessa indica</i> (Hebost)	큰핏쟁이나비	1	1
<i>Neptis sappho</i> (Pallas)	애기세줄나비	1	1
<i>Minois dryas</i> (Scopoli)	꽃뚝나비	1	2
<i>Ypthima argus</i> Butler	애물결나비	1	1
<i>Ypthima mothsukkyi</i> (Bremer et Grey)	물결나비	1	1

\*Note: Umu., Umul; Bae., Baekgaeayak; Oeg., Oegaeyak; Mae., Maesil; Mig., Mig\_i; Mi., Migi; Meo., Meonge; Non., Nongganbawi; Tta., Ttandae; Seo., Seokhwang; Sor., Soru; Gye., Gyeongchi; Tok., Tokki; Son., Song; Ba., Bae; Jak., Jakeunhui; Ti., Ttammok; Sou., Seung; Han., Hang; Hwa., Hwang; Bi., Bieong; Che., Cheong