



# A Review of Ecological Characteristics of Endangered Butterflies in South Korea

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## ABSTRACT

Butterflies are known to play an important role in pollination and have been a target for several taxonomical and ecological studies. Butterflies are particularly used as indicators of various environmental issues, such as environmental change, habitat land use changes, environmental pollution, etc. In the present review, we collected information on their morphology, distribution, and wintering, and analyzed the three traits for all the endangered butterfly species (n=14). Fourteen previous studies were used for this review. For the morphological analysis, both *Aporia crataegi* (56.0 and 66.5 mm for male and female, respectively) and *Argynnis nerippe* (62.5 mm) were determined to have the longest wingspan, and *Cigaritis takanonis* the shortest (29.0 mm). In terms of distributional analysis, five species (*Hipparchia autonoe*, *Sinia divina*, *Protantigius superans*, *Chalinga pratti*, and *Plebejus subsolanus*) used the forest center habitat at high elevation, but nine species used the forest boundary habitat at low elevation. For the wintering analysis, ten species were found to spend the winter as larvae, and *P. superans* and *P. subsolanus* spent the winter as eggs; *S. divina* spent the winter as a pupa. This review is the first to comprehensively summarize the ecological characteristics (morphology, distribution, and wintering) of the whole endangered butterfly species in South Korea. In particular, the review could provide scientific information on the endangered butterflies to establish their future restoration plans.

**Keywords:** Butterfly, Distribution, Habitat, Morphology, Restoration, Wintering

## Introduction

The International Union for Conservation of Nature Red List calculates the number of species every year based on the latest research by taxonomists. It is reported that there are 2.16 million species on Earth in 2022, and among them, insects are known to have the largest number of species at 1.05 million (Richie, 2022). In South Korea,


a total of 60,010 species of living organisms are known to live in 2023 (NIBR, 2024). Of these, a total of 20,710 species of insects are found in the country. On the other hand, 282 species are known to be designated as endangered species under protection (NIE, 2023). Among them, a total of 29 species are designated as endangered species (eight and 21 species in Class I and II, respectively) and are protected in South Korea.

Insects are important living organisms in terms of biodiversity, ecological roles, agriculture, human health, and natural resources (Robbins & Opler, 1997). Among them, butterflies with diverse morphologies between species have been a target of continuous interest from a number of people globally due to their attractive appearance. Butterflies are the most actively studied taxonomically

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and ecologically among insects, and are known to play an important role in the pollination and evolution of plants (Kasambe, 2018). It is, therefore, necessary to understand the diversity of plants in various habitats to understand the diversity of butterflies (Nimbalkar *et al.*, 2011; Paek *et al.*, 2024). Butterflies are additionally frequently used as indicators of environmental change, habitat fragmentation, habitat land use changes, agricultural activities, and environmental pollution in fields related to ecology (Kim *et al.*, 2020; Nakamura, 2011; Paek *et al.*, 2024; Samways, 2005). Recently, their distribution and abundance have been seriously affected by habitat destruction and climate change caused by humans (Fox *et al.*, 2011). Considering the importance of ecological information of butterflies for their conservation and management, review studies have rarely been conducted for the endangered butterfly species on a domestic scale in South Korea (Paek, 2011).

This study aimed to review the ecological characteristics of endangered butterflies in South Korea. For this review, we first collected information on their morphology, distribution, and wintering from previous studies. Based on these references, we summarized the three parameters for each butterfly and then analyzed the pattern of the three traits for the all species.

### List of Korean Endangered Butterflies

Among the 29 species of insects designated as endangered wild animals, butterflies account for 10 species by the Korea Ministry of Environment (Fig. 1). The four species designated as Class I are *Parnassius bremeri*, *Hipparchia autonoe*, *Aporia crataegi*, and *Sinia divina*. The species designated as Class II are *Protantigius superans*, *Cigaritis takanonis*, *Melitaea ambigua*, *Argynnis nerippe*, *Leptalina unicolor*, and *Chalinga pratti*. In addition, *Phengaris kurentzovi*, *Phengaris teleius*, *Plebejus subsolanus*, and *Melitaea latefascia* are designated as candidate species for endangered wild animals (Fig. 1).

### Literature Review of the Ecological Characteristics of Endangered Butterflies

A total of 14 works of literature (books, papers, etc.) were used to gather information on the ecological characteristics of endangered butterflies. We investigated the size of wingspan, habitat type, and developmental stage of wintering for each butterfly species from the 14 references. It is to be noted that we could not collect any information on the developmental stage of wintering for *M. ambigua*. Using the fundamental data, we sequentially analyzed patterns of the three traits. We successfully figured out the difference of the three traits among species or between groups of butterflies.

### Morphological Characteristics of Butterflies

We selected the wingspan of 14 butterfly species, including four candidate species, as a morphological trait available for all the species and analyzed them (Table 1; NIBR, 2022; Paek & Ok, 2018; Paek *et al.*, 2019). In general, the wingspan of butterflies belonging to the family Lycaenidae (*S. divina*, *P. superans*, *C. takanonis*, *P. kurentzovi*, *P. teleius*, and *P. subsolanus*) was shorter than that of the other butterflies, excluding *L. unicolor*, which had a mean of 27.0 mm and 32.5 mm for male and female, respectively. Both *A. crataegi* (male: 56.0 mm, female: 66.5 mm) and *A. nerippe* (62.5 mm) had the longest wingspan. In contrast, *C. takanonis* had the shortest wingspan (29.0 mm). In the case of *A. crataegi*, the male was slightly shorter than the female. Similarly, in the case of *L. unicolor*, the male (27.0 mm) presented a shorter wingspan than the female (32.5 mm).

### Distributional Characteristics of Butterflies

In terms of distributional traits, the type of habitats of 14 butterfly species, including four candidate species,

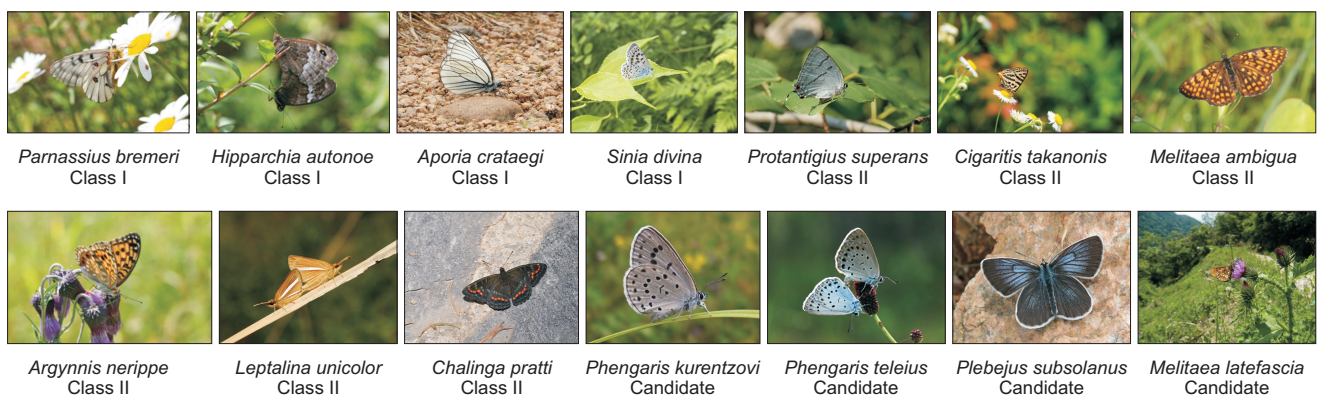


Fig. 1. Photos of target butterfly species (n=14) in this study.

**Table 1.** Morphological characteristics (wingspan) of endangered butterflies

Class	Species	Sex	Minimum (mm)	Maximum (mm)	Mean (mm)
I	<i>Parnassius bremeri</i>	Male/female	36	75	55.5
	<i>Hipparchia autonoe</i>	Male/female	49	60	54.5
	<i>Aporia crataegi</i>	Male	53	59	56.0
	<i>A. crataegi</i>	Female	65	68	66.5
	<i>Sinia divina</i>	Male/female	28	36	32.0
II	<i>Protantigius superans</i>	Male/female	30	38	34.0
	<i>Cigaritis takanonis</i>	Male/female	26	32	29.0
	<i>Melitaea ambigua</i>	Male/female	34	50	42.0
	<i>Argynnis nerippe</i>	Male/female	53	72	62.5
	<i>Leptalina unicolor</i>	Male	26	28	27.0
	<i>L. unicolor</i>	Female	30	35	32.5
	<i>Chalinga pratti</i>	Male/female	57	60	58.5
Candidate	<i>Phengaris kurentzovi</i>	Male/female	31	37	34.0
	<i>Phengaris teleius</i>	Male/female	33	41	37.0
	<i>Plebejus subsolanus</i>	Male/female	32	35	33.5
	<i>Melitaea latefascia</i>	Male/female	34	41	37.5

Source: NIBR (2022), Paek and Ok (2018), Paek et al. (2019).

**Table 2.** Distributional characteristics (habitat type) of endangered butterflies

Class	Species	Habitat type
I	<i>Parnassius bremeri</i>	Lowland forest boundary
	<i>Hipparchia autonoe</i>	Highland forest center
	<i>Aporia crataegi</i>	Lowland forest boundary
	<i>Sinia divina</i>	Highland forest center
II	<i>Protantigius superans</i>	Highland forest center
	<i>Cigaritis takanonis</i>	Lowland forest boundary
	<i>Melitaea ambigua</i>	Lowland forest boundary
	<i>Argynnis nerippe</i>	Lowland forest boundary (island and coast)
	<i>Leptalina unicolor</i>	Lowland forest boundary
	<i>Chalinga pratti</i>	Highland forest center
	Candidate	<i>Phengaris kurentzovi</i>
<i>Phengaris teleius</i>		Lowland forest boundary
<i>Plebejus subsolanus</i>		Highland forest center
<i>Melitaea latefascia</i>		Lowland forest boundary

Source: NIBR (2022), Paek and Shin (2010).

was analyzed (Table 2; NIBR, 2022; Paek & Shin, 2010). A total of five species (*H. autonoe*, *S. divina*, *P. superans*, *C. pratti*, and *P. subsolanus*) used the highland forest center habitat. The remaining nine species were found to use the lowland forest boundary habitat. *A. nerippe* is locally distributed in inland areas and primarily distributed

in habitats on the west coast islands and along the coast. It is known that endangered butterfly species using the lowland forest boundary habitat are significantly affected by habitat environmental changes, development, cultivation, and afforestation. A total of 14 butterfly species are threatened with extinction but among them, the Class I

**Table 3.** Wintering characteristics (developmental stage of wintering) of endangered butterflies

Class	Species	Developmental stage of wintering
I	<i>Parnassius bremeri</i>	Larva
	<i>Hipparchia autonoe</i>	Larva
	<i>Aporia crataegi</i>	Larva
	<i>Sinia divina</i>	Pupa
II	<i>Protantigius superans</i>	Egg
	<i>Cigaritis takanonis</i>	Larva
	<i>Melitaea ambigua</i>	Unknown
	<i>Argynnis nerippe</i>	Larva
	<i>Leptalina unicolor</i>	Larva
	<i>Chalinga pratti</i>	Larva
Candidate	<i>Phengaris kurentzovi</i>	Larva
	<i>Phengaris teleius</i>	Larva
	<i>Plebejus subsolanus</i>	Egg
	<i>Melitaea latefascia</i>	Larva

Source: Baek *et al.* (2007), Joo *et al.* (1997), Kim (1973; 2002; 2005; 2010), Kim and Seo (2012), Kim *et al.* (2012), NIBR (2022), Paek and Shin (2010), Paek *et al.* (2024), Park and Kim (1997).

*A. crataegi* and three candidate species in Lycaenidae (*P. kurentzovi*, *P. subsolanus*, and *M. latefascia*) are rarely found in South Korea and are known to be in danger of extinction. The four species are all known to inhabit the lowland forest boundary habitat.

### Wintering Characteristics of Butterflies

The developmental stage of wintering for 14 butterfly species, including four candidate species, was analyzed as a trait for wintering (Table 3; Baek *et al.*, 2007; Joo *et al.*, 1997; Kim, 1973; 2002; 2005; 2010; Kim & Seo, 2012; Kim *et al.*, 2012; NIBR, 2022; Park & Kim, 1997; Paek & Shin, 2010; Paek *et al.*, 2024). Ten species are known to spend the winter as larvae. Among them, *P. bremeri* are known to spend the winter as first-instar larvae in eggs. However, it was determined that both *P. superans* and *P. subsolanus* spend the winter as eggs. As an exception, *S. divina* has been known to spend the winter as a pupa. However, the wintering stage of *M. ambigua* is still unknown.

### Conclusion

In recent years, habitat destruction and loss due to large-scale development and the effects of rapid climate change have led to a decrease in biodiversity, posing a

great threat to the stability of the ecosystem on the Earth, where Korea is also no exception. In particular, butterflies, among insects with very high species diversity and large populations, are frequently exposed to these factors, which have led to several extinctions. For example, large-scale residential development (e.g., apartment complex, industrial complex, etc.) has led to significant degradation and loss of butterfly habitats in lowland forest boundary areas. In such a situation, several local governments are creating alternative habitats for disturbed butterfly populations, especially butterfly species (*P. bremeri*, *A. crataegi*, etc.) inhabiting lowland forest border areas mixed with various types of habitats, including grasslands, forests, and wetlands adjacent to human residential facilities. Therefore, understanding the ecological characteristics of each endangered butterfly species is essential along with their food. This review paper provides scientific information on the size of wingspan, type of habitat, and developmental stage of wintering for the establishment of restoration plants for endangered butterfly species (10 endangered species and four candidate species), and for conducting restoration projects. This review will additionally help understand the fundamental ecology of endangered butterfly species in South Korea.

### Author Contributions

Munki Paek: study conception and design, analysis and interpretation of results, and draft manuscript preparation (in Korean); Youngho Cho: study conception and design, and scientific name confirmation of butterflies; Ji Yeong Kim: reference writing and manuscript editing; Baek-Jun Kim: analysis and interpretation of results, manuscript editing, draft manuscript preparation (in English), and correspondence.

### Conflict of Interest

The authors declare that they have no competing interests.

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### References

Baek, Y.H., Kwon, M.C., and Kim, H.W. (2007). *Pocket Butterfly Encyclopedia*. Slow & Steady.

- Fox, R., Warren, M.S., Breton, T.M., Roy, D.B., and Robinson, A. (2011). A new Red List of British butterflies. *Insect Conservation and Diversity*, 4, 159-172. <https://doi.org/10.1111/j.1752-4598.2010.00117.x>
- Joo, H.J., Kim, S.S., and Son, J.D. (1997). *Korean Butterflies: Color Book*. Kyohaksa.
- Kasambe, R. (2018). Butterflies of Western ghats. *Internet Archive*. Retrieved October 26, 2024 from <https://archive.org/details/ButterfliesOfWesternGhatsSecondEdition20183/page/n1/mode/2up>.
- Kim, H.K. (1973). The seasonal succession of butterflies at Mt. Koryong (Aengmu-Bong), Korea with special reference to food plants of the various species of larvae. *Journal of Korean Research Institute for Better Living*, 11, 33-57.
- Kim, H.W., Cho, Y., Adhikari, P., Jeon, J.Y., Han, Y., and Seo, C. (2020). Occurrence data of southern butterflies in South Korea. *GEO DATA*, 2, 1-6. <https://doi.org/10.22761/DJ2020.01.01.001>
- Kim, J.H. (2005). *The Easy Guide to Finding Insects*. Jinsun.
- Kim, S.S., Lee, C.M., Kwon, T.S., Joo, H.J., and Sung, J.H. (2012). *Korean Butterfly Atlas [1996-2011]*. National Institute of Forest Science.
- Kim, S.S., and Seo, Y.H. (2012). *Life Histories of Korean Butterflies*. Sakyejul.
- Kim, Y.S. (2002). *Illustrated Book of Korean Butterflies in Color*. Kyohak.
- Kim, Y.S. (2010). *Illustrated Book of Korean Butterflies in Color*. Kyohak.
- Nakamura, Y. (2011). Conservation of butterflies in Japan: status, actions and strategy. *Journal of Insect Conservation*, 15, 5-22.
- National Institute of Biological Resources (NIBR). (2022). *Red Data Book of Republic of Korea: Volume 7. Insect I*. NIBR.
- National Institute of Biological Resources (NIBR). (2024). *2023 Biodiversity Statistics of Korea*. NIBR.
- National Institute of Ecology (NIE). (2023). *Data Book of Endangered Wildlife*. NIE.
- Nimbalkar, R., Chandekar, S., and Khunte, S. (2011). Butterfly diversity in relation to nectar food plants from Bhor Tahsil, Pune District, Maharashtra, India. *Journal of Threatened Taxa*, 3, 1601-1609. <https://doi.org/10.11609/JoTT.o2612.1601-9>
- Paek, M. (2011). *Nature Hwa Cheon-Insects*. Hwacheon-Gun.
- Paek, M., Cho, Y., Kim, J.Y., Kim, D., and Kim, B.J. (2024). A review of host and nectar plants of endangered butterflies in South Korea. *Proceedings of the National Institute of Ecology of the Republic of Korea*, 5, 99-110. <https://doi.org/10.22920/PNIE.2024.5.4.99>
- Paek, M., and Ok, M.K. (2018). *Bori Large Encyclopedia of Detailed Illustrations: Butterfly Encyclopedia*. Bori Publishing.
- Paek, M., and Shin, Y.H. (2010). *Butterflies of the Korean Peninsula*. Nature and Ecology.
- Paek, M., Shin, Y.H., and Kim, K.W. (2019). *Insects of Yangpyeong-gun in Korea*. Yang Pyeong Insect Museum.
- Park, K.T., and Kim, S.S. (1997). *Atlas of Butterflies (Lepidoptera)*. Korea Research Institute of Bioscience and Biotechnology; Center for Insect Systematics.
- Ritchie, H. (2022). How many species are there?: how many species do we share our planet with? how many of these species have we found and identified? *Our World in Data*. Retrieved October 26, 2024 from <https://ourworldindata.org/how-many-species-are-there>.
- Robbins, R.K., and Opler, P.A. (1997). Butterfly diversity and a preliminary comparison with bird and mammal diversity. In M.L. Reaka-Kudla, D.E. Wilson, and E.O. Wilson (Eds.), *Biodiversity II: Understanding and Protecting Our Biological Resources* (pp. 69-82). Joseph Henry Press.
- Samways, M.J. (2005). *Insect Diversity Conservation*. Cambridge University Press.