

## Short Communication

# Diversity of butterflies (Lepidoptera: Papilionoidea and Hesperioidea) of the south-eastern corner of Tsaghkunyats Mountain ridge, Republic of Armenia

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**Abstract.** A study was conducted in the surroundings of Karenis village (South-Eastern corner of Tsaghkunyats Mountain Ridge) to document the composition of Papilionoidea and Hesperioidea species in the area. The specimens were collected in the spring, summer, and early autumn of 2021-2023. During the research, 149 specimens were collected, representing 40 species, belonging to five families. The findings indicated that most of these species were from the family Nymphalidae, while the fewest species represent Papilionidae and Hesperidae, respectively. Nymphalidae was the most abundant, likely due to their ability to feed on a variety of plants. The rarest species was *Melitaea perseae* (Kollar, 1850), and the most abundant was *Pieris brassica* (Linnaeus, 1758). Diversity indices were calculated for identified families. Accordingly, the Shannon–Wiener index ( $H'$ ) value for the area was 3.521 in total, while different values recorded for each family were 0.637 (Papilionidae), 2.075 (Pieridae), 1.061 (Hesperidae), 2.235 (Lycaenidae) and 2.589 (Nymphalidae). Although the study site showed decent butterfly diversity, it is among the poorer spots in the mountain range in terms of species richness. It seems that due to the rapid rate of urbanization and increasing population, species adapted to urban environments characterized by higher mobility and lower habitat specificity are prevalent in Karenis.

**Keywords:** Abundance, evenness, fauna, species richness, species diversity

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Butterflies are a crucial part of terrestrial ecosystems, playing a key role in maintaining ecological balance. They have a co-evolutionary relationship with plants, meaning their lives are deeply interconnected. Often referred to as "flying flowers," butterflies not only display remarkable beauty but also enhance the aesthetic value of their environment with their vibrant wing colors (Ghazanfar *et al.*, 2016). They serve as important indicators of a healthy ecosystem, providing insights into its condition (Legal *et al.*, 2020). Butterflies are also effective pollinators, feeding on nectar while helping plants reproduce in a mutually beneficial relationship. Some species migrate over long distances, carrying pollen between plants that are far apart, promoting genetic diversity among plant species. This genetic variation helps plants resist diseases and increases their chances of survival. Additionally, butterflies are a vital food source for various animals, such as birds, reptiles, and amphibians, and contribute to natural pest control. However, butterfly populations are rapidly declining due to human activities, habitat destruction, pesticide use, and a lack of awareness about their importance (Ghazanfar *et al.*, 2016; Warren *et al.*, 2021).

In the Republic of Armenia, the butterfly fauna consists of 236 species (Aghababayan & Khanamirian, 2024), including 11 species (5%) classified as Critically Endangered (CR), 18 species (8%) as Endangered (EN), 22 species (9%) as Vulnerable (VU), 39 species (17%) as Near Threatened (NT), 24 species (9%) as Data Deficient (DD), and 122 species (52%) as Least Concern (LC). Of these, three CR species are globally endangered, with only two or three populations worldwide, making them candidates for inclusion in the IUCN (International Union for Conservation of Nature) Red List (IUCN, 2024). Notably, the current Red Book of Animals of the Republic of Armenia (Aghasyan & Kalashyan, 2010) only lists 24 species. While the National Butterfly Monitoring Scheme covers 95% of the country (Butterfly Conservation Armenia), faunistic studies do not yet

cover all regions of Armenia. One such area is near Karenis village, located in the southeastern part of the Tsaghkunyats Mountain Ridge. This area is under intensive use by the local community, which may lead to habitat degradation and a decline in butterfly populations, including endangered species. Research into the butterfly fauna of this region can help fill a geographic gap and provide important data for conservation efforts. This study aims to document the butterfly species in this area and determine the local distribution of potentially threatened species.

Karenis village, situated in the central part of the Kotayk region between 40°23'40" N 44°37'25" E and 40°23'20" N 44°36'16" E, lies at an elevation of approximately 1450 -1560 meters above sea level (Gulyan & Balyan, 2013). This area is predominantly characterized by tragacanth (*Astragalus* spp.) and Oshindra (*Artemisia* spp.) vegetation, along with a variety of sedges (Cyperaceae family representers) and steppe plants that are prevalent. The tragacanth steppes are largely of secondary origin, having developed from grassy steppes due to overgrazing by livestock (Gabrielyan, 1971). Karenis experiences a humid continental climate with no dry season and warm summers. The average annual temperature in the area is 9.94°C, which is slightly lower (-0.46%) than the national average for Armenia. Annually, Karenis receive approximately 105.82 millimeters of precipitation and experience rainfall on about 179.35 days, accounting for 49.14% of the year.

This study's material was collected from the spring, summer, and early autumn of 2021 to 2023 (three time sampling for each season), from eight spots in Karenis (Site 1: 40°23'35" N 44°36'10" E (1560 m elevation), Site 2: 40°23'50" N 44°36'50" E (1525 m), Site 3: 40°23'45" N 44°36'25" E (1487 m), Site 4: 40°24'10" N 44°37'00" E (1545 m), Site 5: 40°23'20" N 44°36'25" E (1502 m), Site 6: 40°23'20" N 44°37'15" E (1561 m), Site 7: 40°23'15" N 44°37'36" E (1656 m), Site 8: 40°23'20" N 44°36'16" E (1480 m)). The specimens were collected using sweep nets and euthanized in killing jars containing ethyl acetate. Each specimen was placed in a labeled envelope and transported to the laboratory for spreading and drying (Volkov, 2014). The identification of the specimens was carried out using several reference guides, including those by Hesselbarth *et al.* (1995), Tuzov (1993), Bozano (1999, 2002, 2003 & 2006), Bozano & Weidenhoffer (2001), Weidenhoffer & Bozano (2007), Eckweiler & Bozano (2007 & 2011), Racheli & Cotton (2009 & 2010), Masui *et al.* (2011), Bozano & Floriani (2012), Korb & Bolshakov (2016), Khanamiryan & Aghababayan (2011 & 2012) Zarikian & Kalashian (2016), Aghababayan & Khanamirian, (2024) and Tikhonov *et al.* (2014). Comparisons were also made using the author's reference collections. Additionally, all available literature and collection data were taken into account. The species diversity, richness, and evenness of the butterfly samples were analyzed using Estimate S (Statistical estimation of species richness and shared species from samples) software. The Shannon-Weiner index ( $H'$ ) was used to assess species diversity, combining both richness and evenness into a single metric. The Margalef Index ( $R'$ ) was used to measure species richness, while the Shannon-Weiner Evenness Index assessed species evenness (Magurran, 1988). We also evaluated the similarity of butterfly assemblages between this site and previously studied locations in the Tsaghkunyats mountains using the Sorensen coefficient (Zarikian *et al.*, 2019).

A total of 149 butterfly specimens, representing 40 species from five families, were recorded in our study. The Nymphalidae family was the most dominant, with 15 species and 58 individuals, followed by Pieridae (10 species, 55 individuals), Lycaenidae (10 species, 26 individuals), Hesperidae (3 species, 9 individuals), and Papilionidae, which had the fewest species and individuals (2 species, 6 individuals) (Table 1). In the Tsaghkunyats mount range, Lycaenidae and Nymphalidae are the families with the greatest number of species and relatively even species distribution. However, in Karenis, which is at the end of this range, there are relatively fewer Nymphalids (30.6% of Tsaghkunyats species) and Lycaenids (26.3%) (Table 2) (Zarikian *et al.*, 2019). This is notable considering the diversity in the overall Tsaghkunyats range. Across Armenia, Nymphalidae (88 species) and Lycaenidae (85 species) are also the most diverse and abundant (Butterfly Conservation in Armenia 2014), likely due to their polyphagous nature, which allows them to thrive in various habitats (Holloway *et al.*, 1987). The Karenis area, being at the end of the range, seems to have fewer of these habitats. However, our study was in a more limited area than Zarikian *et al.* (2019) and less species diversity could be expected. *Pieris brassicae* (Linnaeus, 1758) from the Pieridae family was the most common species in this study, mirroring its abundance in the Tsaghkunyats range. This might be due to the availability of host plants and food sources in the study area. In contrast, the Papilionidae family had the fewest individuals and species, though it still represented 40% of Armenia's Papilionidae species (Table 2). The rarest species was *Melitaea persea* (Kollar, 1850) with only one individual.

Table1. The checklist of butterfly fauna recorded along the Karenis village.

| No.                 | taxa                                               | species frequency | No.                | taxa                                                 | species frequency |
|---------------------|----------------------------------------------------|-------------------|--------------------|------------------------------------------------------|-------------------|
| <b>Papilionidae</b> |                                                    |                   | 20                 | <i>Polyommatus icarus</i> (Rottemburd, 1775)         | 3                 |
| 1                   | <i>Iphiclides podalirius</i> (Linnaeus, 1758)      | 4                 | 21                 | <i>Satyrus spini</i> (Schiffmuller, 1775)            | 2                 |
| 2                   | <i>Papilio machaon</i> (Linnaeus, 1758)            | 2                 | 22                 | <i>Callophrys danchenkoi</i> (Zhdanko, 1998)         | 2                 |
| <b>Pieridae</b>     |                                                    |                   | 23                 | <i>Polyommatus bellargus</i> (Rottemburg, 1775)      | 4                 |
| 3                   | <i>Anthocharis cardamines</i> (Linnaeus, 1758)     | 3                 | 24                 | <i>Polyommatus thersites</i> (Cantener, 1835)        | 2                 |
| 4                   | <i>Pontia daplidice</i> (Linnaeus, 1758)           | 6                 | 25                 | <i>Lycaena thersamon</i> (Esper, 1784)               | 2                 |
| 5                   | <i>Pieris pseudorapae</i> (Verity, 1908)           | 7                 | <b>Nymphalidae</b> |                                                      |                   |
| 6                   | <i>Pieris ergane</i> (Geyer, 1828)                 | 2                 | 26                 | <i>Vanessa atalanta</i> (Linnaeus, 1758)             | 2                 |
| 7                   | <i>Pieris rapae</i> (Linnaeus, 1758)               | 5                 | 27                 | <i>Vanessa cardui</i> (Linnaeus, 1758)               | 6                 |
| 8                   | <i>Pieris brassicae</i> (Linnaeus, 1758)           | 15                | 28                 | <i>Aglais urticae</i> (Linnaeus, 1758)               | 7                 |
| 9                   | <i>Colias alfacariensis</i> (Staudinger, 1871)     | 2                 | 29                 | <i>Polygonia c-album</i> (Linnaeus, 1758)            | 2                 |
| 10                  | <i>Colias croceus</i> (Geoffroy, 1785)             | 5                 | 30                 | <i>Argynnis pandora</i> (Denis & Schiffmuller, 1775) | 5                 |
| 11                  | <i>Gonepteryx farinosa</i> (Zeller, 1847)          | 2                 | 31                 | <i>Argynnis aglaja</i> (Linnaeus, 1758)              | 3                 |
| 12                  | <i>Euchloe ausonia</i> (Hubner, 1805)              | 3                 | 32                 | <i>Issoria lathonia</i> (Linnaeus, 1758)             | 4                 |
| <b>Hesperiidae</b>  |                                                    |                   | 33                 | <i>Melitaea didyma</i> (Esper, 1778)                 | 5                 |
| 13                  | <i>Thymelicus lincola</i> (Ochsenheimer, 1808)     | 2                 | 34                 | <i>Melitaea perseae</i> (Kollar, 1850)               | 1                 |
| 14                  | <i>Thymelicus sylvestris</i> (Poda, 1761)          | 4                 | 35                 | <i>Melitaea phoebe</i> (Denis & Schiffmuller, 1775)  | 2                 |
| 15                  | <i>Pyrgus serratulae</i> (Rambur, 1839)            | 3                 | 36                 | <i>Lasiommata megera</i> (Linnaeus, 1767)            | 5                 |
| <b>Lycaenidae</b>   |                                                    |                   | 37                 | <i>Melanargia larissa</i> (Geyer, 1828)              | 3                 |
| 16                  | <i>Lycaena phlaeas</i> (Linnaeus, 1761)            | 5                 | 38                 | <i>Maniola jurtina</i> (Linnaeus, 1758)              | 7                 |
| 17                  | <i>Lampides boeticus</i> (Linnaeus, 1767)          | 2                 | 39                 | <i>Chazara briseis</i> (Linnaeus, 1764)              | 2                 |
| 18                  | <i>Aricia agestis</i> (Denis & Schiffmuller, 1775) | 2                 | 40                 | <i>Coenonympha pamphilus</i> (Linnaeus, 1758)        | 4                 |
| 19                  | <i>Polyommatus ripartii</i> (Freyer, 1830)         | 2                 | Total              |                                                      | 149               |

The Shannon-Weiner index ( $H'$ ) value for the area is 3.521 in total, while different values recorded for each family are 0.637 (Papilionidae), 2.075 (Pieridae), 1.061 (Hesperiidae), 2.235 (Lycaenidae) and 2.589 (Nymphalidae) (Table 3). The evenness ( $E$ ) of 0.955 (for total), and the Margalef Index ( $R'$ ) is 7.79. These results indicate high species evenness, meaning that most species are evenly distributed without any dominating in the ecosystem. An  $R'$  value of 7.79 suggests a high level of species richness (Table 3). The Sørensen similarity index of 0.439 shows a big similarity between the species in Karenis and those found in the broader Tsaghkunyats range, likely due to the limited sampling period and small study area (Fig. 1).

Table 2. Comparative number and percentage of butterfly species and families in Karenis, Tsaghkunyats mount range, and Armenia.

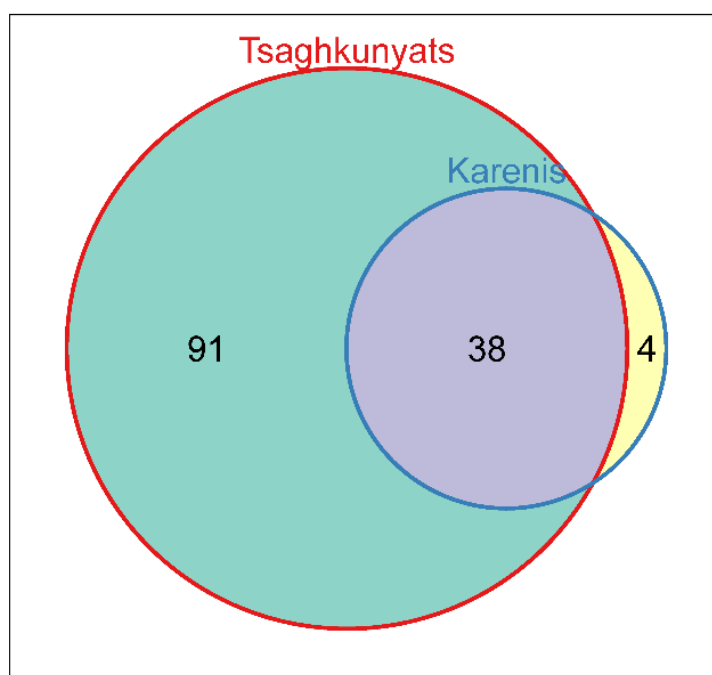
| Family       | No. of species in Karenis | No. of species in Tsaghkunyats (Zarikian <i>et al.</i> , 2019) | Percentage of species compared to Zarikian <i>et al.</i> , 2019 study (%) | No. of species in each family in Armenia | Percentage of species compared to Armenian butterflies (%) |
|--------------|---------------------------|----------------------------------------------------------------|---------------------------------------------------------------------------|------------------------------------------|------------------------------------------------------------|
| Papilionidae | 2                         | 5                                                              | 40                                                                        | 5                                        | 40                                                         |
| Pieridae     | 10                        | 21                                                             | 47.6                                                                      | 27                                       | 37                                                         |
| Hesperiidae  | 3                         | 16                                                             | 18.75                                                                     | 31                                       | 9.6                                                        |
| Lycaenidae   | 10                        | 38                                                             | 26.3                                                                      | 85                                       | 11.7                                                       |
| Nymphalidae  | 15                        | 49                                                             | 30.6                                                                      | 88                                       | 17                                                         |

Table 3. Abundance and species diversity indices of Karenis butterflies'

| Measure                              | Total  | Papilionidae | Pieridae | Hesperiidae | Lycaenidae | Nymphalidae |
|--------------------------------------|--------|--------------|----------|-------------|------------|-------------|
| S (Species Richness)                 | 40     | 2            | 10       | 3           | 10         | 15          |
| Abundance                            | 149    | 6            | 50       | 9           | 26         | 58          |
| D (Simpson's index)                  | 0.036  | 0.55         | 0.156    | 0.358       | 0.115      | 0.082       |
| 1 - D (Simpson's index of diversity) | 0.964  | 0.44         | 0.84     | 0.64        | 0.885      | 0.918       |
| 1/D (Simpson's reciprocal index)     | 27.778 | 1.79         | 6.41     | 2.79        | 8.69       | 12.19       |
| $H'$ (Shannon-Wiener index)          | 3.521  | 0.637        | 2.075    | 1.061       | 2.235      | 2.589       |
| $E$ (Evenness)                       | 0.955  | 0.918        | 0.901    | 0.966       | 0.971      | 0.956       |
| Margalef Index ( $R'$ )              | 7.79   | 0.55         | 2.3      | 0.91        | 2.76       | 3.44        |

The comparison of the species composition from our study in the vicinity of Karenis village and the Tsaghkunyats Mountain range in the Kotayk region (Zarikian *et al.*, 2019) revealed that 38 species recorded in our study were consistent with those reported by Zarikian *et al.* (2019). Additionally, four species—*Pieris ergane* (Geyer, 1828), *Polyommatus ripartii* (Freyer, 1830), *Satyrrium spini* (Schifferrmüller, 1775), and *Melitaea persea* (Kollar, 1850)—were recorded for the first time in the Tsaghkunyats range. These findings contribute to completing the mosaic of species composition in this region.

No new species were recorded in this study for Armenia, highlighting the need for further research to compile a more complete and updated list of butterflies in Karenis village, a small part of the Tsaghkunyats Mountain range. Although the study site exhibited moderate butterfly diversity, it ranks among the less species-rich locations within the mountain range. A closer examination of the species composition reveals that rapid urbanization and population growth have favored species adapted to urban environments. These species, characterized by high mobility and low habitat specificity, are prevalent in Karenis, including *Pieris rapae* (Linnaeus, 1758), *Pieris brassicae* (Linnaeus, 1758), *Vanessa cardui* (Linnaeus, 1758), and *Polyommatus bellargus* (Rottemburg, 1775). However, the data collected in this study is not enough to fully assess the butterfly diversity and richness in the area. Nonetheless, the findings contribute to a better understanding of the local butterfly populations and provide a more up-to-date species list for the region.



**Fig. 1.** The species composition similarity for the vicinity of Karenis village and Tsaghkunyats Mount range in Kotayk region.

### Author's Contributions

**Lilit Sargsyan:** Conceptualization, investigation, draft preparation and visualization. **Noushig Zarikian:** methodology, formal analysis; final review, edit and supervision.

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## Data Availability Statement

All data for this study are available by the corresponding author upon request.

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## Ethics Approval

Insects were used in this study. All applicable international, national, and institutional guide lines for the care and use of animals were followed. This article does not contain any studies with human participants performed by any of the authors.

## Conflict of Interest

The authors declare no conflict of interest.

## Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

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## تنوع پروانه‌های (Lepidoptera: Papilionoidea and Hesperioidea) گوشه جنوب شرقی خط الراس کوه تساغکونیاتس، جمهوری ارمنستان

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**چکیده:** مطالعه‌ای در اطراف روستای کارنیس (گوشه جنوب شرقی خط الراس کوه تساغکونیاتس) برای مستندسازی ترکیب گونه‌های Papilionoidea و Hesperioidea منطقه انجام شد. جمع‌آوری‌ها در فصول بهار، تابستان و اوایل پائیز ۲۰۲۱–۲۰۲۳ انجام شد. در طول تحقیق، ۱۴۹ نمونه جمع‌آوری شد که شامل ۴۰ گونه متعلق به پنج خانواده بودند. یافته‌ها نشان می‌دهد که بیشتر این گونه‌ها به خانواده Nymphalidae تعلق دارند، در حالی که کمترین گونه‌ها به ترتیب متعلق به Papilionidae و Hesperidae بودند. احتمالاً Nymphalidae به دلیل توانایی آنها در تغذیه از گیاهان مختلف بیشترین فراوانی را داشت. نادرترین گونه *Melitaea perseae* (Kollar, 1850) و فراوان‌ترین گونه *Pieris brassica* (Linnaeus, 1758) بود. شاخص‌های تنوع برای خانواده‌های شناسایی شده محاسبه شد. بر این اساس، مقدار شاخص شانون-وینر ( $H'$ ) برای منطقه در مجموع ۳/۵۲۱ بود، در حالی که مقادیر ثبت شده برای هر خانواده ۰/۶۳۷ (Papilionidae)، ۲/۰۷۵ (Pieridae)، ۱/۰۶۱ (Hesperidae)، ۲/۲۳۵ (Lycaenidae) و ۲/۵۸۹ (Nymphalidae) بود. اگرچه سایت مورد مطالعه، تنوع پروانه‌ای مناسبی را نشان داد، اما از نظر غنای گونه‌ای در میان نقاط فقیرتر این رشته کوه قرار دارد. به نظر می‌رسد با توجه به سرعت سریع شهرنشینی و افزایش جمعیت، گونه‌های سازگار با محیط‌های شهری – که با تحرک بیشتر و تخصص زیستگاهی کمتر مشخص می‌شوند در کارنیس رایج هستند.

**کلمات کلیدی:** غنای گونه‌ای، فون، فراوانی، یکنواختی، تنوع گونه‌ای

### اطلاعات مقاله

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