

HISTORICAL DEVELOPMENT AND MODERN BIOECOLOGICAL INSIGHTS INTO THE LEPIDOPTERA FAUNA OF CENTRAL ASIA

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Abstract: This paper provides a comprehensive examination of the chronological development, research evolution, and current bioecological understanding of butterflies belonging to the order Lepidoptera within Central Asia. Drawing upon archival sources and earlier scientific records, it traces the establishment of entomological traditions in the region and outlines recent advancements in faunistic and ecological studies. The analysis highlights key issues related to the conservation of butterfly biodiversity, anthropogenic impacts on ecosystems, and strategic priorities for forthcoming investigations.

Keywords: Lepidoptera, butterfly diversity, Rhopalocera, Pieridae, bioecological patterns, Central Asia, endemic species, human-induced impact.

Introduction

The stability and continuity of the biosphere are intrinsically connected with the protection of biological diversity. Among terrestrial organisms, insects (Insecta) represent one of the most extensive and taxonomically rich animal groups. Within this class, the Lepidoptera-encompassing butterflies and moths characterized by scaled wings-occupy a prominent position owing to their ecological, economic, and aesthetic functions in natural systems.

Butterflies play dual ecological roles: as consumers of plant matter during the larval stage and as essential pollinators during adulthood. Their abundance and distribution make them reliable bioindicators of ecosystem health. The geographic and climatic heterogeneity of Central Asia-with its deserts, steppe-meadow landscapes, and mountainous terrains-has fostered exceptional species diversity among Lepidoptera.

The main purpose of this research is to evaluate, from a scientific standpoint, the historical progression and current ecological condition of butterflies across Central Asian territories.

Materials and Methods

The present investigation employed a combination of classical and modern research techniques, including:

1. **Historical and analytical review:** Foundational entomological works from the nineteenth and twentieth centuries (notably those of Ershov, Shetkina, and Kreytsberg) were critically reassessed to reconstruct the regional research chronology [2,3].

2. **Comparative biogeography:** National and regional faunal lists from Uzbekistan, Tajikistan, Turkmenistan, and Kazakhstan were compared to identify similarities and distributional differences.
3. **Ecological categorization:** Species were arranged into groups according to habitat preferences-mesophilous, xerophilous, hydrophilous, eurybiotic, and synanthropic assemblages.
4. **Contemporary literature synthesis:** Peer-reviewed articles published between 2015 and 2024 in journals such as Zootaxa, Pensoft, and ResearchGate (authored by Matov, Korb, Yakovlev, Shapoval, and others) were systematically examined [5,6].
5. **Quantitative evaluation:** Data on species composition and ecological ratios were statistically processed, and results were expressed in percentage form to reveal structural balance among ecological types.

Results

Historical overview. Research on the butterfly fauna of Central Asia traces back to the middle of the nineteenth century. The earliest faunistic surveys were conducted by N. G. Ershov, who recorded 367 species from the Turkestan region, including 10 species belonging to the family Pieridae. His pioneering work laid the foundation for future entomological exploration in the region. Subsequent contributions by Russian naturalists such as A. Fedchenko, E. Eversmann, and M. Menetries significantly expanded the known diversity of Central Asian Lepidoptera through their numerous expeditions [1].

By 1911, the creation of the Entomological Station in Tashkent marked a decisive institutional step in the systematic study of insects, serving as a major scientific hub for lepidopterological investigations across the region.

During the Soviet era, entomological research was largely oriented toward the study of economically important insects-particularly agricultural pests and pollinators. Consequently, diurnal butterflies (Rhopalocera), especially members of the Pieridae family, received comparatively little attention during this period.

In Tajikistan, Yu. L. Shetkina (1960s), in her monograph “Higher Lepidoptera of the Sands of the Vakhsh Valley,” documented 90 butterfly species, of which 12 were Pieridae. Her research provided a detailed morphological and phenological description of each species [2].

In the arid landscapes of Turkmenistan, investigators such as A. V. Tsvetaev, T. B. Tokgaev, M. A. Daricheva, and A. G. Davletshina studied the entomofauna of the Karakum and Kyzylkum deserts. Their surveys revealed 16–38 species of diurnal butterflies, including *Pieris rapae*, *Pontia daplidice*, *Colias erate*, and *Zegris fausti* [4].

In Uzbekistan, A. Kreytsberg made substantial contributions to the faunistic investigation of Lepidoptera. He identified 27 species of Pieridae from mountainous

habitats and recommended 10 of them for inclusion in the Red Data Book of Uzbekistan [3].

In the southern regions of Kazakhstan and along the Syrdarya Valley, recent works by S. K. Korb, A. Yu. Matov, and M. Yakovlev have focused on the taxonomic revision of genera such as *Drasteria*, *Cryphia*, and *Semagystia*, leading to the description of new species endemic to Central Asia [5,6].

Current state of research. To date, over 15,000 insect species have been documented within the territory of Uzbekistan, of which more than 1,000 species are classified under the order Lepidoptera. Within this group, around 300 species of diurnal butterflies have been officially recorded across various ecological zones of the country.

The majority of Pieridae species are distributed throughout mountainous and submontane habitats, whereas the arid and semi-arid ecosystems of the plains remain comparatively underinvestigated. Current regional estimates indicate that Tajikistan supports over 90 diurnal species, Turkmenistan harbors approximately 40, and southern Kazakhstan is home to nearly 120 species of day-flying butterflies.

Most butterflies of Central Asia are classified within the Palaearctic zoogeographical region, with a strong representation of Iran–Turan faunal components. Several taxa, such as *Colias aurorina* and *Pontia glauconome*, exhibit endemic or subendemic characteristics, reflecting the region’s unique biogeographical history.

Studies conducted by Jumaev, and Suleymanov primarily examined butterflies in the context of agricultural entomology, identifying their potential roles as crop pests. However, their ecological, bioindicator, and conservation-related functions have yet to be comprehensively analyzed [7].

Bioecological and Biogeographical Analysis

Butterfly species inhabiting Central Asia display a high degree of ecological plasticity and environmental specialization, enabling them to survive across extreme climatic gradients—from humid foothills to arid desert zones. Their population dynamics, phenology, and adaptive coloration patterns are closely associated with local temperature and vegetation regimes (Table 1).

Table 1. Summary of Ecological Analysis Results

Ecological group	Proportion (%)	Description	Examples of Species
Mesophilic	35-40	Inhabiting moderately humid areas	<i>Pieris brassicae</i> , <i>Colias croceus</i>
Xerophilic	40-45	Adapted to desert and semi-desert environments	<i>Pontia daplidice</i> , <i>Colias erate</i>

Hydrophilic	4-5	Occurring in humid habitats	<i>Pieris napi</i>
Eurybiotic	10-12	Tolerant of various environments	<i>Colias alfacariensis</i>
Synanthropic	2-3	Adapted to human-modified landscapes	<i>Pieris rapae</i>

According to their life cycles (Figure 1):

- 60% species are univoltine (one generation per year),
- 30% bivoltine (two generations),
- 10% multivoltine (three or more generations).

Species are distributed mainly across meadow, mountain-steppe, orchard-forest, and desert-steppe biotopes.

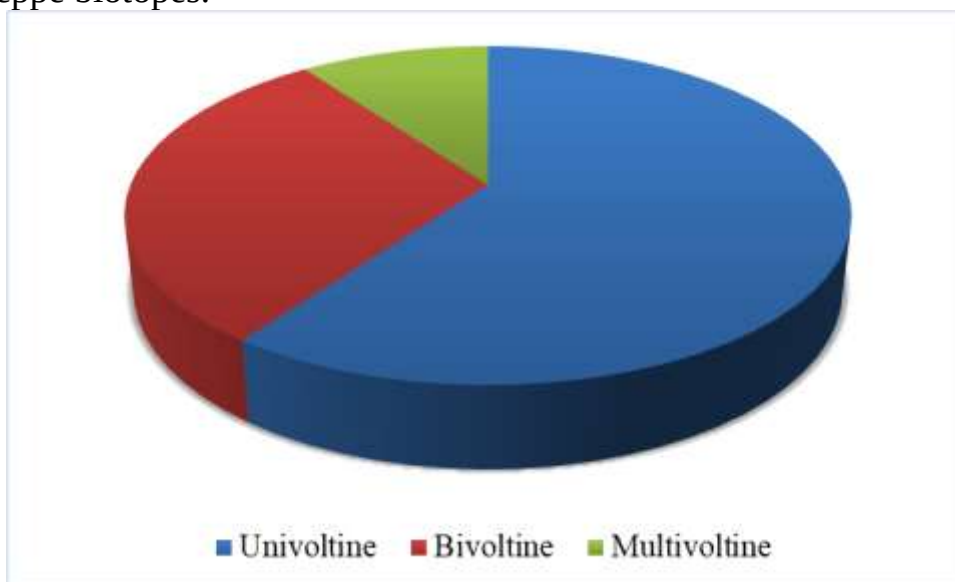


Figure 1. Proportion of species according to their developmental stages.

Discussion

Historical records on the butterfly fauna of Central Asia show that early entomological investigations were primarily faunistic and taxonomic in orientation. Only in recent years have researchers begun to consider the ecological and bioindicator potential of these species, though such studies remain limited in both scale and methodology.

The decline in butterfly diversity throughout the region is influenced by a complex interplay of anthropogenic and environmental factors. The most significant pressures include:

- Human-induced disturbances: large-scale land reclamation projects, widespread pesticide application, and habitat degradation caused by agricultural expansion;
- Climatic shifts: progressive desertification, prolonged droughts, and changes in vegetation cycles that disrupt butterfly life histories;
- Loss of host plant resources: excessive use of chemical herbicides leading to the disappearance of larval food plants in cultivated landscapes.

On the basis of current assessments, more than ten butterfly species occurring in Uzbekistan and adjacent territories are now regarded as threatened or endangered, emphasizing the urgent need for targeted conservation measures and regionally coordinated monitoring programs.

Conclusion

Despite the considerable historical progress achieved in documenting the butterfly fauna of Central Asia, large portions of the region-particularly desert and semi-desert ecosystems-remain inadequately surveyed. These habitats represent critical but underexplored components of the regional biodiversity structure.

Ongoing anthropogenic pressures, including habitat transformation, agricultural intensification, and chemical pollution, have placed numerous butterfly species at risk of local or complete extinction. Such trends underline the necessity for immediate and coordinated conservation actions.

Future research directions should emphasize the integration of molecular-genetic analyses, the implementation of digital monitoring and remote-sensing systems, and the application of bioindication methodologies for environmental assessment.

Equally important is the creation of a centralized, cross-border Lepidoptera database shared among the Central Asian states, which would serve as a foundation for comparative biodiversity studies, long-term ecological monitoring, and the formulation of region-wide conservation strategies.

REFERENCES

1. Ershov, N. G., & Fedchenko, A. P. (1890). Lepidoptera of Turkestan Region. St. Petersburg.
2. Shetkina, Yu. L. (1960). Higher Lepidoptera of the Sands of the Vakhsh Valley. Dushanbe.
3. Kreytsberg, A. (1980-1989). Fauna of Uzbekistan Butterflies (Family Pieridae). Tashkent.
4. Davletshina, A. G., Avanesova, G. A., & Mansurov, A. K. (1979). Entomofauna of the South-West Kyzylkum. Tashkent: Fan.
5. Korb, S. K., & Matov, A. Yu. (2019). Revision of Drasteria of Central Asia. Zootaxa.

6. Yakovlev, R. V., Shapoval, N. A., Shapoval, G. N., & Naydenov, A. E. (2022). Review of the *Dyspessa salicicola* (Eversmann, 1848) species group (Lepidoptera, Cossidae: Cossinae). *Acta Biologica Sibirica*, 8, 693-712.
7. Suleymanov B., Jumaev R. & Abduvosiqova, L. (2021). Lepidoptera Found In Cabbage Agrobiocenosis The Dominant Types Of Representatives Of The Category Are Bioecology. *The American Journal of Agriculture and Biomedical Engineering*, 3(06), 125–134.