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PHENOLOGICAL FEATURES AND PATTERNS OF SEASONAL DEVELOPMENT OF THE ENTOMOFAUNA OF TUGAI FORESTS IN THE KHOREZM REGION

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Annotatsiya. Ushbu maqolada Xorazm viloyati (Shovot va Urganch tumanlari) Amudaryo bo‘yi havzasidagi to‘qay ormonlarida yashovchi entomofaunaning fenologik xususiyatlari va mavsumiy rivojlanish qonuniyatlari o‘rganilgan. 2023–2025-yillar davomida uch mavsum — bahor (aprel–may), yoz (iyun–avgust) va kuz (sentyabr–oktyabr) bo‘yicha olib borilgan dala kuzatuvlarida taksonomik, morfologik, faunistik, molekulyar-genetik, statistik, ekologik va qiyosiy tahlil usullaridan foydalanildi. Hasharotlar zichligi yoz mavsumida eng yuqori darajaga yetib, yillik umumiy zichlikning 43,8 foizini (21,6 ekz./m²) tashkil etdi, bahor mavsumi esa eng past ulushni — 25,2 foizni (12,4 ekz./m²) ko‘rsatdi, kuz mavsumi esa 31,0 foiz (15,3 ekz./m²) bilan oraliq o‘rinni egalladi. Dominant turlar orasida Pyrrhocoris apterus umumiy zichlikning eng katta qismini (29,3%) tashkil etsa, Xylotrechus namanganensis eng kichik ulushni (12,5%) ko‘rsatdi. Barcha mavsumlarda populyatsiya zichligining yillar bo‘yicha barqaror ortishi qayd etildi, 2025-yilga kelib 2023-yilga nisbatan umumiy o‘sish 8,9 foizni tashkil etdi. Olingan natijalar to‘qay ekotizimlarini ekologik monitoring qilish va muhofaza qilishni rejalashtirish uchun empirik asos bo‘lib xizmat qiladi.

Kalit so‘zlar: to‘qay ekotizimi, entomofauna, fenologiya, mavsumiy dinamika, populyatsiya zichligi, dominant turlar, Amudaryo, Xorazm viloyati.

Аннотация. В статье рассматриваются фенологические особенности и закономерности сезонного развития энтомофауны, обитающей в тугайных лесах бассейна реки Амударья Хорезмской области (Шаватский и Ургенчский районы). Полевые наблюдения, проведённые в течение трёх сезонов — весной (апрель–май), летом (июнь–август) и осенью (сентябрь–октябрь) за период 2023–2025 годов, — выполнялись с применением таксономического, морфологического, фаунистического, молекулярно-генетического, статистического, экологического и сравнительного методов. Плотность насекомых достигла максимума летом, составив 43,8% от общей годовой плотности (21,6 экз./м²), тогда как весной был зафиксирован наименьший показатель — 25,2% (12,4 экз./м²), осенью — промежуточный показатель в 31,0% (15,3 экз./м²). Среди

доминирующих таксонов наибольшую долю в суммарной плотности составил *Pyrrhocoris apterus* (29,3%), наименьшую — *Xylotrechus namanganensis* (12,5%). Во всех сезонах отмечен устойчивый межгодовой рост плотности, достигший к 2025 году общего увеличения на 8,9% по сравнению с 2023 годом. Полученные результаты создают эмпирическую основу для экологического мониторинга и планирования природоохранных мероприятий в тугайных экосистемах.

Ключевые слова: тугайная экосистема, энтомофауна, фенология, сезонная динамика, плотность популяции, доминантные виды, Амударья, Хорезмская область.

Abstract. This paper examines the phenological characteristics and seasonal development patterns of the entomofauna inhabiting the tugai forests of the Amu Darya basin within the Khorezm region (Shavat and Urgench districts). Field observations conducted across three seasons—spring (April–May), summer (June–August) and autumn (September–October)—over 2023–2025 employed taxonomic, morphological, faunistic, molecular-genetic, statistical, ecological and comparative methods. Insect density peaked in summer, accounting for 43.8% of total annual density (21.6 ind./m²), whereas spring contributed the smallest share, 25.2% (12.4 ind./m²), with autumn intermediate at 31.0% (15.3 ind./m²). Among the dominant taxa, *Pyrrhocoris apterus* contributed the largest proportion of cumulative density (29.3%), while *Xylotrechus namanganensis* contributed the least (12.5%). A consistent inter-annual increase in density was recorded across all seasons, reaching 8.9% overall growth by 2025 relative to 2023. These findings provide an empirical basis for ecological monitoring and conservation planning within tugai ecosystems.

Keywords: tugai ecosystem, entomofauna, phenology, seasonal dynamics, population density, dominant species, Amu Darya, Khorezm region.

Introduction. Tugai forests constitute one of the most distinctive floodplain ecosystems of Central Asia, sustaining exceptionally high biological diversity along the Amu Darya river corridor. Insects occupy a central position within these communities, mediating energy flow and nutrient cycling; consequently, tracking their seasonal development offers a sensitive proxy for the functional condition of the ecosystem as a whole. Phenology—the study of the timing of recurring biological events in relation to climatic variables—provides the conceptual framework for interpreting such change, since temperature, humidity, photoperiod and food availability jointly govern insect emergence, reproduction and diapause.

A number of recent regional studies have documented the faunistic composition and bioecological traits of specific insect taxa across Uzbekistan, including Coleoptera, Lepidoptera and Hymenoptera groups, and have characterised their distribution and seasonal activity within Khorezm and adjacent provinces [1; 2; 4; 5]. Related work on the life cycle and seasonal activity of particular carabid and hymenopteran species has further illustrated how faunistic and ecological analysis can reveal fine-grained phenological patterns [6; 7], while comparative

approaches applied to beneficial insect groups have underscored the practical value of such monitoring [3; 8]. Despite this growing body of research, the seasonal development dynamics of the entomofauna specific to Khorezm's tugai forests have not been addressed through sustained multi-year observation, which motivates the present study.

Aim and Objectives

The aim of this study is to determine the phenological characteristics and seasonal development patterns of the entomofauna inhabiting the tugai forests of the Amu Darya basin in Khorezm region. The specific objectives are: (i) to identify the seasonal species composition of insects in the study area; (ii) to compare population density and abundance across spring, summer and autumn; (iii) to characterise the seasonal activity of dominant species; (iv) to assess the inter-annual (2023–2025) trend in population density; and (v) to interpret the observed patterns in relation to prevailing ecological factors.

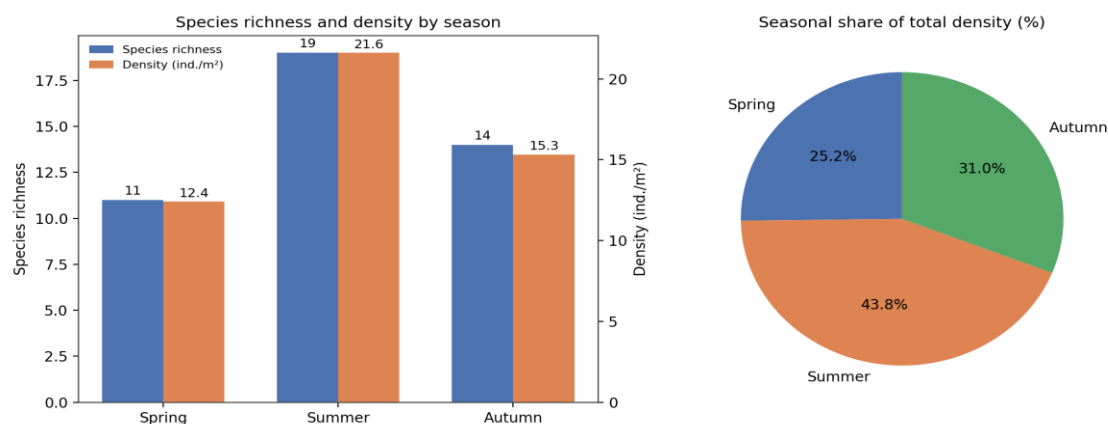
Materials and Methods

Fieldwork was conducted within the tugai forests of the Amu Darya basin in the Shavat and Urgench districts of Khorezm region between 2023 and 2025, spanning three seasonal windows: spring (April–May), summer (June–August) and autumn (September–October). A combined methodological approach was applied. Taxonomic and morphological analyses were used to identify and classify collected specimens to species level, while molecular-genetic analysis served to resolve morphologically similar taxa and confirm their systematic status. Faunistic methods established the species inventory and distribution across tugai biotopes [1; 4], and ecological analysis linked seasonal fluctuations in abundance to temperature, humidity and food-resource availability [5; 6]. Statistical treatment of the quantitative data (species counts, individual counts, density) yielded seasonal and annual means, and comparative analysis was used to evaluate differences across seasons and years [3].

Results and Discussion

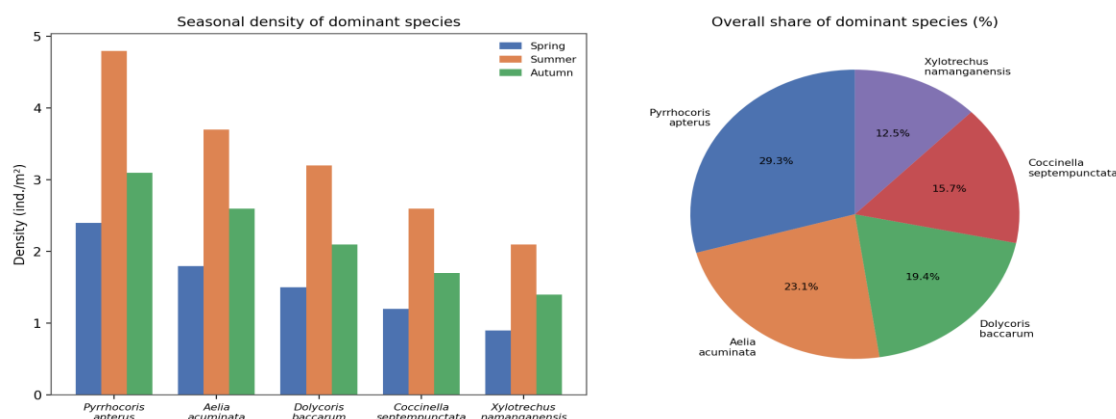
Across the three-year survey, the entomofauna of the study area displayed a clearly defined seasonal pattern in species richness and density (Figure 1).

Figure 1. Seasonal species richness, density and percentage share of annual density (2023–2025 means)



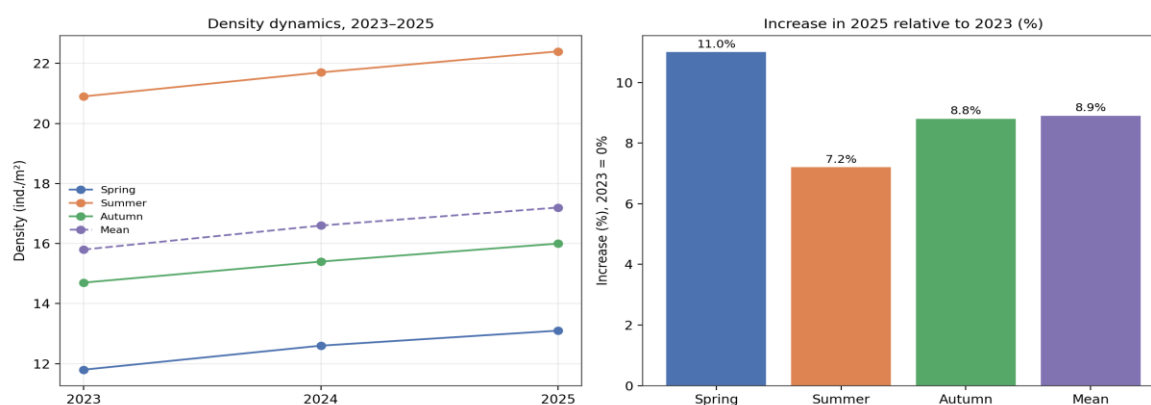
Spring density (12.4 ind./m², 11 species) represented only 25.2% of the annual total, consistent with the incipient stage of population build-up under still-variable thermal conditions and a developing forage base. Density peaked sharply in summer, reaching 21.6 ind./m² (19 species)—43.8% of the annual total—reflecting optimal temperature, adequate moisture and abundant food resources. Autumn density (15.3 ind./m², 14 species; 31.0% of the total) declined moderately as temperatures fell and vegetation senesced, marking the transition toward overwintering. The resulting seasonal trajectory—modest spring growth, a pronounced summer peak, and autumn decline—mirrors the general phenological pattern reported for insect assemblages elsewhere in Uzbekistan [6; 7].

Figure 2. Seasonal density of dominant species and their overall percentage contribution



All five dominant species followed the same seasonal trajectory, with density maximal in summer and lower in spring and autumn (Figure 2). Cumulative three-year contributions were unevenly distributed: *Pyrrhocoris apterus* accounted for the largest share (29.3%), followed by *Aelia acuminata* (23.1%), *Dolycoris baccarum* (19.4%) and *Coccinella septempunctata* (15.7%), while *Xylotrechus namanganensis* contributed the smallest proportion (12.5%). This gradient suggests differing degrees of ecological plasticity among taxa, with *Pyrrhocoris apterus* exhibiting the broadest tolerance to the seasonal conditions of the tugai habitat and *Xylotrechus namanganensis* the narrowest.

Figure 3. Inter-annual density dynamics (2023–2025) and percentage increase relative to 2023



Density increased consistently across all seasons over the three-year period (Figure 3). Relative to 2023, density by 2025 had risen by 11.0% in spring, 7.2% in summer, 8.8% in autumn, and 8.9% on average. The comparatively larger relative increase in spring suggests that the early-season population is more responsive to incremental improvements in habitat and climatic conditions than the already near-saturated summer peak. The sustained upward trend across years points to a gradual stabilisation of favourable ecological conditions—improved food availability and vegetation cover—although longer-term monitoring is needed to disentangle climatic from anthropogenic drivers.

Conclusion

The three-year survey demonstrates that the entomofauna of the tugai forests along the Amu Darya in Khorezm region follows a well-defined phenological cycle, characterised by a modest spring build-up, a pronounced summer maximum, and an autumn decline preceding overwintering. Population density increased steadily year-on-year across all seasons between 2023 and 2025, indicating a relatively stable and improving ecological condition of the habitat. Among dominant taxa, *Pyrrhocoris apterus* showed the broadest ecological amplitude and *Xylotrechus namanganensis* the narrowest. These results offer an empirical foundation for the ecological monitoring of tugai entomofauna and for developing conservation measures targeting rare and narrowly distributed species; extending observations to include the winter season would further complete the annual phenological cycle.

References

1. Badalova, M.F., Jumanazarova, N.J., Abdullaev, I.I. The mosquito *Anopheles* (A.) *algeriensis* Theobald, 1903 of north-western Uzbekistan [in Uzbek]. Bulletin of Khorezm Ma'mun Academy, Khiva, 2025, no. 6/1(127), pp. 19–23.
2. Bekchanova, M.X., Latipova, N.B., Jumadurdiyeva, B.D. The fauna of the tribe Smerinthini (Lepidoptera) distributed in the Khorezm oasis [in Uzbek]. Bulletin of Khorezm Ma'mun Academy, Khiva, 2025, no. 6/1(127), pp. 26–28.
3. Tajiyev, Z.R., Babajanov, I.T., Ollanazarov, S.B. A study of the bioecological characteristics of ants (Formicidae) under the conditions of the Khorezm oasis [in Uzbek]. Journal of Universal Science Research, 2025, vol. 3, no. 4, pp. 319–323.
4. Alimova, L.X., Sayfullayev, G'M. Ecological and faunistic characterisation of darkling beetles (Tenebrionidae) of the lower Zarafshan region [in Uzbek]. Bulletin of Khorezm Ma'mun Academy, Khiva, 2025, no. 6/1(127), pp. 6–9.
5. Bekchanov, N.X. An identification key to the genera of apterous representatives of the tribe Tentyriini (Coleoptera: Tenebrionidae) of Uzbekistan [in Uzbek]. Bulletin of Khorezm Ma'mun Academy, Khiva, 2025, no. 6/1(127), pp. 24–26.

6. Atajanov, T.S., Doschanova, M.B., Mavlanov, X. Bioecological characteristics of *Harpalus rufipes* in meadow-alluvial soils of Khorezm region [in Uzbek]. Bulletin of Khorezm Ma'mun Academy, Khiva, 2025.

7. Bekchanov, X.U., Yavkachev, D.A. Species composition of Lepidoptera damaging medicinal plants in the Khorezm oasis [in Uzbek]. Bulletin of Khorezm Ma'mun Academy, Khiva, 2024, no. 5-1.

8. Muhtorova, I. A study of the entomofauna of beneficial insects [in Uzbek]. Universal International Scientific Journal, 2025, vol. 2, no. 4, pp. 185–189.