O‘ZBEKISTON RESPUBLIKASI

OLIY TA’LIM, FAN VA INNOVATSIYALAR VAZIRLIGI

FARG‘ONA DAVLAT UNIVERSITETI

FarDU. ILMIY XABARLAR

1995-yildan nashr etiladi
Yilda 6 marta chiqadi

2024/6-SON
ILOVA TO‘PLAM

НАУЧНЫЙ ВЕСТНИК. ФерГУ

Издаётся с 1995 года
Выходит 6 раз в год

MUNDARIJA

FIZIKA-TEXNIKA

KIMYO

BIOLOGIYA

FarDU. Ilmiy xabarlar – Scientific journal of the Fergana State University

Volume 30 Issue 6, 2024-yil DOI: 10.56292/SJFSU/vol30_iss6_2t/a196

UO'K: 595.78

THE IMPACT OF GLOBAL CLIMATE CHANGE ON THE DISTRIBUTION AND POPULATION DYNAMICS OF LEPIDOPTERANS: THE CASE OF THE MULBERRY MOTH (*GLYPHODES PYLOALIS* WALKER, 1859)

ВЛИЯНИЕ ГЛОБАЛЬНОГО ИЗМЕНЕНИЯ КЛИМАТА НА РАСПРОСТРАНЕНИЕ И ДИНАМИКУ ПОПУЛЯЦИЙ ЧЕШУЕКРЫЛЫХ: НА ПРИМЕРЕ ТУТОВОЙ ОГНЕВКИ (*GLYPHODES PYLOALIS* WALKER, 1859)

GLOBAL IQLIM O'ZGARISHLARINING TANGACHAQANOTLI HASHAROTLAR TARQALISHI VA POPULYATSIYA DINAMIKASIGA TA'SIRI: TUT PARVONASI (*GLYPHODES PYLOALIS* WALKER, 1859) MISOLIDA

Shermatov Malikjon Rakhmatjonovich[1]
[1]Fergana State University, Doctor of Biological Sciences, dotsent
https://orcid.org/0000-0003-3966-4683

Botirov Elyor Arabboyevich[2]
[2]Fergana State University, Teacher

Qayumova Oygul Ismoiljonovna[3]
[3]Fergana State University, Teacher

Mukhammedov Muminjon Ma'ruf ugli[4]
[4]Fergana State University, Teacher

Annotatsiya

Maqolada global iqlim o'zgarishlari sharoitida tangachaqanotli hasharotlarning tarqalish xususiyatlari Farg'ona vodiysida tut parvonasi misolida tahlil etilgan. So'nggi 22 yil davomida tadqiqot hududida minimal va maksimal haroratning keskin o'zgarishlari bilan bog'liq iqlim anomaliyalari soni ortgan. Tut plantatsiyalarida olib borilgan uzoq muddatli tadqiqotlar shuni ko'rsatdiki, mavsumiy ekologik o'zgarishlar tut parvonasining populyatsiya dinamikasiga sezilarli ta'sir ko'rsatadi. Ayniqsa, 2002, 2008 va 2014-yillardagi qish fasllari, shuningdek, 2015 va 2021-yillarning bahor fasllaridagi keskin sovuqlar keyingi mavsumlarda tut parvonasi populyatsiya zichligining sezilarli darajada pasayishiga olib kelgan. 2022-yil yozidagi haddan tashqari qurg'oqchilik va uzoq davom etgan yuqori haroratli kunlar ham tut parvonasining rivojlanish sur'atini cheklashi mumkinligi kuzatilgan. Ushbu natijalar global iqlim o'zgarishlari sharoitida zararkunanda tangachaqanotli hahsarotlarga qarshi kurashishning moslashuvchan strategiyalarini ishlab chiqish zarurligidan dalolat beradi.

Аннотация

В данной статье проанализировано особенности распространения чешуекрылых в контексте глобального изменения климата на примере тутовой огневки в Ферганской долине. За последние 22 года в исследуемом регионе усилились климатические аномалии, характеризующиеся резкими колебаниями минимальных и максимальных температур. Многолетние исследования, проведенные на тутовых плантациях, показали, что сезонные изменения окружающей среды существенно влияют на динамику популяции тутовой огневки. В частности, резкие похолодания зимой 2002, 2008 и 2014 годов, а также весной 2015 и 2021 годов привели к заметному снижению плотности популяции в последующие сезоны. Напротив, экстремальные засушливые условия летом 2022 года и продолжительные периоды высоких температур подчеркнули потенциал этих факторов для ограничения скорости развития тутовой огневки. Эти результаты подчеркивают необходимость разработки адаптивных стратегий для борьбы с вредителями чешуекрылых в условиях глобальных изменений климата.

Abstract

This article analyzes the distribution patterns of Lepidopterans in the context of global climate change, focusing on the mulberry moth in the Fergana Valley as a case study. Over the past 22 years, climatic anomalies characterized by sharp fluctuations in minimum and maximum temperatures have increased in the study region. Long-term studies

conducted in mulberry plantations revealed that seasonal environmental changes significantly influence the population dynamics of the mulberry moth. Notably, sharp cold snaps during the winters of 2002, 2008, and 2014, as well as the springs of 2015 and 2021, caused a marked decline in population density in subsequent seasons. Conversely, extreme drought conditions during the summer of 2022 and prolonged high-temperature periods highlighted the potential of these factors to limit the development rate of the mulberry moth. These findings underscore the necessity of devising adaptive strategies to manage Lepidopteran pests amidst ongoing global climate changes.

Kalit so'zlar: *Farg'ona vodiysi, Lepidoptera, Glyphodes pyloalis, Grapholita molesta, iqlim o'zgarishi, tarqalish, cheklovchi omillar.*

Ключевые слова: *Ферганская долина, Lepidoptera, Glyphodes pyloalis, Grapholita molesta, изменение климата, распространение, лимитирующие факторы.*

Key words: *Fergana Valley, Lepidoptera, Glyphodes pyloalis, Grapholita molesta, climate change, distribution, limiting factors.*

INTRODUCTION

The influence of environmental factors on the distribution of various insect species is one of the key topics in ecological research. This is especially true for Lepidoptera, which include a variety of species that play an important role in ecosystems as pollinators and as pests of agricultural crops. The expansion of the ranges of these insects depends on a number of factors, such as climate conditions, availability of food resources, the presence of natural enemies, and landscape changes. The influence of these factors can be both limiting and facilitating the development of new territories.

In recent years, the influence of climate change on the population dynamics of harmful insect species has emerged as a critical issue for ensuring global food security in the 21st century. Specifically, an increasing body of research highlights the role of rising global temperatures as a key abiotic factor driving shifts in the geographical and altitudinal distributions of phytophagous insects. One of the primary concerns is that global temperature increases are expanding the ranges of these pests, often toward higher latitudes and altitudes. For example, it has been projected that a global average temperature increase of 1°C could result in a northward shift of up to 200 km in the range of many Lepidoptera species, with altitudinal shifts of up to 40 meters [1].

Based on this, the study of these aspects allows us to predict possible changes in the structure of fauna in response to global environmental changes, such as climate change or anthropogenic impact.

LITERATURE ANALYSIS AND METHODOLOGY

A study conducted by leading researchers from the China Insect Pest Monitoring Laboratory predicts that within the next 50 years, the global distribution of the codling moth (*Cydia pomonella*) will expand, based on climate modeling data from 1989 to 2018 [2].

Similarly, the fig moth (*Choreutis nemorana*), which was historically confined to regions from the Mediterranean to Asia and parts of southwestern, eastern Europe, and northwestern Africa, has shown a notable range expansion since 2006, now moving toward northern Europe. A comparable trend has been observed with the cotton bollworm (*Helicoverpa armigera*) in both South and North America [3].

According to the results of international studies, due to global climate change, the population ranges of such dangerous pests as potato moth and tomato moth will expand even more [4].

Climate change observed on a global scale and anthropogenic factors also have an impact on agriculture. Especially in recent decades, as a result of a threefold increase in the movement of goods and people between countries, the spread of agricultural pests has become even more intense. Every year, up to 40% of food crops perish worldwide due to damage caused by pests and plant diseases [5].

The mulberry moth (*Glyphodes pyloalis* Walker) is a widespread species in Southeast Asia (Japan, Korea, Malaysia, China, India, Nepal, Pakistan) and is found in North America (USA - Florida, Mississippi, Virginia; Mexico), and has been recorded in Azerbaijan, Georgia and Russia [6]. In the second half of the last century, its range expanded northward through India and Pakistan - across Afghanistan. The natural and climatic conditions of the region contributed to a sharp increase in the number of the mulberry or "Afghan moth", which led to its colonization of new habitats and the formation of the "Afghan focus of distribution". Moving north along the "Afghan

winds" prevailing in the summer months, by the end of the 1990s the mulberry moth reached the border of the Central Asian republics (Tajikistan, Turkmenistan, Uzbekistan, Kyrgyzstan) and Iran. In Uzbekistan (Surkhandarya), the first significant damage to mulberry trees by the moth was noted in 1993. Its first outbreaks in the Fergana Valley were discovered in the Altyaryk region in 1997 [7].

The article presents an analysis of the importance of environmental factors in the expansion of the ranges of lepidopteran insects using the example of dangerous pests of the *Glyphodes pyloalis* and the *Grapholita molesta*. The distribution of the mulberry moth was analyzed in the period 2000-2022, based on research material collected in the territories of mulberry plantations and plantings of mulberry trees on the outskirts of fields and observations carried out in the Fergana, Andijan and Namangan regions (Fig. 1).

The distribution of the Grapholita molesta was analyzed in the 2019 season in apple orchards of the Uchkuprik district of the Fergana region.

In continuation of field observations and studies, the spread of the mulberry moth in the Fergana Valley and the degree of intensity of this process, as well as its determining factors and data on the directions of spread were studied separately by year and analyzed in comparison. The obtained information, as well as the indicators of infestation by the mulberry moth in each region, were studied and at the same time the breadth of the most dangerous spread of the pest was identified. Additional data on the infestation of mulberry trees were obtained from the plant protection centers of the Fergana, Andijan and Namangan regions. Climate data for the period 2001-2022 were obtained from the Fergana Hydrometeorological Center, and a statistical analysis was performed following G.F. Lakin [8].

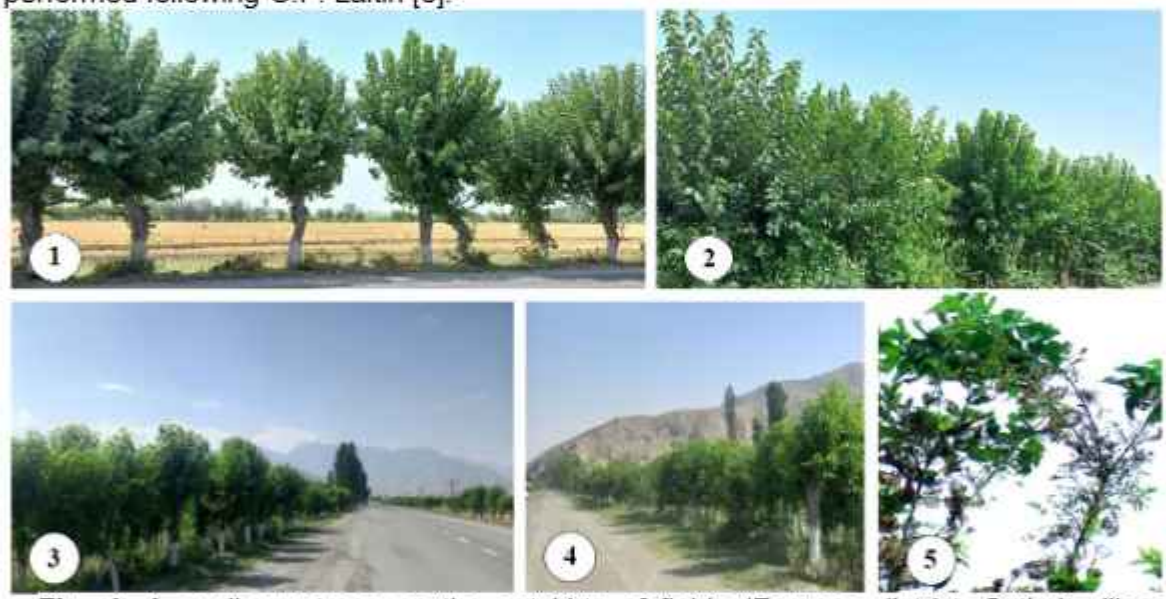

Fig. 1. 1- mulberry trees on the outskirts of fields (Fergana district, Satkak village), **2-** mulberry plantation (Ulugnar district, Sariksuv village), **3-** mulberry trees on the outskirts of fields (Sokh district, Sarikanda village), **4-** mulberry trees on the outskirts of fields (Fergana district, Shakhimardan village), **5-** damage to a mulberry branch (Mingbulak district, Karashahar village).

RESULTS

Our analysis of climate trends in the study area over the past five decades, based on data from the Fergana Hydrometeorological Center, revealed that the average annual temperature during the periods 1971-2000 and 2001-2022 differed by +1.1°C (Table 1).

Table 1

The difference in average monthly air temperature in 1971-2000 and 2001-2022 in the Fergana region (in °C)

Years	Months												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1971-2000	-0,7	1,5	8,3	16,1	20,8	25,3	27,3	25,3	20,3	13,5	7	1,7	**13,9**
2001-2022	0,8	3,7	10,6	16,8	22,1	26,2	28,1	26,6	21,5	14,1	7,0	1,8	**15,0**
Difference	**1,5**	**2,2**	**2,3**	**0,7**	**1,3**	**0,9**	**0,8**	**1,3**	**1,2**	**0,6**	**0,0**	**0,1**	**+1,1**

A statistical analysis was conducted to examine changes in the average monthly temperature in the Fergana region over the period 2001-2022. The results indicated a marked increase in climatic anomalies characterized by sharp fluctuations in both minimum and maximum temperatures. These variations have contributed to unstable seasonal weather patterns, which in turn have influenced the distribution of lepidopteran pests.

In particular, over the past two decades, fluctuations in the population density of the mulberry moth (*Glyphodes pyloalis*) in mulberry plantations in the Fergana Valley were observed, with these fluctuations closely linked to seasonal environmental changes [9]. The onset of relatively warm and dry winters in the valley has been associated with increased population densities of the mulberry moth in the following season. Notably, favorable weather conditions during the years 2001, 2002, 2004, 2005, 2006, 2007, 2010, 2011, 2018, 2019, and 2020 corresponded with significant outbreaks of the mulberry moth in the Fergana Valley. During these years, large-scale damage to mulberry plantations was reported, particularly in central and western Fergana.

Conversely, periods of extreme cold, such as those experienced during the winter months of 2002, 2008, and 2014, as well as in the spring months of 2015 and 2021, were associated with a noticeable decline in the population density of the mulberry moth in subsequent seasons. However, despite these cold spells, localized populations of the pest remained in certain areas, particularly in central Fergana and the western regions.

Anomalous climatic conditions were also observed during the summer of 2022, when temperatures in the Fergana Valley were significantly higher than average for prolonged periods. Between July 22-26, temperatures in the eastern part of the valley exceeded 40-41°C, while the southern regions experienced temperatures ranging from 41-42°C during the same period. The western regions saw temperatures around 41°C between June 26-28, and between July 21-27, temperatures reached 41-43°C. In Central Fergana, the last week of June recorded temperatures above 41°C, and the final ten days of July saw temperatures ranging from 42-44°C. These extreme heat conditions, coupled with prolonged dry spells, may have acted as a limiting factor on the spread and development of the mulberry moth.

Notably, despite the extreme heat in 2022, the mulberry moth's population density remained low in Central Fergana and the western regions-areas typically characterized by stable pest populations. In these regions, damage to mulberry trees was minimal by the end of the autumn season. However, in the northern, eastern, and southern parts of the valley, particularly in the adyr and foothill zones, new foci of relatively stable mulberry moth populations were observed (Fig. 1).

From the results of our research on the spread of the mulberry moth in the Fergana Valley, conducted by us over a period of more than 20 years in recent years, it became known that the most significant factors in the expansion of the pest's range were anthropogenic factors, as well as wind, food plant and temperature factors. Among the mentioned factors in the spread of the mulberry moth, a special place belongs to the wind blowing in the direction of the east of the valley.

BIOLOGIYA

Among the mentioned factors in the spread of the mulberry moth, a special place belongs to the wind blowing in the direction of the east of the valley. In particular, if in the vegetation season of 2001 the mulberry moth was distributed at a distance of 73 km from the center of distribution to the north of the valley (Namangan region Yangikurgan district), then in the territories close to the eastern border (Andijan region Kurgantepa district) this pest spreads at a distance of up to 127 km. If during 1997-2001 The average annual speed of spread of the mulberry moth towards the eastern zone of the Fergana Valley was 25.4 km, while in the north direction this figure was 14.6 km, and in the south 7.8 km.

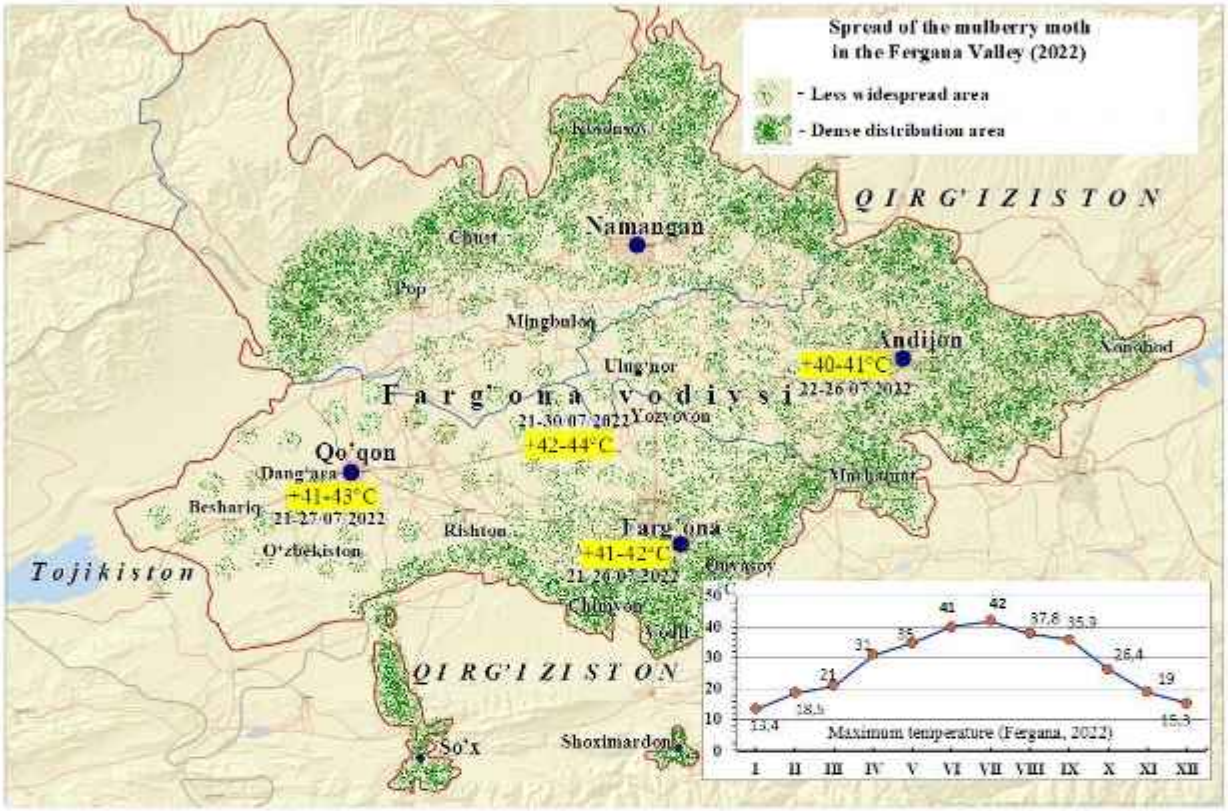

Fig. 1. Spread of the mulberry moth in the Fergana Valley (2022)

In this regard, the situation observed in the 2019 season also fully confirms the above opinion. In particular, in our studies conducted this season in the apple orchards of the Uchkuprik district of the Fergana region, the *Grapholita molesta* that flew onto a white cloth illuminated by a special lantern were sprayed with white phosphorescent reflective paint; the butterflies attracted by the light of the lanterns were noted at different distances, starting from the specified point. As a result of the studies, it was found that the butterflies during the egg-laying period fly within the orchard at a distance of up to 200-300 meters, and that in one evening they are able to spread in the direction of the wind up to 2-5 km (Oksu village, 27.07-18.10.2019).

CONCLUSION

Against the background of global climate change, the processes occurring in the agroecosystems of the Fergana Valley, including unstable changes in seasonal weather conditions, have also affected the distribution of Lepidoptera. In studies conducted in mulberry plantations of the Fergana Valley over the past 25 years, fluctuations in the population density of the mulberry moth associated with seasonal changes in environmental factors were noted. The observed sharp cold snaps in the winter of 2002, 2008, 2014, as well as in the spring months of 2015 and 2021, caused a noticeable decrease in the population density of the mulberry moth in subsequent seasons. The onset of relatively warm and dry winters in the valley has been associated with increased population densities of the mulberry moth in the following season. In contrast to the above-mentioned cases, the observed dry climate conditions, as well as the prolonged effect of days with maximum temperatures in the summer season of 2022, indicate the

possibility of their serious influence as a factor limiting the rate of development of the mulberry moth.

REFERENCES

1. Abhishek Pareek, Meena B.M., Sitaram Sharma, Tetarwal M.L., Kalyan R.K., Meena B.L. Impact of Climate Change on Insect Pests and Their Management Strategies. In book: Climate Change and Sustainable Agriculture. New India Publishing Agency, 2017. P.253-286.

2. Siwei Guo, Xuezhen Ge, Ya Zou, Yuting Zhou, Ta o Wang, Shixiang Zong. Projecting the Global Potential Distribution of Cydia pomonella(Lepidoptera: Tortricidae) Under Historical and RCP4.5 Climate Scenarios // Journal of Insect Science, (2021). 21(2): 15; 1-12.

3. Willy De Prins, Jean-Yves Baugnée, André Georis, René Spronck & Raphaël Spronck. *Choreutis nemorana* (Lepidoptera: Choreutidae) well established in Belgium // Phegea 42 (2) 01.vi. 2014: 29-32.

4. Suckling D. M., Conlong D. E., Carpenter J. E., Bloem K. A., Rendon P., Vreysen M. J. Global range expansion of pest Lepidoptera requires socially acceptable solutions // Biol Invasions, 2017. 19: 1107-1119.

5. Shermatov M.R. Farg'ona vodiysi agroekotizimlari tangachaqanotli hasharotlari (Insecta, Lepidoptera): Biol. fan. dokt. (DSc) diss.. – Toshkent, 2024. - 447 b.

6. Шерматов М.Р. Распространение и зона вредоносности тутовой огнёвки (Lepidoptera, Pyralidae, Pyraustinae) в Ферганской долине // Узбекский биологический журнал. Ташкент, 2014. №6. – С. 36-39.

7. Шерматов М. Р., Ахмедов М. Х. К биологии тутовой огневки (Lepidoptera, Pyralidae) в Ферганской долине // Узбекский биологический журнал. Ташкент, 2002. №4. – С. 53-57.

8. Лакин Г.Ф. Биометрия: Учеб. пособие для биол. спец. вузов-4-е изд., перераб. и доп.-М.: Высш. шк., 1990. – 352 с.

9. Шерматов М.Р. Распространение, биология и экологические особенности тутовой огневки (*Glyphodes pyloalis* Walker) в Ферганской долине: автореф. дис. … канд. биол. наук. Ташкент, 2010. 24 с.