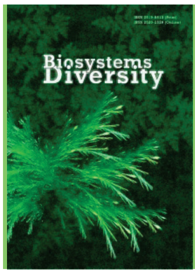

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Elm (*Ulmus*) leaf miners in North-East Kazakhstan

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Leaf miners are increasingly causing damage to plants, often causing their death. There are about 10 thousand species of leaf miners in the world. The purpose of this study is to establish the location, species diversity, as well as the degree of damage caused by leaf miners to the leaves of *Ulmus* L. genus trees in the Pavlodar Region. In the course of the study, a visual inspection of the affected areas was used, as well as the selection, drying of damaged foliage and, subsequently, the removal of larvae and adult insects from it, followed by their study. During the vegetation seasons in 2019–2022, in Pavlodar, Ekibastuz and Aksu cities, as well as in Zhelezinka and Koktobe villages, elm leaves were studied for the presence of leaf miners, a visual inspection of the damage locations was conducted, and samples were taken, which later became the material for growing and detailed study of insects at different development stages. The article considers phyllophagous insects mining elm leaves in the North-East of Kazakhstan (Pavlodar Region) in 2019–2022. In the course of the conducted studies on the territory of the Pavlodar Region, 8 species belonging to 5 genera were identified: *Stigmella* Schrank, 1802, *Orchestes* Illiger, 1798, *Fenusa* Leach, 1817, *Bucculatrix* Zeller, 1839 and *Phyllonorycter* Hubner, 1822. Leaf miners that belong to the *Agromyza* genus of the Agromyzidae family were also identified. All representatives are obligate leaf miners, developing at the larval stage in the mesophyll of elm leaves. Most of the leaf-mining insects are represented by *Agromyza* and *Stigmella* species. They are among the most dangerous for the biocoenosis of the Pavlodar Region. Moreover, *Agromyza* insects have high plasticity and may become a problem in other regions. The obtained data will help to contribute to further studies in this direction, and also show the development degree of an understudied problem: the influence of leaf miners on the nature of Kazakhstan.

Keywords: leaf-mining insects; Nepticulidae; Gracillariidae; Bucculatricidae; Curculionidae; fauna.

Introduction

Pavlodar Region is located in the North-East of Kazakhstan. The Region's territory is represented by various landscape zones: forest-steppe, steppes, dry steppes, semi-desert islands in the South-Western part, mountain landscapes of the Kazakh Uplands.

The *Ulmus* L. genus of woody plants belongs to the elm family (Ulmaceae), which includes a large number of species. The genus representatives are widely distributed on the territory of the Republic of Kazakhstan and other countries. As a rule, these are tall trees with an extensive branched crown and a thick trunk. They are characterised by alternate, simple leaves, most often unequal at the base, rough on top and jagged along the edges. The size of the flowers is small, they are collected in bundles of leaf buds in the axils, in most trees they appear before the leaves blossom. In many cases, female and male flowers form on different trees. Elms are characterised by fruits in the form of rounded samaras. Each of the species of this genus is decorative. The strong, dense, water-resistant wood is effectively used in furniture manufacture, construction, river-ship building, in many cases it is used instead of oak, and is also used for firewood (Kamkin et al., 2011).

In the Pavlodar Region, there are several types of elm: Siberian elm (*Ulmus pumila* L.), wych-elm (*Ulmus glabra* Huds.), American elm (*Ulmus americana* L.). Siberian elm (*U. pumila*) is the most common species. It is a tree up to 20 meters tall with thick, fissured bark. The leaves are alternate, whole, unequal at the base, small, oblong-elliptical, biserrated along the edge. Stipules are lanceolate. It blooms in April. This elm species is light-demanding, halomesoxerophytic, oligotrophic, relatively winter-hardy, drought-resistant under local conditions, insensitive to harmful atmospheric impurities, tolerates significant salinity. The range of elms on the continent is very wide and is connected with various landscapes, in the eastern part of Central Asia, it is most often found along river valleys and mountain slopes. Elms are characterised by rapid growth even in steppe and semi-desert conditions. In Kazakhstan, most often, they are limited to river valleys, settle on pebble and loamy soils, in the foothills of the Dzhungarian Alatau, often in plantations. In Pavlodar Region, they are the main culture of artificial plantations, often penetrating into steppe and forest communities (Dai et al., 2011).

The presence of elms in the artificial windbreaks of the region, and their resettlement in natural biocoenoses, became the reason for this study of organisms connected with this crop (Seliutina et al., 2020). This article is devoted to the study of the phyllophagous insect fauna mining elm leaves in the Pavlodar Region. One of the important problems in both fundamental and applied biology is in the study of the relationship of organisms in altered biocoenoses after the appearance of unusual components in them. Biological invasions of alien species into coenoses are recognised as an important agent of global ecological transformations (Sinchuk et al., 2020; Jacobsen, 2021). The abovementioned, according to researchers, leads to a significant loss of economic value, biological diversity and functions in the invaded ecosystems (Zhang, 2018; Kirichenko et al., 2019). One of the invading groups of organisms that cause changes is leaf parasites of plants, belonging to the leaf miners' group. Leaf miners are a taxonomically diverse association of endophagous insects (Aukema et al., 2010; Kirichenko et al., 2017). Many of them are pests of forestry, cultural and market gardening, and the crop industry in general. Taxa represented by important invasive species are of particular importance in the group of leaf miners (Lopez-Vaamonde et al., 2010; Zhang et al., 2020; Chen et al., 2022).

The main reasons for the leaf miners' migration are global processes, the openness of markets, rapid changes in response in economic relations between countries, often located in different parts of the world (Holoborodko et al., 2022). The listed factors contribute to the penetration of organisms that are not typical for certain geographical regions of the world. In this vein, the group of leaf miners stands apart, because their colonisation of new territories and, accordingly, biogeocoenoses, most often occurs without attracting the attention of specialised services. Therefore, the fauna study of the newly formed faunal complex of leaf-mining insects, their biology and ecology, the invasion by new species of biocoenoses alien to them remains an urgent task for science.

Interpretation of the results of a study of *Ulmus* leaf miners

The studies were conducted in the Pavlodar Region during the vegetation seasons in 2019–2022, in Pavlodar, Ekibastuz and Aksu cities, as well as in Zhelezinka and Koktobe villages (Fig. 1).

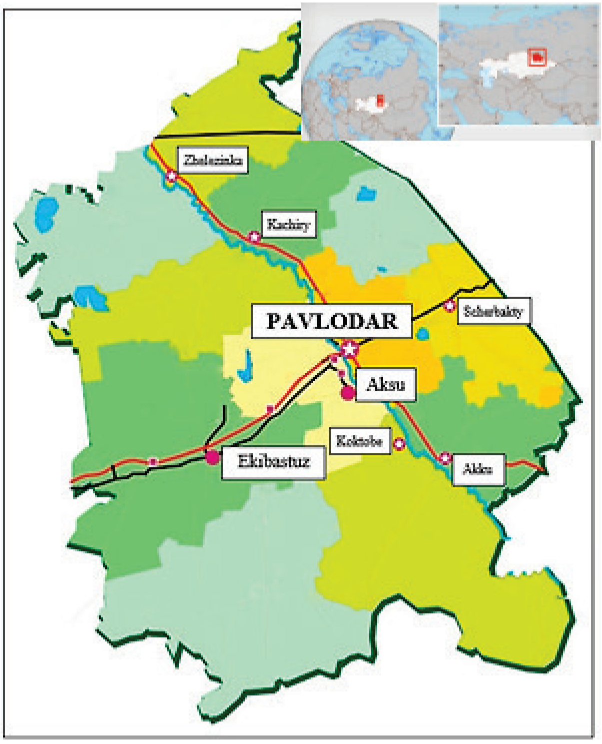

Fig. 1. Places of collection of elm leaves with leaf-mining insects in Pavlodar Region

In general, each leaf-mining insect consumes only a relatively small amount of leaf matter during its life; comparing leaf miners with free-living species, one would be assume that leaf miners could never cause real damage to trees and cultivated plants. However, there are species that should be considered as separate pests. They appear either in excessive numbers, when there are no leaves left on some trees, or when they appear very early, which causes significant damage to the development of very young plants. This applies primarily to the spring generative period. Based on this, an important task is to clarify the conditions contributing to paths of invasion. It is not just the plant parts that have been destroyed by nutrition that are no longer available for food synthesis and translocation that should to be considered; much larger areas of leaves are ringed by the leaf miners' activity; the vessels of the sap-carrying leaves rupture, translocations are interrupted, and nutrients from these areas can no longer be used by the plant as a whole. In addition, large-scale damage occurs even before the drying process begins. Numerous small damages accumulate and cause great harm to the development of the infected tree. Unfortunately, the factors explaining the strong influence of leaf miners on young plants currently remain unclear. The degree of contamination by leaf miners, which leads to similar results has not been assessed. At the same time, the narrow association of leaf miners to individual families of plant taxa is noted.

Phyllophagous insects of the Pavlodar Region, despite their importance, have not been studied. In the course of this study, 8 species of elm phyllophages were identified in the Region, belonging to the Nepticulidae, Gracillariidae, Curculionidae, Tenthredinidae and Bucculatricidae families, to 5 genera: *Stigmella* Schrank, 1802, *Orchestes* Illiger, 1798, *Fenusa* Leach, 1817, *Bucculatrix* Zeller, 1839 and *Phyllonorycter* Hubner, 1822 (Table 1).

Table 1
Insects mining Elm leaves (*Ulmus* L.) (Pavlodar Region, Kazakhstan)

No.	Phyllophagous insect family	Phyllophagous insect genus	Phyllophagous insect species
1	Nepticulidae	*Stigmella* Schrank, 1802	*Stigmella ulmivora* Fologne, 1860, *S. viscerella* Stainton, 1853, *S. lemniscella* Zeller, 1839, *S. kazakhstanica* Puplesis, 1991
2	Gracillariidae	*Phyllonorycter* Hubner, 1822	*Phyllonorycter schreberella* Fabricius, 1781
3	Bucculatricidae	*Bucculatrix* Zeller, 1839	*Bucculatrix capsica* Puplesis & Sruoga, 1991
4	Curculionidae	*Orchestes* Illiger, 1798	*Orchestes alni* Linnaeus, 1758
5	Tenthredinidae	*Fenusa* Leach, 1817	*Fenusa ulmi* Sundevall, 1847
6	Agromyzidae	*Agromyza* Fallen, 1810	*Agromyza* sp.

Leaf miners were also identified, which belong to the *Agromyza* Fallen, 1810 genus of the Agromyzidae family. The share of species of each genus from their total number is presented (Fig. 2). All Nepticulidae species in Pavlodar Region belong to the *Stigmella* genus (4 species). Other miner species are less common: *Orchestes* (1 species), *Fenusa* (1 species), *Bucculatrix* (1 species) and *Phyllonorycter* (1 species). Phyllophagous insects of the *Agromyza* Fallen, 1810 genus were also identified.

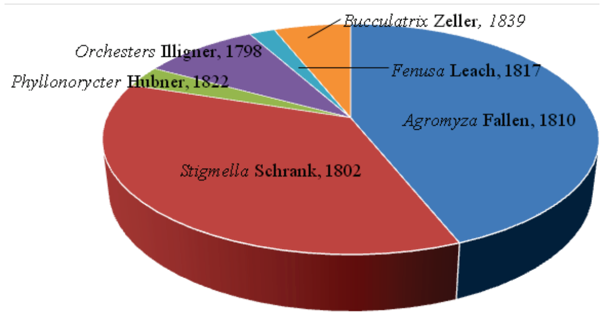

Fig. 2. The ration of phyllophagous insects by genera

Stigmella ulmivora Fologne, 1860 is a common species in Pavlodar Region (Fig. 3). The egg is located in the anterior side of the leaf, usually near the vein. Excrement is linear in the initial part of the mine. The larva is green and blue-green. The larva emerges on the underside of the leaf. The preferred trees are European subboreal type. In the city of Pavlograd this type was found in the Leisure Park, City Embankment, City Garden, Metallurgists Park, Victory Square, Constitution Square, Childhood Square, Bereke Square, Veterans Square; in Ekibastuz city, "Shakhter" Park; in Aksu city, City Park; in Zhelezinka village, Victory Park; from the beginning of June to the end of August 2019-2022, *Ulmus* sp.

Fig. 3. Stigmella ulmivora mines on *Ulmus*

Stigmella viscerella Stainton, 1853 is common and widespread in the region (Fig. 4). The egg is located in the front side of the leaf. The corridor is strongly curved, in the "gut" form. The larva is green. Excrement at the beginning and end of the mine is black and warm brown. In the central part they are folded in the spiral form. Fresh mines are reddish. There can be more than one mine in a leaf.

Fig. 4. *Stigmella viscerella* mines on *Ulmus*

Stigmella lemniscella Zeller, 1839 is a common species in the study region (Fig. 5). The egg can be located both in the front and in the back of the leaf. The mine corridor is relatively narrow, barely widening at the end. The corridor often follows the edge of the leaf for some distance. The excrement is dispersed at the beginning of the mine. The mine exit is on the top side. Pupation is external. The larva is yellow.

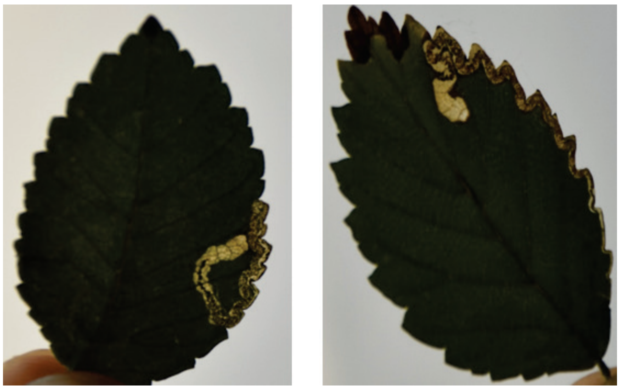

Fig. 5. *Stigmella lemniscella* mines on *Ulmus*

Stigmella kazakhstanica Whitaker & Salzman, 2020 is rare in region (Fig. 6). The egg is located in the front side of the leaf. The mine is curved in shape. It is initially completely filled with brownish excrement. The mine is gradually expanding. The larva can be found in June and August.

Fig. 6. *Stigmella kazakhstanica* mine on *Ulmus*

The study also identified the type of *Bucculatrix caspica* Whitaker & Salzman, 2020 (Fig. 7). Oviposition occurs in front of the leaf. The mine is shaped like a long narrow corridor with black linear deposits. Pupation occurs in the cocoon.

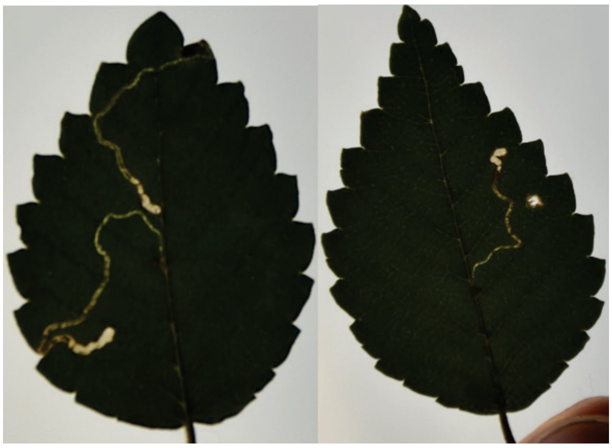

Fig. 7. *Bucculatrix caspica* mines on *Ulmus*

Also, the authors examined the type species *Phyllonorycter schreberella* Fabricius, 1781 for better analysis (Fig. 8). Oviposition occurs at the bottom of the front side of the leaf. The mine is short, from round to oval shape, slightly swollen, the lower surface is tooth-like, often crossing the lateral vein. The epidermis has several folds along its length. The dark brown pupae located in a hard greenish cocoon; the cocoon is free located in the mine, and its wall is not covered with excrement.

Fig. 8. *Phyllonorycter schreberella* mines on *Ulmus*

Mines of *Orchestes alni* Linnaeus, 1758 type were also found in Pavlodar region (Fig. 9). Oviposition occurs in the upper part of the vein; its trace remains visible. From this point, the corridor extends in full depth to the tip of the leaf, where it expands to the spot. The larva eventually pupates in a globular cocoon made inside the mine. Because the mine is made while the leaf is still unfolding, the leaf may be severely deformed. This insect is probably widespread throughout the USA. This miner was found in Quebec and Ontario, Canada.

As for Kazakhstan, mines of *Fenusa ulmi* Sundevall, 1847, affecting foliage were also found on the territory of Pavlodar region (Fig. 10). Oviposition can be in any part of the leaf, connected with the vein. A very transparent spot contains a yellow-white larva. The final mine can occupy a significant part of the leaf. The mine usually starts in the vein's axil, but not at the leaf edge, in large leaves the mine remains limited by the lateral veins. Excrement is in the form of black grains. The sawflies taxonomy feeding on Elm is currently problematic and unresolved.

Mines of the type *Agromyza* Fallen, 1810, were also observed within the boundaries of the study area (Fig. 11). Mines are with a wide stroke, often serpentine, excrement scattered randomly. After the feeding period, the larva leaves the leaf, pupating in puparia in the soil. This type leaves were found in Pavlodar city: Leisure Park, City Embankment, Lenin Park, Metallurgists Park, City Garden, Gagarin Park, Victory Square, Constitution Square, Childhood Square, Bereke Square, Theatre Square, Veterans Square; in Ekibastuz city, "Shakhter" Park; in Aksu city, City Park; in

Zhelezinka village, Victory Park; in Koktobe village, Victory Park; from the beginning of June to the end of August 2019–2022, *Ulmus* sp.

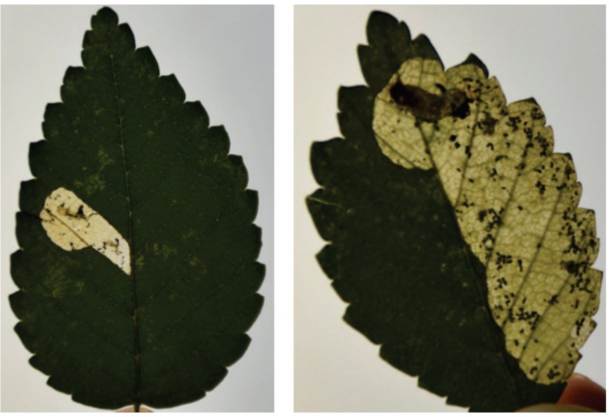

Fig. 9. *Orchestes alni* mines on *Ulmus*

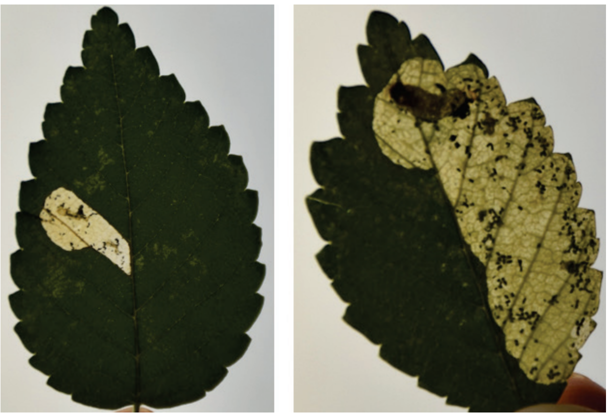

Fig. 10. *Fenusa ulmi* mines on *Ulmus*

Fig. 11. *Agromyza* sp. mines on *Ulmus*

The results of the studies showed the species diversity of leaf miners in the North-East of Kazakhstan. 8 species of this pest were studied and their distribution was established. Recently, there has been a worrying tendency of an accelerated global spread of leaf miners, resulting in increased damage to green spaces and crops, as also shown by the results of this study (Table 2). These tiny leaf-eating insects belong to the family Agromyzidae and are actively expanding their range, affecting different regions and creating significant problems for agriculture and the environment. Although various studies have shown that in most cases these insects have a main plant for food, modern climate change and increased traffic can expand their diets, significantly harming local agriculture and green spaces. In Brazil alone, *Leucoptera coffeella* leaf miners are responsible for the loss of more than 70% of the coffee crop, which causes enormous damage to the economy and food industry.

Table 2
Occurrence of larvae of various leaf miner species in the Pavlodar region

Species	Number of larvae per 100 leaves
Stigmella ulmivora	81.9 ± 3.4
S. viscerella	138.3 ± 7.0
S. lemniscella	92.0 ± 6.0
S. kazakhstanica	5.4 ± 0.7
Phyllonorycter schreberella	24.1 ± 1.7
Bucculatrix caspica	50.5 ± 2.2
Orchestes alni	77.9 ± 4.6
Fenusa ulmi	21.8 ± 1.3
Agromyza sp.	387.8 ± 21.3

Factors contributing to the rapid spread of leaf miners include:

1. Climate change. Along with changing climatic conditions, some areas previously unsuitable for these pests have become favourable for their survival and reproduction. Warm temperatures and altered precipitation create optimal conditions for leaf miners to breed. The activity of leaf miner larvae directly depends on the ambient temperature, the higher the air temperature, the more actively the larvae feed and grow; in the last 20 years, a favourable environment has arisen due to global warming for the development of these insects.

2. Global trade/ International trade and transportation play an important role in the spread of invasive species, including leaf miners. These pests can "take up" plants or agricultural products and get to new places. In recent years, there has been a high activity of trade between the countries of Central Asia and the countries of Africa, which has caused the spread of *Stigmella multispicata* Rociene & Stonis from Siberia to Northern Africa, which can cause irreparable damage to the ecology of this region.

The consequences of the accelerated spread of leaf miners are twofold:

Impact on Green Spaces. Leaf miners cause damage to a variety of green spaces, including ornamental trees, shrubs, and city parks. The spread of infection leads to unsightly appearance of the affected plants and can even lead to premature leaf fall, deteriorating the general condition and aesthetics of green areas.

Damage to crops. Leaf miners are not limited to ornamental plants; they also pose a significant threat to crops. Pests can attack crops such as wheat, rice and corn and tomatoes, resulting in reduced yields and economic losses for farmers and the agricultural industry.

Solving the problem of leaf miners requires an integrated approach, including monitoring, early detection and effective pest control measures. In addition, there is a need to raise awareness among farmers and the agricultural industry about the risks posed by these pests in order to stimulate timely action to mitigate their impact on crops and green spaces. International cooperation and knowledge sharing can also play an important role in managing and containing the global spread of leaf miners.

Assessing the spread and impact of the leaf beetle on green spaces

The results of the studies show that currently the distribution of leafminer is a poorly studied area in the study and preservation of green plantings on the territory of Kazakhstan. Analysing the studies of other scientists, several critically important factors can be identified. For example, Chen et al. (2022) found that in 2022 the colonisation density of the initial generation of leaf-mining moths was about 1.5 ± 0.5 mines per 100 leaves (n = 210). At the same time, a significant number of elms were not damaged by leaf-mining insects. In the authors' studies, it was established that the smallest moth groups were found only on model trees that grew in arroyos. The observations in July made it possible to establish the development of the second generation of leaf miners. The first half of September was characterised by an almost twofold increase in the number of leaf miners on model trees. In 2021, the distribution density of the initial leaf miner generation increased to 49.9 ± 8.2 mines per 100 leaves (n = 187). At this time, all the elms in the forest stand were already inhabited by moths. The growth of the second generation of moths was prevented from progressing by the early fall of elm leaves towards the end of August. In 2022, the initial moth generation reached 234.3 ± 13.5 mines per 100 leaves (n = 169). In June, the approach of the formation of caterpillars from the initial moths' generation was noted. The authors established the fact of oviposition of the adult insects of the initial generation ten days earlier than the standard term. The beginning of August was characterised by the appearance of caterpillar mines of later generations, and the end of August was characterised by the first adult insects of the second generation. Accordingly, the third year of the population distribution of leaf-mining insects in forest plantations can be distinguished by the achievement of the damage limit. This may indicate the formation and further development of the problem with the abovementioned miner in the Pavlodar Region.

Discussing the possible options for the distribution of the insects by to regions with a continental climate, Whitaker & Salzman (2020) suggested that 7 species of leaf miners found by them over the past 15 years were most likely brought with constant traffic flows. The species of leaf miners studied by the abovementioned scientists are characterised by small size, the formation of their main centres of invasion along railways or roads, and a sharp expansion in directions coinciding with transport routes. Leaf miners brought into the territory by rail and road transport were found exactly at the time of the full-fledged development of the region and the active supply of materials by transport (Berggren et al., 2022). This information is partially confirmed by the leaf miners' strategy of spreading throughout the territory of Kazakhstan, although a full-fledged study on this problem has not been conducted.

Xu et al. (2021), describing leaf miners of the *Stigmella ulmivora* species, established that, as a rule, an egg is located on the underside of the leaf near the vein. The nature of the mine is described as a narrow corridor in the mesophile of the leaf blade. The excrement dispersal on the last segment is very variable: sometimes it forms a narrow central line, in another variant it is widely dispersed or even folded (Mou et al., 2016). The larva colour is blue-green. The collections in the Pavlodar Region for the discussed species of miner fully correspond to the characteristics given by the abovementioned authors. In this sense, attention should be paid to the stability of the external features of *S. ulmivora* from different regions of the world.

Bandeira et al. (2021) describe the *Phyllonorycter schreberella* leaf miner and report that it, along with *P. tristrigella*, feeds on elm. However, the two mines are completely different: the mine of *P. schreberella* is short, rounded to oval, kind of swollen, lower surface of the tentiform mine, often crossing a lateral vein, while *P. tristrigella* forms a longer and narrower tubular mine. The epidermis has several longitudinal folds (Yang et al., 2021). The studies of elm leaves in the Pavlodar Region helped clarify and show that the dark brown miner pupa is located in a hard greenish cocoon; the cocoon lies freely in the mine and its wall is not covered with excrement.

The authors' observations on the leaf miner of the *Agromyza* genus are consistent with the studies of Alipanah et al. (2022), who, like us, note that the larva forms mines of a rather atypical shape. It first creates a linear mine moving from the edge of the leaf to its base, reaching the initial divergence of the leaf centre. Subsequently, the larva turns in the opposite direction and forms an expanding serpentine mine. It is at the end and becomes a spot (Maunsell et al., 2016). There may be a slightly different scheme of the mine. In most cases, one larva develops in one mine. Each leaf can hold 1–3 mines. The results of field collections make it possible to discuss certain features of the distribution of leaf miners of elm leaves in Pavlodar Region. The authors note that the overwhelming majority of leaf miners belong to the Agromyzidae family and make up 44% of the total diversity of phyllophagous species, while it is represented by only one genus. This genus is distributed everywhere, both in the immediate proximity of the Irtysh River, and at a distance from it, closer to the Central Kazakhstan part (Ekibastuz city). Perhaps this is an indicator of this taxon's plasticity (Leroy et al., 2020).

Discussing the problem of the phenology of damage to the leaves of tree crops, the point of view of Hobern et al. (2021), who come to the conclusion that some species of leaf mining insects injure leaves in summer, others in spring, and others cover the entire spring-autumn cycle, is supported by the authors of this study. The timing of formation of different generations overlaps, which complicates the establishment of the implementation time of protective operations. The studies of the abovementioned authors on the seasonal dynamics of leaf damage established that the greatest damage occurs in summer (June–August). In the circle of leaf mining insects, representatives of Diptera (Agromizidae flies) and Lepidoptera (leaf-mining moths) dominate, to a lesser extent, Coleoptera (weevils, leaf beetles, buprestid beetles), as well as Hymenoptera (sawflies) (Lacourt, 2020).

The harmfulness of leaf miners is described in the work of Liu et al. (2018). In their studies, they note that the damage caused by leaf miners is expressed in a decrease in the plants' viability, their intensity of fruiting and decorative effect, disruption of growth rates and seed quality. The damage caused by leaf miners increases in areas where one or two closely related plant species are grown, in nurseries, greenhouses, on plantations of forest or medicinal monocultures (Jat et al., 2022).

The work of Tokár & Laštůvka (2018) is devoted to the study of damage caused by leaf miners. They established that for the ovipositor, the female makes punctures from the upper edge of the leaf to obtain plant juice from it. Puncture places reduce the aesthetic characteristics of plant leaves. The larvae, by forming passages in the leaves, cause not only the decrease in efficiency of photosynthesis, but they also provoke earlier leaf falling or wilting. In the photographic materials presented in the article, in the figures, the visible damage to the leaf blade can be fully viewed (Goulet & Bennett, 2021).

The field collections of leaf material with leaf miners, collected by the author of this study on the *Ulmus* genus, confirm the statements described in the comparative study of damaged leaves in the work of Dai et al. (2011). The authors point out that the damage is visually similar to the symptoms of the appearance of leaf spot fungi, as well as various abiotic influences. Differences in the effect of leaf miners on leaves and fungi are quite easy to distinguish if you move the spot area of the leaf apart. In cases of damage caused by leaf miners, holes will be present on the leaf through which the insect enters, and the excrement of leaf miners will be also found. Leaf spot fungi cause damage to these areas without tunnel development (Sinclair & Hughes, 2010).

A kind of special opinion on the harmfulness of leaf miners is available in the publication of Zhang et al. (2020). They state that leaf miners have little or no effect on the life of shrubs and trees. The caused damage is more likely to spoil the appearance, and treatment decisions are made based on the visual problems of the plants. According to researchers, many leaf miners have a large number of natural predators. With their help, as a rule, it is possible to effectively regulate the population of these insects (O'Hanlon et al., 2021). Sharp increases in the number of leaf miners, according to the authors, are rather short-lived. The only exception is invasive species, which are not as effectively controlled by natural enemies. For example, in the state of Colorado (USA), where they were introduced only recently, samples of non-native phyllophagous insects are elm leaf miners (European elm flea weevil, elm leaf beetle), apple and birch leaf miners (Woods et al., 2022).

The results of the authors' studies on elm leaf miners showed that the found and studied species of leaf miners of this tree crop fit the characteristics described by other authors mentioned in the article, which indicates the reliability of diagnosis of the species. In addition, the observations present a practical way to predict the situation with leaf miners of plants of the *Ulmus* genus in the Pavlodar Region of the Republic of Kazakhstan in further studies.

Conclusions

The representatives of the Nepticulidae family (the *Stigmella* genus) are represented in the region by four species of elm leaf miners. In the analysing the process of distribution of the leaf miners of this taxon, it was established that the representatives of *S. ulmivora*, *S. viscerella*, and *S. lemniscella* are the most widespread. These types of leaf miners are found everywhere on the elm. The exception is the *S. kazakhstanica* species, which was established only in Pavlodar city and was not established in elm leaves collections in Aksu and Ekibastuz cities, in the South and North of the region. Thus, in the course of the conducted studies on the territory of Pavlodar Region, 4 species of the *Stigmella* Schrank, 1802 genus and 4 species belonging to other genera were identified: *Orchestes* Illiger, 1798, *Fenusa* Leach, 1817, *Bucculatrix* Zeller, 1839 and *Phyllonorycter* Hubner, 1822. In general, the identified species are characterised by dendrophilicity and confinedness to fodder plants of certain species, i.e., monophagy. Potentially dangerous pests are: *S. viscerella*, *S. lemniscella*, *O. alni*, as well as flies from the *Agromyza* genus, because they form a large number of mines on the leaf blade, which leads to plant suppression and defoliation.

Currently, Kazakhstan remains a "blank spot" in relation to the study of leaf miners. The vegetation on the territory of the country, represented by natural forest stands, forests, cultural plantings of windbreaks, and protective belts of cities, for example, the "Green Belt of Astana", is subject to the possible appearance of introduced species of insects which are part of the "leaf miners" group. Based on this, there is a practical need to understand the process and methods of the leaf miners' introduction to the territory of Kazakhstan, the degree of colonisation of woody vegetation by new species of leaf miners and their relationship with the species of leaf miners characteristic of the country and its specific regions. Therefore, it is urgent to solve the problem of establishing the biodiversity of plant leaf miners for the Republic of Kazakhstan.

The importance of this work is dictated by the need to develop measures to prevent invasion, as well as the emergence of new taxa of leaf miners of cultivated plantations and natural forest stands. The research will contribute to knowledge of global biodiversity and management of invasive species by identifying potentially invasive species, understanding distribution patterns and highlighting the ecological impacts of certain leaf miners. Furthermore, the call of this study to address the lack of research on leaf miners in Kazakhstan emphasizes the importance of filling biogeographical gaps, fostering international scientific collaboration, and facilitating the development of effective conservation and ecosystem management strategies on a broader scale.

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