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## Distribution of *Lymantria dispar* in forests of CSI «Kyzylzharskoe forestry» of the North Kazakhstan region

*Lymantria dispar* is one of the most dangerous, widespread forest pests. In most of its range this species gives periodic outbreaks of mass reproduction. Its polyphage caterpillars can eat about 300 plant species, but they cause special damage to birch plantations. Based on this, a number of studies on the distribution of the *Lymantria dispar* have been conducted in the Kyzylzharskoye forestry in the North Kazakhstan region: accounting, collection, analysis of all stages of pest development. Repeated outbreaks of pest activity were identified in researching territory in 3 zones: minor damage zone (the occurrence of foci less than 30 %), periodic intensive damage zone (31–70 %) and permanent damage (more than 70 %). Also pointed that prolonged drought for several years has a great influence on the duration of outbreaks of *Lymantria dispar* mass reproduction. It confirmed by our records of increasing amount of pests in 2016 and 2017 years. With the aim of exterminating the pest and reducing the foci of infection of birch plantings with *Lymantria dispar*, CSI «Kyzylzharskoe forestry» carried out forest treatment with the biological preparation «Hercules–48 %». This drug belongs to the 3rd class of danger and is safe for people, warm-blooded animals, birds, bees and useful entomofauna.

*Keywords:* oviposition, larvae, pupa, imago, *Lymantria dispar*, spread, phenology, birch, pest.

### Introduction

The forest, as a natural complex, consists of many communities of organisms that have a close relationship in their growth and development and the food chain. Being part of the forest fauna, pests organically enter the forest community. In virgin (natural) forests their life activity does not lead to any destructive consequences and does not harm the existence and renewal of forest vegetation. But forest pests interfere with rational use of forests, therefore they are also called pests of forestry.

Gnawing leaves phyllophages often create complex foci in which damage to the plantations of each species increases manyfold. These species are especially dangerous in the period of outbreaks of mass reproduction. Owing to the open way of life, insects in the active phases of development are directly exposed to climatic factors that favor their nutrition, growth, development, dispersal and reproduction, or cause greater mortality [1]. Among the leaf-eating pests of the North Kazakhstan region in recent years, large foci of the *Lymantria dispar* dominate.

Gypsy moth (*L. dispar*) — the most common species that causes enormous damage not only to deciduous plantations, but also to parkland, and also dangerous for fruit trees [2]. In general, in the forests of the republic, the Gypsy moth is ubiquitous, except for saxaul. Significant harm is brought to the birch forests of Northern Kazakhstan, forest cultures of East Kazakhstan, fruit crops of the south and southeast Kazakhstan and floodplain forests of the West Kazakhstan region. With a high number of caterpillars, the degree of damage to the leaves reaches 80–90 %. Outbreaks of mass reproduction are observed after 6–7 years and are suppressed as a result of epizootic of viral and bacterial diseases causing pest death [3].

### Methodology

*Butterfly-males* of the gypsy moth are 40–55 mm in the wingspan, brownish-gray, females — 60–90 mm, white or yellowish-white; fly in July–August. Males appear 4 to 6 days earlier than females, they are active day and night; females also fly with the onset of twilight; neither males nor females eat. Females put all the eggs in one pile of masonry, lay them and cover them with hairs from the abdomen.

*Egg* round, flattened, with a diameter of 1.18 to 1.35 mm. By the time of wintering, caterpillars are already in the eggs. Eggs are very hardy and can withstand up to minus 50 °C, and also make them invisible in the environment (mimicry). Wintering of the clutches in the litter ensures a good survival of the caterpillars, but in the hibernating masonry (on walls, pillars, etc.), caterpillars often die 70–100 % of the freezing or drying in the early spring period.

The caterpillars born from eggs are yellow at first, after 2–3 days become dark, with a black matte head and six longitudinal rows of warts bearing long thin hairs and short bristles (aerophores), due to which they are easily transported through the air. For several days, depending on the weather, the caterpillars sit on the surface of the masonry, or next to it on a litter, bark or other surface, after which they begin to creep, moving upward and toward the light, in search of food. At this time, owing to the hair and the allocated silk thread, they are easily transported over long distances. The age of the caterpillars is determined by the width of the head capsules.

Caterpillars of the 2nd and 3rd ages are dark, usually with a light chest spot on the dorsal side. Caterpillars of the 4th–6th ages can have a body color ranging from dark gray to light yellowish-red; head capsule dark brown or yellow with two black strips. From the 4th age they reliably differ from caterpillars of other species of leaf-eating insects in the color of paired dorsal warts: the front five pairs are blue, the next six pairs are red.

Pupae are dark brown, matte, with tufts of rare reddish hairs, among the folded leaves in the crowns of trees and shrubs, on trunks, in various cracks and other places [4].

Gypsy moth in the egg stage in winter, with the generated embryos. In spring, with the onset of stable warm weather and at an average daily temperature of 5–6 °C, the caterpillars emerge from the egg. After hatching, they sit for several days in the «mirrors», not creeping, and then rise to the crown (when the buds begin to blossom). Caterpillars during this period are very light, covered with dense bristles, at the base of which there are aerial air bubbles. This facilitates the resettlement of caterpillars by the wind at considerable distances from the vertex of the deposition. After the flight, the caterpillars begin to eat. Trees are damaged in the flowering stage and growth stage. Caterpillars of younger ages feed on the buds, then skeletonize the leaf and gnaw it off the edges, and the caterpillars of the last two ages become very voracious and roughly tear the entire leaf [5].

The *Lymantria dispar* is a thermophilic species. Optimum temperature of development is 20–25 °C. At this temperature development takes 35–40 days, at lower temperatures development is delayed to 50–80 days; at a temperature of less than 100 °C — ceases. The sum of the average daily temperatures required for development is 650–700 °C. The caterpillar pupates in June–early July in crowns, on trunks, in cracks in the cortex and other secluded places. The pupa phase lasts 12–20 days.

Flight begins in July, sometimes earlier, depending on geographical location and weather conditions. Males fly out 5–7 days earlier than females. Females of Western European populations do not fly, Eastern European flights do for distances of 100–200 m, Siberian and Far Eastern are capable of active flight over long distances [3].

#### Results and discussion

The *Lymantria dispar* phenology in 2017 was studied in the territory of Kyzylzhar district in forests of CSI (Communal State Institution) «Kyzylzharskoe forestry» and CSI «Sokolovskoe forestry». Observations of this quarantine object have been carried out since April. To determine the viability of oviposition, specimens were collected in Bogolyubovskoe (12.04) and Nalobinskoe (18.04) forest areas and in laboratory conditions the hatching of caterpillars was noted on 19 April.

According to the conducted researches, the appearance of the first caterpillars in the forests of the Kyzylzhar region occurred on May 05 (Table 1).

Table 1

#### Indicators of development and appearance of phases of *Lymantria dispar* in birch plantations of Kyzylzhar district of North Kazakhstan region

Development phase	Date of occurrence of phases	Phase
The 1st appearance of caterpillars	05.05.2017	Caterpillar
Mass output of caterpillars	19.05.2017	
The appearance of the 1 <sup>st</sup> pupae	06.06.2017	Pupa
End of pupation	08.07.2017	
The appearance of the 1st adults	19.06.2017	Imago
The beginning of a mass flying of imago	23.07.2017	
The end of the flying	05.08.2017	

Beginning of hatching of *Lymantria dispar* caterpillars was observed on May 5 in forest plantations of Vagulinsky rural district of Vinogradovskoe forestry at the air temperature +14,0 °C, the sum of average daily positive temperatures for this period was 284.0 °C. In natural conditions, the hatching of caterpillars from eggs is observed simultaneously with the appearance of the birch buds, since it is here that it is the main fodder.

The newly born caterpillars were in original «mirrors». Mass hatching of caterpillars and movement to the crown was observed on May 16 in the Lesnoy rural district in the Nalobinskoe forestry. In the second decade of May the caterpillars of the *Lymantria dispar* were in the 1st age. The harmfulness of the caterpillars was noted in the third decade of May and the age of the caterpillars of the silkworm was: the 2nd age — 90 %, the 3rd age — 10 %.

In the third decade, pupation of gypsy moths caterpillars began. The pupa phase continued in the first and second decades of July. Pheromone traps were installed on the territory of forest districts of Kyzylzhar region to determine the beginning of the flight of male moths (Figure).



Figure. Pheromone trap

The beginning of the flight of butterflies was observed on July 19 in the Kyzylzhar rural district, which was later than last year (11.07.2016). The first to fly males. The fly of the pest imago occurred in the period from the first decade of July to the second decade of August. During the year, *Lymantria dispar* developed only in one generation.

Based on the results of the research, a table of the main phases of development of the *Lymantria dispar* during the whole of 2017 in the territory of the Kyzylzhar region of the North Kazakhstan region was compiled (Table 2).

Table 2

**Development of *Lymantria dispar* in conditions of Kyzylzhar district of North Kazakhstan region in 2017**

January– March	Months (decades)																						
	April			May			June			July			August			September			October			November– December	
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3		
E	E	E	E	E	E	E																	
		L	L	L	L	L	L	L															
							P	P	P	P													
										I	I	I	I										
												E	E	E	E	E	E	E	E	E	E	E	E

Note. E — egg; L — larvae; P — pupa; I — Imago.

According to the phenological observations of the *Lymantria dispar* for 2017, it is possible to make an approximate forecast for the time of hatching, pupation, appearance of an adult pest and laying eggs for the following year.

To determine the degree of infection of forests by *Lymantria dispar*, from September 4 to October 2, an autumn monitoring was carried out on an area of 1368 hectares, of which 84.4 hectares of area was infected with this pest. During the survey at the beginning of the third decade of September, the laying of *Lymantria dispar* in the Kyzylzhar rural district of the Kuybyshevskoe forestry and the Arkhangel'skiy rural district of the Bogolyubovskoe forestry was discovered. The analysis of the selected samples showed that the number of eggs in the oviposition ranges from 96 to 601 eggs. The percentage of damaged and eaten eggs is 1.0–4.0 %. During the autumn survey, the number of infected trees is 0.1 %.

Due to the low degree of infestation of forests in the Kyzylzhar region by *Lymantria dispar* in 2017, under optimal weather conditions, a focal pattern of damage to the *Lymantria dispar* should be expected for the next year.

On the territory of CSI «Kyzylzharskoye forestry», the predominant species is birch, which is 84.8 % of the total forest area. Therefore, in these forest stands of the CSI special attention is paid to the detection and destruction of eggs of the *Lymantria dispar*. Forester and forest pathologist 2 times a year conduct a detailed forest pathological examination of trees for the presence of oviposition, caterpillars and pupae of *Lymantria dispar* and apply effective preparations for pest control.

In 2016, in the forests of CSI «Kyzylzharskoe forestry» with a total area of 1416.34 hectares, an examination was conducted for the degree of infection by the *Lymantria dispar* (Table 3).

Table 3

**Area of inspection and infection of *Lymantria dispar* in forest areas of CSI «Kyzylzharskoe forestry» in 2016**

Forest area	Survey area, ha	Average number of ovipositions per tree	Area of infection, ha
Teplovskoe	289.14	2	6.1
Bogolyubovskoe	131.4	2	2.5
Kuibyshevskoe	786.0	2	7.5
Sosnovskoe	209.8	–	–
Total in CSI	1416.34	2	16.1

During the forest inspection, foci of *Lymantria dispar* eggs were found on an area of 16.1 hectares, of which the area of infection in the Teplovskoe forestry area was 6.1 hectares, Bogolyubovskoe — 2.5 hectares and Kuibyshevskoe — 7.5 hectares. The average number of pest oviposition per tree was 2 pieces, which makes it possible to judge a satisfactory forest pathological situation, and in the Sosnovskoe forestry there were no foci of infection by an unpaired silkworm.

When examining the territory of the State Forest Fund of the North Kazakhstan region, it was established that the average number of eggs of an *Lymantria dispar* per tree varies from 1 to 4 pieces and a forecast was made for forest damage from the life of the pest for 2017. To achieve effective control measures since the appearance of foliage, fighter measures were taken to combat the quarantine pest of the *Lymantria dispar*.

In 2017, outbreaks of mass distribution of *Lymantria dispar* on the territory of 247 hectares of forest plantations were observed in the regions of the North Kazakhstan region. The infestation of forest tracts by oviposition was also noted in CSI «Kyzylzharskoe forestry» (area 84.4 ha) (Table 4).

Table 4

**Area of inspection and infection of *Lymantria dispar* in forest areas of CSI «Kyzylzharskoe forestry» in 2017**

Forest area	Survey area, ha	Average number of ovipositions per tree	Area of infection, hectares
Teplovskoe	51.5	0	0
Bogolyubovskoe	350.5	1	47.7
Kuibyshevskoe	304.7	1	36.7
Sosnovskoe	–	–	–
Total in CSI	706.7	1	84.4

The total area of the forest plantations surveyed in the territory of CSI «Kyzylzharskoe forestry» is 706,7 ha. While in the Sosnovskoe forestry, a survey of forest plantations was not carried out, because in 2016, the foci of infection by an gypsy moth were not detected.

In 2017, the total area of infection by an unpaired silkworm in the CSI «Kyzylzharskoye forestry» was 84.4 ha and exceeds the infection area by almost 5 times compared to the data for 2016. So, in the Bogolyubovskoye forestry the area of infection was 47.7 ha, in Kuibyshevskoye — 36.7 ha. Due to the fact that the Kyzylzhar region is located on the border with the Russian Federation, the increase in the area of infection in the forestry can be explained with the flight of a *Lymantria dispar* from the border areas. As is known, the *Lymantria dispar* is characterized both by mass outbreaks of reproduction and by their recessions in significant areas of forests. In Teplovskoye forestry in 2017, we found the absence of eggs of the *Lymantria dispar*.

With the aim of exterminating the pest and reducing the foci of infection of birch plantings with an *Lymantria dispar*, treatment with the help of the biochemical «Hercules 48 %» was carried out at CSI «Kyzylzharskoye forestry». This drug belongs to the 3rd class of danger and is safe for people, warm-blooded animals, birds, bees and useful entomofauna. The effectiveness of the drug «Hercules» is 98 %, which makes it possible to judge the success of the treatment of plantings against the *Lymantria dispar* with this drug.

Monitoring surveys of forest plantings in the North Kazakhstan region to identify the presence of *Lymantria dispar* were conducted in September-October 2017, and in CSI «Kyzylzharskoye forestry» in order to identify the presence of egg-laying *Lymantria dispar* in the plantations were laid trial plots in the territory of the Kuibyshevskoye forestry. In a detailed survey of these areas, the egg-laying of the *Lymantria dispar* was not detected.

Analyzing the results of research on the infestation of the forests of the CSI «Kyzylzharskoye forestry», we can note the tendency to reduce the damage to forests by *Lymantria dispar*.

We established that the largest outbreaks of mass reproduction of *Lymantria dispar* in the territory of the district are observed in 2016 and 2017, which we associate with weather conditions. Two, or three years before the mass reproduction of the *Lymantria dispar*, in the period of the smallest pest, spring, spring-summer or summer droughts are observed. The greatest significance for the realization of silkworm outbreaks is not so much the duration of droughts, as their intensity. If the droughts were spring-summer and intense, then the outbreak reached a high mark the next year. If the climatic conditions are not stable, but intense droughts are present within one month, the prodromal phase ranges from three to five years depending on climatic conditions. When climatic conditions can not be called stable, no drought, and prodromal phase is developed in connection with fluctuations of temperate and rainy conditions, the outbreak of mass reproduction of the gypsy moth is slowed down before the onset of more favorable climatic conditions. Thus, the climate is crucial for the further dynamics of the outbreak of the pest. Climatic conditions also have an effect on the nature of the outbreak of the flare. The onset of unfavorable climatic conditions (excessively wet) leads to the attenuation of the outbreak of the pest the next year, which was noted in 2010.

### Conclusion

In Kazakhstan, the frequency of an outbreak of mass reproduction of a *Lymantria dispar* was noted at 20 years and in 3–5 years. In the North-Kazakhstan region, along the perimeter of the border with the Russian Federation (Kurgan Region) and Kostanay Region, there was also a massive dispersal of the pest of plants, i.e. phytophagous. His settlement was recorded in Zhambyl, Mamlyut, Kyzylzhar, Ayyrtau and Yesil districts, which allows us to conclude that there are outbreaks in very large areas.

The outbreak of pest activity in the region is explained by the mobility of this pest, so the silkworm comes to us from the Chelyabinsk region. From harmful caterpillars fruit trees in orchards, plantings in cottages and in kitchen gardens also suffered. The forests near the Russian-Kazakh border were literally denuded, all these foliage were eaten by these caterpillars.

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## Солтүстік Қазақстан облысының «Қызылжар орман шаруашылығы» ҚММ ормандарында *Lymantria dispar* таралуы

*Lymantria dispar* орман зиянкестерінің ішіндегі ерекше қауіпті өкілдерінің бірі болып табылады. Таралу аймағының көп бөлігінің бұл түрі көп мөлшерде таралу ошағын құрайды. Оның улы құрты өсімдіктердің 300 түрге жуығын жояды, ерекше зақымдайтындары ақ қайың екпелері болып саналады. Осы себептерге байланысты Солтүстік Қазақстан облысының «Қызылжар орман шаруашылығында» сарықанат жібек көбелегінің таралуы бойынша зерттеу: есеп, санағы, зақымдағыштың таралу сатыларын анықтап талдау жұмыстары жүргізілді. Зерттеу аумақтарының 3 зоналарында зиянкестердің белсенділігінің бірнеше таралу аймақтары анықталды: болмашы зиян келтіру (30 % дан төмен кездесетін ошақтары), қарқынды мерзімдік зиян келтіру (30–70 %) және үздіксіз зиян келтіру (70 % көп). Сонымен қоса сарықанат жібек көбелегінің көп мөлшерде көбею ошақтарының таралып жалғасуының себебі бірнеше жылдар бойы құрғақшылықтың ұзаққа созылуы үлкен әсерін тигізді. Бұл біздің есептеуімізде зиянкестер санының 2016 және 2017 жж. көбейгені дәлелдеген. Зиянкестерді жою мақсатында және ақ қайың екпелерінде сарықанат жібек көбелектерінің зақымдау ошағын азайту үшін «Қызылжар орман шаруашылығында» ҚММ «Геркулес-48 %» биопрепаратымен ормандарды өңдеу жұмыстары жүргізілді. Аталып отырған препарат қауіптілігі бойынша 3-класқа жатқызылады және де адамдарға, жылықанды жануарларға, құстарға, араларға және пайдалы энтомофаунаға қауіпсіз болып табылады.

*Кілт сөздер:* жұмыртқалау, дернәсіл, қуыршақ, имаго, сарықанат жібек көбелек, таралуы, фенологиясы, ақ қайың, зақымдағыш.

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## Распространение *Lymantria dispar* в лесах КГУ «Лесное хозяйство Кызылжарское» Северо-Казахстанской области

*Lymantria dispar* является одним из самых наиболее опасных распространенных вредителей леса. На большей части своего ареала этот вид дает периодические вспышки массового размножения. Его многоядные гусеницы способны поедать около 300 видов растений, но особенный вред наносят березовым насаждениям. Исходя из этого в «Лесном хозяйстве Кызылжарское» Северо-Казахстанской области провели ряд исследований по распространению непарного шелкопряда: учет, сбор, анализ всех стадий развития вредителя. На изучаемой территории были установлены неоднократные вспышки активности вредителя в 3 зонах: незначительного вреда (встречаемость очагов меньше 30 %), периодического интенсивного вреда (31–70 %) и перманентного вреда (более 70 %). Также отмечено, что на продолжительность вспышек массового размножения непарного шелкопряда большое влияние оказывает длительная засуха в течение нескольких лет. Это подтверждено в наших учетах повышением численности вредителя в 2016 и 2017 гг. С целью истребления вредителя и уменьшения очагов заражения березовых насаждений непарным шелкопрядом в КГУ «Лесное хозяйство Кызылжарское» проводилась обработка лесов биопрепаратом «Геркулес-48 %». Данный препарат относится к 3 классу опасности и является безопасным для людей, теплокровных животных, птиц, пчел и полезной энтомофауны.

*Ключевые слова:* яйцекладка, личинка, куколка, имаго, непарный шелкопряд, распространение, фенология, береза, вредитель.

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