

Biology and Harmfulness of Lepidoptera (Insecta: Lepidoptera) Damaging Generative Organs of Saxaul (Chenopodiaceae : Haloxylon) in the South-East desert Area of Kazakhstan

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Insects, as one of the most important biogenic factors that have a significant impact on the survival of seedlings and productivity of Saxaul (Haloxylon). Eating or developing in the inside of the trunk, branches, shoots, leaves, roots, flowers and fruits, they cause significant changes in the composition and structure of plant communities, negatively affect the lifespan of plants, and overall for productivity of the grassland. In studies conducted in the desert area of the South-East of Kazakhstan we registered 35 species of Lepidoptera on the Saxaul (Haloxylon) that were trophically associated with different organs, and among them 8 species were as the potential pests of generative organs.

Key words: Saxaul (Haloxylon), pests, Lepidoptera, harmfulness.

Since the end of the twentieth century worldwide significantly increased the size of the desertification because of the abiotic and anthropogenic factors. According to the report of the 4th GEF Assembly in 2010 the 24% of land worldwide is degraded; among them for about 20-25% of degrading land is rangeland¹. In Kazakhstan since the 60-ies the territory of desertification increased by 10-12%.

Desert and semi-desert areas of Kazakhstan occupy a large area - more than 124 million hectares. Forests in Kazakhstan are rear and they differ greatly from other forests in the world. Saxaul forest occupies 49.7% out of 26.7 million hectares of the forest fund of Kazakhstan (about 15 million hectares)². Saxaul forest zones form a special type of desert vegetation and they play a huge role in maintaining the balance of the

desert ecosystem. In addition they clamp sands, protect pastures and have a sanitary-hygienic value. Clamping the huge masses of sandy and sandy loam soils, they protect oases, channels, transport roads, pipelines and industrial objects from the filling of sand and increase pasture productivity.

In recent years, in the desert area of South and South-Eastern Kazakhstan in the fight against desertification a reforestation is conducted. For example, in Kyzylorda by the AASB (Afforestation of the Aral Sea Bed) program of the World Bank in 2015 year the cultivation of Haloxylon was produced on more than 79 thousand hectares. State Institution for the protection of forests and wildlife in Zhambyl and Almaty areas annually produced crops of Saxaul in average of 400-500 ha. The expansion of artificial areas of Saxaul depends upon many abiotic and biotic factors, and the survival rate of seedlings is very low.

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Insects, as one of the most important biogenic factors that have a significant impact on the survival rate of seedlings and on the vegetative productivity of Saxaul. Caterpillars of Lepidoptera are eating the young shoots, leaves and generative organs of Saxaul. Developing in the inside of the trunk, branches, roots, flowers and fruits, they inhibit the growth and longevity of plants. Their mass reproduction changes the composition and structure of plant communities, reducing the productivity of forage lands^{3,4}. The harmful activities of Lepidoptera play a special role in the damaging of the generative organs of Saxaul^{5,6}. Their harmful activities spreading over the large areas, reduce the biomass of plants up to 30%, and seeds productivity for more than 30%, in some areas up to 80%⁷.

The important issues in combating major pests of generative organs of Saxaul are the establishing of harmfulness and the vulnerable stages of development of insects.

MATERIALS AND METHODS

The basis for this work was the materials collected by authors in the deserts of Sariesikatirau, the Moyinkum and the Taukum in 2014-2015. Faunal collections and observations of the biology of harmful of Lepidoptera were carried out starting from the second decade of April till

the second decade of October in Saxaul forests and crops of the State institution for the protection of forests and wildlife in Zhambyl and Almaty areas.

The harmfulness identification of collected species of Lepidoptera was carried out by the laboratory staff "Taxonomy of insects" - Sinew S. Y., Mattov A. Y. "Institute of Zoology" Russian Academy of Sciences of Saint-Petersburg and by Yakovlev R.V. (FSBAO HPE "Altai State University", Barnaul, Russia). We express them a great gratitude.

During the fieldwork for the collection of Lepidoptera faunal material were used the generally accepted methods in entomology⁸⁻¹⁰ with the following modifications: a monitoring of caterpillars nutrition of the various organs of Saxaul was carried out in a night time; for catching of imago was used a gasoline generator with output power of 1kW/hour and a 500 watts luminescent lamp.

To determine the total number (population density) of caterpillars of Lepidoptera in some parts of Saxaul, the average number of caterpillars on a single tree of 10 trees was calculated. In the autumn the number of Saxaul seeds and its damage were determined. From the total mass of collected seeds was chosen 1 kg. After that by a method of quartering was selected a certain number of seeds for the further conduction of practices in assessing the damage and germination.

Table 1. Definition of a voracity of caterpillar of *Orgyia dubia* Tausch. Bakanas, may 2015

Variants	The number of caterpillars in options	The average number of leaves on single branches	The average number of damaged leaves	The number of damaged leaves in %
1	3	25	5	20
2	5	25	7	28
3	7	25	12	48
4	10	25	17	68

Table 2. The harmfulness of caterpillars of *Phtheochroa subfumida* *Hysterosia subfumida* Flkv., September-October, Bakanas, 2015

The number of caterpillars per one plant	The number of seeds on 1 branche of Haloxylon	The number of damaged seeds on 1 branch of Haloxylon	The percentage of damaged seeds
10	210	57,33	27,3
25	210	89,25	42,5
50	210	181,89	86,6
Control	210	-	-

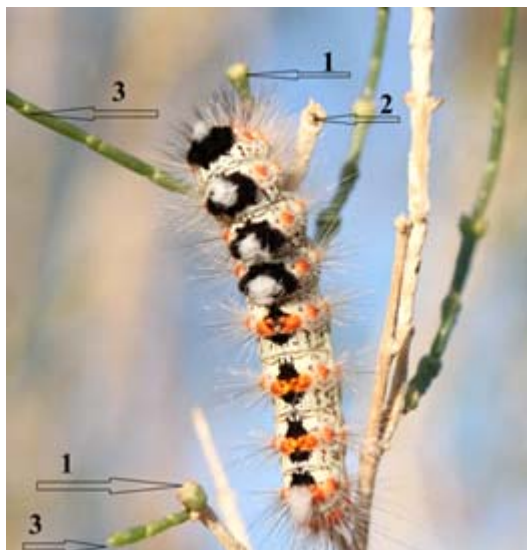


Fig. 1. Caterpillar of *Orgyia dubia* Tausch. Is damaging the assimilating shoots: 1 – damaged shoots, 2 – damaged shoots of last year, 3- undamaged shoots



Fig. 2. Caterpillar of *Pseudohadena immunda* in a ground cocoon before pupation



Fig. 3. A-outlet of the caterpillar, B-receptacle, C-petals

The harmfulness of caterpillars of *Orgyia dudia* Tausch. and *Hysterosia subfumida* Flkv. was carried out in special cages that were placed on the twigs of plants. Were added for 10 caterpillars of middle age (at this age would be carried out tests with insecticides). The number of healthy leaves was counted before adding the caterpillars, then in 5 days after adding and in the end of experiment development was counted the number of damaged leaves and fruits. The harmfulness of caterpillars was rechecked four times.

The harmfulness damaging of seeds by caterpillars was determined by the coefficient of harmfulness – q [11], by the formula:

$$q = \frac{(a - b)}{a} \cdot 100$$

where,

q – a coefficient of harmfulness;

a – is the number of intact organs (seed);

b – is the number of damaged organs (seeds).

In autumn after the harvest of the seeds of *Haloxylon* was determined the degree of damage by caterpillars of *Gelechiidae* and the *Case-bearer*. Samples of seeds were taken from 10 trees; the collected seeds of *Haloxylon* were carefully mixed, and then by a method of quartering was left the required number of seeds. After that the number of damaged seeds and the number of caterpillars in this sample was counted. In laboratory was determined the weight of 1000 seeds, among 100 seeds was counted the number of damaged, non-damaged seeds and the number of caterpillars per 1 kg.

To test the influence of insecticides against many species of caterpillars that are damaging generative organs of *Saxaul* (*Haloxylon*) were selected insecticides from the “List of pesticides (agricultural chemicals), approved for use on the territory of the Republic of Kazakhstan for 2013-2022”¹².

The discussion and results

The studies conducted in the desert area of the South-East of Kazakhstan we registered 35 species of *Lepidoptera* on the *Saxaul* that were trophically associated with different organs, and among them 8 species were as the potential pests of generative organs⁶. Their development and feeding by the generative organs are associated



Fig. 4. The caterpillars of *Case-bearer* (A) and *Hysterosia subfumida* (B) are damaging seeds of Saxaul

with biological features development of Saxaul and are divided into two seasons: spring species, that are damaging flowers and autumn species – damaging seeds or fruits of Saxaul.

Biology of Lepidoptera that are damaging generative organs of Saxaul

In terms of deserts, seasonal and trophic relations of insects with Saxaul, including Lepidoptera are multifaceted. They are characterized with a synchronous development of the host plants and their organs. For example, during the growing period of Saxaul, harmfulness of Lepidoptera that are damaging generative organs appears twice: in spring, when the plant is in the phase of flowering and autumn, when we see the formation of fruits (seeds). Below is the resulting data on the biology and food relations and the harmfulness of some species of Lepidoptera inhabiting of Saxaul.

***Orgyia dubia* Tausch (Lepidoptera: Erebidae, Orgyidae)**

Is widespread in Europe, North Africa, Central Asia, Central Asia¹³⁻¹⁵. In Kazakhstan is widespread in the zone of deserts and semi-deserts everywhere. As a pest of Saxaul was marked by the researches Parfentiev V. J. and Nurmuratov T. N.^{7,16}.

Morphology

The wingspan of the male *Orgyia dubia* is from 18 to 25 mm. Length of a tendril is equal to the third part of the body. Front fender is off-white and yellowish, with brown wavy lines. Female *Orgyia dubia* is wingless, vermiform, chunky, thorax and abdomen are yellowish, length is up to

20 mm. The egg is whitish globular-smooth, with a diameter of about 1.5 mm. The adult caterpillar is cylindrical, with a length from 15 mm to 30 mm. On the dorsal side, starting from the fourth body segment it has four black beams, with the middle of white colour, the same figure is on the last segment (Fig.1). Bristle-like hairs are white and black, of different lengths, they are arranged on colored bumps (mostly black, white and orange), and all over the body are grouped in a bunch. Pupa is yellowish, in a silky cocoon, covered with sparse hairs.

Biology

According to our observation, the first caterpillars appear in late April, and in some years (in cold spring) - at the beginning of May. The peak of their appearance is at the end of May. According to V.Ya. Parfentyev¹⁶ *Orgyia dubia* develops in two generations. The first generation is in the beginning of June and the second generation is in the late of July or early in August. Caterpillars are active during the morning and evening hours of the day.

Harmfulness

Caterpillars of the first generation of *Orgyia dubia* damage the assimilating shoots or leaves and generative organs of Saxaul. Damaging the assimilating shoots they stop their further growth, thereby prevents the formation of generative organs and the supply of nutrients to the plant. As the result the shoots dry up, where the generative organs do not generate (Fig. 1). For the definition of voracity of caterpillars of the middle ages (mainly 3) of *Orgyia dubia*, were

selected an equal branches of Saksaul with 25 asimilitude shoots (leaves) left, almost the same length (average length of shoots is 10 cm). At the end of caterpillars feeding (before pupation) was counted the number of damaged leaves. The results obtained are shown in table 1.

The table shows that if the number of caterpillars is three on one branch, the plant loses 20% of assimilatory leaves within 12 days, respectively 5 – 28%, 7 – 10% and 48 – 68%. Thus, if the number of caterpillars of *Orgyia dubia* is three on one branch of Saxaul it is necessary to conduct a chemical treatment.

***Pseudohadena immunda* Ev**

A light brown butterfly with a wing span of 40-45 mm.

Biology

The caterpillars appear in late March and early April. Their full development is completed at the end of May. Then the caterpillars pupate in the vicinity of plants, in the ground cocoon (Fig. 2) at a depth of 10 cm. In late May and early June the imago appears, their maximum occurrence is observed in mid-June. With the onset of hot summer (August) the appearance of imago is almost finished. Further from the end of September till the early October oviposition happens. The eggs are discharged under the plant in crevices on the surface of the soil. They are very solid, ranging in size from 1 mm to 1.5 mm.

Harmfulness

Pseudohadena immunda from time to time, gives mass reproduction. On pastures of Betpakdala in 1967 the number of caterpillars reached for 124 per 1 m² on the area of 500 thousand hectares, and in 1969 in the Ili basin deserts their harmfulness is marked on the area of 50 hectares. At the same time on one bush of Saksaul with a height of 90 cm there were 162 caterpillars, with a height of 45 cm there were 118 caterpillars [17, 18].

The harmfulness of *Hysterosia subfumida* Flkv., on Saxaul. In the years of observation in the South Pribullshje were met in a big mass 1 species of *Hysterosia subfumida* and 1 species of the Case-bearer which are the main pests of seeds of Saxaul. The nature and time of damage to these species it similar. Both are developing inside the seeds (Fig.3 and 4).

During the study period we have studied the harmfulness of *Hysterosia subfumida* and *Case-*

bearer. The results of these surveys are shown in table 2.

The period of harmfulness activity of *Phtheochroa subfumida* is 25-30 days. During its development one caterpillar eats up on average from 5.7 to 18.8 seeds of Saxaul. The harmfulness of *Phtheochroa subfumida* depends on the size, weather conditions and other reasons.

CONCLUSION

In studies conducted in the desert area of South-East of Kazakhstan we registered 35 species of Lepidoptera on the Haloxylon that were trophically associated with different organs, among them 8 species as the potential pests of generative organs. Their development and feeding by the generative organs are associated with biological features development of Haloxylon and are divided into two seasons: spring species, that are damaging flowers and autumn species – damaging seeds or fruits of Haloxylon.

Species diversity of Lepidoptera leaving on Haloxylon are subdivided into the following family: *Cossidae* - Teredo; *Tortricidae* - Leafroller – 1; *Coleophoridae* - the Case-bearer -2; *Scythrididae*- Flower moths -2; *Gelechiidae* - Twirler moths -1; *Pyalidae* - Snout moths -3; *Sphingidae* – Hawk moths -1; *Zygaenidae* - Burnet or Forester moths -1; *Geometridae* – Inchworms -1; *Lasiocampidae* – Eggars, Snout moths, or Lappet moths -1; *Noctuidae* – Owlet moths -17; *Arctiinae* – Erebid moths-2; *Orgyidae*-Orgids-1. The pests are divided into different groups depending upon the plant organs they affect: pests of shoots of 12 species, shoots and leaves – 9, shoots and seeds 3, shoots, leaves and seeds of -1 seeds - 4, leaves – 3, and the stem – 1, root – 1, stem – 1. According to the trophical specialization they are subdivided into: monophagy - 2 types, narrow oligophagy – 12, oligophages – 2, wide oligophagy – 8 and polyphages – 11.

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