COLEOPTERAN SPECIES (INSECTA: COLEOPTERA), FEEDING ON SAXAUL (*AMARANTHACEAE: HALOXYLO*N) IN DESERT AREAS OF SOUTH-EASTERN KAZAKHSTAN

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Резюме

По результатам проведенных исследований и наблюдений нами на юго-востоке Казахстана в зоне пустынь в 2014-2015 гг, на саксауле из отмеченых 17 видов жесткокрылых (INSECTA: Coleoptera). Жуки обнаруженные нами в зоне пустынь повреждают генеративные, вегетативные, а их личинки повреждают корни и стволы саксаула.

Они распространена повсеместно. Среди них, как вредители корней выделяются: *Julodis variolaris Pall., Sphenoptera orichalcea Pall.* и *Sphenoptera potanini Jak.* Они повреждают корни многих видов диких пастбищных растений и в том числе саксаула в зоне пустынь юго-востоке Казахстана.

Abstract

A study on the diversity, distribution, bio-ecology and harmfulness of insect pests, feeding on saxauls particularly in man-made areas, is considered an urgent task of the agro-ecological science in Kazakhstan.

As a result of the research in 2014-2015 a total of 17 *Coleopteran* species (Insecta: Coleoptera) were found in the desert areas in South-Eastern Kazakhstan, 6 of them being most common and potential pests of the vegetative and generative organs as well as of the root system of saxaul.

Among them, particularly dangerous as pests of the root system were *Julodis variolaris* Pall., *Sphenoptera orichalcea* Pall., and *Sphenoptera potanini* Jak.

Key words: species composition, beetle fauna, distribution, pests, Haloxylon.

INTRODUCTION

Haloxylon species (*Amaranthaceae*), known also as saxaul, inhabit arid environments on the continents of Africa and Asia (Nurmuratov, 1998). *H. ammodendron* and *H. persicum* are dominant components of the vegetation of the sandy and clay deserts across Central Asia, from western China and Mongolia to the Caspian Sea. They cover a total area of 1 million km^2 across the Turanian deserts as well as appearing in the hot deserts of the Middle East. The ecological role of *Haloxylon* species in Central Asian deserts is quite significant. The forests of both species play an enormous role in combating land degradation. *Haloxylon* forest contributes to desertification control in several ways, by helping to fix shifting sands, increasing biological productivity of arid areas, restoring degraded pasture and forest, and serving as a source of good firewood. Herbaceous species flourish under closed *Haloxylon* canopies; hence *Haloxylon* forests produce substantial amounts of edible biomass appropriate for the grazing of sheep and camels throughout the year. Being highly drought-resistant, it has played an important role in the establishment of shelter belts and the fixation of sand dunes as a counter to desertification. The thick bark of the saxaul tree stores water. Quantities of the bark may be pressed for drinking water, making saxaul an important source of water in arid regions where it grows.

In Kazakhstan, deserts occupy a very large area of about 140 million ha. A large part of it is covered with xerophytic vegetation, among which saxaul (Haloxylon) accounts for over 10 million ha. Saxauls are called desert forests as their upper and lower tiers mutually influence each other, creating their own environment in which they grow and produce a significant biomass of wood (60 to 70 t/ha) (Koksharova, 1983; Vorobiev et al., 1986), and have their own characteristic entomofauna.

Saxaul and other shrubs of the family Amaranthaceae occupy 54% of the total forested area of the country, while conifers – 19,3%, deciduous –

12,2%. The largest areas with saxauls in Kazakhstan are concentrated in the northern and eastern Aral Sea area, the rivers Amu Darya and Syr Darya, in Muyunkum sands and vast territories of southern Balkhash. White saxaul (*H. persicum)* grows on upland terrain, dunes, clean sand; black saxaul (*H. ammodendron)* - in the depressions, valleys, ancient channels of desert rivers. Saxaul forests are considered as most productive, high value plantings in sands of Muyunkum, Saryesikatyrau, the Aral Sea region and in the valleys of the rivers Chu and Ili. In these areas there are cultivated Haloxylon crops. To date, natural forests of Haloxylon are largely reduced, as a result of uncontrolled use for domestic needs of local population. Harmful insects also play an important role in this aspect (Marikovskiy, 1955; Serkova, 1958; Sinadsky, 1964; Kostin, 1973; Taranov Rams, 1984; Taranov, 1987; Nurmuratov, 1998).

MATERIALS AND METHODS

The studies were conducted in desert (sand Moyynkum) (Zhambyl region) and Sarah Sands Esik Atyrau (Almaty region) South East Kazakhstan. Field data collection was conducted in the summer of 2014-2015 using traditional and generally accepted methods (Dobrovolsky, 1969; Fasulati, 1971; Paly, 1979). Surveys were conducted at weekly intervals.

For insects on aerial parts of saxauls the method of beating was used, visual observations, and sweeping net. Insects in the roots were collected by digging out the sand around the plants, cutting along the root or stem, etc. To collect insects active at dusk and at night light traps with white screen were used. For collecting soildwelling insects pits were dug out, 50x50 cm, and 50 cm in depth.

During or after the collection of the collection of live insects were sacrificed for that ethyl acetate was used, and the larvae were stored 70% alcohol. Killing insects used for the transportation of special mattresses and bags. Instruction sequences in vitro have defined data types.

RESULTS AND DISCUSSION

As a result of the research in 2014-2015, a total of 17 coleopteran species were identified, having different trophic relations with Haloxylon (Table 1). They live in a variety of landscapes, from deserts to high mountains. Larvae and adults damage flowers, shoots, trunks and roots of saxaul. Particularly dangerous could be *Julodis variolaris, Acmaeodera solskyi, A. koenigi, A. circassica, A. gibbulosa, Cyphosoma tatarica, Lampetis argentata, Cratomerus fedtschenkoi, Sphenoptera potanini, S. orichalcea*.

From the estabished Coleopteran species, 15 feed on generative organs mostly as adults, from family Buprestidae and Cerambicidae. Adults and larvae of one species from family Coccinellidae - *Bulaea lichatschovi*, known to feeding on pollen, were very abundand on the generative organs of haloxylon. Leaves were damaged mainly by leaf beetles (Chrysomelidae), roots and branches - by larvae of Jewel beetles (Buprestidae) and Horn beetles (Cerambycidae) (Table 1).

Biology and phenology of some of the most numerous species feeding on saxaul in the desert areas of South-Eastern Kazakhstan were studied and results are presented bellow:

Julodis variolaris is distributed in Eastern and South-eastern arid regions (Tleppaeva, 2013) in deserts and semi-deserts and in Chu-Iliiskih mountains and the spurs of the Jungar Alatau (Kostin, 1973). It is not found in the northern and northeastern part of the country.

The adults are large yellow-greenish beetles, 30-40 mm long, with prothorax and head coverred with long hairs. The elytra have large spots of yellow hairs (Fig. 1). The larva is whitish in color, ranging in length from 40 to 50 mm, body is covered with hairs. The first adults in the sandy Moyynkum desert emerged in late April and early May.

The beetles are active during the sunny hot hours of the day. They feed on generative organs of saxaul and other desert plants. In early summer, after mating, females start laying eggs in the vicinity of the root system, mainly of plants of the family Amaranthaceae. Fresh laid eggs are milky white, later becoming yellowish, 3 to 5 mm long. According to our observations 10-13 days after oviposition, the first larvae hatch.

The larvae first instar are feeding on root hairs (rhizoids), while older larvae – on lateral and central root, making in them spiral tunnel, which is the typical damage. Unlike many species of Jewel beetles, larvae of the desert jewel beetles develop in the soil loose, damaging the roots of the plants outside. According to our observations, young larvae live at a depth of 10-17 cm, but in the late summer they go deeper in the soil and overwinter.

During the second year larvae live and develope at a depth of 40 to 80 cm, overwinter and in next spring move upwards to the root collar of the plants to pupate. Complete development takes 2 years in three callendar years. The adult, being active on the aerial parts, is the most vulnerable stage, hence the period May-July is the most suitable time to apply chemical treatment (Table 2).

Table 1. Coleopteran pests (Insecta: Coleoptera) on saxaul (*Haloxylon* spp.) in the desert zone of South-Eastern Kazakhstan in 2014-2015

№	Species	Organothrophic specialization	Host specificity
	Family Coccinellidae		
1.	*Bulaea lichatschovi* (Hummel 1827)	generative organs	polyphagou
	Family Cerambycidae		
2.	*Apatophysis mongolica* Semenov, 1901	generative organs, roots	oligophagous
3.	*Turcmenigena varentzovi* Melg.	generative organs, roots	oligophagous
4.	*Opsilla coerulescens* Scopoli, 1763	generative organs, roots	oligophagous
	Family Buprestidae		
5.	*Julodis (s. str.) variolaris* (Pallas, 1771)	generative organs, roots	oligophagous
6.	*Sphenoptera (s. str.) cuprina* Motschulsky, 1860	generative organs, roots	oligophagous
7.	*S. (s. str.) exarata* (Fischer, 1824)	generative organs, roots	oligophagous
8.	*Sphenoptera potanini* Jak.	generative organs, roots	oligophagous
	Family Chrysomelidae		
9.	*Entomoscelis adonidis* (Pall., 1771)	leaves, flowers	polyphagous
10.	*Labidostomis metallicacentrisculpta* (Pic, 1920)	leaves, flowers	polyphagous
11.	*Labidostomis senicula* Kr.	leaves, flowers	polyphagous
	Family Silphidae		
12.	*Aclypaea calva calva* Reitter, 1890	leaves	polyphagous
	Family Curculionidae		
13.	*Baris artemisiae* (Hbst., 1795)	roots, flowers	polyphagous
14.	*B. scolopacea* Germar 1824	roots, flowers	polyphagous
15.	*Chloebius immeritus* Schoenherr, 1834	leaves, flowers	polyphagous
	Family Tenebrionidae		
16.	*Microdera convexa* Tauscher, 1812	young shoots	polyphagous

Fig. 1. *Desert Juwel beetle Julodis variolaris Pall*

Table 2. Phenological development of *Julodis variolaris* in the region of village Aidarly, South-Eastern Kazakhstan, in 2014-2015

Stage of development	Months																	
	April			May			June			July			August			September		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
pupa	(-)	(-)	O	O	O													
imago				+	+	+	+	+	+	+	+							
egg								.	.	.	.							
larva 1 year										-	-	-	-	-	-	-	-	-
larva 2 year	**(-)**	**(-)**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pupa	(-)	(-)	O	O	O													

Fig. 2. *Dead young saxaul plants in natural thickets in Moynkum desert in 2014, damaged by the larvae of Julodis variolaris*

Older larvae can live without food for a long time, as in the laboratory, they have lived without food for five months. The results of soil excavation show that the larvae of this species prefer dense clay soils. In nature, damaged or dead saxaul plants by the feeding of the larvae are found in groups (Fig. 2).

Turcmenigena varentzovi is common in the deserts of Central Asia, Kazakhstan and South-Western China. Larva is making a tunnel in the base of the trunk and in the root of white (*Haloxylon persicum*) and black saxaul (*H. ammodendron*). The species developes one generation for three years. It overwinters three times in the tunnels and in late May and June durring the third year of development, before pupation the larva gnaws cavity in the root right under the cortex. The fully grown larvae is 2 cm in length. In three years, the length of the tunnel reaches about 20-25 cm and the width - about 2.5 cm. The space behind the larva in the tunnel is filled with brown frass. The pupal stage lasts about 1-1.5 months. First emerging adults appear in early July and are found until mid-August. They are active at twilight and during the night, and during the day are hiding in cravices or occasionally stay on the trunks in secluded places. Adults feed on green shoots of saxaul. Females lay eggs in small portions at the top of the root cortex of healthy and weakened plants. The species is common on almost all saxaul plants in the region of Semirechye. Infestation on haloxylon plants is quite high and reaches approximately 1 larva per 10 plants surveyed.

Aclypea calva is found in the Piedmont plains and clay deserts of southern Kazakhstan and Central Asia. It has one generation per year. First adults appear in April and are active until the end of June. They are active during the day and feed on young leaves of many shrubs and dwarf shrubs of the Amaranthaeae family: *Eurotia ceratoides, Salsola orientalis, Salsola arbuscula*, saxaul (*Haloxylon ammodenron*), Kochia (*Kochia prostrata*). In the region of the village Bakanas Kerbulak sometimes up to 2 beetles per plant were collected, causing significant harm to the young shoots, reducing the growth by 8%. The larvae damage herbaceous plants, eating the base of their stems. The duration of larval stage is about 2 months. In May they start to pupate and overwinter at pupal stage in the soil (Table 4).

Sphenoptera orichalcea is distribited in Russia (lower Volga and the North Caucasus), Central Asia, Central and Western Kazakhstan (Caspian Sea region, river Syr Darya, the foothills of Tien Shan) (Kostin, 1973) and in the deserts of the South-Eastern Kazakhstan.

Pronotum is wide, solid, not less than 1,5 times the width of its length, with double punctures - in small and rare points in the middle and in large dense points on the sides. The median longitudinal groove is narrow and shallow, often quite noticeable. Prothorax on the sides of very large shallow points. The median process in small distinct rare points. In females, it is naked, in males standing covered with dense long hairs. Elytra wide, gradually tapering to the end. 1st segment of hind legs is longer than the 5th. Various coloration, with predominant colors bronz- or golden-green, green, copper and bronze. Body lenghth varries from 7 to 17 mm (Kostin, 1973).

The larva makes a tunnel inside the root of many of Amaranthaceae plants: *Eurotia ceratoides, Anabasis salsa, Salsola orientalis*, *Salsola arbuscula*. It has one generation per year. For one year the tunnel reaches about 5-7 cm with a width of about 0.7 cm. The space behind the larva in the tunnel is filled with frass (Fig. 3). The larva before pupation gnaws cavity under the cortex. The pupal stage lasts about 1 month. Young adults appear in mid-May and are active until mid-July. They are active during the day, eating green shoots of host plants. Females lay eggs in small portions at the top of the root bark of healthy and weakened plants. Population density is quite high and reaches approximately 2 larvae per 10 plants surveyed.

Table 3. Phenological development of *Turcmenigena varentzovi* in the region of village Aidarly, South-Eastern Kazakhstan, in 2014-2015

Stage of development	Months																	
	April			May			June			July			August			September		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
pupa	(-)	(-)	O	O	O													
imago				+	+	+	+	+										
egg								.	.	.	.							
larva 1year										-	-	-	-	-	-	-	-	-
larva 2 year	**(-)**	**(-)**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
larva 2 year	**(-)**	**(-)**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pupa	(-)	(-)	O	O	O													

Table 4. Phenological development of *Aclypea calva* in the region of village Aidarly, South-Eastern Kazakhstan, in 2014-2015

Stage of development	Months																	
	April			May			June			July			August			September		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
imago	(O)	+	+	+	+	+	+	+	+									
egg/larva						.	.	.	.	-	-	-	-	-	-	-	-	-
larva	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pupa						O	O	O	O	(O)	(O)	(O)	(O)	(O)	(O)	(O)	(O)	(O)

***Fig. 3**. The larva of Sphenoptera orichalcea develops inside the root system of young saxaul plants*

Sphenoptera potanini is found in the desert area of southern, southeastern Kazakhstan, and Central Asia. The body is more slender, with less convex bottom. Pronotum is strongly narrowed anteriorly, its sides are almost straight. Gaps between elytra smoothed, only slightly protrude in front and on top. 3-rd antennal segment slightly longer than 2-nd and almost two times shorter than the 4-th. Males are bluish-golden-green monochrome. Females - copper and bronze top and bottom, sometimes elytra greenish bronze. The lenght is 18-22 mm (Kostin, 1973). It has one generation for two years. The larva is tunnelling the wooden stems of saxaul. It attacks both healthy and weakened bushes. The lenght of the tunnel reaches about 10 cm and is wide about 1 cm. The space behind the larva in the tunnel is filled with frass. The larva before pupation gnaws cavity under the bark. The pupal stage lasts about 1 month. Young adults appear in mid-June and are active until mid-August. They are active during the day, eating green shoots of host plants. Females lay eggs on the bark in small portions in the base of the trunk. The infestation reaches approximately 1 larva per 10 plants surveyed.

Sphenoptera hauseri is found in the deserts of Kazakhstan and Central Asia. The larva is making tunnel in the branches of saxaul. It has one generation per year. The lenght of the tunnel is up to 6 cm and the width - about 0.7 cm. The space behind the larva in the tunnel is filled with frass. The larva before pupation gnaws cavity under the bark. The pupal stage lasts about 1 month. Young beetles emerge in early June and are active until early August. They are active during the day. Males and females are winged. They eat green shoots of host plants. Females lay eggs on the bark of small portions in the bending branches. They attack healthy and weakened bushes. The infestation is high and reaches about 3 larvae per 10 plants surveyed.

Microdera convexa is found in Russia (Lower Volga), the deserts of Kazakhstan and northern part of Central Asia. It has one generation per year. Young beetles appear in April and are active until the end of June. They are active during the day when feed on young leaves of many shrubs and dwarf shrubs of the Amaranthaceae family: *Eurotia ceratoides, Salsola orientalis, Salsola arbuscula,* and saxaul. In the area of the village Bakanas Kerbulak sometimes up to 3 beetles per surveyed plant were recorded, which cause significant harm to the young shoots reducing growth by 10%. The larva develops in the soil, chewing the roots. The duration of the larval stage is about 2 months, and of the pupal - 2-3 weeks. In late September the beetles emerge, feed for some time, and after that overwinter in the soil.

Bulaea lichatschovi is found in clay and thistle deserts southeast of Russia, the Northern Caucasus, Kazakhstan and Central Asia. It has one generation per year. Young beetles appear in April and are active until the end of July. They are active during the day, feeding on young leaves, shoots and flowers of many shrubs and dwarf shrubs of the Amaranthaceae family: *Salsola orientalis*, *Salsola arbuscula*, quinoa (*Atriplex verrucifera*, *A. tatarica*), and *Halocneum strobilaceum*) In the area of the village Bakanas, Nurly Kerbulak sometimes up to 15 beetles per plant were counted. The damage on the young shoots and flowers is significant and reduces growth by 20%. Larvae are also herbivorous and feed in the same way and on the same Amaranthaceae plants. The duration of the larval stage is about 2 months, and of the pupal - 3-4 weeks. In late September the adults emerge, feed, and then overwinter in the soil.

CONCLUSIONS

1. A total of 16 species of Coleoptera (Insecta: Coleoptera) were found to feed on different plant organs of saxaul in the desert area of Ssouth-Eastern Kazakhstan in 2014–2015.

2. The phenology of the most numerous and harmful species was described.

3. Six of the species, mainly from families Bupresidae and Cerambycidae are considered potential pests of vegetative and generative organs and root system of saxaul.

4. Among the pests of the root system most dangerous are *Julodis variolaris*, *Sphenoptera orichalcea* and *Sphenoptera potanini*.

5. Chemical control should be applied against the adult before laying eggs.

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