ON THE DEVELOPMENT OF THE FAUNA OF SUGAR-BEET INSECT PESTS UNDER THE IRRIGATION CONDITIONS IN THE SOUTHEAST EUROPEAN PART OF THE USSR

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No one has yet made a special study of the array of sugar-beet insect pests which has developed under irrigation conditions in the Southeast European part of the USSR and our knowledge of this fauna is still completely inadequate. Odd bits of information about the ranges of some of the more widespread species attacking sugar beet are to be found in works by Silant'yev (1894), Ponomarenko (1930), Pilyugina (1935), Sakharov (1947), Megalov (1949) and Grivanov and Zahkarov (1958). Reports relating to the right bank of the Volga reflect the dry farming conditions there. Fuller information is available only in Sakharov's book "Insect Pests of the Lower Volga" (1947), summarizing previously scattered information and based partly on the author's personal research on field crop pests over a period of more than forty years. Sakharov mentions thirty-nine insect species attacking sugar beet. Most of the above-mentioned works relate to the period before 1945. Since then great changes have taken place in agriculture in the southeast and these cannot but have affected the insect fauna.

Study of the insect pests of beet is of more than purely scientific interest in giving information about crop pests in the southeast; it is also of practical value, since there is a whole series of insects which can do important damage to sugar beets.

The work reported here is based on research done by the author in 1962-1967 under the direction of Professor A. A Megalov, to whom my warm acknowledgments are due. I also take this opportunity of thanking L. V. Khizhnyakov of the Saratov Agricultural Institute for help in determining certain species.

LOCATION AND METHODS OF RESEARCH

The specific composition of the assemblage of sugar-beet insect pests was investigated and the damage caused was studied by inspecting fields of sugar beet in the Engels District of the Saratov Province, at the "Engel'sskiy", "Podstepnoye", "Rovnoye" state farms and at the "XIX Parts"yezd' collective farm and the teaching and experimental farm of the Saratov Agricultural Institute. Material belonging to the Saratov Plant Protection Station was used.

The pests were studied on the above-ground and underground parts of the beet. The infestation rate in different plots was determined from soil samples, from counts on the soil surface and on the plants, and by visual inspection of the plots. In addition a pest count was taken by sweeping with an insect net (Mukhin, 1961) and collecting with glass jars containing fixing fluid (0.5 liters), completely buried in the soil (Fedosimov, 1961; Chernyshov, 1961).

The research area is characterized by certain climatic and soil peculiarities. The climate is severely continental, with bleak winters and sultry summers. The heated air masses reaching the area from the Central Asian and Caspian deserts cause drought in spring, summer and fall. With the dry winds relative humidity often falls to 10% and temperature rises to 35-40% (Shubin, 1952). With the high temperatures and lack of precipitation the soil rapidly dries out under the cloudless sky; humidity is not even sufficient for normal plant growth. Owing to the intensive evaporation plants sometimes wilt even when soil moisture is present. In spring the soil and the atmosphere heat up rapidly, with the result that the soil water is rapidly used up. During this period insects use up the wild vegetation and many of them migrate to cultivated plants with the onset of unfavorable conditions. In such cases beet fields are the most attractive to many pests. A characteristic feature of the research area is the great length of the growth period (between the transition of mean diurnal temperatures across +10° intervals), which lasts 157 days, with an aggregate of 2870° effective temperature. Mean annual precipitation is 300-320 mm. During the growth period 150-170 mm of precipitation falls (Agroclimatic Manual for the Saratov Region, 1958). The duration of the growth period and the aggregate of effective temperatures make it possible to cultivate sugar beets under irrigation conditions; but this also enables the insects to complete their life cycle. Many of them (the mangold fly, Pegomyia hyosciami Panz., the cabbage moth, Mamestra brassicae L., the turnip moth, Agrotis segetum Schiff. and the root aphid, Pemphigus fuscicornis Koch.) produce several generations during the hot period.

The soils are dark chestnut, of medium thickness or shallow, slightly alkalized. Total humus content is 3.6%. Maximum hygroscopicity in the top meter layer is 13-14% (Prasolov and Antipov-Karatayev, 1939; Bul'cheva, 1946). The soil contains a large quantity of mineral colloids, causing reduced water permeability. The root layer is characterized by diminished absorbent capacity. The amount of sodium and potassium absorbed does not exceed 3.2% of the total bases, while calcium and magnesium account for 95.7% (Letunov et al., 1936; Antipov-Karatayev, and Filippova, 1937).

FORMATION OF THE PEST ENTOMOFAUNA

With the development of irrigation, sugar beet has come to occupy increasingly large areas on the left bank of the Volga in the southeast. The growth of the areas under beet is also creating a numerical increase in the beet pest population, as the insects move from the weeds and other crops, and is also improving growth conditions for certain pest species. In some cases irrigation is improving breeding conditions for certain species. Weeds are of paramount importance in the life of insects, promoting their accumulation and multiplication. Most pests are in one way or another associated with weeds. In the southeast the southern beet flea beetle (Chaetocnema breviuscula Fald.) does great damage to beets. In the absence of beet the flea beetles develop on weeds, and even where there are beet fields they prefer the more weed-infested plots. We found that the beet flea beetle first occupies fields infested with Chenopodiaceae weeds, and that their numbers depend on the abundance of these weeds (Table 1).

Table 1

Concentration of beet flea beetles in beet fields containing varying amounts of weeds

Count date	Previous crop	Present crop	Weeds (Number per m^2)	Flea beetles (Number per m^2)
25 V	Potato	Beet . .	236	15
	Pulses	» . .	624	27
	Maize	» . . .	489	24

In beet fields relatively free from weeds there are fewer beet flea beetles. Fields completely clear of weeds are even less infested. Here it should be noted that the flea beetles lay twice as many eggs around weeds of the family Chenpodiaceae as around beets.

The gray sugar-beet weevil, Tanymecus palliatus F., is a polyphagous pest and in nature develops on various agricultural crops and weeds. The adults are found in all crop rotation areas (Table 2).

The number of these weevils is somewhat greater on beet than on other crops and varies from year to year, undoubtedly depending on the weed situation in the fields. In fields overgrown with perennial sucker-forming weeds there are more of these insects than in areas with other weeds (Table 3).

The number of beetles shows a clear dependence on the quantity of perennial weeds. Where maize was followed by a second maize crop there were 42 perennial weeds per m^2 and the number of beetles was 0.7 per m^2. Where vegetables were followed by vegetables there were eight perennial weeds per m^2 and the beetle population was 0.1 per m^2.

This pest accompanies not only the crops, but also perennial weeds and can therefore transfer from any crop to beet fields that are infested with perennial weeds.

Beet cultivation has certain special features. This crop is sown in widely spaced rows which are as a rule 60 cm apart under irrigation conditions. The seedlings at first grow slowly, with the result that the spaces between the rows are for a long time not covered by the plants. This in turn leads to better heating of the beet plots during the first half of summer as a result of solar radiation and also to better heat radiation by comparison with other crops. The more intensive heating of the beet fields and the presence of a preferred food attracts a whole series of pests: the southern beet flea beetle, the gray sugar-beet weevil, the oriental weevil Bothynoderes foveicollis Gebl.), the sluggish weevil (Cleonus piger Scop.), the banded weevil (Chromoderus fasciatus Mull.), the beet root weevil (Bothynoderes punctiventris Germ.) the sand beetle (Opatrum sabulosum L.),

Table 2

Tanymecus palliatus population in various crop rotation areas

Year	Percentage of T. palliatus		
	on beet	on pulses	on grain
1964	36.4	32.3	31.3
1965	42.6	21.2	36.2
1966	37.3	26.4	36.3

Table 3

Tanymecus palliatus population in relation to the weed situation

Previous crop	Present crop	Weeds (Number per m^2)		Number of weevils per m^2
		annuals	perennials	
Potato	Beet	213	23	0.3
Pulses	»	602	22	0.3
Maize	»	455	34	0.5
»	Maize	424	42	0.7
Beet	Beet	134	16	0.2
Maize	Pulses	228	26	0.3
Vegetables	Vegetables	482	8	0.1
»	Maize	546	12	0.2
Mustard	Beet	1456	14	0.2
Pulses	Maize	1382	16	0.2

the nocturnal ground bettle (Gonocephalum pusillum F.), and others, all of which go over to beet from other crops which are by this time already carpeted with a continous cover and are therefore less well heated. The intensive heat radiation from the beet fields attracts the beet webworm Loxostege sticticalis L., the turnip moth and other pests, which eagerly lay their eggs in these areas.

Irrigation has left its mark on the development of the fauna that comprises the insect pests of beet. With a comparatively small amount of precipitation (about 250 mm) the population of the gray sugar-beet weevil is reduced (Luk'yanovich, 1930). Irrigation improves the soil and atmospheric humidity and thereby improves enviromental conditions for this pest. Podkopay (1964), forecasting the appearance of this polyphagous pest on newly irrigated lands, suggest that irrigation does not create favorable conditions for its development. Our findings, on the contrary, indicate an increase in the population of the pest on irrigated lands, due not only to an increase in the soil and atmospheric humidity, but also to the increased Canada thistle population on irrigated ground (Table 4).

With irrigation the numbers of the gray beet weevil are twice as high as on non-irrigated land. On average the population is 0.35 per m^2, against 0.17 on non-irrigated land.

Irrigation improves breeding conditions for the mangold fly, mass outbreaks of which were recorded in the southeast in 1938 (Sakharov, 1947). During the last five years it has done annual damage to the beet crop, in some areas damaging as much as 90% of the crop. Irrigation also activates such pests as the beet stalk borer Lixus subtilis Sturm, and the cabbage moth.

Human activity also creates favorable conditions for certain pests, as Bey-Biyenko (1961, 1965), Grigor'yeva

Table 4

Population of T. palliatus in dry and irrigated fields

Crop	Field	No. of thistle plants per m^2	Number of beetles per m^2
Maize	Irrigated . .	7	0.4
»	Non-irrigated . .	3	0.2
Pulses	Irrigated . .	9	0.5
»	Non-irrigated . .	5	0.1
Wheat	Irrigated . .	6	0.3
»	Non-irrigated . .	4	0.2
Sugar beet	Irrigated . .	8	0.4
Shoulders of irrigated areas		16	1.6

(1965) and others have pointed out. Such conditions are evidently created also for certain pests attacking beet in the southeast.

The formation of a insect pest fauna on irrigated beet in the southeast must not be regarded as completed; but already a whole series of insect pests is doing immense damage to fields of this crop.

SPECIFIC COMPOSITION OF BEET PESTS

On the basis of published data and our own researches the list of beet pests in the southeast has now reached 79 species. These include 41 species of Coleoptera, 3 of Diptera, 9 of Hemiptera, 9 of Homoptera, 15 of Lepidoptera and 2 of Orthoptera (see Table 5, which also shows the population of each pest and the duration and extent of damage.

Of the flea beetles (Halticinae) the southern beet flea beetle and the striped flea beetle, Phyllotreta vittula Redt., account for the largest populations.

We found that of all the Halticinae occurring in beet fields, the southern beet flea beetle was the predominant species (Table 6). Averaging over the three years 1964-1966 we find that it accounted for 64% of all Halticinae in May and 58% in June. Phyllotreta vittula was the next most prolific species, representing 70-80% of the remaining Halticinae population. The density of all Halticinae found on beet sowing was 30-50 per m^2.

The Cassidinae, Cassida nebulosa L. and Cassida nobilis L. (there are several other species as well) have not done much damage to beet during the last five years. Only 0.5 to 5 specimens per m^2 were observed on the sown plots. These insects feed and lay their eggs on Canada thistle and lesser bindweed; they can hardly be regarded as serious beet pests in the southeast.

In the family Cryptophagidae the pygmy mangold beetle, Atomaria linearis Steph., is fairly numerous and does appreciable damage to beet seedlings.

The beet stalk borers had a density of 0.3-5 specimens per m^2, represented chiefly by Lixus subtilis Sturm.

Of the beet weevils the most common (2-8 per m^2) are the eastern, gray, slow, striped and common species; the rest occur singly and do not constitute a danger to the beet crop. Table 7 shows the ratio of species according to our observations.

Bean and pea weevils of the genus Sitona occur on beets in fairly large numbers, sometimes reaching several hundred per m^2, but do little damage.

The Tenebrionidae, Elateridae and Scarabaeidae do not produce many larvae. These pests live in the soil, but do little damage to the beet plants, except for an occasional plant which dies because the larvae eat through the central root. The larval population in irrigated fields of beet did not exceed 0.1-1 per m^2. Tenebrionidae, with a density of 2-5 per m^2, did a certain amount of damage to beet. The commonest members of this family are the sand beetle and the small nocturnal ground beetle.

Of the Diptera, the mangold fly has the highest populations and constitutes a real threat to beet sowings.

Of the Hemiptera, the commest is Poeciloscytus cognatus Fieb., which appears on beets in the first ten days of June, transferring to beet from perennial grasses and weeds. It may reach a population of 10-20 per beet plant. In view of the fairly well developed leaf surface of the beet plants during this period damage is not too great. The remaining species of this order occur in comparatively small numbers and scarcely represent a threat to the beet crop.

The leafhoppers (Auchenorrhyncha) are of no economic importance. They appear in large numbers on beets in midsummer, with a density of 10-20 per plant. Whitish patches appear on the leaves at the points where these insects suck, but we did not observe any stunting or wilting of the plants. The commonest species was Macrosteles laevis Rib.

Of the aphids (Aphidinea) the most important is the root aphid. This appears on beet sowings at the beginning of July and develops in columns covering the entire surface of the root.

Among the Lepidoptera we noted the cabbage moth, turnip moth and Pyrameis cardui L.; only single specimens of other species were found. According to published data the turnip moth, the gamma moth, Autographa gamma L. and the beet webworm have in the past done damage to beet in the southeast (Pilyugina, 1935).

Of the Orthoptera, Calliptamus italicus L. was found in small numbers and Gryllotalpa gryllotalpa L. singly.

ECONOMIC IMPORTANCE OF PEST SPECIES

Of the species listed in Table 5 many are of no economic importance, because they are not sufficiently numerous and prefer feeding on other plants, and in the second half of summer they feed on the well-developed leaf surface.

Many species, on the other hand, are of great economic importance as sugar-beet pests. Damage due to some of them had already been noted by the end of the nineteenth century. Silant'yev (1894) wrote of crop damage due to the beet stalk borer. The southern beet flea beetle has been known as a beet pest in the Saratov Province ever since the crop was introduced there. Beet proved extremely susceptible from the moment of its introduction. The harvest depended entirely on whether the seedlings had escaped damage by the flea beetle. From 1913 to 1927 inclusive beet harvests varied from 85 to 400 centners per hectare. Zolotarev (1932) noted that annual fluctuations in the harvest were due mainly to the destruction of plants by the ground flea beetle. In 1920, 1921, 1923, 1924 and 1926 this pest completely destroyed the beet seedlings and there was no harvest (Ramikh, 1932). The mangold fly, according to Sakharov, (1947), "did substantial damage to beets near Saratove" in 1938 and the beet webworm did serious damage to beets in 1929-1930 (Pilyugina, 1935). Damage by other species in the southeast was not mentioned.

During our research period beet flea beetles, mainly Chaetocnema breviuscula Fald., damaged the seedlings. The average damage for the three years 1964-1966 was 42% (of plants) during the first five days after the appearance of seedlings, 78% during the second five days, 97% during the third five days and 100% during the fourth five days. In the fourth five day period the average number of injuries to each plant was 7.4.

The various species of beet weevils (eastern, gray, slow, striped and common), together with the nocturnal ground beetles (sandy and lesser) did substantial damage to the seedlings. In the first five days after the seedlings appeared 49% of the beet plants were attacked, in the second five days 74%, in the third five 82% and in the fourth five days 100%, when 25-50% of the leaf surface was destroyed.

Table 5

Specific composition of sugar-beet pests

Pest	Population	Duration of damage	Extent of damage
Coleoptera			
1. *Chaetocnema breviuscula* Fald.	+++	+++	+++
2. *Ch. concinna* Marsh.	++	++	++
3. *Ch. tibialis* Ill.	+	++	++
*4. *Phyllotreta atra* F.	+++	++	+
*5. *Ph. undulata* Kutsch.	++	++	+
*6. *Ph. nigripes* F.	++	++	+
*7. *Ph. vittata* F.	++	++	+
*8. *Ph. nemorum* L.	++	++	+
*9. *Ph. vittula* Redt.	+++	++	++
10. *Cassida nebulosa* L.	++	++	++
11. *C. nobilis* L.	++	++	++
*12. *Atomaria linearis* Steph.	+++	++	+++
13. *Lixus subtilis* Sturm.	+++	+	++
*14. *L. incanescens* Boh.	++	+	++
*15. *L. flavescens* Boh.	++	+	++
16. *Bothynoderes punctiventris* Germ.	++	++	+++
17. *B. foveicollis* Gebl.	+++	++	+++
18. *Tanymecus palliatus* F.	++	+	+++
19. *Psalidium maxillosum* F.	+++	+	+++
20. *Chromoderus fasciatus* Müll.	++	++	+++
21. *Ch. declivis* Ol.	+	++	++
22. *Cleonus tigrinus* Panz.	+	+	++
23. *C. piger* Scop.	+	+	++
24. *Baris scolopacea* Germ.	+	++	++
*25. *Ulobaris loricata* Boh.	+	++	++
*26. *Otiorrhynchus conspersus* Germ.	+	++	++
27. *O. ligustici* L.	+	++	++
28. *Sitona lineatus* L.	+++	++	++
29. *S. crinitus* Hbst.	+++	++	++
30. *S. lineellus* Bonsd.	+++	++	++
31. *Opatrum sabulosum* L.	+++	++	++
32. *Pedinus femoralis* L.	++	++	++
33. *Gonocephalum pusillum* F.	+++	++	+++
*34. *Blaps halophila* Fisch.	+	++	++
*35. *B. lethifera* Marsh.	+	++	++
36. *Selatosomus latus* F.	+	+++	++
37. *Agriotes gurgistanus* Fald.	+	+++	++
38. *A. sputator* L.	+	++	++
39. *Amphimallon solstitialis* L.	+	+++	++
40. *Rhizotrogus aequinoctialis* Hbst.	+	+++	++
*41. *Rh. vernus* Germ.	+	+++	++
Diptera			
42. *Pegomyia hyosciami* Panz.	+++	+++	+++
*43. *Chortophila cilicrura* Rd.	+++	+++	++
*44. *Tipula* pr. *oleracea* L.	++	+++	+
Hemiptera			
45. *Poeciloscytus cognatus* Fieb.	+++	+	+++
46. *P. vulneratus* Panz.	++	+	++
47. *Lygus pratensis* L.	++	++	++
*48. *Orthotylus flavosparsus* J. Sahlb.	+	+	++
*49. *Atomoscelis onustus* Fieb.	+	+	++
*50. *Piesma quadrata* Fieb.	+	++	++
*51. *Adelphocoris lineolatus* Goeze.	+	+	++
*52. *Eurydema ornata* L.	++	+	+
*53. *Eu. oleracea* L.	++	+	+
Homoptera			
*54. *Macrosteles laevis* Rib.	++	+	++
*55. *Dictyophara europaea* L.	++	+	++
*56. *Eupteryx atropunctata* Goeze.	++	+	+
*57. *Empoasca flavescens* F.	++	+	+
*58. *Limotettix striola* Fall.	++	+	+
*59. *Oliarius leporinus* L.	++	+	+
60. *Aphis fabae* Scop.	++	+	++
*61. *A. gossypii* Glov.	++	+	+
*62. *Pemphigus fuscicornis* Koch.	++	+	+++
Lepidoptera			
63. *Agrotis segetum* Schiff.	++	+	+++
64. *A. exclamationis* L.	++	+	++
65. *A. ypsilon* Rott.	++	+	++
66. *A. vestigialis* Rott.	++	+	++
67. *Laphygma exigua* Hb.	++	+	++
68. *Heliothis viriplaca* Hfn.	++	+	++
69. *Autographa gamma* L.	++	+	++
70. *Mamestra brassicae* L.	+++	+	+++
71. *Scotogramma trifolii* Rott.	++	+	++
72. *Polia dissimilis* Koch.	++	+	++
73. *P. oleracea* L.	++	+	++
74. *Graphiphora c-nigrum* L.	++	+	++
75. *Loxostege sticticalis* L.	+++	++	+++
*76. *Pyrameis cardui* L.	++	+	++
77. *Euxoa tritícii* L.	++	+	++
Orthoptera			
78. *Calliptamus italicus* Z.	+	+	++
79. *Gryllotalpa gryllotalpa* L.	+	++	++

Key to symbols: *) pests found for the first time on beets in the southeast. Column 2: +++ high, ++ low, + singly. Column 3: +++ damage from seedlings to harvesting, ++ from seedlings to the 3–5 leaf phase, + from the 3–4 leaf phase to harvesting. Column 4: +++ appreciable economic damage, ++ no significant economic damage, + no damage observed.

Table 6

Ratio of the different species of flea beetles on beets

Count date	Species (%)			
	southern	common	western	other
15 V	64.6	12.2	0.9	22.3
15 VI	58.8	14.1	0.8	26.3

Table 7

Ratio of the various species of weevils on beets

Year	Count date	Species				
		eastern	gray	slow	striped	common
1964	May	28	21	19	8	24
1965	»	32	34	13	13	8
1966	»	40	27	6	7	11

In 1964, 52% of the plants were damaged by Atomaria linearis Steph and in 1966, 57%. Of the plants attacked about 10% died before thinning and about 5% after thinning. Those which died after thinning, of course, yielded no production and this in turn affected the harvest.

The mangold fly, which has two generations annualy, at first damaged the seedlings and then reduced the quality of the tops, which are used for silage (Fig. 1).

The beet stalk-borer did serious damage (Fig. 2).

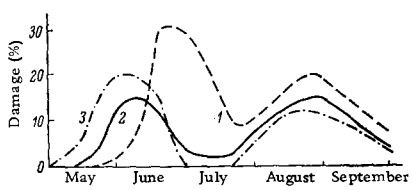

Fig. 1. Damage due to the mangold fly.
1) 1964; 2) 1965; 3) 1966.

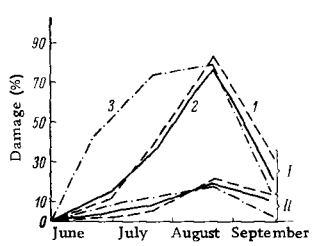

Fig. 2. Damage due to the beet stalk borer.

I) number of plants damaged;
II) degree of damage to leaves; 1) 1964; 2) 1965; 3) 1966.

The root aphid sucks the juices from the roots, killing the fibrous rootlets and causing the plant to wilt and die. The damaged plant becomes flaccid and rots. Infestation of the beet fields takes the form of attacks on small groups of 10-20 plants. About 15-16% of the plants were found to be infested with aphids. The beet plants start dying at the end of July and the damage continues until harvesting.

Some damage due to larvae of the cabbage moth, turnip moth and Pyrameis cardui was observed.

The main beet pests in the irrigated fields of the southeast have been found to be the southern beet flea beetle, Atomaria linearis, the eastern, gray, slow, striped and common weevils, the beet stalk-borer, Lixus subtilis, the sand and lesser nocturnal ground beetles, the mangold fly, Poeciloscytus cognatus, the root aphid, the cabbage moth, the turnip moth and the beet webworm.

The most critical phase of the beet's development is its growth from the seedling stage to the development of two pairs of true leaves. During this period the insects greatly thin out the plantations and reduce the harvest. The pests noted during this critical phase were Atomaria linearis, the southern beet flea beetle, the eastern, gray, slow and common beet weevils, the sand beetle (blats) and the lesser nocturnal ground beetle.

Damage to the roots was due to Atomaria linearis, Chortophila cilicrura Rd. and the beet root aphid. The leaves were damaged by the southern beet flea beetle, the eastern, gray, slow, striped and common beet weevils, the sand beetle and the lesser nocturnal ground beetle, the cabbage and turnip moths and the beet webworm. Lixus subtilis attacked the leaf stalks.

SUMMARY

The following may appear as pests on beets in irrigated fields in the southeast part of the USSR: Halticinae, Atomaria linearis, Bothynoderes foveicollis, Cleonus piger, Chromoderus fasciatus, Bothynoderes punctiventris, Tanymecus palliatus, Pegomyia hyosciami, Poeciloscytus cognatus Mamestra brassicae, Agrotis segetum, Loxostege sticticalis and Lixus subtilis.

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