Tobacco Thrips (*Thrips tabaci* Lind.) as a pest of Tobacco plant in Crimea

BY

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Tobacco Thrips (*Thrips tabaci* Lind.) belongs to the family *Thripidae* Uzel, suborder *Terebrantia* Hal., *Thysanoptera*, and is known in literature as one of the most important tobacco pests. Occuring in various countries of Europe, America and Australia, Tobacco Thrips has a particularly great economic importance in Crimea, i. e. the area where best kinds of Russian tobacco are grown.

In Crimea this pest was recorded already in the nineties of the last century by Mokrzecki, who published a series of notes on its biology in his annual reports. Since then, this pest has been continually attracting special attention in Crimea, but no regular investigations were made until 1925, when the author had an opportunity to study this pest. Observations on Thrips were made under field and laboratory conditions during five years, from 1925 to 1929. The author's thanks are due to Prof. Priesner, who identified all the species of Thysanoptera.

I. Fauna of the Thrips of the Tobacco plant.

The fauna of the Thrips inhabiting tobacco-plants and tobacco plantations is fairly rich. The following species were found on tobacco flowers:

1. *Thrips tabaci* Lind., adult and larva.
2. *Thrips minutissimus* L., adult.
3. *Frankliniella tenuicornis* (Uz.), larva.
4. *Haplothrips tritici* Kourd., adult.
5. *Aeolothrips fasciatus* (L.), adult.

6. *Taeniothrips tritici* var. *pallidivestis* Pries., adult.
7. *Taeniothrips meridionalis* Pries., adult.

The adults of *Thrips minutissimus* f. *obscura* Coefeld were found in the ground. Only one species was found in large numbers and in all its stages on tobacco leaves, viz. *Thrips tabaci* Lind. Thus, although different species can be found on tobacco plants and in tobacco fields, only *Thrips tabaci* Lind. can be considered as an actual pest of tobacco in Crimea.

II. **Description of stages.**

During its metamorphosis the Tobacco Thrips passes through the following stages, which are usual in the group of Terebrantia.

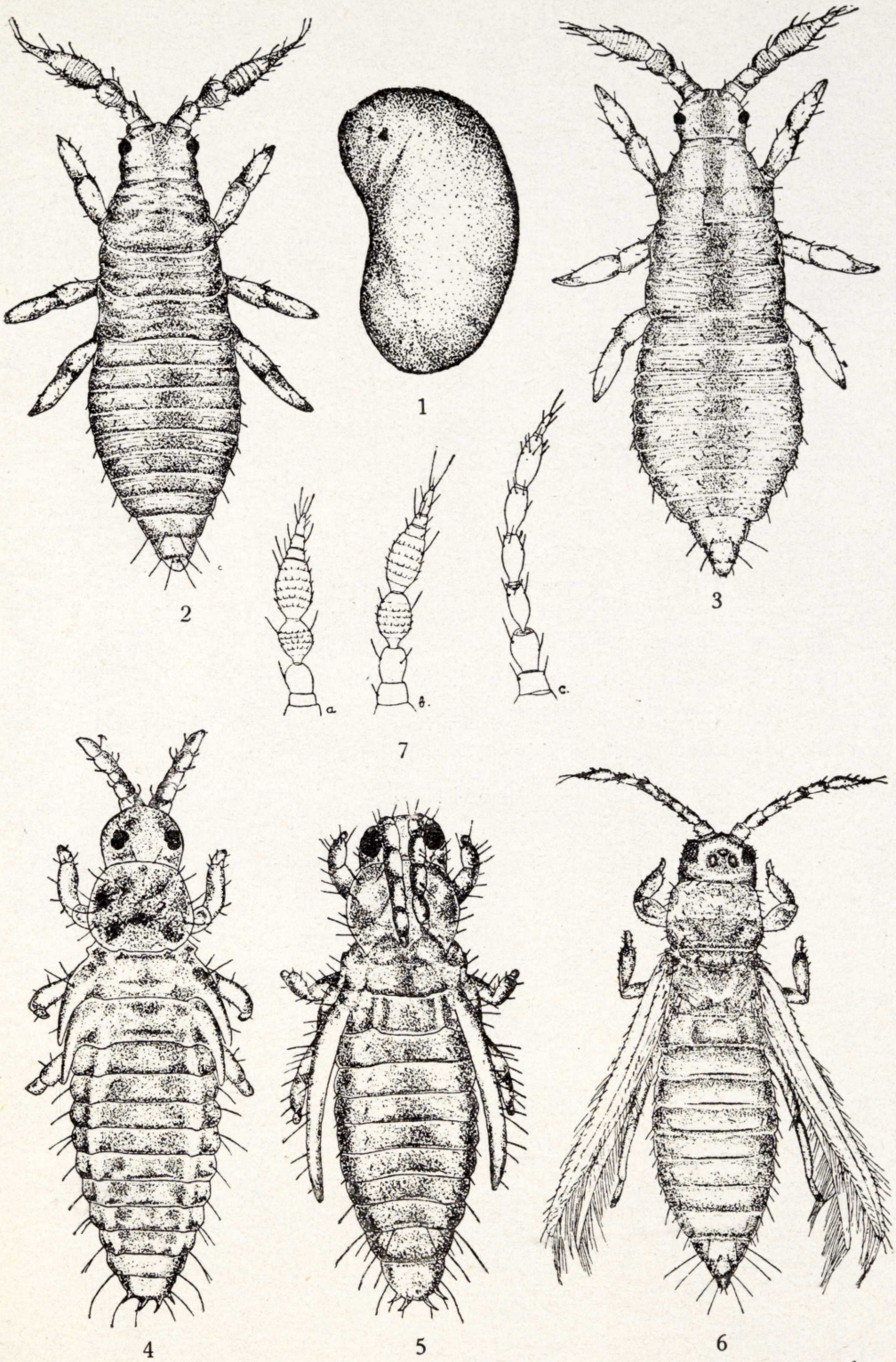
1. Egg (fig. 1).
2. Larva I (fig. 2, 7 *a*).
3. Larva II (fig. 3, 7 *b*).
4. Pronymph (fig. 4).
5. Nymph (fig. 5).
6. Adult (fig. 6, 7 *c*).

Consequently, in metamorphosis there occur, besides the emergence, four moults dividing 2 larval, 2 nymphal and the adult stages.

Only the egg, larva and adult have been fully described in the literature. The nymphal stage has been very briefly described by Quaintance and the pronymph has not yet been observed by anyone. Moreover, as there are no satisfactory figures of this pest, we include the figures of all stages, and description of the nymph and the pronymph.

1. **Pronymph** (fig. 4).

Body pale yellow. The size is slightly less than that of the fully grown larva, viz. 0,7-0,8 mm. Antennae clearly divided into segments and directed forwards. The front part of the eyes red, the back part black. Prothorax rounded quadrate, with two notches on the posterior margin. Mesothorax broad and short, bearing rudimentary anterior wings, the ends of which hardly reach the posterior



Figs. 1-7.—*Thrips tabaci* Lind. 1, egg; 2, first larva; 3, second larva; 4, pronymph; 5, nymph; 6, adult; 7, *a*, antenna of the first larva; *b*, *do.* of the second larva; *c*, *do.* of the adult.

margin of metathorax. In its anterior part, in front of rudimentary wings, the mesathorax bears lateral projections. Metathorax is similar in shape to mesothorax. The rudiments of the posterior wings reach the middle bristle of the second abdominal segment. The abdomen consists of ten segments, which are clearly distinguishable when seen from above. The first nine segments are similarly shaped, viz. elongated rectangular; their width decreases posteriorly, so that the ninth segment is equal to about half of the first. The tenth segment bears four spines. The body, legs, antennae and rudiments of wings are covered with sparse bristles, and the whole body is included in a tight transparent membrane, through which the outlines of the insect are visible.

2. **Nymph** (fig. 5).

Body pale yellow. Length 0,7-0,8 mm. Antennae divided into segments and thrown back over the vertex on to the upper part of the thorax almost reaching with their ends the posterior extremity of the prothorax. Eyes distinctly facetted, red. Prothorax round, specially in front and at the sides, indistinctly separated from the mesothorax. Mesothorax long and narrow, clearly divided from metathorax. The rudimentary wings of mesothorax are covered by those of metathorax. Metathorax is also oblong, narrow, with two notches on its posterior margin. The rudimentary wings of the metathorax are long, reaching the middle of the sixth abdominal segment. The abdominal segments, from first to eighth do not differ from each other when seen from above; they are oblong, quadrate, with the corners rounded; their width decreases gradually, so that the eighth is only slightly larger than half of the first. The last segment is much narrower than the others and bears four spines; the seventh and eighth segments bear longer bristles than the others. The whole body is enclosed in a tight transparent membrane, through which the insect is visible.

III. Bionomics.

1. Hibernation.

On the south coast of Crimea the first adult specimens of the Tobacco Thrips are invariably found in the beginning of May, when the young tobacco plants are ready to be transplanted. During 5 years of our investigations we never found the Thrips on the plants still in the frames, even in the regions where the insect is widely spread, although they were very numerous on the tobacco plantations.

Our observations demonstrated clearly that the Thrips hibernates in the soil of the plantations and of their margins. In 1929 our photoeclectors collected up to 45-50 specimens from one sq. metre of the soil in the fields, and up to 80-90 specimens from one square metre in the margins.

Monoliths of the soil taken in winter show clearly that the greatest number of Thrips are to be found in the upper turf layer. We have found also, that the Tobacco Thrips is to be found in large numbers amongst the dead stems of the tobacco and of other plants, among grass, fallen leaves and other debris of vegetation left after the gathering of the crop.

2. Life of the adult.

After hibernation, the adult Thrips needs food before ovipositing, and can often be seen feeding. In 1928-29, we observed the adult Thrips in large numbers on many cultivated and wild plants, from which it later disappeared, reappearing in great numbers on the young tobacco plants. It appears, therefore, that in spring, after hibernation, the adult Thrips undertakes migrations on wings.

As females, which had hibernated, can oviposit after feeding, they must have been already fertilized, for according to our observations an unfertilized female is enable to lay eggs. The periods of oviposition alternate with periods of feeding on tobacco. By the time when first ovipositions take place, the young tobacco plants are already all transplanted into the fields, and eggs are laid on them. The adult

lives for 20-25 days, during which time up to 100 eggs are laid. Oviposition is performed in a manner typical for the whole group of Terebrantia. The female pierces the cuticle of the leaf with its ovipositor, and lays an egg into the palissade tissue, at a certain angle to the cuticle. After oviposition the wound is healed, and the place can be recognised only by its lighter colouration, and by the outlines of the egg.

A female lays 3-4 eggs in a day; the same number of eggs can usually be observed under the microscope in the females ready for oviposition.

The first ovipositions by the hibernated Thrips were observed in 1926 on 29th May, in 1927 on 14th June, and in 1928 on 23rd May. They take place on the lower leaves of tobacco plants, while eggs of the following generations are laid on the middle and upper leaves. Our observations do not agree with those of Dobrovolsky, who declares that Thrips usually oviposit in the apical parts of the leaves, for we have noticed that the eggs are laid mainly near the margin.

3. **The egg stage.**

According to our observations, this lasts 4-4,5 days.

4. **Hatching of larvae.**

The larva has to exert itself considerably during the emergence, in order to become free. The whole process of emergence, from the moment when the head of the larva can be seen in the wound of the epidermis, until the tip of the abdomen is free lasts about 30 minutes, and longer in cases of riper and tougher leaves. It has been noticed that a considerable number of larvae perish if they hatch out during dry weather; this accounts for the decrease in numbers of the Thrips during the dry summer period.

The emerging larva is enclosed in a membrane resembling the «amnion» of the Acrididae. This skin is cast off either together with the egg-shell, or when the greater part of the body is free of the egg. The newly emerged larva soon crawls to a new place and after several hours begins to feed.

5. Life of the first-stage larva.

The life of the first-stage larva is passed on a leaf of the food-plant, which it never leaves. It is most active in the morning and towards the evening; the activity apparently continues through the night. This stage lasts four days, during which the larva punctures one after another many cells of the leaf, mainly near the veins, and sucks out their contents.

6. The first moult.

Some hours before the moult, the skin on the body of the larva becomes loose. About 2,5-3 hours before the skin is shed, the larva crawls to the lower surface of the leaf, to which it attaches itself by its legs, and remains hanging down. The old skin bursts on the dorsal side of the thorax, usually between the middle of the first and the end of the third segments. The head is the first to emerge; it hangs down and the antennae are thrown backwards and upwards. When half or more of the body and the legs are free, the larva swings itself rythmically and catches hold of the leaf with its legs. A little later the skin is thrown off to the tip of the abdomen, the larva stretches the antennae and the whole body and begins to crawl about the leaf.

7. The life of the second stage.

The whole life of the second stage, like that of the first, is passed on the food plant. Although it has been stated in literature that the larvae of this stage can descend from the plant for hibernation, this has never been observed by us. The stage lasts about four days; larvae are most active during the morning and towards the evening, apparently continuing their activity through the night.

8. Second moult.

The larva of the second stage leaves the exposed surface of the leaf only just before the actual moult, which takes place either on the lower surface of the leaf, or more often, in its axil, and is performed in the same manner as the first.

9. Life of the pronymph.

The pronymph is very inactive and moves only when it is touched; it is able to crawl, but does not feed. This stage lasts 1,5-2 days, after which the insect moults.

10. Life of the nymph.

The nymph is quite motionless and does not feed; its life lasts 1-1,5 days, after which it moults and turns into an adult insect.

11. The whole life cycle lasts 34,5-37 days, as follows:

	Days.
Egg stage	4-4,5
Larva of the 1st stage	4
Larva of the 2nd stage	4
Pronymph	1,5-2
Nymph	1,5-2
Adult insect	20-25

These data on the duration of stages has been obtained by numerous observations made from June to September in the years 1926-1929, and can be considered as correct for Crimea and for localities with similar climatic conditions. We are inclined to think, however, that the durations vary somewhat in spring and late autumn, when they may become longer, but it is probable that these variations in the above mentioned climatic zone are not very important and concern mainly the hibernating adult stage, which lasts 5-6 months.

It is very probable that outside the Crimean climatic zone the differences in duration of stages are considerable; thus, there are indications that in more northerly localities the egg stage can last up to 10 days and in more southern ones only 3 days. The larval stage may vary between 1-3 days, those of nymph and pronymph between 4-7 days. The whole life-cycle varies between 7 days (Java) and many weeks.

12. Probable number of generations.

The literature data on the number of generations of Tobacco Thrips are rather contradictory. According to Reh, «many» generations have been observed in South Europe; Lindeman states that there are three generations in Bessarabia.

As under Crimean and analogous conditions the whole life cycle of Tobacco Thrips lasts on the average 35 days, it can be assumed that during the vegetative period of the tobacco plant, i. e. from May to November, five generations may develop.

13. The seasonal balance of the pest.

Under natural conditions it is very difficult to follow the sequence of generations, as they overlap so that throughout the whole vegetati-

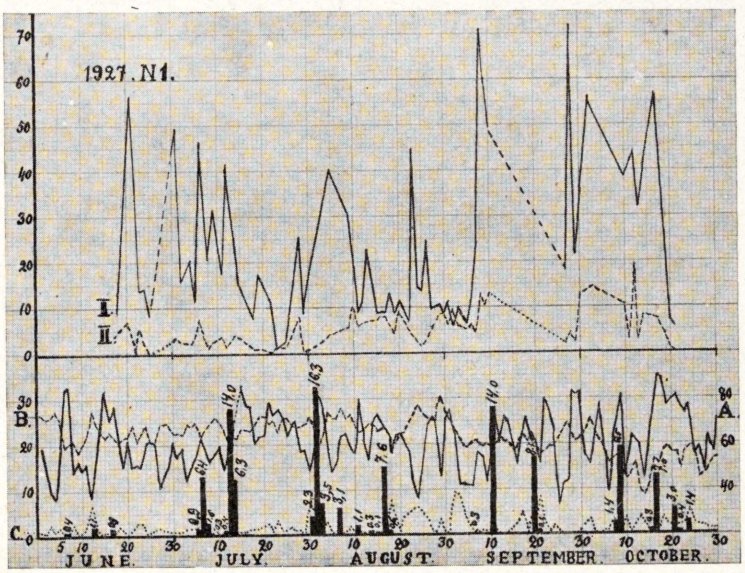


Fig. 8.—A curve of daily fluctuations in the number of *Thrips tabaci* in 1927 I, curve of larvae (scale on the left shows the number of individuals per 100 sp. cm. of leaf surface); II, *do.* of adults; *A*, relative humidity (scale on the right); *B*, temperature (scale on the left); *C*, wind force; solid black columns - precipitation in mm.

ve period of the tobacco plant, all stages, from eggs to adult insects, can be found. The gradual increases and decreases in the numbers

of the Tobacco Thrips can be revealed only by a careful study of its seasonal balance, by means of the curves which represent the seasonal life of the pest, its appearance on the plantations, gradual increase in its numbers, its spreading and gradual decrease due to various causes (figs. 8, 9, 10).

They are based on the numbers of larvae and adults found per 100 sq. cms. of the tobacco leaf surface in an infested plantation.

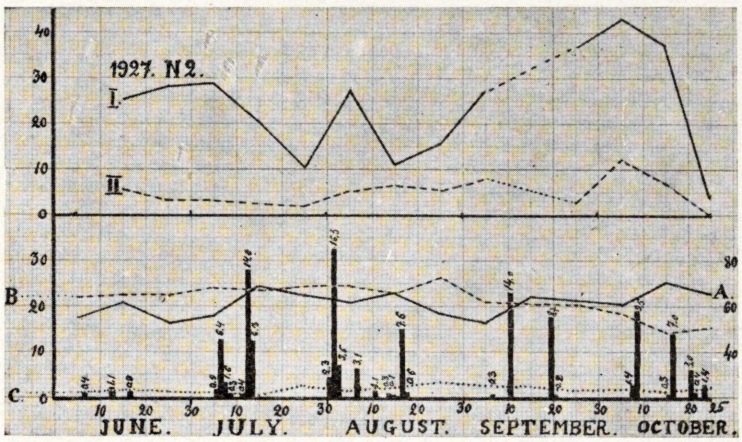


Fig. 9.—A curve of fluctuations in the numbers of *Thrips tabaci* in 1927, by decades. For explication see figure 8.

These figures have been obtained by a special method, which will be fully explained in our future and more complete paper on this pest.

On analysing the curve of the figure 8 based on daily observations one is struck by numerous fluctuations, which show that separate plants and even separate leaves of the same plant are not infested to the same degree. A true estimation of infestation can be obtained only by means of average figures, and the curve of figure 9, which is based on observations for 10 days periods, gives a better idea of the balance of the pest, while the curve in figure 10, which summarises the observations for several years, gives a still more correct estimation of the number of generations.

The curves of the abundance of adults show fewer fluctuations than those of the larvae, and this suggests that the adult insect lives not only on the tobacco, but on other plants, as well.

When studying the dependence of the development of the pest

on physico-ecological factors, we noticed that the first appearance of the pest on the tobacco plant (the beginning of curves representing adults) takes place in May. This has been confirmed by direct observations. The average daily temperature at this time is 16-22° C. The numbers of adult Thrips on tobacco plants in spring are apparently entirely dependent on the conditions of hibernations, for it has been noticed that after the winter 1925-1926, which could be consi-

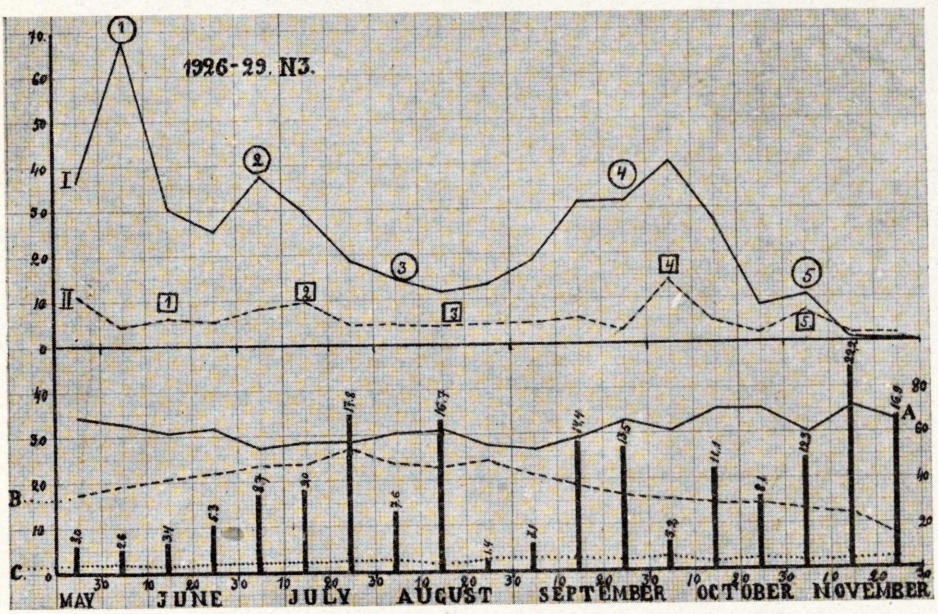


Fig. 10.—A summary curve of seasonal fluctuations in the numbers of *Thrips tabaci*, in 1926-1929. Figures in circles denote the dates of maximum concentration of larvae of the respective generations; figures in squares, *do.* of adults. For other explications see figure 8.

dered as warm (average temperature 6,9° C) with abundant precipitation (635,7 mm.), there were very few Thrips on tobacco plants in spring, viz. 1 specimen per 100 sq. cms. of leaf surface. After the winter of 1926-1927, which was warm (average temperature 6,9° C) and dry (183,4 mm.), the Thrips were considerably more numerous and 6 specimens were found per 100 sq. cms. After the winter 1927-28, which was cold (average temperature 5,1° C) with a normal rainfall (360,5 mm.) the Thrips were even more numerous, viz. 11 specimens per 100 sq. cms. We conclude, therefore, that the deciding factor is not the temperature prevailing during winter, which the hi-

bernating stage is apparently well able to resist, but the amount of precipitation.

According to observations made by MacGill, the development of Tobacco Thrips depends to some extent on humidity, in particular on the rain-fall. In Crimea, the soil is apt to become covered by a hard layer after the rain, and this prevents the emergence of Thrips from the soil after hibernation.

The numbers of Tobacco Thrips (see curves representing larvae) increase in early summer and in autumn, when the daily temperature is not high (not above 23°C); the falling off in the numbers of Thrips corresponds to the period of highest daily temperatures (29-30°C). Our observations show, therefore, that the summer heat in Crimea is detrimental to the development of Thrips.

As far as the rainfall is concerned, we are able to confirm the general opinion (Enko, Hooker, Watson) regarding its importance in the balance of the pest. The curves show that in all cases of considerable rainfall, the rate of development of Thrips becomes slower (e. g. 23rd-24th July 1926, when 36,7 mm. and 20,8 mm. of rain fell).

Again, if the curves (not reproduced here) for all the years during which observations were made be compared, it becomes obvious that in the summers of 1926, 1927 and 1929, there were maximums in the numbers of larvae, while there was no such maximum in 1928. This was due to rainfalls of 1926, 1927 and 1929, which moderated the high temperature of August. We conclude, therefore, that rains are detrimental to Thrips only immediately after they had fallen, but that conditions prevailing soon after a rainfall are very favourable for its development. The influence of wind is negligible; however, it has been observed that strong winds, occuring on 1.VIII.1926, 2-3.IX.1927 and 19-20.IX.1928 decreased the numbers of adults.

The summary of the detailed curves shows that the maximums in the numbers of larvae occur five times during the season lasting from may to september, viz.:

	I	II	III	IV	V
1926.....	End of May.	25.VI	15.VII	15.VIII	
1927.....		5.VII	5.VIII	5.IX	5.X
1928.....	5.VI	5.VII	25.VII	15.VIII	15-20.IX
1929.....	End of May.	15.VI	15.VII	5.IX	5.XI

The curve which presents the summary for four years (fig. 10) clearly shows that there are five maximums in the numbers both of larvae and of adults, i. e. there are five generations. Out of the five above mentioned maxima only the 3rd is not so obvious, owing to the summer depression of the species, produced by low humidity and high temperature. The above data correspond to direct observations, and prove that it is possible to estimate approximately the numbers of the pest during the season.

IV. **The food plants.**

Up to the present, Tobacco Thrips has been found on 51 plants, belonging to 23 different families, as follows.

1. Fam. **Solanaceae.**

1. *Nicotiana tabacum* L.
2. *N. rustica* L.
3. *Solanum nigrum* L.
4. *Datura stramonium* L.
5. *Lycopersicum esculentum* Mill.
6. *Solanum tuberosum* L.

2. Fam. **Papilionaceae, Leguminosae.**

1. *Medicago sativa* L.
2. *M. lupulina* L.
3. *Alhagi camelorum* Fisch.
4. *Melilotus* sp.
5. *Astragalus cicer* L.
6. *Trifolium repens* L.

3. Fam. **Cruciferae.**

1. *Lepidium latifolium* L.
2. *Brassica rapa* L.
3. *B. oleracea* L.
4. *B. botrytis cauliflora.*
5. *Iberis* sp.?

4. Fam. **Rosaceae.**

1. *Pirus malus* L.
2. *P. communis* L.
3. *Prunus domestica* L.
4. *Potentilla* sp.?

5. Fam. **Chenopodiaceae.**

1. *Beta vulgaris* L.

6. Fam. **Cucurbitaceae.**

1. *Cucumis sativus* L.
2. *C. melo* L.

7. Fam. **Compositae.**

1. *Chrysanthemum inodorum* L.
2. *Eupatorium cannabinum* L.
3. *Gaillardia* sp.?

8. Fam. **Geraniaceae.**

1. *Geranium pyrenaicum* L.

9. Fam. **Labiatae.**

1. *Lamium amplexicaule* L.
2. *Nepeta cataria.*
3. *Brunella vulgaris* L.

10. Fam. **Ranunculaceae.**

1. *Helleborus foetidus.*

11. Fam. **Gramineae.**

1. *Triticum sativum* Lam.
2. *Panicum sanguinale* L.

12. Fam. **Liliaceae.**

1. *Allium oleraceum* L.
2. *A. porrum* L.
3. *A. sativum* L.

13. Fam. **Primulaceae.**

1. *Cyclamen coum.*

14. Fam. **Ampelidaceae.**

1. *Vitis vinifera.*

15. Fam. **Caryophyllaceae.**

1. *Dianthus caryophyllus.*
2. *Saponaria* sp.

16. Fam. **Malvaceae.**

1. *Gossypium herbaceum* L.
2. *Malva* sp.

17. Fam. **Papaveraceae.**

1. *Papaver* sp.?

18. Fam. **Borraginaceae.**

1. *Symphytum* sp.?

19. Fam. **Resedaceae.**

1. *Reseda odorata* L.

20. Fam. **Tropaeolaceae.**

1. *Tropaeolum* sp.?

21. Fam. **Nyctaginaceae.**

1. *Mirabilis* sp.?

22. Fam. **Crassulaceae.**

1. *Sedum* sp.?

23. Fam. **Umbelliferae.**

1. *Sarum* sp.?

It is probable that Tobacco Thrips feeds on many other plants, besides those enumerated. According to Priesner, this insect has been found on numerous cultivated and forest plants, mainly on flowers. In Central Europe it has been recorded on flowers of over 100 species. However, not all the plants on which Tobacco Thrips has been found are used for oviposition, and not all of them are suitable for the food of larvae. On such plants as *Chrysanthemum inodorum* L., *Eupatorium cannabinum* L., *Triticum sativum* Lam., etc., only the adult stage, which occasionally feeds on them, can be found. But the greater number of plants enumerated in our list serve as food for all stages of this pest, which is, therefore, a polyphagous insect.

V. Data on the Ecology of Tobacco Thrips.

Most seriously infested plantations are situated on the northern foot-hills of Crimean mountains, in the steppe-forest zone. The pest is also very numerous throughout the southern coast of Crimea, on the

plantations situated among the forests. These two main areas are separated by the Yaila mountains, the vegetation of which is unsuitable for the Thrips. The breeding places are characterised by the presence of forests and water, which are essential for creating the optimum conditions for the development of Thrips. The presence of water is particularly necessary, for in our opinion, humidity is the most important of all ecological factors.

In 1926 (10.VIII), 1927 (24.VIII, 24.IX) and 1928 (24.VII), the relative humidity of 21 per 100, 33 per 100 and 30 per 100 respectively, caused a decrease in the numbers of larvae, which then perished soon after hatching. The temperatures of 27,5°C (28.VII.1926) and 31°C (28.VIII.27), when humidity was low, had the same effect. The optimum temperature is 20-25°C.

The vegetation surrounding the plantations on which the Tobacco Thrips breeds may vary, but it is essential that the food plants be present.

This species is extremely resistant to external conditions—it is sufficient to mention that it can exist in masses even in hot-houses; again it is not particular as to the vegetation on which it feeds. It can be concluded, therefore, that ecologically it is very plastic, and is almost cosmopolitan in its distribution.

VI. The ecomonic importance of the pest.

1. Injury to plants.

As the species is exceedingly polyphagous, it damages many cultivated plants, each of which is damaged in a different manner.

On the tobacco plant the Thrips (chiefly larvae) injures the lamina of the leaf. In spring only the lower surface of the leaf is touched, but in summer and autumn the upper surface is also damaged.

The insects congregate along the veins of the leaf, and with their proboscis puncture the leaf, sucking up the contents of the surrounding cells; this causes the cells to collapse and die off. The injured parts of the leaf first turn yellow, and then rusty brown; these rusty-brown spots are usually found near the veins of the leaf, forming stripes

along them, either on the lower surface only, or, towards the end of summer, on both sides.

Owing to the dying off of a considerable number of cells, the chemical contents of the leaves are changed. The amount of carbohydrates is the first to decrease, as well as apparently the amount of organic acids, on which the elasticity and the flavour of the leaves depend.

A comparison of chemical analyses of tobacco infected by Thrips and of healthy «Nikitinsky Dubeck», which were made by the Department of Agricultural Chemistry of the Nikita Botanical Gardens, has shown that while healthy tobacco contains 20,05-20,1 per 100 of carbohydrates, the infected tobacco contains only 16,1-17,96 per 100.

The change in the quality of tobacco leaves, damaged by Thrips is detected by smocking tests. The damaged leaves become coarser that the healthy ones, and less hygroscopic; they burn like paper, and the flavour is much weakened. The ash left is not of the usual colour. Besides, injured tobacco leaves are noticeably lighter than the healthy ones, and break easily when they are sorted.

An expert can estimate the deterioration in the quality of tobacco by the amount of brown spots and stripes. Naturally, a leaf damaged on one side only will be of a greater value than one damaged on both.

2. The effect of injury on the plant.

The damage done by Thrips to individual cells has a marked effect on the leaves, and on the plant bearing them. A leaf damaged in early spring remains smaller than the normal ones. This is particularly noticeable in the years of mass infestations. The infested leaf matures quicker; it turns yellow, and its lamina hangs down and becomes rolled up earlier than the healthy ones. When a tobacco plant is only partly infected the undamaged leaves develop in the normal way, but a badly infected plant grows more slowly, the whorls of leaves are fewer, and the leaves themselves are smaller, so that during the years of mass infestations by Tobacco Thrips the tobacco plantations present a very patchy appearance.

3. The commercial importance of the pest.

Tobacco Thrips, which appears in early spring, commences to injure the tobacco plants as soon as the later are transplanted to the plantations. Its injurious activity continues throughout the whole vegetative period of the tobacco plant, until late autumn; the pest remains living on the plantation for a long time after the harvest.

It is most injurious in its larval stages during summer, when it feeds on the upper and middle whorls of the leaves, i.e. on the most valuable parts of the plant. Again, mass infestations by Tobacco Thrips affect the whole tobacco plants, particularly in those cases when they take place in spring, for this decreases the harvest. It follows, therefore, that both the quality and the quantity of the harvest are affected by this pest.

The Tobacco Thrips is recorded from many other tobacco growing regions of Russia and other countries, but it is of highest economic importance in those regions where the best grades of tobacco are grown, e.g. Crimea, for in Russia Crimean tobaccos are estimated to be 3-4 times as valuable as tobaccos grown in other regions. Accordingly, Crimean tobacco is judged by very high standards. Leaves damaged on one side only are not considered as belonging to the top of the first grade; those damaged on both sides are not included in the first grade at all. In commercial practice, the tobacco leaves damaged by Thrips are usually placed in the 3rd grade, and more often, altogether rejected. According to our calculations, the damage by Tobacco Thrips depreciates the value of Crimean Dubeck tobacco by 30-60 per 100, and of Crimean American tobacco by 50-70 per 100, causing yearly a loss of hundreds of thousands of roubles to Crimea.

VII. Control of the pest.

The following control measures will be here discussed:

Uprooting and burning of the remaining stems of the tobacco-plants; spraying with contact insecticides; rotation of crops; clean culture and manuring. All these measures have been already mentio-

ned in literature (Quaintance, Hooker, Reh), but scarcely any attemps have been made to demonstrate their economic value.

1. Uprooting and burning parts of plants remaining after the harvest.

According to our observations, this is the cheapest and most effective method of control under the conditions prevailing in Crimea where tobacco is cultivated on same plantations year after year. It is based on the following considerations; in August-September, when the tobacco leaves are gathered, the Thrips migrate on to the remaining parts of the plants. If these parts are now collected into heaps, the insects remain in them and many of them seek hibernation quarters in the topmost layers of the soil beneath the heaps. After 1,5-2 weeks, provided the weather be favourable, the heaps should be sufficiently dry to be burned. It is not recommended to leave the heaps unburnt longer than this, for the Thrips may start dispersing for hibernation.

It is not important whether the plants are pulled out or simply cut, but they must be collected into a few large heaps, and not into many small ones, scattered all over the plantation. This work should be carried out simultaneously with the gathering of the last crops.

This measure, if carried out carefully and throughout a large area every autumn serves to protect the next year's crop from mass injury by Thrips.

2. Weeding.

Since many weeds serve as food plants to the Tobacco Thrips, the plantations must be carefully and systematically weeded, particularly in the early spring, before planting out of the tobacco.

The weeds on the margin of the fields form the turf in which the Thrips hibernate. It is essential, therefore, that all the weeds growing on the margins of the plantations should be pulled out and burnt in the autumn.

3. Rotation of crops.

Rotation of crops is useful as a means of combating the Thrips, but only on the condition that tobacco be followed by densely growing

crops (i.e. corn and annual fodder crops, except those which may serve as food plants to the Thrips).

4. Contact insecticides.

Thrips can be effectively controlled by spraying with soap emulsion (20 gms of soap to a litre of soft water) and with 0.05 per 100 tobacco extract. The spraying, particularly with soap emulsion, should be practised in the early spring, while the plants are yet young, and long before the gathering of the crops, and must be applied twice, with an interval of 4-5 days.

This measure is very expensive, and its application on the plantations of peasants is very limited.

5. Manuring.

Manuring of plantations with salpetre has been recommended against the Thrips. This measure has not been studied by us; however, the introduction of salpetre, or of ammonia sulphate into the soil alters its reaction, and we have found that the reaction of the soil is of importance to the hibernating Thrips. Again, the manuring with salpetre affects the chemical constitution of the tobacco leaves and its taste, and this too is of importance to the Thrips. We have noticed that some plantations, on the South coast of Crimea, manured with nitrogenous fertilizers in early spring, before the planting our of the tobacco, suffered less than others, although they were situated in the midst of an infested area.

Bibliography.

Dobrovolsky, W. A.

1927. Contribution to the knowledge of bionomics of Tobacco Thrips (in Russian).—Krasnodar.

Hooker, W. A.

1907. The Tobacco Thrips, a new and destructive enemy of shadegrown tobacco.—*U. S. A. Bureau of Entomology*, Bull. No. 65.

LINDEMAN, K.

1888. On chief insect pests of tobacco in Bessarabia (in Russian).—Odessa.

MOKRZECKI, S. A.

1898. Report on the activities of the Government Entomologist of the Tavrian Zemstvo (in Russian).—Simferopol.

1898. «Dimir pas», a disease of tobacco in Crimea.—Simferopol.

PRIESNER, H.

1928. Die Thysanoptera Europas.

QUAINTANCE, A. L.

1898. The Strawberry Thrips and the Onion Thrips.—Florida.

REH, L.

1925. Thysanoptera.—Sorauer, *Handbuch der Pflanzen Krankheiten*, III.

WARDLE, R. A.; MACGILL, E. I.; WARDLE AND SIMPSON, R.

1927. The biology of Thysanoptera with reference to the cotton plant. 1-3. London.