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Wheat Striate Virus

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Souhrn

Na ochuravění obilnin, jež se kalamitně vystupňovalo na Českomoravské vysočině v letech 1954 až 1956, se podílel vedle hlavního původce těžkých škod viru sterilnosti a zakrslosti ovsa (VSZO) ještě virus proužkovitosti pšenice (VPP). Studium symptomatologie ukázalo, že VPP se u hostitelských obilnin projevuje charakteristicky odlišně od VSZO. VPP je však podobně jako VSZO specificky rozšiřován křísem *Calligypona pellucida* Fabr. Při dlouhodobé individuální testaci vektorů pocházejících z lokality zamořené VSZO a VPP byly rozlišeny podle patogenních účinků na obilí čtyři skupiny hmyzu: 1. nepatogenní, 2. vyvolávající příznaky VSZO, 3. vyvolávající příznaky VPP a 4. vyvolávající většinou příznaky VSZO, ale občas též VPP anebo obou těchto virů současně. VPP je ve svém přenašeči persistentní a je přenášen jak larvami různých vývojových stupňů, tak i imagy *C. pellucida* obojího pohlaví. VPP býval přenášen méně pravidelně než VSZO. Mezi jednotlivými křísy byly značné diference v přenášečské účinnosti pro VPP, takže lze předpokládat existenci v tomto směru různě efektivních ras. V polních populacích u nás převládají patrně méně účinné rasy. K přenesení VPP bylo třeba minimálně devítihodinového pobytu vektora na hostiteli, zdá se však, že by stačila i kratší doba. Extrakty z rozdrcených listů proužkovitých pšenic, jakož i z infekčních křísů inokulovány do rostlin mechanicky (vtíráním, injekcemi) nezpůsobily nákazu. Pokusy o přenos půdou a kokoticí (*Cuscuta campestris* Yunck.) byly negativní. Termický bod inaktivace viru v živém přenašeči se nepodařilo stanovit. V SSSR popsané viry „zakuklivanije" obilnin a ruská mosaika ozimé pšenice se liší od VSZO a VPP mimo jiné též produkováním typických inklusí a tím, že je lze snadno přivést ke krystalisaci.

Summary

In addition to the oat sterile-dwarf virus (OSDV) as the main agent causing grave damage to cereal crops in the Bohemian-Moravian Highlands during 1954—56, when the disease reached catastrophic proportions, it was found that wheat striate virus (WSV) also played a part. Symptomatological study showed that there are characteristic differences between the effect of WSV on the host plants and that of OSDV. Similarly to OSDV, however, WSV is specifically spread by the leafhopper *Calligypona pellucida* Fabr. Following long-term individual testing of vectors taken from localities infested with OSDV and WSV, four groups of insects were distinguished according to their pathogenic effects on cereal crops: 1. nonpathogenic, 2. producing OSDV symptoms, 3. producing WSV symptoms, 4. producing for the most part OSDV symptoms, but occasionally WSV or symptoms characteristic for both viruses simultaneously. WSV is persistent in its vector and is transferred by *C. pellucida* larvae at different stages of development and by imagos of both sexes. WSV tends to be transferred less regularly than OSDV. Considerable differences in efficiency of carrying WSV are to be found between individual leafhoppers, so that it is possible to assume the existence of races with varying efficiency in this respect. Among field populations in this country less efficient races prevail. For the transmission of WSV to be effected it was necessary for the vector to remain on the host for at least nine hours, but it seems that a shorter period might suffice. Extracts of crushed leaves of wheat plants suffering from the striate disease and from infective leafhoppers failed to cause infection when inoculated mechanically (by rubbing, injection) into plants. Attempts to achieve transmission through the soil or by dodder (*Cuscuta campestris* Yunck.) gave negative results. It was not possible to determine the thermal inactivation point of the virus in the live vector. The mosaic (zakuklivanie) virus of oat and the Russian mosaic of winter wheat as described in the U.S.S.R. differ from OSDV and WSV among other points by the production of typical inclusions and by the fact that they can easily be induced to crystallize.

Introduction

It has already been reported in short notes (Průša 1958, 1959a, 1959b, 1959c, Průša et al. 1959) that during investigation of the catastrophic oats disease, which reached particularly serious dimensions in the south-western parts of the Bohemian-Moravian Highlands in 1954—56, in addition to oat sterile-dwarf virus (OSDV) as the main factor causing grave damage to crops, wheat striate virus (WSV) was also identified. It was reported that both viruses have the same vector, the leafhopper *Calligypona pellucida* Fabr., in nature. They are persistent in this vector and WSV can be transmitted transovarially in a high percentage of cases by infected females to their offspring, which was not observed in the case of OSDV.

This paper deals with the part of the experiments which led to the discovery of WSV in Czechoslovakia, to the elucidation of its symptomatology in the main host plants and to the investigation of some of its characters.

Signs of WSV were observed as early as 1956. They were dealt with in more detail in 1957, when very striking cases of striated plants were found in winter wheat in a field next to that on which oats had been completely infested with OSDV the year before. This was in the experimental locality Sázava, the focal area of the OSDV epidemic in the Pelhřimov district. The character of the distribution of striated wheat in the crop (high degree of infection confined to the part of the field in the close proximity of the previous year's oat crop and a sharp drop in the proportion of diseased plants in a direction away from the previous oat field and deeper into the wheat field) indicated that the factor causing these symptoms in wheat was identical with that which had caused grave damage to oats (PRŮŠA 1957). Experiments showed, however, that the striation was produced by another virus, which was then named from the most typical sign on the first host plant on which it was identified, wheat striate virus. The remarkable type of distribution of the striated plants in the wheat crop was explained as being due to WSV having the same vector as OSDV; this vector gave preference to oats, but passed over to winter wheat when the remaining oats, which is cultivated here as a spring crop, died out completely during the autumn and winter.

Material and Methods

In the first experiment with WSV striated winter wheat found at the beginning of June 1957 near the village of Sázava was used as the source of infection. Oat seedlings variety Valečovský bílý were used as test plants. Infectivity was tested by three groups of insects: a mixture of aphid species caught on corn at Sázava, a mixture of bug species (Heteroptera) from the same source and a mixture of leafhopper species from a mixed crop of barley and oats at Ruzyne near Prague. Each group of insects was first left for three days' acquisition feeding on striated wheat and then fed for a week on healthy oats plants. Cages formed of two curved hard brass wires placed at right angles to each other and covered with white Silon stockings (BRČÁK 1959) were used in order to isolate the insects on the plants. The insects were killed at the conclusion of the test-feeding by spraying with the nicotine preparation Floron. Further particulars about this experiment are given in Table 1.

The question of the transmittability of WSV by different aphid species, caught on corn and grass fodder plants in the area of the maximum occurrence of WSV and OSDV, to the different corn crops was simultaneously examined in a series of similar tests. Further reference is not made to the results obtained, as they were negative.

After it had been established that the spread of virus signs is specifically related to the leafhopper *Calligypona pellucida* Fabr., the method of mass application of insects to groups of plants was replaced by the process of long-term individual testing of each leafhopper separately for a series of receptive plants (for details see PRŮŠA et al. 1959).

The insects used in the main experiment were caught at the edges of fields upon which there had been a completely infested crop of oats the year before (1957). The locality was Sázava. The insects were transferred by means of an entomological exhaustor, which had been modified for the purpose (Fig. 1) so as to allow both the necessary freedom of manipulation when catching the leafhoppers in special isolation cages of strong brass wire and Silon fabric (see illustration in PRŮŠA et al. 1959), and also rapid and careful transference of the insect from plant to plant. The main alteration was that instead of attaching the insect-isolating fabric to the tube, which with its rubber extension is placed in the operator's mouth, it was connected to the end of the tube through which the insects are drawn into the exhaustor. This ensured that the indrawn insect could not enter the main part of the exhaustor direct and remained in the bend of the lower tube, from which it could then be blown out into another isolator on a further test plant without the apparatus being taken apart. In these tests, as in further experiments from which information was obtained about the course of virus symptoms, young seedlings of the following varieties were used as test plants: Oats Valečovský bílý, wheat Ratbořská jarní and Blanka jarní, barley Stupický plnozrnný and Triumf, rye Těšovské jarní.

Determination of the period essential for the vector to stay on the plant in order to bring about infection was carried out with naturally infected imagos of *C. pellucida* from the oats epidemic area. The leafhoppers were put individually to feed on the test plants at graded intervals of time. The experiment was carried out twice during June and July 1958. Results are recorded in Table II.

In experiments involving the mechanical transmission of WSV inocula prepared from diseased plants and from infected leafhoppers were used. Preparation of the inoculum from plants was carried out as follows: Leaves picked from typically striated wheat plants were cut up into small pieces and 5 g. of this material was put into a cooled porcelain mortar. Following the addition of 10 ml. of cold phosphate buffer (Sörensen) of pH 7 and a pinch of sand, the mixture was thoroughly ground. Liquid was squeezed out of the pulp through a Silon sheet into a measuring glass and the squeezed pulp was returned to the mortar, where it was mixed with a further 5 ml. of buffer and ground again. The homogenate was put into the Silon sheet and thoroughly squeezed again by hand and by means of virological forceps, the expressed liquid being added to that in the measuring glass. In this way 16·1 ml. of inoculum was prepared. Inoculation followed at once. It was carried out by transferring the inoculum by means of a pipette into small swabs of folded gauze, which were sprinkled with carborundum powder; the leaves of the young test plants (60 oats, 30 wheat and 30 barley, sown 18. 6. 1957 in 10 cm. jars, 5 in each jar, inoculation carried out 3. 7. 1957 at the phase of the 1st to 3rd leaves) were lightly wiped several times with these gauze swabs. The methods used in the experiments on the mechanical transmission of cereal viruses using inoculum obtained by extracting homogenates from the bodies of infected leafhoppers have been published in a previous paper (Průša et al. 1959).

The attempt to transmit cereal viruses through the soil was started in May 1958 on a fenced plot in the garden. The fenced plot was filled to about 10 cm. with a layer of soil into which in the previous autumn a considerable amount of chopped straw and roots from oats plants suffering from OSDV, and wheat infested with WSV, had been placed. Four rows of oats and one row of wheat were sown in this plot. The possibility of infection from without was eliminated by placing a large, angular isolation cage of Silon fabric with a wooden frame over the whole plot. A total of 406 oats (Valečovský bílý) and 102 wheat (Blanka) plants were included in the test.

The thermal inactivation point of cereal viruses, which were found to be untransmittable by mechanical means, was examined directly within the bodies of live leafhoppers. Naturally infected insects, caught on crops in the area where disease had developed, were placed fifteen at a time in thin-walled test-tubes closed by fine silon fabric. The test-tubes were put into a water bath for varying periods of time. The temperature of the water baths was maintained at exactly 35° C, 37·5° C and 40° C by means of Vertex and electronic contactors (apparatus shown in Fig. 2). These groups of leafhoppers were then placed on healthy oats plants in order to test their infectivity.

Results and Discussion

Experiments with Vectors

As shown in Table I, in no part of the first experiment were plants with typical signs of WSV observed. Plants covered with aphids and bugs remained almost entirely healthy. Only in the variant using leafhoppers were 15 out of 75 test plants found to be infected with OSDV. OSDV was transmitted in this case from the striated wheat, which was evidently simultaneously infected with OSDV, although this could not be recognised from the symptoms.

In addition, it was recorded that some plants, in which aphids had been used for transmission, developed small, brownish or rusty-yellow spots about 10 days after the feeding (Fig. 3). These were mostly to be found on the oldest leaf and it was usually possible to see a minute, dark-

Table 1. Attempt at transmitting WSV by three groups of insects (1957)

Feeding period		Species mixture	No. of insects on plant	No. of test plants	Date of sowing oats	Diseased	
Acquisition on diseased wheat	Test on healthy oats					WSV	OSDV
						No.	No.
14.—17. 6.	17.—24. 6.	aphids	3—5	35	5. 6.	0	0
				40	11. 6.	0	0
14.—17. 6.	17.—24. 6.	bugs	2—3	35	5. 6.	0	0
				40	11. 6.	0	0
14.—17. 6.	17.—24. 6.	leafhoppers	2—3	35	5. 6.	0	7
				40	11. 6.	0	8
Non-infected control plants:				70	5. 6.	0	0
				80	11. 6.	0	0

coloured centre indicating the point of puncture. After feeding by bugs, spots of a different character appeared on the leaves of young plants; they were more numerous and looked like pale dots, while as in the above case they were still to be seen a long time after the killing of the tested insects. Sporadically some of both kinds of spots grew considerably larger, took on an ochre-brown colour and acquired a watery consistency. Since it was demonstrated, however, that none of these spots, which were met with here and there in later experiments with sucking insects as well, had any causal connection with WSV or OSDV, no great attention was devoted to them.

The series of tests carried out concurrently with aphids collected from crops and grasses in the area of virus diseases gave almost entirely negative results and therefore no further description has been given here. These tests, however, confirmed that aphids have no connection with the spreading of WSV.

During February and March 1958 a pilot experiment with 12 leafhoppers (*C. pellucida*) was carried out under laboratory conditions. They were adult females whose development had been artificially accelerated by adjustment of the temperature and lighting conditions. They came from the OSDV epidemic areas, having been caught as larvae in the autumn of the preceding year. The insects were placed individually on 6 oats and 6 wheat plants. In each case 3 leafhoppers were left on each host plant for 20 hours, another 3 for 3 days. The insects were then removed and the experimental plants were given supplementary illumination.

None of the plants showed any of the characteristic signs of WSV. OSDV developed, however, in one oats and one wheat plant. In both cases this took place in the variant with the 20-hour test feeding period. The rest of the plants remained healthy. This very limited experiment showed for the first time the fundamental differences in pathogenic capacity between individual leafhoppers of the same sex, age and origin, for only 2 out of 12 produced typical signs of OSDV after less than a day on the host, while others, evidently uninfected, did not produce this result even after 3 days of feeding. In addition, this result already indicated quite clearly that the virus of wheat striation is probably not identical with OSDV, because in the case of the only successfully infected wheat plant the characteristic stripes failed to develop; on the contrary, the symptoms of disease (dwarfing, more intense tillering, slight yellowing from the tips of the youngest leaves) were those which were later found to be caused by OSDV (PRŮŠA 1958, PRŮŠA et al. 1959).

At the beginning of April a more extensive experiment of five months duration was started in order to investigate the pathogenic effects of 160 leafhoppers *C. pellucida* from Sázava (locality where the occurrence of WSV and OSDV was greatest) on various cereals. Each leafhopper was tested individually on a certain series of cereals. The periods of test feeding ranged from one to three weeks in most cases. The leafhoppers were tested from the stage of hibernating larvae throughout the whole of their further development, usually up to their natural death. As a rule they fed on 6 to 9 test plants consecutively. For the first three passages larvae of the third to fifth stage of growth were used, while from the end of the fourth passage, by which time many insects had already matured, adults were used. The results obtained enabled the leafhoppers to be divided, according to the pathological state which developed following their feeding on the test plants, into the following four groups:

1. Non-pathogennic insects. There were 23 leafhoppers in this group (14·4%). Plants on which they fed were never diseased. Following their feeding either no slowing of growth took place, or there was a slight slowing which was atypical as regards the disease concerned and became somewhat more pronounced with increasing length of the insect's stay on the host plant.
2. Insects calling forth symptoms typical of OSDV. There were 96 leafhoppers in this group (61·2%).
3. Insects producing symptoms characteristic exclusively of WSV. There were only 3 leafhoppers in this group (1·9%).
4. Insects causing for the most part symptoms typical of OSDV, but occasionally of WSV as well, or of both viruses simultaneously. A group of 36 insects behaved in this way (22·5%).

Further, it was found that the leafhoppers tested transmitted OSDV not only in a high percentage of cases (83·7%), but also very regularly and usually to all plants on which they had the opportunity to feed. As opposed to this WSV was not transmitted nearly so frequently and regularly, but only at irregular intervals of time and usually to a minority of the test plants. Among a total of 39 leafhoppers (24·4% of the total) infected with WSV there were remarkable differences in the efficiency of transmission of this virus. Only 3 individuals (7.7%) infected all the plants on which they fed, 10 leafhoppers (25·6%) infected a half to three-quarters of the plants and the remaining 26 leafhoppers (66·7%) infected less than half the plants on which they were placed. While no particular differences were found in the efficiency with which *C. pellucida* transmits OSDV, the facts noted above indicate that there exist races with varying efficiency as regards their ability to transmit WSV. It would appear that in our field populations the less efficient races predominate. This assumption is supported by field observation according to which WSV occurs only sporadically in the crops, which would otherwise be difficult to explain.

The finding of considerable differences among individual leafhoppers as regards their efficiency in transmitting WSV is in complete agreement with a similar observation on the European cereal striate mosaic virus, which was published recently in Great Britain (WATSON 1959, WATSON and SINHA 1959). This virus is probably identical with our WSV. The above authors distinguished three races of the vector according to the ability to acquire and transmit the virus: highly efficient (transmitting the virus to 90 to 100% of the test plants), efficient (transmitting to 40 to 50% of the test plants), and inefficient (transmitting to 10 to 20% of the test plants). Although more accurate data on the representation of the different races in field populations have not yet been obtained, it is assumed that in England, too, the least efficient race predominates.

Dlabola (1958a, 1958b), who worked with similar material to that used by the present authors, mentions that he observed signs of striation only after feeding by *C. pellucida* larvae placed in large numbers on the cereal crops. He considered the cause to be due rather to some kind of toxin injected by the leafhopper with its saliva into the plant during feeding than to a virus. In the present tests, on the contrary, in spite of a certain irregularity and fluctuation in transmission (the maximum transmission of WSV was for example recorded following test feeding at the end of April and the beginning of May, when the majority of leafhoppers were in the last but one and last phase before transformation to imagos), it was definitely established that ability to transmit WSV is not limited to any special stage of development of the vector, but that it is exhibited by larvae at different stages and by imagos of both sexes. Further, one leafhopper suffices for infection.

Finally, the above experiment also showed that WSV persists in its vector for a very long time (e.g. one leafhopper transmitted WSV to 6 plants over a period of several months) and that it therefore belongs to the so-called persistent viruses.

The Relation between the Length of the Vector's Stay on the Host Plant and the Probability of Successful Infection

The results summarised in Table II show that the first transmission of OSDV took place after a thirty-minute stay by a leafhopper on its host, while in the case of WSV nine hours were necessary.

Table 2. Examination of the period of feeding by the leafhopper *Callígypona pellucida* on oats plants necessary to cause infection

Length of stay of a leafhopper on host	Tested leafhoppers	No. of leafhoppers transmitting OSDV		No. of leafhoppers transmitting WSV	
		total	%	total	%
5 minutes	21	0	0	0	0
10 minutes	20	0	0	0	0
30 minutes	20	1	5	0	0
60 minutes	20	2	10	0	0
90 minutes	20	2	10	0	0
2 hours	20	3	15	0	0
3 hours	20	3	15	0	0
6 hours	20	5	25	0	0
9 hours	20	7	35	1	5
15 hours	10	4	40	1	10
20 hours	20	9	45	1	5
24 hours	20	11	55	2	10
30 hours	14	8	57·1	2	14·3
2 days	16	10	62·5	2	12·5
3 days	9	9	100	1	11·1
4 days	8	8	100	1	12·5
6 days	6	6	100	2	33·3

It must be noted, however, that irregularity in WSV transmission, due to the probable existence of vector races of varying efficiency, and the fact that there were relatively few individuals infected with this virus among the leafhoppers used, makes it necessary to assume that a shorter feeding period could suffice to produce infection by WSV, too. This view is also supported by data from England (Slykhuis and Watson 1958), according to which it was observed that European cereal striate mosaic virus was exceptionally transmitted after only half-an-hour of test feeding.

The experiment also showed that the duration of test feeding by the vector has an effect within a certain time interval on the probability of transmission of the disease, but not on its destructivity. The plants exhibited practically equally severe signs of disease when they were infected following feeding by the infected insects lasting several hours or some days.

Attempts at Mechanical Transmission of WSV

The first attempt at mechanical transmission of WSV using sap from striated wheat was evaluated at the end of August 1957. Out of 120 inoculated plants only one wheat plant showed signs of WSV. All the rest (60 oats plants, 30 barley and 29 wheat) remained healthy. This experiment was later repeated twice without any of the characteristic symptoms of the disease being produced. It was therefore assumed that the single case of transmission was probably accidental and that WSV, like OSDV, is non-transmittable by mechanical means using the sap of diseased plants.

In 1958 an experiment was also carried out to determine whether the two cereal viruses identified in Czechoslovakia can be transmitted by mechanical inoculation (rubbing into stalks and leaves, injection into stalks) with concentrated extracts of the crushed bodies of infected leafhoppers. The negative result of this experiment, which has already been published (Průša et al. 1959), also goes to confirm that WSV and OSDV cannot be transmitted mechanically.

Attempt to Transmit WSV through Dodder (*Cuscuta campestris* Yunck.)

The attempt to transmit WSV by means of *Cuscuta campestris* Yunck. failed. Since, however, the experiment was not sufficiently extensive (only 8 young wheat plants were used for infection), and since the dodder attached itself to the wheat with some difficulty, this result cannot be regarded as final.

Attempt at Transmitting Cereal Viruses through the Soil

None of the 406 oats and 102 wheat plants, grown in soil infested in the autumn of the previous year with considerable quantities of straw and roots from virus-infected cereal crops, showed any symptoms of WSV or OSDV disease. It can thus be concluded that neither of these viruses is transmitted by soil. The result of the experiment is also in agreement with observations made in previous years under field conditions with less strict control (viz Průša 1958).

Attempt at Thermal Inactivation of Cereal Viruses

Since both WSV and OSDV are not mechanically transmittable by sap extracted either from diseased plants or from infected leafhoppers, an attempt was made to establish the point of thermic inactivation of these viruses directly in the bodies of the living vectors. Significant inactivation was not obtained for either virus by warming the leafhoppers to a temperature of 35° C for a period of 3 hours or less, to 37·5° C for 45 min. or less nor to 40° C for 10 min. Following 45 min. heating to 37·5° C, however, more than half the leafhoppers died and following 10 min. at 40° C only one insect out of 15 remained alive.

Histologico-Cytological and Biochemical Examination

Wheat, oats and barley plants infected with both OSDV and WSV were subjected to careful histologico-cytological examination by several reproductions of the method which in the U.S.S.R. enabled specific and diagnostically important phenomena (inclusion bodies) in cereals suffering from the "zukuklivanie" virus and the Russian winter wheat mosaic virus to be demonstrated (Sukhov 1940, 1943, 1956, Sukhov, Vovk and Alexeyeva 1943). In certain respects these viruses resemble those dealt with in the present paper. It was found that in cases of WSV and OSDV disease neither needle crystals nor large looped inclusions appear in the live epidermal and guard cells. These are characteristic in cases of "zakuklivanie" virus disease in cereals. It was further found that, in contrast to the two Russian viruses, in cases of WSV and OSDV needle-shaped bodies are not even formed after treatment of the sections or tissue homogenates with 0·1 N HCl solution and adjustment of the pH of the medium to 4·0.

The absence of these remarkable intracellular bodies was later kindly confirmed by the leading Soviet virologist V. L. RYZHKOV (1959), who received specimens of WSV and OSDV infected cereals, preserved in alcohol, for investigation.

Further evidence of the distinct character of WSV and OSDV as compared with the Russian viruses was obtained during experiments on crystallizing out of virus substances by methods described in the U.S.S.R. (SUKHOV 1943, 1956, SUKHOV, VOVK and ALEXEYEVA 1943). The procedure by which it was possible to prepare the Russian viruses in crystalline form was repeated several times on the present material with negative results.

Symptomatology of Wheat Striate Virus Disease

Concurrently with investigation of the etiology of signs of disease in cereals thorough symptomatological observations were made on oats, wheat and barley which had been naturally, or especially artificially, infected with OSDV and with WSV. It was revealed that WSV differs considerably in its effects on the host from OSDV and that it has a somewhat shorter incubation period.

The first perceptible symptom following WSV infection is not a change in growth, as with OSDV, but a colour change. Three weeks following infection (and later too) striation can appear on the youngest leaves in the form of pale or yellowish lines of varying length. There is an increase in the number of chlorotic lines running parallel to the veins, they lengthen, grow broader and run together to form stripes. This chlorosis passes over to some of the older leaves and to all leaves developing after infection; it may cover the leaf sheaths and parts of the stalks. At a more advanced stage of this typical systemic disease almost the whole of the plant may, therefore, take on a cream colour. The characteristic striation, which is similar on the different cereal species, is illustrated in Figs. 4 and 5.

Following the well-defined appearance of striation the growth of the diseased plants is practically halted. Stimulation of tillering and proliferation in the flower organs, insofar as they develop at all, do not take place. Ears or panicles (glumes are also striated — see Fig. 6) can only be formed in plants that have been infected at a later stage of development; the seeds are then shrunken and inferior.

Plants which have been infected at an early stage (the phase of the first to third leaves) lose their chlorophyll within 6 to 8 weeks and die. Similarly, the majority of cereals infected during the first two months of growth die prematurely. WSV is more destructive of barley and wheat than OSDV. In some cases it was even noted that elongated necroses developed on the chlorotic parts of barley leaves, var. Triumf (Fig. 7). Similar necroses also accompany American wheat striate mosaic virus disease on the wheat variety Minter (SLYKHUIS 1952, 1953). With oats there was not such a difference in the destructivity of WSV and OSDV, but plants infected with WSV died sooner.

During combined infection by WSV and OSDV the course of the disease is the most severe and death of the hosts takes place most rapidly. Combined infection was most easily recognisable from the external symptoms in oats. Here, in addition to the striation indicating WSV, there quite often appeared symptoms revealing the presence of OSDV (swelling of stalks in the region of the tillering nodes, increased tillering, darker colouring of the green parts, etc.). With wheat or barley showing symptoms of WSV it was, on the contrary, impossible to decide by the external symptoms whether plants were or were not suffering at the same time from the less destructive OSDV. This could be determined, however, not only from the results of the feedings which preceded and followed in the series of passages of the leafhopper concerned to other test plants, but also from some experiments in which OSDV was transmitted from plants exhibiting symptoms of WSV alone.

Symptomatologically WSV is related to the wheat striate mosaic virus described in the U.S.A by SLYKHUIS (1952, 1953). The American virus is, however, transmitted by the leafhopper *Endria inimica* Say., which does not occur in Europe. A virus which is probably completely identical with WSV has also been described in England under the name European cereal (wheat) striate mosaic virus (SLYKHUIS 1958, SLYKHUIS and WATSON 1958). The present authors do not fully agree with the above authors as regards the naming of the virus, mainly because its characters definitely place it among the so-called "cicadophile yellows" and it should therefore not be termed a mosaic. Examples of striation in cereals observed by SLYKHUIS (1958) during his visit to Germany and Denmark evidently belong to this virus too. WATSON (1959) demonstrated a disease similar to the English virus disease in material brought to England from Spain, where it seems to be attaining dangerous proportions. News of the occurrence of a virus similar to WSV has also been published recently in Sweden (LINDSTEN 1959). All this indicates that WSV is fairly widely distributed in Europe.

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Вирус полосатости пшеницы

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Резюме

В 1954—1956 гг. эпидемически распространилось на Чешско-моравской возвышенности новое заболевание зерновых культур; кроме основного фактора – вируса стерильности и карликовости овса (ВСКО)-играл здесь меньшую роль и вирус полосатости пшеницы (ВПП). Симптоматологическое изучение показало, что ВПП на зерновых — хозяевах выявляет характеристические отличия от ВСКО. Однако, ВПП, также как и ВСКО, распространяется специфически цикадкой *Calligypona pellucida* Fabr. Использованием долговременного теста векторов происходящих из местностей зараженных ВСКО и ВПП удалось нам выявить четыре по своему патогенному действии отличающиеся группы насекомых: 1) непатогенные, 2) индуцирующие признаки ВСКО, 3) индуцирующие признаки ВПП, 4) индуцирующие преимущественно признаки ВСКО, однако, иногда также признаки ВПП или обеих вирусов одновременно. ВПП персистирует в своем хозяине и переносится как личинками разных фаз развития, так и имаго *C. pellucida* обеих полов. ВПП по сравнению с ВСКО переносится менее регулярно. Между отдельными цикадками наблюдаются значительные различия в степени эффективного переноса ими ВПП, следовательно, возможно предполагать существование в этом направлении в разной степени эффективных рас. В полевых популяциях у нас преобладают менее действенные расы. Для успешного переноса ВПП надо по меньшей мере девяти часов пребывания вектора на хозяине, однако кажется, что достаточно и более короткого срока. Экстракты из разрушенных листьев полосатых пшениц, также как и из инфекционных цикадок, инокулированные в растения механически (втиранием, инъекцией) не привели к заражению. Попытки перенести вирус посредством почвы или повилики (*Cuscuta campestris* Yunck.) не увенчались успехом. Точку термической инактивации в живом переносчике установить не удалось. В СССР описанные вирусы закукливание злаков и русская мозаика озимой пшеницы отличаются от ВСКО и ВПП, кроме другого, также и продукцией типичных включений и тем, что их легче возможно привести к кристаллизации.