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PRAGUE, 1972

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EUROPEAN AND MEDITERRANEAN CEREAL RUSTS CONFERENCE, 1976

As previously announced, this Conference will be held in Switzerland from 6 September to 11 September 1976. The Conference will be held at Interlaken, where suitable accommodation is available: the Local Secretary is Dr. A. Brönnimann.

OVERWINTERING OF *PUCCINIA HORDEI* IN ENGLAND

BY M.B. SIMKIN & B.E.J. WHEELER

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In England, brown rust of barley caused by *Puccinia hordei* Otth is generally more prevalent on spring-sown crops in the South. Recently it appears to have increased in importance in these areas and in some years, 1970 for example, has been unusually severe (King, 1972). We have been investigating the epidemiology of this disease and this short contribution reports our observations and experiments on the perennation of the fungus.

OVERWINTERING AS UREDOSPORES AND UREDOSORI

Previous work by D'Oliviera (1939) indicated that *P. hordei* could overwinter as uredospores or as a dormant uredo-mycelium on winter barley and volunteer plants. In November 1970, an experiment was set up to examine (1) the viability of uredospores from pustules during the winter (2) the ability of pustules to produce further uredospores if transferred to favourable environments and (3) the development of uredo-mycelium on newly-produced leaves and tillers.

Seedlings of the cultivar Zephyr were raised, two per pot (25 cm diam), to the first-leaf stage in an unheated greenhouse. These were inoculated with uredospores of *P. hordei* - race U.N. 16*, kept at high humidities for 24h in another greenhouse at 17 ± 2°C with a 16h photoperiod to induce infection and returned to the untreated greenhouse until pustules erupted on the inoculated leaves. The amount and distribution of the rust on each leaf were recorded and the plants were then placed outside in the Walled Garden at Silwood Park on 1 December in five blocks of ten pots. Every 14 days, five pots, one at random from each block, were sampled and the following carried out (1) uredospores were collected from pustules and their germination at 20°C and 100% rh tested in chambers like those of Manners & Hossain (1963) and also on leaves of healthy seedlings; (2) leaf segments with pustules were floated on water containing 20 ppm benzimadazole, incubated at 25° with a 16h photoperiod and the pustules were examined every 2 days for the production of new spores; (3) all new leaf material i.e. produced after transfer outside, was examined for incipient pustules by the techniques of Shipton & Brown (1962).

Table 1 summarizes the main results. Rust pustules were present on inoculated leaves until 17 March; all these leaves were dead by 31 March. Mycelial infections on newly-produced leaves were first detected on 16 February but pustules were not found on these leaves until 24 April, indicating a slow development of the fungus during the relatively wet and cold conditions during this period. The germination of the uredospores which were present fluctuated only slightly and seedlings inoculated with these uredospores became infected in all instances. Pustules transferred

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* This was kindly supplied by Dr. R. Johnson of the Plant Breeding Institute, Cambridge.

to a controlled environment (treatment 2, above) continued to produce spores until the leaf pieces died. Seedlings had begun to tiller by 3 March and mycelial infections were first found on tillers on 31 March. Clearly the winter conditions of 1970-71 allowed the slow but continuous development of P. hordei on barley in the field.

Table 1. Development of P. hordei on barley, winter 1970-71.

	Sampling date (1971)								
	Jan	Feb		March			April	
	20	3	16	3	17	31	14	28
Pustules on leaves	+	+	+	+	+	-	-	+
% germination of uredospores	67	63	68	65	68	*	*	69
Ability of pustules to produce new spores	+	+	+	+	+	*	*	+
Mycelial infections on new leaves	-	-	+	+	+	+	+	+
Infections on tillers	*	*	*	-	-	+	+	+

\+ present - absent

* no reading possible i.e. no pustules or no tillers

A similar, but less extensive experiment, suggested this was also true for the winter of 1971-72. In this experiment two blocks, each of thirty pots of seedling barley, were put outside on 21 November 1971. One block was of seedlings that had been grown and then inoculated with P. hordei as described for the 1970-71 experiment and which bore sporulating pustules. The second block was of uninoculated but otherwise similar seedlings. Mycelial infections were detected on these uninoculated seedlings by 23 January 1972. The first pustules erupted on these seedlings in early March and by late April numerous pustules were clearly visible on both parent plants and tillers.

SURVEY FOR AECIA ON ORNITHOGALUM PYRENAICUM

Although the aecial state has been recorded fairly frequently on species of Ornithogalum in continental Europe, the report by Dennis & Sandwith (1948) of its occurrence on O. pyrenaicum in woods near the Berkshire/Wiltshire border remains the only record of aecia in the United Kingdom. Through the courtesy of the Director, Royal Botanic Gardens, Kew, the herbarium specimens of this collection were lent to us and the locality determined from an accompanying sketch map. This site was visited on 12 May 1972 and again on 22 May 1973 by courtesy of the owner, Mr. J. Boord. On both occasions plants of O. pyrenaicum were found and some of these had uredosori of Puccinia liliacearum Duby but none were found infected with P. hordei. Two other sites in the district which, like the first had relatively abundant O. pyrenaicum and were near fields of barley were also visited on 1 and 12 May 1972 and on 22 May 1973. At neither locality were aecia of P. hordei found. On the available evidence it would appear that aecia of P. hordei are very rare indeed and that probably their development requires somewhat unusual conditions for this country. Nevertheless, the distribution of O. pyrenaicum in those areas of England in which brown rust is often most severe is a factor to be considered, for even the occasional development of aecia could facilitate the development of a new race of the pathogen.

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THE CHOICE OF BARLEY GENOTYPES TO DIFFERENTIATE RACES OF *PUCCINIA HORDEI* OTTH

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The increased incidence of brown rust caused by *Puccinia hordei* Otth on barley crops in Britain during the mid 1960's has resulted in increased efforts to develop resistant varieties. In order that breeding programmes could proceed logically and that varietal recommendations could be made more meaningfully, the National Physiologic Race Survey (Cereal Pathogens) was expanded to include surveys of pathogen variation in *P. hordei*, and these are carried out at the Welsh Plant Breeding Station.

The basis of a physiologic race survey is the set of differential varieties. A set of eleven was assembled from North American and European sources (Table 1). Their selection was based on genetic information available at the time. The seed of these genotypes and nine others was obtained from Dr. R. Johnson, Plant Breeding Institute, Cambridge. The first six genotypes in the Table were selected from the nine North American differentials of Levine & Cherewick (1952) which they considered critical to identify their fifty-two "consolidated" races. Subsequent genetic studies of Roane & Starling (1967) indicated that the genotypes Oderbrucker and Speciale carry gene Pa as does Sudan; similarly Lechtaler and Gold both have gene Pa_4. Therefore, only Sudan and Gold of these five varieties have been included in the present set. Roane & Starling (1967) suggested the inclusion of Estate (Pa_3) in the North American differentials and this has also been included in the present set. Batna and Peruvian were included as they differentiated two races at Cambridge, and since Cebada Capa and Ricardo were resistant to these two races (Dr. R. Johnson, pers.comm.) they were also included to complete the set of eleven differentials. Consequently, races differentiated by these varieties can be compared with those identified on the set of nine North American varieties and, in addition, the occurrence of races capable of overcoming other resistance genes at present being used in European breeding programmes can be detected.

Table 1. Barley varieties used for differentiation of physiologic races of *Puccinia hordei* Otth in Britain.

C.I. No.	Differential	Gene	Authority
1257	Bolivia	Pa_2 Pa_6	Roane & Starling (1970)
5051	Reka 1	Pa_2	Roane & Starling (1967)
1024	Quinn	Pa_2 Pa_5	Roane & Starling (1967)
6489	Sudan	Pa	Roane & Starling (1967)
1145	Gold	Pa_4	Roane & Starling (1967)
6481	Egypt 4	?	
3410	Estate	Pa_3	Henderson (1945)
3391	Batna	C.I. 935 locus	Starling (1956)
935	Peruvian	Pa_2 locus	Starling (1956)
6193	Cebada Capa	1 dom. gene	Starling (1956)
6306	Ricardo	Pa_2 + ?	Henderson (1945)

The most significant result obtained from the surveys conducted since 1968 is that the population of P. hordei in Britain is composed of a number of physiologic races, the most widely virulent of which occur most commonly. As far as can be determined, cultivars currently being grown on a large scale do not carry resistance genes and so the survival of these complex races would not appear to relate to any selective advantage conferred by their virulence genes. The most common race (designated race F) is virulent on all the differentials except Cebada Capa and Estate. The other common race (designated race E) is similar to race F but lacks virulence on Reka 1.

Information on the effectiveness of resistance genes is of value to breeders in planning future programmes. Therefore, in order that this survey may maintain its relevance to European agriculture, the author plans to expand the set of differential varieties to include genotypes which have been found to confer resistance to all known British races in tests at the Welsh Plant Breeding Station and which are, therefore, used in breeding programmes. These include Gondar, Aim (CI 3737), La Estanzuela 75A, Forrajera Klein x Rika No. 7 (CI 11801), and a selection from Rika x F_1 (Baladi 16 x Rika No. 7) from the European Barley Disease Nursery. The author would welcome suggestions for the inclusion of other genotypes which are of specific interest to other European breeders and pathologists.

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PHYSIOLOGIC RACES OF PUCCINIA GRAMINIS VAR. TRITICI IN GREECE DURING THE PERIOD 1963 - 1969

BY ELPIS A. SKORDA

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Research on the physiologic specialization and frequency distribution of wheat stem rust races in Greece during the years 1955-1959 indicated that the race population was essentially stable in composition. Characteristically, race 21 was the most prevalent and was followed in frequency by race 14, which together accounted for approximately 80% of the isolates. The remainder consisted of a number of minor races, none of which became of economic importance. From 1960-1962 the race population started to change in respect of its prevalent races: in 1960 race 14, hitherto second in prevalence disappeared and third race 34 previously the third commonest began to increase in frequency (Skorda, 1966).

Research on the physiologic specialization of wheat stem rust has since continued along similar lines, apart from minor modifications, and the results obtained for the period 1963-1966 will be reported in the present paper.

MATERIALS AND METHODS

The rusts samples studied for race identification were of diverse origin with respect to ecogeographical distribution and host plant variety.

Every year 50-60 nurseries (60-70 varieties each) were sown in stations (sampling stations) predetermined and uniformly distributed over the country. In each station the samples were taken at the peak of the rust season from susceptible wheat varieties in the nursery as well as from cultivated varieties and grasses in the same locality.

Each sample was increased on a mixture of susceptible wheat varieties and identified on the common set of differentials which was supplemented with other varieties.

From each nursery five to twenty specimens were analysed. However, for estimating the frequency distribution they were taken as a single specimen with as many isolates as the number of identified races. This estimate of the frequency distribution of races and of shifts in population from year to year was considered to be a better representation than one based on the total number of specimens analysed in any one nursery.

RESULTS AND DISCUSSION

A total of 249 isolates yielded 27 physiologic races (Table 1). Many of the races show low frequency; only four races were found at least during four seasons in more than 10% of the sampling, namely 14, 17, 21 and 34. For the remainder only 2 races were found four times during the 7 years of study and the other 20 found 1-3 times. The greatest diversity in race composition was observed in 1969.

Table 1. Number and frequency distribution of physiologic races of wheat stem rust in Greece, 1963-1969.

	1963		1964		1965		1966		1967		1968		1969		Total (1963-69)	
Race	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
9													1	2.0	1	0.4
10					1	2.9					2	5.7			3	1.2
11					1	2.9							2	4.0	3	1.2
14	6	18.7	5	8.8	4	11.7	3	13.6	3	15.8	5	14.2	3	6.0	29	11.6
17	6	18.7	11	19.3	2	5.9	2	9.1	3	15.8	3	8.6	6	12.0	33	13.2
19													2	4.0	2	0.8
21	13	40.6	21	36.8	10	29.0	11	50.0	9	47.4	15	42.8	12	24.0	91	36.5
24					1	2.9	1	4.5			2	5.7	2	4.0	6	2.4
34	4	12.5	8	14.0	5	14.7	2	9.1	2	10.5	6	17.1	4	8.0	31	12.4
40													2	4.0	2	0.8
42			1	1.7	1	2.9							2	4.0	4	1.6
53													1	2.0	1	0.4
75					2	5.9									2	0.8
78									1	5.3	1	2.9	1	2.0	3	1.2
95							1	4.5							1	0.4
116	2	6.2	1	1.7											3	1.2
117					1	2.9									1	0.4
122			3	5.3	5	14.7	1	4.5	1	5.3					10	4.0
123													4	8.0	4	1.6
143			1	1.7											1	0.4
176	1	3.1													1	0.4
187			2	3.5											2	0.8
189			4	7.0									2	4.0	6	2.4
191					1	2.9									1	0.4
207													2	4.0	2	0.8
245							1	4.5			1	2.9	1	2.0	3	1.2
270													3	6.0	3	1.2
Total number of isolates	32		57		34		22		19		35		50		249	
Total number of races	6		10		12		8		6		8		17			

This investigation revealed that new races had appeared, which had not been identified previously in Greece. These races are 10, 42, 95, 116, 117, 122, 123, 143, 187, 189 191, 245 and 270. On the other hand races present in previous years were not found during this period,namely 5, 16, 39, 60, 71, 88, 107, 133, 186, 194, 235, 273, 276 and 280.

Race 21 proved to be dominant in the seven experimentation years representing 36.5% of the total isolates, followed by races 17 with 13.2% and 34 (12.4%) and finally by race 14 (11.6%). The other 23 races were sporadically detected and only in very low percentages. Race 34, however, continued to increase and rose to third position. Race 14, which disappeared from 1960-1962 appeared again from 1963 and was present every year up to 1969 in a high frequency, usually fourth in prevalence.

The virulent races 9, 11 and 40 which were also identified in previous years, as well as race 189 which appeared for the first time in 1964, continued to be rare. Essentially the relative importance of these races remained the same as in 1955-1962.

It must be stressed that some of the new races found appeared long ago in neighbouring countries (Italy, Yugoslavia etc.) but for one reason or another were not detected again for many years. Furthermore, races which had been found in the past were not found during this period of study (Massenot, 1961; Skorda, 1968; Basile, 1968).

No important changes were noted in the distribution of the four dominant races as compared to the previous period of research (1955-1962). The distribution of dominant races is generally, almost the same as that in neighbouring countries (Skorda, 1968).

As far as oversummering of wheat stem rust in Greece is concerned, it is noteworthy that on many occasions the parasite developed on mature plants in breeding plots in mid-autumn, prior to the emergence of wheat seedlings in the fields, over the country.

From this study it seems clear that races found in most years showed the highest frequency, and so it could be concluded that losses caused by stem rust in our country must be due to a vigorous development of the prevalent races, rather than to an increase of other races usually present only in negligible amounts.

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ON ADDITIONAL GENES FOR STEM- AND LEAF RUST RESISTANCE IN SOME EUROPEAN WHEAT CULTIVARS POSSESSING RESISTANCE DERIVED FROM RYE

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Resistance to leaf- stem- and yellow rusts of some European wheat cultivars is derived from rye (Bartos *et al.* 1973 *a*). In the cultivar Kavkaz which belongs to these cultivars an additional gene for stem rust resistance has been found (Bartoš *et al.* 1973 *b*).

To find out if additional genes for stem- and leaf rust resistance can be detected in other cultivars possessing resistance derived from rye they were tested with ten stem- and eight leaf rust cultures. Two stem rust races proved satisfactory for this purpose. Other isolates displayed reactions identical with one or the other race. In the tests with leaf rust, reactions of three cultures were of discriminating value.

In stem rust we distinguish the 0 infection type from the ;1 infection type because the 0 type is stable and characteristic for the gene Sr 5. The infection type 0 as a reaction to leaf rust developed later in several cases to type ;1. Therefore we do not consider the difference between 0 and ;1 in observations on leaf rust as determined genetically. Results of the tests are summarised in Table 1.

Table 1. Reactions of cultivars possessing rust resistance derived from rye to two stem- and three leaf rust cultures.

	Stem rust culture		Leaf rust culture		
	G346	G222	511	600	96
Aurora	0	;1	0	0	4
Benno	;1	1	0	4	3
Bezostaya 2	;	;1	0	;	4
Burgas 2	0+;	;1	0	;	4
Cebeco 97	;1	1	0	4	3-
Kavkaz	0	;1	0	4	4
Lovrin 10	0	;1	0	4	4
Lovrin 13	;1	;1	0	;	4
Orlando	0	;1	0	4	3-
Predgornaya 2	0	;1	0	4	4
Saladin	;1	1	0	4	3
Salzmünder) Bartweizen)	;1	;1	0	4	4
Skorospelka 35	0	;1	0	;	4
Weique	;1	;1	;	4	3
Winnetou	;	;1	0	4	3
Zorba	;1	;1	0	4	4

Seed of the cultivars was obtained from Ing. I. Bares CSc, World Wheat Collection, Institute of Genetics and Plant Breeding, Praha, Ruzyne.

On the basis of their stem rust reactions two groups of cultivars were distinguished. One group (cultivars Benno, Bezostaya 2, Burgas 2, Cebeco 97, Lovrin 13, Saladin, Salzmünder Bartweizen, Weique, Winnetou, Zorba) displayed reactions of type ;1 to all cultures. The other group (cultivars Aurora, Kevkaz, Lovrin 10, Orlando, Predgornaya 2, Skorospelka 35) showed type 0 reactions to cultures avirulent to Sr 5 but type ;1 reactions to cultures virulent against Sr 5. This and previous results concerning genes for resistance in Kavkaz suggest that cultivars of this group probably possess Sr 5 in addition to the gene for stem rust resistance derived from rye.

On the basis of their leaf rust reactions, two other groups of cultivars were differentiated. One group (cultivars Benno, Cebeco 97, Kavkaz, Lovrin 10, Orlando, Predgornaya 2, Saladin, Salzmünder Bartweizen, Weique, Winnetou, Zorba) was resistant to isolates avirulent to the gene for resistance derived from rye and susceptible to isolates virulent against this gene. The second group (cultivars Aurora, Bezostaya 2, Burgas 2, Lovrin 13, Skorospelka 35) was resistant even to isolates virulent against the gene for resistance derived from rye unless the isolates were avirulent to Lr 3. One leaf rust culture combining virulence against both genes mentioned above was virulent against all cultivars. This suggests that the cultivars of the latter group possess a gene for leaf rust resistance, probably Lr 3, in addition to the gene derived from rye.

Cultivars Aurora and Skorospelka 35 seem to carry at least two genes for resistance to stem rust and two genes for resistance to leaf rust. This is in agreement with findings by Voronkova _et al_. (1972) who postulated several genes for leaf rust resistance in the cultivar Skorospelka 35. Lesovoy _et al_. (1972) found only one gene for leaf rust resistance in Kavkaz and one in Aurora. They used races virulent against Lr 3 and therefore was not able to detect the second gene in Aurora.

Genetical studies are necessary to confirm our conclusions. However, the results show satisfactorily that several cultivars possessing resistance derived from rye carry additional genes for stem and/or leaf rust resistance.

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CHANGES IN THE FREQUENCY OF OCCURRENCE OF PHYSIOLOGIC RACES OF PUCCINIA STRIIFORMIS ON WHEAT IN THE U.K.

BY R.H. PRIESTLEY, JULIA SMITH, J.K. DOODSON & N.H. CHAMBERLAIN *

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Between 1966 and 1972 sixteen races of *Puccinia striiformis* Westend. (yellow rust of wheat) were identified in the United Kingdom. The methods of race identification, descriptions of the seedling reactions of differential varieties, and the system of race nomenclature have been published elsewhere (Chamberlain, Clothier & Wolfe, 1972; Doodson & Chamberlain, 1972; Johnson, Stubbs, Fuchs & Chamberlain, 1972).

This paper is concerned with the effect of changes in wheat varieties grown in the U.K., and the effect of the geographical distribution of isolates on the frequency of occurrence of the important races of *P. striiformis* in the U.K.

CHANGES IN FREQUENCY OF MAJOR RACES

A total of 1,580 isolates of *P. striiformis* has been identified and six races were identified from more than 10% of the total isolates tested in any one year (Table 1). The non random method of isolate collection may have biased these values slightly although isolates were collected from a very wide range of wheat varieties and geographical locations. Changes in the frequency of occurrence of these important races were apparent from year to year, with some races decreasing and others increasing.

Table 1. Percentage frequency of the important races of *P. striiformis* identified in the U.K., 1966 - 1972.

Race	Year						
	1966	1967	1968	1969	1970	1971	1972
37 E 132	43	42	25	13	7	1	0
41 E 136	0	0	4	7	2	21	19
104 E 9	33	41	68	53	20	5	0
104 E 137	0	0	0	9	38	57	42
108 E 9	0	0	0	4	22	2	1
108 E 173	0	0	0	0	0	0	20
other races	6(2)	2(2)	0(0)	5(3)	9(2)	5(6)	3(7)
race mixtures	18	15	2	9	2	10	15

Figures in parentheses are the number of other races identified in each year

CHANGES IN WHEAT VARIETIES

Percentage seed sold per variety. The percentage of wheat seed sold per variety in the U.K. for the years 1967 - 1972 is given (Table 2) but comparable data for 1966 are unavailable. The varieties in the Table are those which have achieved sales of greater than 5% of the total seed sold in any one year. Large changes in the popularity of some varieties have taken place during this period.

* Present address: Rothwell Plant Breeders Ltd., Rothwell, Lincoln LN7 6BR, England.

Table 2. Percentage wheat seed sold per variety 1967 - 1972.

	Year					
	1967	1968	1969	1970	1971	1972
Winter wheats						
Cappelle-Desprez	54	65	49	42	34	32
Champlein	8	12	9	8	5	5
Joss Cambier	0	0	10	19	32	25
Cama	0	0	1	8	8	6
Maris Ranger	0	0	1	5	9	14
Spring wheats						
Kloka	22	4	10	1	1	0
Opal	6	1	1	0	0	0
Rothwell Sprite	1	5	7	1	1	0
Kolibri	0	0	2	11	7	6
Other varieties	10	14	11	6	5	12

data obtained from NACAM and Ministry of Agriculture surveys

RELATIONSHIP BETWEEN RACES AND VARIETIES

Percentage seed sold of varieties susceptible to each race. The results of seedling tests in which the six important races of *P. striiformis* have been inoculated on to the popular wheat varieties are given (Table 3). The variety Opal has been omitted from the Table because of insufficient data. Some races are virulent on a relatively small number of varieties whereas one race (108 E 173) is virulent on all varieties.

Table 3. Seedling reactions of important races of *P. striiformis* on popular wheat varieties.

	Race					
	37 E 132	41 E 136	104 E 9	104 E 137	108 E 9	108 E 173
Winter wheats						
Cappelle-Desprez	R	S	S	S	S	S
Champlein	R	S	S	S	S	S
Joss Cambier	R	S	R	S	R	S
Cama	R	S	R	S	R	S
Maris Ranger	R	R	R	R	S	S
Spring wheats						
Kloka	S	S	S	S	S	S
Rothwell Sprite	S	R	R	R	S	S
Kolibri	S	R	R	R	S	S

S, susceptible; R, resistant

The percentage of seed sold of varieties susceptible as seedlings to each of the six races of *P. striiformis* has been calculated (Table 4). A comparison of Tables 1 and 4 shows that between 1967 and 1972 a decrease in the percentage of seed sold of varieties susceptible to races 37 E 132 and 104 E 9 is accompanied by a decrease in the frequency of occurrence of isolates of these two races. However, increases in the frequency of occurrence of isolates of the other four races cannot be explained solely in terms of seedling virulence or the percentage of seed sold of varieties susceptible as seedlings to these races.

Table 4. Percentage of seed sold of varieties susceptible as seedlings to the important races of *P. striiformis*, 1967 - 1972.

	Year					
Race	1967	1968	1969	1970	1971	1972
37 E 132	23	9	17	2	1	0
41 E 136	84	80	80	77	78	68
104 E 9	84	80	69	50	39	37
104 E 137	84	80	80	77	78	68
108 E 9	85	85	78	67	56	58
108 E 173	85	85	89	94	95	88

Race specialisation to individual varieties. The percentage of isolates of each race from individual varieties has been calculated (Table 5), omitting those varieties from which less than 10% of the isolates of each race have been obtained. Some races are highly specialised to individual varieties; for example race 108 E 9 is virulent on six popular varieties (Table 3), and yet 47% of the isolates of this race have originated from the single variety Maris Ranger (Table 5), indicating that there is specialisation to varieties in addition to that due to seedling virulence factors. Other races are specialised to a lesser degree, in some cases to more than one variety, which may not be highly popular. It is noteworthy that the introduction of the varieties Joss Cambier and Maris Ranger (Table 2) which were at that time resistant to the widespread races (Tables 1 and 3) was followed by the appearance of races 104 E 137 and 108 E 9 virulent on these varieties (Table 3) and highly specialised to them (Table 5). There appears to be competition between races on certain varieties, notably between races 41 E 136 and 104 E 137 on the varieties Joss Cambier and Cama.

Table 5. Percentage of isolates of important races of *P. striiformis* from individual varieties 1967 - 1972.

Race	Variety and frequency of isolates
37 E 132	Rothwell Perdix (16%)
41 E 136	Cama (15%) Joss Cambier (15%) Cappelle-Desprez (14%)
104 E 9	Cappelle-Desprez (23%) Hybrid 46 (11%) Champlein (10%)
104 E 137	Joss Cambier (30%) Cama (11%)
108 E 9	Maris Ranger (47%)
108 E 173	Cardinal (26%) Maris Ranger (19%) Maris Dove(17%) Kleiber (11%)

GEOGRAPHICAL DISTRIBUTION OF RACES

The percentage frequency of isolates of each race from England (excluding Northumberland), Scotland (including Northumberland) and other countries in the United Kingdom (Wales and Northern Ireland) is presented (Table 6). Races were not evenly distributed throughout the U.K.; the majority of isolates were collected in England although race 41 E 136 was more frequently isolated from Scotland. Thus competition between 41 E 136 and 104 E 137 may be limited because they are distributed in different regions.

Table 6. Geographical distribution of important races of *P. striiformis* 1967 - 1972.

Race	% frequency		
	England *	Scotland *	Other
37 E 132	68	23	10
41 E 136	17	81	3
104 E 9	80	16	4
104 E 137	94	4	3
108 E 9	93	3	3
108 E 173	92	5	3

* Northumberland has been included with Scotland and omitted from England

DISCUSSION

Some physiologic races of *P. striiformis* are highly specialised to individual varieties and this cannot be explained solely in terms of virulence. This supports our view that there are other factors apart from the known resistance genes causing this specialisation.

It can be postulated from our results that there are three stages in the relationship between physiologic races of *P. striiformis* and wheat varieties. A race may at first be isolated from and specialised to a relatively small number of varieties previously resistant to the other widespread races. Secondly the race may begin to be isolated from other varieties on which it is virulent but not necessarily specialised. Thirdly, if as a result of field infections these varieties become less popular and are consequently grown to a lesser degree, then the frequency of occurrence and the importance of the race will also decrease.

Races have differed in their geographical distribution during the period studied, and this has been important in investigating competition between races on popular varieties.

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THE COMPLEMENTARY EFFECT OF AT LEAST TWO GENES FOR RESISTANCE TO PUCCINIA RECONDITA F. SP. TRITICI OPERATING IN THE WINTER WHEAT CULTIVARS AURORA AND KAUKAZ

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The Russian wheat cultivars Aurora and Kaukaz were experimentally introduced in Romania in 1969. Their high yield capacity and high levels of resistance to rusts and powdery mildew made them suitable for commercial use, thus, in 1973, these two cultivars accounted for about 15% of the total wheat area.

One of their parents, the Russian wheat cultivar Bezostaia 1, introduced in Romania in 1961, is still the prevalent commercial wheat variety. Its initial resistance to leaf rust has gradually become ineffective, Bezostaia 1 being now rated as susceptible under field conditions.

In direct connection with the area cultivated with these varieties, an obvious increase of race 77 was encountered, thus, this race together with race 20, comprises over 75% of the total leaf rust isolates determined in 1968 - 1970 (Negulescu & Cojocaru-Ionescu, 1973) and 1971 - 1972 (Negulescu & Ionescu-Cojocaru unpublished).

Bartos *et al*. (1969) announced a gene for resistance to leaf rust in the cultivar Bezostaia 1, which he supposed to be Lr 3. He also found (Bartos *et al*., 1973), using a culture of leaf rust race 77, a gene for resistance which operates in the cultivar Kaukaz.

The simultaneous presence of these wheat cultivars and leaf rust forms in Romania contributed to the detection of the complementary effect of at least two genes for resistance to *Puccinia recondita* f. sp. *tritici* in the wheat cultivars Aurora and Kaukaz.

MATERIALS AND METHODS

The pedigrees and the origin of the wheat cultivars used in the present study are given in Table 1.

Table 1. Pedigrees and origins of wheat cultivars used in the present study

Variety	Origin	Pedigree
Aurora and Kaukaz (Lein, 1973)	USSR	(Neuzucht/Bezostaia 4) Lutescens 314 h 147//Bezostaia 1
Bezostaia 1 and Bezostaia 4	USSR	* Lutescens 17/Skorospelka 2
Weique 358/65 and Salzmünder Bartweizen (Lein, 1973)	W. Germany	Probable Riebesel 51/52 and Salzmünde 14/44, having an alien chromosome from *Secale* and *Agropyron*, respectively.

These cultivars, as well as the others listed in Table 3, have been used as "supplementals" in studies on the pathogenic specialization of *Puccinia recondita* f. sp. *tritici* in Romania.

* Publication of the Academy of Science, USSR, Moscow 1963

The seedling tests were made with representative leaf rust cultures of races 77 and 20. The tests made in 1972 and 1973 included rust cultures from previous years, stored in liquid nitrogen.

RESULTS

The low infection types (Stakman et al., 1962) "o", "o;" expressed by Bezostaia 1 when inoculated with race 20, are similar to those of the material possessing Lr 3 (Mi, Do and Lr 3 in the Whichita and Thatcher backgrounds), suggesting the presence of at least one gene from resistance to leaf rust race 20 in this variety (Tables 2, 3).

Table 2. Infection types induced by two representative cultures of races 20 and 77 of leaf rust on the differential set used in physiologic specialization studies in Romania.

SN†	Line or cultivar name	Abbreviation and gene	Race 20 72-5--42-1	Race 77 72-5--1-1
1	Malakof	Lr 1, Ma	4	4
2	Carina	Lr 2 b, Ci	4	4
3	Brevit	Lr 2 c, Bv	4	3
4	Webster	Lr 2 a, Wst	3+	4
5	Loros	Lr 2 d, Ls	4	3
6	Mediterranean	Lr 3, Mi	o;	4
7	Hussar	Lr 11, Hs	4	4
8	Democrat	Lr 3, Do	o;1	4
17	6*Wichita/Malakof	Lr 1 (Wi)	4	3+
19	7*Wichita/Webster	Lr 2 a (Wi)	4	4
21	8*Wichita/Loros	Lr 2 d (Wi)	3+	4
23	10*Wichita/Mediterranean	Lr 3 (Wi)	o;1	4
30	Wichita *8/Transfer	Lr 9 (Wi)	o	o
16	6*Thatcher/Centenario	Lr 1 (Tc)	4	4
18	7*Thatcher/Webster	Lr 2 a (Tc)	3+	4-
20	6*Prelude/Loros	Lr 2 d (Pl)	4	4
22	6*Thatcher/Democrat	Lr 3 (Tc)	o;1	3+
24	6*Thatcher/Exchange	Lr 10 (Tc)	3	3+
25	6*Thatcher/Exchange	Lr 16 (Tc)	3	4
26	Klein Lucero/Thatcher *6	Lr 17 (Tc)	2,3-	3
27	7*Thatcher/Africa 43	Lr 18 (Tc)	4	4-
28	6*Thatcher/Aniversario	6*Tc/Aiv	o;1	3
15	Agent	Ag	X(o;1,2)	X(1,2,3)

† Sequential numbers after Loegering & Browder (1971)

The low infection types "o;", "o", "1" as well as the high infection types "3", "4" on "Neuzucht" inoculated with races 77 and 20 respectively of leaf rust suggest that "Neuzucht" has at least one gene for resistance to leaf rust race 77 and no genes for resistance to race 20 (Tables 2, 3). These infection types are similar to those expressed by Salzmünder Bartweizen, Weique 358/65 and Lovrin 10.

The low infection types on Aurora and Kaukaz, "o;", (Table 3) demonstrate that the resistance of these cultivars is effective against both race 20 and race 77 of leaf rust. Based on the pedigrees and the infection types expressed by these two cultivars we suggest that their resistance to leaf rust races 20 and 77 is controlled by at least two genes for resistance, one inherited from Bezostaia 1 and the other from "Neuzucht" (Tables 2, 3) which are not Lr 9 (Transfer), Lr 19 (Agatha), or Agent genes.

Table 3. Infection types induced by representative cultures* of leaf rust races 20 and 77 on Aurora, Kaukaz and their direct parents

	Race 20			Race 77		
	1971	1972	1973	1971	1972	1973
	Isolate					
	20-11-2	72-5-42-1	73-3-10-2	77-2-1	72-5-1-1	73-5-30-1
Bezostaia 1	o;	o;c	o;1	4-	4	4
Neuzucht	3	4-	4	o;	o;	o;1
Aurora	o	o;	o;	o;	o;	o;
Kaukaz	o;	o;	o;	o;	o;	o;
Weique 358/65	4	4	3+	o;	o;	o;
S.Bartweizen	4	4	4-	o;3	o;1	o;1
Lovrin 10	3	3+	4	o;	o;	o;1
Agatha (Lr 19)	o;	o;	o;	o;	o;	o;

*Race 20: 6,8,15,22,23,28,30/1,2,3,4,5,7,16,17,18,19,20,21,25,26,27
Race 77: 15,24,30/1,2,3,4,5,6,7,8,16,17,18,19,20,21,22,23,25,26,27,28
Codes and virulence formulae after Loegering & Browder (1971)

The complementary effect of these two genes in the adult stage of development of Aurora and Kaukaz is suggested in Table 4, where, in the presence of both race 20 and race 77 of leaf rust, the wheat cultivars Bezostaia 1 and "Neuzucht" are susceptible, whereas the wheat cultivars Aurora and Kaukaz are resistant.

Table 4. The field resistance of Aurora, Kaukaz and their direct parents in Romania.

	Year		
	1970	1971	1972
Bezostaia 1	S	S	S
Neuzucht	S	S	S
Aurora	R	R*	R*
Kaukaz	R	R*	R*

*Few, susceptible type, uredopustules were recorded at the end of the period of vegetative growth.

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THE OUTBREAK OF A NEW FORM OF RACE 77 OF *PUCCINIA RECONDITA* F. SP. *TRITICI* ON WHEAT CULTIVAR AURORA IN ROMANIA IN 1973

BY FLORICA NEGULESCU & M. IONESCU-COJOCARU

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Physiologic race 77 of *Puccinia recondita* f. sp. *tritici* was first identified by Rădulescu (1939), in 1938. Since then, race 77 has gradually extended to comprise over 60% of the total leaf rust isolates (Negulescu & Cojocaru-Ionescu, 1973; Negulescu, 1971).

Endemic in Romania, leaf rust usually appears at the end of May or the beginning of June. As a consequence of a secondary leaf rust attack (recorded in Fundulea on 27 June 1971), a severe epidemic affecting the wheat cultivar Aurora, developed over the whole country.

Since its introduction the cultivar Aurora has shown a high yield capacity and full resistance to all three rust species attacking wheat, either in experimental, or commercial plots. The resistance of Aurora to leaf rust proved to be specific (Bartos *et al*., 1969; Muresan *et al*., 1972) with "o" or "o;" reactions in both seedling and mature stage of the plants. However, a small number of uredopustules of susceptible types have recently been recorded at the end of the period of vegetative growth of this cultivar.

A form of race 77, which overcame the resistance of wheat cultivar Aurora in 1973, is described in this paper.

MATERIALS AND METHODS

Leaf rust samples received through the National Winter Wheat Rust Nursery planted in seventeen locations, as well as three rust samples collected from Aurora in the Soviet Union at Krasnodar, were analysed.

In order to detect the new form, the field collections were firstly passed through a set of previously resistant wheat cultivars: Aurora, Burgas 2, Whichita*8Transfer (Lr9) and Agatha (Lr19). Isolates from each sample were then routinely determined on the differential set (Table 2) which includes some of the sources of resistance currently used in Romanian breeding programs.

RESULTS

All of the leaf rust cultures collected from cultivar Aurora in 1973 produced high infection types "3" or "4" (Stakman *et al*., 1962) on Aurora and Burgas 2 and low infection types "o" or "o;" on the other two cultivars of the "short set" with resistant cultivars (Table 1).

The reactions expressed by the cultivars used in the studies of pathogenic specialization in Romania (Table 2) clearly show that the new form belongs to standard race 77 (Johnston & Browder, 1966; Johnston & Manns, 1932) but differs from the form of race 77 determined in previous years.

When inoculated on Thatcher and Whichita "mono gene" lines the 1973 form of race 77 induced low infection types "o" and "X^R" on Lr 9 (Wi) and Lr 10 (Tc) respectively. The reactions showed by the other "mono gene" lines were high, "3" or "4", unchanged in comparison to those recorded in the previous years.

Table 1. The infection types produced by several leaf rust samples from Aurora takes from different part of Romania, in 1973.

Samples (cultures)	Aurora	Burgas 2	Lr 9 (Wi)	Agatha
73 - 3 - 3	4	4	o;	o;
73 - 7 - 3	4	4	o;	o;
73 - 5 - 3	4,o;1	4	o	o
73 -12 - 3	4-	4-	o;	o
73 -17 - 3	4	4	o	o
73 -11 - 3	4	4	o;	o;
73 -16 - 3	3,4	4,1‡	o;	o;
73 -13 - 3	4,o;	3,4	o;	o;
73 - 4 - 3	4	4,o;	o;	o
73 -15 - 3	4	4	o	o;

Table 2. Infection types induced by two representative cultures of *P. recondita* f. sp. *tritici* race 77 from 1972 and 1973 on the cultivars and lines used in physiologic specialization studies in Romania

SN†	Line or cultivar name	Abbreviation and gene	Race 77 1972 72-5-1-1	Race 77 1973 72-7-3-3
1	Malakof	Lr 1, Ma	4	4
2	Carina	Lr 2 b, Ci	4	4-
3	Brevit	Lr 2 c, Bv	3	3+
4	Webster	Lr 2 a, Wst	4	4
5	Loros	Lr 2 d, Ls	3	4
6	Mediterranean	Lr 3, Mi	4	4
7	Hussar	Lr11, Hs	4	4
8	Democrat	Lr 3, Do	4	4
17	6*Wichita/Malakof	Lr 1 (Wi)	3+	4
19	7*Wichita/Webster	Lr 2 a (Wi)	4	4
21	8*Wichita/Loros	Lr 2 d (Wi)	4	4
23	10*Wichita/Mediterranean	Lr 3 (Wi)	4	3+
30	Wichita*8/Transfer	Lr 9 (Wi)	o	o;
16	6*Thatcher/Centenario	Lr 1 (Tc)	4	4
18	7*Thatcher/Webster	Lr 2 a (Tc)	4-	4
20	6*Prelude/Loros	Lr 2 d (Pl)	4	4
22	6*Thatcher/Democrat	Lr 3 (Tc)	3+	4
24	6*Thatcher/Exchange	Lr 10 (Tc)	3+	X^R(o;1,3)
25	6*Thatcher/Exchange	Lr 16 (Tc)	4	3±
26	Klein Lucero/Thatcher *6	Lr 17 (Tc)	3	3±
27	7*Thatcher/Africa 43	Lr 18 (Tc)	4-	4
28	6*Thatcher/Aniversario	6* Tc/Aiv	3	4-
	Agatha	Lr 19, Aa	o;	o;
15	Agent	Ag.	X(1,2,3)	o;
	Bezostaia 1	Bez.1	4	4
	Neuzucht	Nzct	o;	4
	Burgas 2	Bgs.2	o;	4
	Aurora	Aur.	o;	4
	Lovrin 10	Lv.10	o;	4
	F 26-67	F 26-67	4	4

† Sequential numbers after Loegering & Browder (1971)

The Lr 19 gene (Agatha) continues to be effective against this new form, displaying the low infection types "o" or "o;", furthermore, the resistance of the cultivar Agent became fully effective "o;" compared to the partial protection offerred in previous years, "X"

The reactions of the three leaf rust cultures from the Soviet Union (Krasnodar) were similar to those of the new form of race 77 from Romania.

Employing the system of nomenclature proposed by Loegering & Browder (1971) the avirulence/virulence formula of the leaf rust race detected in Romania in 1973 is: 15, 24, 30/1, 2, 3, 4, 5, 6, 7, 8, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28.

The analysis of all available data from the annual survey of virulence of Puccinia recondita f. sp. tritici shows that the newly detected form of race 77 accounts for over 60% of the leaf rust cultures determined in 1973 in Romania.

CONCLUSIONS AND DISCUSSION

Considering the wide virulence spectrum of race 77 of Puccinia recondita f. sp. tritici and the specific type of resistance to leaf rust which characterizes the cultivar Aurora and other varieties or breeding lines with similar resistance (Lein, 1937), the present ineffectiveness of this material was predictable.

The results of the annual survey of pathogenic specialization of Puccinia recondita f. sp. tritici in Romania in 1973 and the data on the Romanian Winter Wheat Rust Nursery clearly show that the attack recorded on Aurora and similar material was induced by a new form of race 77, as a result of a secondary cycle of infection. This new virulence comprises over 60% of the total leaf rust isolates.

The cultivar Aurora (as well as other similar material utilized in Romanian wheat breeding programme) loses its direct usefulness. Nevertheless this does not exclude the use of this outstanding genetic pool for a continuous accumulation of "strong" genes for leaf rust resistance still efficient like Lr 9, Lr 10, Lr 19, Agent genes, etc.

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EUROPEAN AND MEDITERRANEAN CEREAL RUSTS FOUNDATION

CHARTER MEMBERSHIP

PREAMBLE

THE BOARD OF THE EUROPEAN AND MEDITERRANEAN CEREAL RUSTS FOUNDATION considering the need to establish a more permanent base for the operations of the Foundation in the form of a working capital by means of soliciting gifts from persons and institutions,

considering Resolution 3 adopted by the European and Mediterranean Cereal Rusts Conference at Prague, 1972,

considering Statutes 10 and 11 of the Foundation's Charter,

decides to establish a Charter Membership according to the following Rules.

RULES

on the Charter Membership of the Foundation

Article 1 - Definitions

1. The European and Mediterranean Cereal Rusts Foundation, chartered on 18th April, 1969, in Wageningen, the Netherlands, will be called the Foundation, in accordance with Statute 1 of the Foundation's Charter.
2. The Board of Governers, mentioned in Statute 4 of the Foundation's Charter, will be called the Board.
3. Any person or institution having made a Qualifying Payment to the Foundation and who has not given notice to the contrary is by definition, a Charter Member.
4. The Qualifying Payment is a once-only gift in money to the Foundation, with a Minimum Value determined by the Board.

Article 2 - The Rights of the Charter Member

1. The Charter Member has no rights except that of having his name printed in one of the Foundation's publications at least once a year, listed according to the year in which the Qualifying Payment has been made, and within each year in alphabetical order.
2. The inaugural Board members as specified in the Foundation's Statute 5 are Charter Members.
3. Persons and institutions having supported the Foundation by giving a Qualifying Payment prior to the date of validation of these Rules are Charter Members.
4. The Charter Membership comes to an end:
   a. with respect to the whole Charter Membership at the date of dissolution of the Foundation.
   b. with respect to the Member concerned, at the request of the Charter Member, on 31st December following the day on which the request was received by the Board.
5. The Charter Member is under no obligation whatsoever towards the Foundation.

Article 3 - The Qualifying Payment

1. The Qualifying Payment is any amount of money at or above the Minimum Value.
2. The Minimum Value of the Qualifying Payment is determined by the Board at a level equalling approximately the annual subscription to the Cereal Rusts Bulletin.
3. Initially, the Minimum Value is determined at Dfl. 20.-
4. The Minimum Value may be adjusted by the Board. The new Minimum Value comes into effect on 1st January following the day of notification in the Cereal Rusts Bulletin, or otherwise.

Article 4 - Final remark

1. These Rules are in accordance with the Foundation's Charter, Statutes 10 and 11.

The Board of the European and
Mediterranean Cereal Rusts Foundation

Dr. Eva Fuchs, Chariman

Dr. R. Johnson, Secretary

Dr. J.C. Zadoks, Treasurer

Minneapolis, 6th September, 1973.

FINANCIAL REPORTS

Income and expenditure account, 1 January 1972 to 31 December 1972

RECEIPTS		PAYMENTS	
Subscriptions, current year	f. 368.17	Bank charges	f. 40.75
Donations	f.3968.71	Administration	f. 624.67
Bank (erroneous booking)	f. 191.31		
Bank interest	f. 8.60	Excess of income over exp.	f.3871.37
	f.4536.79		f.4536.79

Balance sheet as at 31 December 1972

CREDIT		DEBIT		
Funds at bank	f.5821.92	J.C. Zadoks, Foundation costs		f. 171.00
		Bank (erroneous booking)		f. 191.31
		Capital, 31.12.71:	f.1410.55	
		Net income, 1972:	f.3871.37	
		Capital		f.4919.61
	f.5821.92			f.5821.92