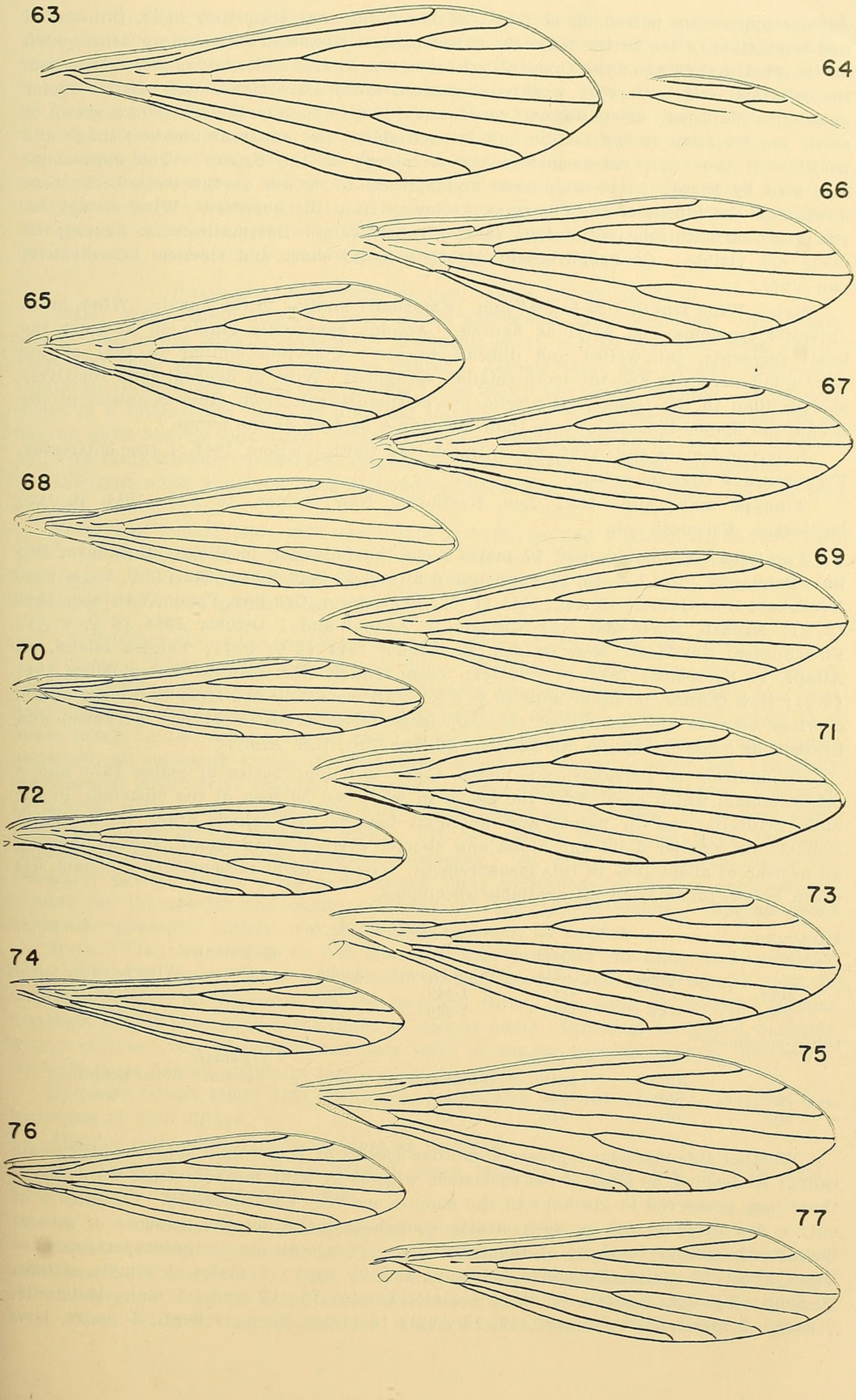
63
64
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77

Ascoids apparently paired on at least the basal antennal segments, short, thin-walled and impossible to see on the majority of specimens. Newstead's scales in a dense patch on the proximal third of the third palpal segment. Pharynx slender, poorly sclerotized, the proximal end with very weakly sclerotized denticulate ridges only visible under optimum conditions. Cibarium as figured, usually with four large teeth and a group of small slender teeth in the middle and at each side. The apparent number, shape and position of the teeth vary considerably, as shown in the figures. The appearance indicated by Figure 33 is often seen and appears to be due to the teeth being bent down into the lumen of the cibarium, i.e. away from the observer. Wing as figured, the length of delta relative to alpha varying considerably. Spermathecae as figured, the ducts not visible. Gonapophyses of eighth sternite short and slender. Cerci short and blunt.

Male. Wing length 1·29 to 1·44 mm. Externally similar to the female. Wing, basal antennal segments and palpi as figured. Ascoids apparently single on at least the basal segments, thin-walled and difficult to see. Cibarium similar to that of the female but narrower and the teeth smaller, as figured. Wing as figured, delta relatively shorter than in the female. Genitalia not distinguishable from other members of the group, the filaments a little more than four times as long as the pump.

Holotype female, slide 1192, Toem, Dutch New Guinea, 9 Sept. 1944, in tree buttresses. Ferguson and Graham colls.

Allotype male, slide 1317, Lae, North-east New Guinea, 16 Aug. 1944, in tree buttresses. Ferguson coll.

Paratypes, 56 females and 17 males from the following localities: Dobadura, Oro Bay, Papua, 26 July, 7, 8, 13, 18 August, and 21 and 22 September 1944 (29 ♀, 3 ♂); Lae, North-east New Guinea, 16 Aug. 1944 (1 ♂); Popendetta, Oro Bay, Papua, 7 October 1944 (3 ♀); Nadzab, North-east New Guinea, 15 August and 1 October 1944 (6 ♀, 6 ♂); Finschhafen, North-east New Guinea, 29 August 1944 (3 ♀, 4 ♂); Tumleo Island, off Aitape, 16 September 1944 (4 ♀, 1 ♂); Toem, Dutch New Guinea, 9 September 1944 (6 ♀); New Guinea, no other data (5 ♀, 2 ♂). All were collected from tree holes or the crevices between the buttressed roots of large forest trees by Majors Ferguson and Graham or members of the 5th Malaria Survey Unit, U.S. Army.

In addition to the above specimens, there is a long series of males (37) and a single female which agree with the above in what can be seen of the cibarium, in the male genitalia and in palpal and antennal lengths, but which differ in having a consistently smaller delta and alpha and shorter average wing length, though there is an overlap of about 10% in this measurement. The pertinent measurements in mm. are given below, taken from all available specimens.

Paratypes:

	15 Males.			56 Females.		
	Alpha.	Delta.	Wing Length.	Alpha.	Delta.	Wing Length.
Max. ..	·280	·144	1·440	·420	·256	1·710
Min. ..	·184	·060	1·260	·220	·080	1·386

Other specimens:

	37 Males.			1 Female.		
	Alpha.	Delta.	Wing Length.	Alpha.	Delta.	Wing Length.
Max. ..	·176	·044	1·314	·168	·044	1·404
Min. ..	·080	·040	1·134			

Whether this material represents another species or is merely a subjective segregate cannot be decided, as most of the specimens with short wing measurements were among those long preserved in alcohol and the mounts are very unsatisfactory. The cibaria of only a few of these can be seen clearly enough to make out the presence of several large teeth similar to those of the paratypes. The localities of these specimens are listed here: 20 males, Dobadura, 18 Aug. and 21 Sept.; 6 males, 1 female, Aitape, 16 Sept.; 3 males, Nadzab, October; 1 male, Tumleo Id., 16 Sept.; 1 male, Hollandia, 6 Sept.; 2 males, Port Moresby, 12, 13 Aug.; 16 males, Toem, 9 Sept.; 5 males, New

Guinea, no other data. Except for the material from Hollandia and Port Moresby, these specimens were taken mainly together with typical *fergusoni*. This species seems to be quite abundant in the eastern part of New Guinea, specimens having been taken in most of the localities where collecting was done from Toem in Dutch New Guinea to Dobadura in Papua. No specimens have been identified in the fairly abundant material from Sansapor on the north-western tip of Dutch New Guinea nor from the islands in Geelvink Bay. The species does not seem to be very closely related to any previously described, though it bears certain resemblances to *P. iyengari* Sint. and its various forms, sharing with them the unarmed pharynx and long delta. It differs, however, in having considerably fewer and more irregularly arranged teeth in the cibarium and in the simple, thin-walled spermathecae.

PHLEBOTOMUS QUINTUS, sp. nov. (Figs. 25, 27, 58, 76.)

Male. Wing length 1·29–1·42 mm. Dorsal abdominal hairs recumbent. No pleural setae. Mesonotum slightly infuscated. Proboscis short, a little less than head height. Palpi and basal antennal segments as figured. Ascoids short and slender, apparently single, on all segments except the terminal three, which are nearly globular. Newstead's scales in a small dense patch on proximal third of third palpal segment. Cibarium as figured, quite heavily sclerotized. Pharynx slender, weakly sclerotized, the apex unarmed but with faint irregular transverse ridges. Wing as figured. Genitalia as figured.

Holotype male, slide No. 1206, Hollandia, Dutch New Guinea, 6 Sept. 1944, in tree buttress.

Paratypes, 1 male, slide 1207, same data as holotype, and 3 males, slides 1044, 2683 and 2685, Finschhafen, at Mape River, North-east New Guinea, 29 Aug. 1944, in tree buttresses. All collected by personnel of the 5th Malaria Survey Unit, U.S. Army, in honour of which the species is named.

PHLEBOTOMUS SANSAPORENSIS, sp. nov. (Figs. 7, 15, 35–38, 49, 61, 74.)

Female. Wing length 1·45 to 1·53 mm. Mesonotum rather strongly infuscated. Dorsal abdominal hairs recumbent. Ventral hairs semi-recumbent. Proboscis less than head height. Third antennal segment and palpi as figured. Newstead's scales in a dense patch on the basal third of third palpal segment. Ascoids short and slender, paired on all segments except the last three, which are abruptly shortened. Pharynx not widened posteriorly, unarmed, with weak ridges and digitate processes. Cibarium as figured, with about 24 relatively short teeth whose apices appear to be bent down into the lumen of the cibarial cavity. It is possible that these teeth represent thickenings on an otherwise tenuous membrane. At other than critical focus the refractive pattern shows a series of broad blunt contiguous structures quite characteristic for the species and easily seen in even the poorest mounts. Spermathecae distorted, apparently simple oval thin-walled capsules, as figured.

Male. Wing length 1·20 to 1·22 mm. Similar to female but alpha and especially delta relatively shorter than in female. Ascoids shorter and more slender than in female, single on all segments but the terminal three. Genitalia as figured. Genital filaments a little more than three times as long as pump. Cibarium as figured, probably with a complete row of smaller and finer teeth of similar type to those in the female, but only those figured visible in the available material.

Holotype female, slide 1151, Sansapor, Dutch New Guinea, 11 Sept. 1944, in tree buttresses at Mar village.

Allotype male, slide 1145, same data as holotype.

Paratypes, 13 males and 14 females, same locality, 11 Sept. and 28 Aug. 1944; 1 female, New Guinea, no other data.

PHLEBOTOMUS NOEMFORENSIS, sp. nov. (Figs. 26, 51–52, 73.)

Female. Wing length 1·40 to 1·53 mm. Mesonotum slightly infuscated. Dorsal abdominal hairs recumbent, at most with occasional erect hairs on the posterior margins of some tergites. Ventral hairs larger, semi-recumbent. Proboscis about equal to head height from vertex to base of clypeus. Third antennal segment and palpi as figured.

Newstead's scales in a small dense patch on proximal third of third palpal segment. Ascoids paired on all but the terminal three flagellar segments (which are abruptly shorter than the preceding segments), slender, short and subequal, as figured. Pharynx not widened posteriorly, unarmed, with faint ridges and obscure digitate processses. Cibarium broad, bearing a comb of about 18 pointed teeth, as figured. Spermathecae not well preserved, apparently thin-walled ovoid structures with the terminal knob sunk in a pit.

Male. Wing length 1·13 to 1·20 mm. Similar to the female, but delta and alpha relatively shorter and wing narrower. Ascoids more slender and shorter, single on each flagellar segment except the last three, from which they appear to be absent. Genitalia of the *Sergentomyia* type, all spines of the style close to apex and aedeagus long and slender. Genital filaments a little more than twice as long as pump. Cibarium much like that of female, but narrower, the teeth smaller, about 13 in number. Pharynx as in female.

Holotype female, slide 1167, Kornosoren, Noemfor Island, Geelvink Bay, Dutch New Guinea, 12 Sept. 1944. Ferguson and Graham colls.

Allotype male, slide 1174, same data as holotype.

Paratypes, 34 males, 11 females, same data as holotype.

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Theodor, O., 1948.—Classification of the Old World species of the subfamily Phlebotominae (Dipt. Psychodidae). *Bull. Ent. Res.*, 39 (1) : 85-115, figs. 1-15, Plates x-xi.

Tonnoir, A. L., 1935.—The Australian species of the genus *Phlebotomus*. *Bull. Ent. Res.*, 26 : 137-147, 3 text-figs. and 1 plate.

Note.—For the sake of those who may be stimulated to follow the lead of Dr. Fairchild's work, it is worth recording that the range of distribution of *Phlebotomus* in Australia is quite wide. Mr. K. R. Norris has recently drawn attention to the existence of specimens, collected by himself, from both Western Australia and South Australia. These specimens were originally examined by Mr. Tonnoir, who determined the one from Crawley, W.A., as *Phlebotomus* near *queenslandi* Hill, and the one from the Waite Institute, Adelaide, S. Aust., as *Phlebotomus englisi* Tonn.? These are now in the C.S.I.R.O. collection at Canberra. During the present year Mr. A. L. Dyce has recovered *Phlebotomus* in a light trap he has been operating at Moree, N.S.W.—Ed.

AUSTRALIAN RUST STUDIES.

IX. PHYSIOLOGIC RACE DETERMINATIONS AND SURVEYS OF CEREAL RUSTS.

By W. L. Waterhouse,
The University of Sydney.

(Plate ix.)

[Read 30th July, 1952.]

Synopsis.

In continuation of earlier work, studies of the life histories and specialization phenomena have been made of the stem and leaf rusts of wheat, oats, barley, and rye. The host range has had to be extended to other grasses in many cases.

In general the aecidial stages of the pathogens are unimportant here. The carry-over of the rust takes place in the uredospore stage on self-sown plants of the cereal host or sometimes on susceptible grasses.

The physiologic races and, in certain cases, the biotypes of these rusts, have been determined during a long period of years and their occurrence surveyed for Australia and New Zealand. The bearing of this work on breeding programmes is emphasized.

General.

Cereal rusts do enormous damage throughout the world. In Australia, studies have been in progress for a number of years, and although results of earlier work have been published (Waterhouse, 1929, 1930, 1933, 1934, 1935, 1936, 1938, 1939, 1951; Waterhouse and Watson, 1941; Watson and Waterhouse, 1949), a detailed account of the later investigations has not been given for some time. This paper is designed to bring up to date the results that have been obtained with the following rusts: stem and leaf rust of wheat, stem and leaf rust of oats, leaf rust of rye, and leaf rust of barley. Results of work on certain grass rusts are not included here.

STEM RUST OF WHEAT.

Introduction.

Weather conditions in recent years have again been responsible for heavy crop losses from disease attack, and these have directed attention to the continuing importance of the wheat rust problem. Butler (1948) estimated that the New South Wales losses caused by stem rust in the 1947–1948 season amounted to £7,000,000, and pointed out that this would have been much greater had it not been for the cultivation of several resistant varieties in some areas. Further heavy losses have occurred since. Apart altogether from rust, other organisms have done much damage under the favourable conditions. It is difficult to give a true assessment of particular losses: some put down to stem rust may well have been due to other causes.

Life History.

Aecidial Stage.

Earlier work with *Puccinia graminis tritici* E. & H. (Waterhouse, 1929, 1936, 1938) has shown that the Australian position is unique in many ways. For example, the rust does not regularly develop the aecidial stage on the barberry. To date only one record of the natural occurrence of this stage has been made (Waterhouse, 1934). Nevertheless controlled work in the plant house has shown that the barberry is a potential source of danger, and the growing of susceptible species is rightly proscribed.

Material sent from other countries for examination has consistently given good germinations of teleutospores which have been over-wintered abroad before being forwarded by air mail in the spring. There have been a few cases, e.g., wheat straw from Greece, in which all attempts have failed to break the dormancy, either by exposing to winter conditions on the Tablelands, or by artificial freezing and thawing, material which had not been thus treated. Year after year Australian material has been exposed to winter conditions on the Tablelands of New South Wales, and also treated in the refrigerator, but very rarely has it been possible to get the spores to germinate. Failures have occurred with spores formed in the spring and in the autumn and therefore not subjected to the high summer temperatures, as well as with rust produced at the usual times. There is a clear need for a fuller investigation of this happening: proper control of teleutospore germination is essential for studies dealing with the genetics of the rust fungi.

Teleutospores on wheat straw from India have yielded cultures from barberries which proved to be races 16 and 21.

Wheat rust sent for determination from Burma in 1947 showed the presence of races 14, 17 and 78. Reference is made elsewhere (p. 235) to the leaf rusts also present in this material.

British material has given many different races. It has already been stated (Waterhouse, 1938) that races 23, 24, 27, 33, 35, 51, 53, 69, 83, 109, 117 and 122 have been sorted out. In more recent work, the following additional races have been determined from teleutospore and uredospore material: 10, 11, 16, 21, 34, 48, 56, 75, 95, 100, 107, 148, 151, 194, 222 and 228.

This is a very wide range of races. Relatively few isolates have been available for examination, but the number of races found is very much greater than in comparable studies of Australian material. The greater diversity is probably due to the presence of the barberry in parts of Britain, and the production on it of new races by hybridization.

It has been the practice to test the overseas races for their reactions on useful extra-differential varieties—viz., "Yalta", "Celebration", and "Eureka". Uniformly resistant reactions have been given on "Yalta", this being in sharp contrast with the susceptibility shown to the common Australian rust. On "Celebration", instead of resistance, susceptibility is usual. There have been cases—e.g., with r. 34—in which isolates giving the normal reactions on the differential set have behaved quite differently on "Celebration", one biotype giving fully susceptible and another completely resistant reactions. "Eureka" is resistant to some but susceptible to others of these races. This again emphasizes the fact that varieties useful as resistant parents in one area may be quite worthless in another where different physiologic races occur. At the same time it is important to have the greatest possible number of races on hand for work designed to classify the genes that are concerned with resistance, as well as to enable tests for wide resistance to be made of new crossbred wheats. The more genes for resistance that are present, the more likely is such a variety to remain resistant under changes that take place in the races present in that area.

Uredospore Stage.

Evidence has mounted to show that the uredospore stage carries the rust over from season to season on "volunteer" wheat, barley, rye, and on certain grasses. During the period under consideration the occurrences on common grasses in time and space are shown in Tables 1 and 2.

It is clear that with the exception of 1945, which was a drought year, rusted grasses came to hand in each of the years. The significance of the widely distributed *Hordeum leporinum* and *Agropyron scabrum* is shown by the fact that they provided more than 90% of the isolates. By reason of its perennial habit, the latter is particularly important. The relative paucity of rusts from the other grasses does not mean that they are therefore unimportant. Thus the other two species of *Hordeum* and the three of *Agropyron* listed have a limited distribution only, but where they do occur they may serve as foci for the spread of the rust. It should not be taken that the grasses listed are the only ones capable of being attacked by wheat stem rust. Further investigation may well bring others to light.

Apart from its occurrence on wheat and grasses, stem rust has commonly been found on rye and barley, sometimes on plants growing out of season. Details of these isolates are set out in Tables 3 and 4.

TABLE 1.

Summary of the Number of Isolations of Physiologic Races of P. graminis tritici *Found on Grasses, Grouped According to Time of Collection.*

Race.	Season of Collection, Ending 31st March of the Year Named.													Totals.
	1939.	1940.	1941.	1942.	1943.	1944.	1945.	1946.	1947.	1948.	1949.	1950.	1951.	
21										1				1
45		1												1
59	1													1
126	13	11	8	5	2	8		1	2	6	2	3		61
126B								8	2	11	2	10	2	35
222BB												20	5	25
222AB												13	2	15
Totals	14	12	8	5	2	8		9	4	18	4	46	9	139

TABLE 2.

Summary of the Number of Isolations of Physiologic Races of P. graminis tritici *Found on Grasses, Grouped According to Their Source.*

Grass Host.	Total No. of Isolates.	Source of Material and Number of Each Race Found.														Totals of Races.						
		A.C.T.		N.S.W.						Qld.			S.A.		W.A.							
		Races.		Races.						Races.			Races.		Race.							
		126.	45.	21.	59.	126.	126B.	222BB.	222AB.	126.	126B.	222BB.	126.	126B.	126.	21.	45.	59.	126.	126B.	222BB.	222AB.
Hordeum leporinum	95	2			1	28	24	18	11				1	1	9			1	40	25	18	11
H. marinum ..	2					1	1												1	1		
H. bulbosum ..	2						2													2		
Agropyron scabrum	32	2	1			8	5	4	4	2	1	3			2		1		14	6	7	4
A. spicatum ..	1										1									1		
A. velutinum ..	1			1												1						
A. pectinatum ..	1					1													1			
Amphibromus Neesii	1					1													1			
Elymus sp. ..	2					2													2			
Aegilops ovata ..	1														1				1			
Deyeuxia quadriseta	1					1													1			
Totals ..	139	4	1	1	1	42	32	22	15	2	2	3	1	1	12	1	1	1	61	35	25	15

In all but two of the years, rust was found on rye. From it four races were isolated. In one case, races 33 and 126 were present together in the one field collection. Race 126 was found in almost 90% of the isolates.

Barley was a host of wheat rust in each of the years. In all, seven races were found on it. On six occasions, races 126 and 126B were found together, once races 14 and 126B, and once races 33 and 126. The commonest race was 126, which occurred to the extent of 70% of the total.

TABLE 3.
Frequency of Occurrence and Distribution of Races of P. graminis tritici *on Rye.*

Year.	Race.	Number of Isolates.	Distribution in Space.					
			N.S.W.	Qld.	Vic.	S.A.	W.A.	N.Z.
1939	33	1		1				
	126	6	5	1				
1940	126	4	3				1	
1941	126	6	5					1
1942	126	6	6					
1943	126	3	3					
1944	126	3	3					
1945	126	4	4					
	126B	1	1					
1946	126	1	1					
	126B	2	1		1			
1947	126	1				1		
	126B	1	1					
1948	126	1	1					
1949		—						
1950	126	1	1					
	126B	1	1					
	222BB	1	1					
1951		—						
Totals ..		43	37	2	1	1	1	1

TABLE 4.
Frequency of Occurrence and Distribution of Races of P. graminis tritici *on Barley.*

Year.	Race.	Number of Isolates.	Distribution in Space.					
			N.S.W.	Qld.	Vic.	S.A.	W.A.	Tas.
1939	33	1		1				
	126	8	4	4				
1940	126	5	4	1				
1941	126	7	7					
1942	45	1	1					
	126	11	8				2	1
1943	126	4	3	1				
1944	126	11	5			1	5	
1945	126	1	1					
	126B	1	1					
1946	126	2	2					
	126B	3	3					
1947	126	3	2		1			
	126B	4	3			1		
1948	126	5	2	1			1	1
	126B	8	5	2		1		
	14	1	1					
1949	126	1	1					
	126B	1	1					
	222AA	1	1					
1950	126	2	2					
	126B	2	2					
1951	222BB	3	3					
	222AB	1	1					
Totals ..		87	63	10	1	3	8	2

Specialization.

In the determination of physiologic races, the set of differential wheat varieties selected by Stakman and Levine (1922) has been used in order that further comparisons with recorded races might be made. The varieties "Reliance C.I. 7370" and "Kanred C.I. 5146" were found to be interchangeable in the work, using the selection of the latter described in a previous paper (Waterhouse, 1929). The typical reactions shown by important races referred to herein are set out in Table 5.

TABLE 5.

Typical Reactions of Certain Physiologic Races of P. graminis tritici *on Selected Differential Varieties of* Triticum *spp.*

Race Number.	Little Club C.I.4066.	Marquis C.I.3641.	Reliance C.I.7370.	Kota C.I.5878.	Arnautka C.I.1493.	Mindum C.I.5296.	Spelmar C.I.6236.	Kubanka C.I.2094.	Acme C.I.5284.	Einkorn C.I.2433.	Vernal C.I.3686.	Khapli C.I.4013.	Eureka.	Yalta.
11	4	4	3	3	4	4	4	3	3	3	1	1		
14	4	2	1	1	3	3	3	3	3	3	1	0		
21	4	4	0	3	4	4	4	4	3	1	0	1		
33	4	2	4	1	1	1	1	3	3	3	1	1		
34	4	4	4	4	4	4	4	3	3	1	0	1		
43	4	3	0	0	0	0	0	x	1	3	1	0		
44	4	3	0	0	0	0	0	3	3	3	1	0		
45	4	2	0	2	4	4	4	x	x	3	3	1		
46	4	3	0	2	4	4	4	1	1	3	3	1		
54	4	3	0	0	0	0	0	1	3	3	1	0		
55	4	4	0	2	4	4	4	x	x	3	3	1		
56	4	3	3	3	1	1	1	3	3	1	1	1		
59	4	2	0	0	1	1	1	x–	3	3	1	0		
126	4	4	3	3	x	x	x	x	x	1	1	1	0	0
126B	4	4	3	3	x	x	x	x	x	1	1	1	4	0
222[1]	4	3	3	3	3	3	3	1	1	0	0	0		
222AA	4	3	3	3	3	3	3	1	1	0	0	0	0	0
222AB	4	3	3	3	3	3	3	1	1	0	0	0	0	4
222BB	4	3	3	3	3	3	3	1	1	0	0	0	3	4

[1] Grateful acknowledgement is made to Dr. E. C. Stakman of Minnesota, U.S.A., for supplying the designation of this race.

During the period under consideration the occurrences of the races in time and space are given in Tables 6 and 7.

TABLE 6.

Summary of the Number of Isolations of Physiologic Races of P. graminis tritici *Grouped According to Time of Collection.*

Race.	Season of Collection, Ending 31st March of Year Named.													Totals.
	1939.	1940.	1941.	1942.	1943.	1944.	1945.	1946.	1947.	1948.	1949.	1950.	1951.	
126	165	267	93	159	104	114	31	54	88	184	48	65	19	1391
126B				2	27	22	36	155	163	184	68	127	49	833
222BB											3	292	122	417
222AB											2	220	66	288
11	1	3		1										5
14										1				1
21										1				1
33	3													3
45	1	4		1										6
56						1								1
59	1													1
222AA											1			1
Totals	171	274	93	163	131	137	67	209	251	370	122	704	256	2948

TABLE 7.

Summary of the Number of Isolations of Physiologic Races of P. graminis tritici *Grouped According to Their Source.*

Race.	Source of Material.								Totals.
	A.C.T.	N.S.W.	Vic.	Qld.	S.A.	W.A.	Tas.	N.Z.	
126	17	918	115	75	66	143	43	14	1391
126B	2	665	23	68	51	7	11	6	833
222BB ..		361	10	44			2		417
222AB ..		246	2	40					288
11		4	1						5
14		1							1
21		1							1
33				3					3
45	1	2		3					6
56		1							1
59		1							1
222AA ..		1							1
Totals ..	20	2201	151	233	117	150	56	20	2948

The locations from which the collections came year by year are as follows:

DETAILS OF THE OCCURRENCES OF THE RACES OF P. GRAMINIS TRITICI.

1939.

r.11.

N.S.W.: H.A. College.
Qld.: Warwick.

r.33.

N.S.W.: Albert.
Qld.: Gatton.

r.126.

N.S.W.: Grafton, Scone, Manilla, Wee Waa, Pilliga, Curlewis, H.A. College, Myall Creek, Bundella, Premer, Tambar Springs, Moree, Warialda, Bingara, Birriwa, Myall Plains, Mendooran, Merrygoen, Narrabri, Pallamallawa, North Star, Inverell, Gum Flat, Cherry Tree Hill, Albert, Gunnedah, Cowra, Cumnock, Rocky Glen, Ulamambie, Purlewaugh, Oberly, Yeoval, Gilgandra, Dubbo, Euchareena, Temora, Cootamundra, Canowindra, Bathurst, Chatswood, Auburn Vale, Tichborne, Nelungaloo, Nundle, Peak Hill, Quandialla, Eugowra, Ballimari, Young, Woodstock, Moulamein, Quirindi, Pine Ridge, Glen Innes, Barry, Newbridge, Millthorpe, Lindfield.
Qld.: Brookstead, Gatton, Roma, Oakey, Dalby, Warwick, Toowoomba.
S.A.: Elbow Hill, Pinkawillinie, Yadnarie, Yeelana, Rudall, Upper Eyre Peninsula, Port Neill.
Tas.: Deloraine, Illawarra, Bishopsbourne, Bish-Long, Erandale, White Hills, Hagley, Longford, Cressy, Brackwell, Oaks, Formosa, North-West Coast, Stoodley, Barrington, Oyster Cove.
A.C.T.: Canberra.

r.45.

N.S.W.: Inverell.

r.59.

N.S.W.: Bathurst.

1940.

r.11.

N.S.W.: Temora, Manilla, Dunedoo.

r.126.

N.S.W.: West Wyalong, Carroll, Narrabri, Condobolin, Parkes, Gunnedah, Grawlin Plains, Ungarie, Biniguy, Trangie, Narrandera, Ivanhoe, Manildra, Temora, Pallamallawa, H.A. College, Black Creek, Wirrinya, Baradine, Wellington, Leeton, Colinroobie, Inverell, Bingara, Culgoora, Werris Creek, Currabubula, Willow Tree, Quirindi, Tamworth, Cobbarah, Leadville, Manilla, Attunga, Boggabri, Mullaly, Oakwood, Dunedoo, Mendooran, Wee Waa, Brobenah, Yerong Creek, Henty, The Rock, Osborne Creek, Loogong, Cudal, Cumnock, Gilgandra, Dubbo, Yeoval, Mathoura, Narromine, Wongarbon, Geurie, Arthurville, Cowra, Bathurst, Bugaldie, Coonabarabran, Binnaway, Euratha, Yanco, Corobimilla, Eursley, Sandigo, Burraja, Ringwood, Daysdale, Jerilderie, Deniliquin, Blighty, Finley, Tocumwal, Berrigan, Cookardinia, Bungowarrah, Urana, Cullwel, Rand, Lockhart, Broken Hill, Caragabal, Eugowra, Forbes, Goolagong, Tragene, Uranquinty, Old Junee, Mangoplah, Downside, Coreinbob, Collingullie, Wagga, Balranald, Moulamein, Greenthorpe, Canowindra, Grenfell, Mascot, Lindfield, Muswellbrook, Blayney, Chatswood, Chullora, Glen Innes.

Qld.: Gatton, Pittsworth, Oaken, Cecil Plains, Warwick, Toowoomba.
A.C.T.: Canberra, Yamba, Watangera, Ainslie.
W.A.: Merredin, Salmon Gums, Perth, Northampton, Borden.
Vic.: Werribee, Swan Hill, Donald, Invergordon, Charlton, Longeronong, Swan Vale.
S.A.: Waite, Roseworthy, Saddleworth.

r.45.

Qld.: Gatton, Pittsworth.
A.C.T.: Canberra.

1941.

r.126.

N.S.W.: Taree, Bathurst, Garthowen, H.A. College, Sydney University, Tichborne, Wongalea, Cowra, Glen Innes, Willow Tree, Chullora, Tamworth, Grawlin Plains, Armidale, Inverell, Attunga, Emerald Hill, Bective, Wallabadah, Quirindi, Boggabri, Milvale, Gunnedah, Bungarby, Parkes, Carroll, Guyra, Furracabad, Nelungaloo.
Qld.: Kincora.
Vic.: Dookie, Salisbury, Longeronong, Werribee, Donald.
S.A.: Waite.
A.C.T.: Canberra, Duntroon.
N.Z.: Christchurch, Auckland.

1942.

r.11.

Vic.: Rochester.

r.126.

N.S.W.: Spring Ridge, Duri, Gunnedah, Inverell, Baradine, Narrabri, Kelso, Tichborne, H.A. College, Pallamallawa, Bunaloo, Tambar Springs, Purlewaugh, Forbes, Bingara, Barraba, Yelindenie, Parkville, Goonumbla, Peak Hill, Alectown, Cowra, Bathurst, Binnaway, Mollyan, Tamworth, Birriwa, Tooraweenah, Neilrex, Cumnock, Grenfell, Eugowra, Parkes, Jemalong, Ooma, Culcairn, Urangeline, Jindera, Boggabri, Strathfield, Glen Innes.
A.C.T.: Canberra.
W.A.: Merredin, Chapman, Mingenan.
S.A.: Waite.
Vic.: Werribee, Werrimull, Rochester, Rutherglen, Dookie, Donald, Charlton, Longeronong, Salisbury, Walpeup.
Tas.: Wilmot, Cressy, Wesley Vale.
N.Z.: Auckland, Lincoln, Nelson.

r.45.

N.S.W.: H.A. College.

r.126B.

N.S.W.: Gunnedah, Tamworth.

1943.

r.126.

N.S.W.: H.A. College, Narrabri, Curlewis, Gunnedah, Tamworth, Coonabarabran, Somerton, Carroll, Tambar Springs, Purlewaugh, Tichborne, Baradine, Bugaldie, Boggabri, Edgeroi, Cowra, Spring Hill, Borenore, Maryvale, Arthurville, Dubbo, Rawsonville, Parkes, Rocky Dam, Inverell, Attunga, Nemingha, Loomberah, Lane Cove, Balladoran, Wongarbon, Eulomigo, Quirindi, Mungeribah, Glen Innes, Delungra, Bannockburn, Manly, Wallabadah, Goonoo Goonoo, Lindfield, Badgery's Creek.
Qld.: Gatton, Willawa, Winton, Brookstead.
W.A.: Merredin, Salmon Gums.
Vic.: Walpeup, Dookie, Rutherglen, Footscray, Longeronong, Werribee, Maribyrnong.
S.A.: Waite, Paskeville.

r.126B.

N.S.W.: Narrabri, Gunnedah, Tamworth, Somerton, Boggabri, Edgeroi, Cowra, Maryvale, Rocky Dam, Inverell, Attunga, Nemingha, Delungra, Bannockburn.
Qld.: Winton.

1944.

r.126.

N.S.W.: Tichborne, Gunnedah, H.A. College, Binnaway, Temora, Cowra, Wagga, Tambar Springs, Curlewis, Grong Grong, Spring Hill.
Qld.: Brookstead.

W.A.: Merredin, Elabbin, Northampton, Nalkain, Binee, Baandee, Mandiga, Kunonoppin, Ballidee, East Ballidee, Wyalkatchem, Kulja, Bencubbin, South Bencubbin, Naraling, East Salmon Gums, Salmon Gums, Doodlakine, Kollerberrin, Quellington, Grass Valley, Wael, Meenar, Carnamah, Wongan Hills, Highbury, Toompup, Chapman.

S.A.: Waite.

Vic.: Walpeup, Dookie, Salisbury, Longeronong, Werribee.

Tas.: Deloraine.

N.Z.: Winton.

r.56.

N.S.W.: Sydney University.

r.126B.

N.S.W.: Milguy, Gunnedah, H.A. College, Temora, Cowra, Beekom, Wagga, Moombooldool, Ariah Park, Curlewis.

Vic.: Walpeup, Dookie.

Qld.: Brookstead.

S.A.: Waite.

1945.

r.126.

N.S.W.: Curlewis, Wallacia, Gilgandra, Mount George, West Maitland, Rocky Glen, H.A. College, Grafton, Breeza, Gosford, Quirindi, Goonoo Goonoo, Killara.

Vic.: Burnley.

S.A.: Waite.

W.A.: Merredin, Perth.

r.126B.

N.S.W.: Curlewis, Mulgoa, Wallacia, Gunnedah, Gilgandra, H.A. College, Gulargambone, Brindley Park, Baradine, Loomberah, Manilla, Quirindi.

Qld.: Gatton.

1946.

r.126.

N.S.W.: Canowindra, Burdett, Waroo, West Wyalong, Bedgerabong, Cowra, Young, Koorawatha, Ariah Park, Bingara, Narromine, Gunnedah, Curlewis, North Star, Wean, Warialda, Gravesend, Bellata, Edgeroi, Pallamallawa, Tamworth, H.A. College, Warrumbungle, Manilla, Dubbo, Castle Mountain.

Qld.: Lawes.

W.A.: Merredin.

N.Z.: Lincoln.

r.126B.

N.S.W.: Nundle, Curlewis, Nea Siding, Murrurundi, Inverell, Garah, Bingara, New Mexico, Gunnedah, Singleton, Scone, Gravesend, Emerald Hill, North Star, Wallangra, Warialda, Bellata, Pallamallawa, Edgeroi, Tamworth, Manilla, Thorli, Dubbo, H.A. College, Baradine, Somerton, Wee Waa, Balladoran, Berrigal Creek, Coonabarabran, Mullaly, Narrabri, Cookabunna, Castle Mountain, Loomberah, Armatree, Cowra, Eumungerie, Young, Koorawatha, Temora, Moombooldool, Milvale, Ariah Park, Ardlethan, Purlewaugh, Elong Elong, Auburn Vale, Bukkulla, Narromine, Gulargambone, Canowindra, Burdett, Bedgerabong, Waroo, West Wyalong, Maryvale, Culcairn, Gilgandra, Young, Boorowa, Gerogery, Tichborne, Glen Innes, Spring Hill.

Qld.: Lawes, Pittsworth, Brookstead.

Vic.: Werribee.

1947.

r.126.

N.S.W.: Holbrook, Albury, Brocklesby, Walbundrie, Finley, Killara, Orange, Cowra, Leeton, Alfred Town, Corowa, Bungowanah, Kycemba, Gundagai, Gerogery, Jindera, Table Top, Walla, Tichborne, Ladysmith, Burradana, Frogmore, H.A. College.

Qld.: Lawes, Brookstead.

S.A.: Roseworthy, Pinnaroo, Baroota, Waite, Ungarra.

Vic.: Walpeup, Lake Cullullmare.

W.A.: Toompup.

r.126B.

N.S.W.: Holbrook, Grong Grong, Cowra, Killara, Inverell, Glenfield, H.A. College, Clarendon, Windsor, Alfred Town, Albury, Brocklesby, Walbundrie, Bungowanah, Kycemba, Corowa, Gerogery, Ringwood, Table Top, Loomberah, Deniliquin, Finley, Leeton, Howlong, Morven, Pleasant Hills, Orange.

Qld.: Lawes, Bongea, Brookstead.

S.A.: Roseworthy, Pinnaroo, Saddleworth, Waite.

Vic.: Walpeup.

N.Z.: Tai Tapu.

1948.

r.14.

N.S.W.: Kelso.

r.21.

N.S.W.: Kosciusko.

r.126.

N.S.W.: Glen Innes, Kosciusko, Curlewis, Tamworth, Wagga, Moree, Delungra, Crooble, Yanco, Westdale, Wee Waa, Narrabri, Edgeroi, Geurie, Coradgery, Mt. Euroa, Wellington, Wongarbon, Eumungerie, Coonabarabran, Tooraweenah, Boggabri, Trangie, North Star, Grafton, Coolamon, Ganmain, West Wyalong, Orange, H.A. College, Bingara, Young, Wombat, Wyanga, Balldale, Brocklesby, Tichborne, Bergalia, Yarraman, Castle Hill, Kelso.

Qld.: Horrane, Hermitage, Warwick, Mt. Tyson, Darling Downs, Biloela, Euanslea, Condamine Plains, Wellcamp, Lawes, Archerfield.

S.A.: Jamestown, Mullewa, Walloway, Roseworthy, Waite, Owen, Mt. Gambier, Penola.

Vic.: Walpeup.

W.A.: Wongoondy, Mendel, Northampton, Grass Patch, Merredin.

A.C.T.: Canberra.

Tas.: Latrobe, Cressy, Deloraine, Pateena, Cambridge, Kindred, Sassafras, Elliott.

r.126B.

N.S.W.: Bingara, Temora, Concord, Inverell, Delungra, Scone, Dubbo, Suntop, Binnalong, Mudgee, Calimpa Siding, Forbes, Wallen Bullen, Peak Hill, Dandaloo, Middlefield, Curlewis, Willow Tree, Merriwa, St. Elmo, Cowra, Walbundrie, Brocklesby, Tamworth, Barraba, Manilla, Quirindi, Manly, Gaylong, Cunningar, Harden, Gosford, Mangoplah, Culcairn, Gerogery, Howlong, Glen Innes, Bogan Gate, West Wyalong, Curlewis, Moree, H.A. College, Coonabarabran, Crooble, Narrabri, Wee Waa, Geurie, Mt. Euroa, Wongarbon, Wellington, Trangie, North Star, Moree, Boggabri, Condobolin, Orange, Gilgandra, Walmer, Fingerpost, Tumbarumbah, Kelso, Blackheath.

Qld.: Biloela, Brookstead, Lawes, Hermitage, Dalby, Horrane, Warwick, Mt. Tyson, Darling Downs, Condamine Plains, Archerfield.

S.A.: Mt. Gambier, Bordertown, Wolseley, Wolloway, Roseworthy.

Tas.: Launceston, Cressy, Campbell Town.

1949.

r.126.

N.S.W.: Curlewis, Boggabri, Castle Hill, Bugaldie, Cowra, Trangie, Bathurst, Grenfell, Bribbaree, Marangarell, Temora, Colinroobie, Ariah Park, Gundagai, Ganmain, Coolamon, Yanco, Leeton, Gunnedah, Trundle, Gunningbland, Umaralla Mount.

W.A.: Merredin, Caversham, Ballidee.

Qld.: Lawes, Hermitage, Scottsdale.

N.Z.: Waikoikoi, Tairei.

r.126B.

N.S.W.: Curlewis, Gilgandra, Cooma, Boggabri, Yanco, Castle Hill, Bellata, Bugaldie, Cowra, Trangie, Bathurst, Grenfell, Bribbaree, Marangarell, Temora, Colinroobie, Ariah Park, Gundagai, Yass, Ganmain, Coolamon, Leeton, Gunnedah, Trundle, Gunningbland.

Tas.: Cressy.

Qld.: Lawes, Dalby, Hermitage, Nabby.

N.Z.: West Eyreton.

r.222AA.

N.S.W.: Tanja.

r.222BB.

Qld.: Lawes, Warwick, Westbrook.

r.222AB.

Qld.: Hermitage.

1950.

r.126.

N.S.W.: Spring Hill, Curlewis, Glen Innes, Gunnedah, Ariah Park, Bathurst, Manildra, Forbes, Wyalong, Leeton, Orange, Deniliquin, Coolamon, Ganmain, Matong, Grong Grong, Narrandera, Urana, Oaklands, Berrigan, Balldale, Henty, Walbundrie, Brocklesby, Marinna, Wagga, Cootamundra, Cowra, Spring Ridge, Temora.

Qld.: Allora, Nabby, Toowoomba.

W.A.: Wongan Hills, Merredin, Gnowangerup, Borden.

S.A.: Waite, Gladstone, Huddleston, Yandiah, Streaky Bay, Wirrulla, Chandada, Pestubie, Coelie, Mt. Cooper, Collie.

Vic.: Rutherglen, Dooen, Walpeup.

Tas.: Moriarty.

r.126B.

N.S.W.: Curlewis, Gunnedah, Berrigan, Deniliquin, Cheeseman's Creek, Bathurst, Parkes, Manildra, Walbundrie, Yiddah, Reefton, Tichborne, Forbes, Marsden, Wyalong, Temora, Leeton, Orange, Coolamon, Ganmain, Matong, Grong Grong, Narrandera, Corobindla, Coonong, Urana, Oaklands, Sangar, Merton, Corowa, Balldale, Henty, Marinna, Illabo, The Rock, Wagga, Junee, Young, Cootamundra, Crowther, Noonbinna, Wallendbeen, Cowra, Blayney, Kingsvale, Tubbet, Gilgandra, Dubbo, Blackheath, Jindera, H.A. College, Spring Terrace.

Tas.: Moriarty, Branxholm.

Qld.: Hermitage.

Vic.: Werribee, Rutherglen, Dooen, Walpeup, Dookie.

W.A.: Red Lake, Merredin, Toompup.

S.A.: Waite, Kapunda, Neale's Flat, Gladstone, Huddleston, Laura, Wirrabara, Yandiah, Streaky Bay, Wirrulla, Chandada, Pestubie, Mount Cooper, Collie, Roseworthy, Belvedere.

A.C.T.: Canberra.

N.Z.: Lyalldale, Hook.

r.222BB.

N.S.W.: Gunnedah, Curlewis, Narrabri, Tamworth, Castle Hill, Bellata, Dubbo, H.A. College, Stoney Creek, Boggabri, Wee Waa, Baan Baa, Carroll, Gravesend, West Wyalong, Appleby, Attunga, Grafton, Piallaway, Raleigh, Manilla, Somerton, Bective, Baradine, Gilgandra, Tambar Springs, Coonabarabran, Mendooran, Dunedoo, Leadville, Bogan Gate, Tintinhull, Spring Ridge, Armidale, Binnaway, Beckom, Cudal, Gosford, Barraba, Bingara, Delungra, Inverell, Warialda, Kelvin, Camden, Lucknow, Manildra, Goonumbla, Tichborne, Yiddah, Barmedman, Forbes, Marsden, Temora, Leeton, Rannock, Sebastopol, Berrigan, Merton, Sangar, Brocklesby, Illabo, The Rock, Junee, Young, Crowther, Noonbinna, Lyndhurst, Murrurundi, Deniliquin, Orange, Quandialla, Lockhart, Blackheath, Molonglo, Glen Innes, Spring Terrace, Quirindi, Upperton, Pine Cliff, Wongarbon.

Qld.: Brookstead, Lawes, Wyreema, Biddleston, Westbrook, Mt. Tyson, Hermitage, Bowenville, Toowoomba, Dalby, Oakey.

Tas.: Moriarty.

Vic.: Rutherglen.

r.222AB.

N.S.W.: Narrabri, Gunnedah, Curlewis, Glen Innes, Ariah Park, H.A. College, Castle Hill, Bellata, Dubbo, Stoney Creek, Boggabri, Wee Waa, Baan Baa, Carroll, Gravesend, West Wyalong, Appleby, Tamworth, Attunga, Grafton, Piallaway, Raleigh, Somerton, Baradine, Gilgandra, Coonabarabran, Tambar Springs, Mendooran, Manilla, Somerton, Spring Ridge, Armidale, Beckom, Gosford, Cudal, Warialda, Kelvin, Camden, Manildra, Goonumbla, Barmedman, Tichborne, Forbes, Temora, Leeton, Berrigan, Brocklesby, Illabo, The Rock, Junee, Young, Crowther, Noonbinna, Lyndhurst, Murrurundi, Orange, Lockhart, Kelso, Wagga, Pine Cliff, Wongarbon.

Qld.: Westbrook, Lawes, Hermitage, Wyreema, Biddleston, Bowenville, Brookstead, Dalby.

Vic.: Rutherglen.

1951.

r.126.

N.S.W.: Barmedman, Parkes, West Wyalong, Yanco, Tichborne.

r.126B.

N.S.W.: Tichborne, Dubbo, Mogriguy, Alectown, Canowindra, Yanco, Cowra, Grenfell, Quandialla, Bulgandry, Walbundrie, Temora, Nea Siding, Albury, Corowa, Daysdale, Savernake, Ringwood, Gilgandra, Deniliquin, Gunnedah.

S.A.: Port Lincoln, Pygeny, Bordertown, Ardrossan, Mangalo.

Vic.: Werribee, Walpeup, Longeronong.

Tas.: Tewkesbury, Sassafras, Cressy.

r.222BB.

N.S.W.: Glen Innes, Tichborne, Curlewis, Kelso, Narrabri, Dubbo, Coradgery, Gilgandra, Mogriguy, Trewilga, Alectown, Wongarbon, North Star, Wellington, Currabubula, Gunnedah, Trangie, H.A. College, Narromine, Leeton, Mendooran, Cowra, Canowindra, Darby's Falls, Yanco, Piallaway, Wee Waa, Mamambri, Boggabri, Quandialla, Woodstock, Binnaway, Baan Baa, Tamworth, Urangeline, Bulgandry, Walbundrie, Armidale, Bribbaree, Manildra, Albury, Corowa, Daysdale, Savernake, Ringwood, Deniliquin.

Qld.: Hermitage, Dalby, Mt. Linster, Pirrinuan, Yarrala, Allora, Mt. Tyson, Brookstead.

Vic.: Dookie, Walpeup, Longeronong.

Tas.: Sassafras.

r.222AB.

N.S.W.: Boorowa, Gilgandra, Barmedman, Glen Innes, Curlewis, Tichborne, Parkes, Boggabri, Tamworth, Coolamon, Yanco, Baradine, Piallaway, Gunnedah, H.A. College, Narrabri, Dubbo, Mogriguy, Trewilga, Tomingley, Alectown, Peak Hill, Garah, Wongarbon, Wellington, Trangie, Currabubula, Leeton, Cowra, Wee Waa, Loomberah, Barraba, Mamambri, Walbundrie, Talbragar.

Vic.: Werribee.

Qld.: Hermitage, Warwick, Dalby, Cecil Plains, Mt. Tyson.

A truer perspective of the overall Australian stem rust position is given by a study of the total determinations that have been made since the investigations were commenced. The spread in time and space is shown in Tables 8 and 9.

TABLE 8.

Summary of the Number of Isolations of Physiologic Races of P. graminis tritici *Grouped According to Time of Collection.*

Physiologic Race.	Season of Isolation Ending 31st March of the Year Stated.															
	1922.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1930.	1931.	1932.	1933.	1934.	1935.	1936.	1937.
11														3	5	2
34					4	18	152	156	90	181	139	143	93	220	189	304
43	20	10	10	55	15	14	21				10	1		4		
44	2	4		1	3	30	6									
45	3			15	5	17	5								4	
46	14		15	24	1	6	2									
54		1				3	1									
55	2			5		1	2									
59															1.	
126																
126B ..																
222BB ..																
222AB ..																
14																
21																
33																
56																
222AA ..																
Totals ..	41	15	25	100	28	89	189	156	90	181	149	144	93	227	199	306

Physiologic Race.	Season of Isolation Ending 31st March of the Year Stated.														Totals.
	1938.	1939.	1940.	1941.	1942.	1943.	1944.	1945.	1946.	1947.	1948.	1949.	1950.	1951.	
11	7	1	3		1										22
34	236														1925
43															160
44															46
45		1	4		1										55
46															62
54															5
55															10
59		1													2
126		165	267	93	159	104	114	31	54	88	184	48	65	19	1391
126B ..					2	27	22	36	155	163	184	68	127	49	833
222BB ..												3	292	122	417
222AB ..												2	220	66	288
14											1				1
21											1				1
33		3													3
56							1								1
222AA ..												1			1
Totals ..	243	171	274	93	163	131	137	67	209	251	370	122	704	256	5223

It is seen that during the whole period there have been three major changes in the races present, changes which have had far-reaching consequences to wheat growers.

First major change in races present.

The first occurred in 1926 when r.34 first appeared in Western Australia and quickly spread throughout the wheat-growing areas of Australia and New Zealand. Its rapid supersession by 1929 of the six races previously present was explainable firstly by its wide host range, and secondly by its capacity to produce crops of uredospores in a shorter time than the other races. This has already been discussed (Waterhouse, 1929).

In addition to r.34, it will be seen that five other races were found, but with a relatively low frequency. Studies of competition between associations of races have thrown much light on the failure of certain races to become established (Watson, 1942). Nevertheless, they can be of importance where barberries occur, serving as parents in crosses with other races.

TABLE 9.

Summary of the Number of Isolations of Physiologic Races of P. graminis tritici *Grouped According to Their Source.*

Physiologic Race.	Source of Material.								Totals.
	A.C.T.	N.S.W.	Vic.	Qld.	S.A.	W.A.	Tas.	N.Z.	
11	2	18	1					1	22
34	68	1387	120	88	105	49	32	76	1925
43		130	7	17	3	2	1		160
44		39		4	2		1		46
45	2	35	3	3	7		2	3	55
46		43	4	3	1		9	2	62
54		4			1				5
55		9		1					10
59		1		1					2
126	17	918	115	75	66	143	43	14	1391
126B	2	665	23	68	51	7	11	6	833
222BB		361	10	44			2		417
222AB		246	2	40					288
14		1							1
21		1							1
33				3					3
56		1							1
222AA		1							1
Totals	91	3860	285	347	236	201	101	102	5223

Second major change in races present.

The second major change occurred in 1941 when the variety "Eureka", a popular and fully resistant stem rust wheat bred by Dr. S. L. Macindoe, was found in the north-west of N.S.W. to be heavily attacked by stem rust. Investigation proved that the typical race 34 reactions were not seriously departed from, but that they conformed more closely to those set down for r.126—a race belonging to the r.34 group. At the same time, plant house studies showed that the original stock culture of r.34 now approximated closely to the behaviour of r.126. However, the two cultures could be separated clearly by using the variety "Eureka" or its parent "Kenya W743" as a differential: the old culture gave a resistant reaction whilst the new gave a susceptible one. This distinction is obscured at high temperatures, but it was clear that a new rust had turned up. It has stopped the growing of "Eureka" which has so many other valuable agronomic characters. Details of these happenings have already been given (Watson & Waterhouse, 1949) and the new rust has been styled r.126B.

It will be noted that r.34, which occupies such an important place in the tables setting out the results obtained prior to 1939, is not listed in the subsequent years. The actual differences between r.34 and r.126 are not great according to the register (Stakman, Levine and Loegering, 1944). Both belong to the same race group. The reactions on the durum varieties of the differential set are those which separate them, and it has been shown (Waterhouse, 1929) that temperature fluctuations may cause variations in their rust reactions which are even wider than those shown in the register for the two races on these varieties.

As stated above, the detailed work involved in the study of r.126B in 1941 brought to light the differences in our cultures. Exactly when the change occurred is not known, and for this reason, in the "new" series of results starting with 1939, r.126 and not r.34 is tabulated, although in part the latter may have been present and included in the r.126 numbers given.

The spread of r.126B took place rapidly owing to the well-deserved popularity and wide cultivation of "Eureka" which screened out the other races. Its dispersal as determined by rust collections submitted for examination is clearly shown in the preceding tables.

A collection of single stems taken at random in November, 1946 from crops of fully susceptible varieties by Dr. I. A. Watson to show the relative frequencies of the two biotypes gave the following results, in which the build-up of r.126B is clear:

TABLE 10.

Relative Frequency of Isolation of the Two Biotypes of Race 126 from Susceptible Varieties in Several Localities.

Locality.	Number of Isolations of Biotypes.		
	r.126.	r.126B.	Both.
Alfred Town	9	7	
Albury District	4	18	5
Brocklesby	1	13	2
Walbundrie	10	21	2
Bungowanah	3	10	
Kycamba	4	3	
Killara	17	17	
Totals ..	48	89	9

Third major change in races present.

The third major change in the rust flora occurred in 1948. Following upon the establishment of r.126B, five new varieties were liberated in New South Wales, viz., "Celebration", "Charter", "Yalta", "Kendee", and "Gabo". All were resistant to r.126 and r.126B. Early field results indicated that "Yalta" was the least resistant, and on occasion showed a considerable amount of rust on its stems. In all these cases, however, plant-house tests showed that 126B was the rust present and that "Yalta" seedlings gave a resistant reaction: particularly favourable conditions had been responsible for the rust development. Nevertheless, commencing in October, 1947, the precaution was taken to include "Yalta" in the differentials used for testing unknown rusts sent for determination. It was found that rusted "Yalta" specimens continued to give 126B reactions until November, 1948, when heavily rusted "Yalta" sent by S. G. Burns from Lawes, Q., gave full "Yalta" susceptibility in the plant-house tests. It was clearly a new rust.

Morphological Studies.

Comparisons of spore morphology sometimes reveal differences between physiologic races of rust, although there are many exceptions to this (Levine, 1923; Waterhouse, 1930).

To date no aecidiospores of the new rust have been available for measurement, but studies of uredospores and teleutospores have been made. Comparisons with other rusts are set out in Table 11.

Table 11.

Comparisons of Measurements of Spore Forms of Certain Australian Races of P. graminis tritici.

Race.	Length in μ.			Width in μ.		
	Mean.	Standard Deviation.	Range.	Mean.	Standard Deviation.	Range.
			Uredospores.			
222	30·61	2·57	25–39	17·37	1·62	15–21
Average of 9 Aust. races	31·25	3·68	21–43	18·14	2·01	11–22
34	30·62	2·58	22–37	18·97	1·77	15–22
43	29·39	3·58	21–37	19·44	1·40	17–22
			Teleutospores.			
222	44·03	5·08	29–62	13·88	2·06	9–19
Average of 3 Aust. races	44·32	7·40	29–75	15·90	2·27	11–22
34	47·89	8·64	30–74	16·78	2·20	13–22
43	43·64	6·07	34–63	14·53	2·79	11–21

In earlier work details were given of measurements of individual Australian races (Waterhouse, 1930). In the case of the uredospores, the average for nine races is here given, and for the teleutospores, three races. It will be seen that race 222 shows no significant departure from the averages for these spore forms. The uredospore measurements approximate most closely to those of r.34, and those of the teleutospores to those of r.43.

Race Determinations.

Race determinations showed that the new rust bears many similarities to race 126. At the usual temperatures for testing, the reactions on "Kubanka" and "Acme" are consistently lower than those given by rs. 126 and 126B, although at high temperatures these differences, and especially those on "Kubanka", are not so clear. On the other hand, reactions on "Arnautka", "Mindum", and "Spelmar", are higher than those of 126 and 126B. Dr. E. C. Stakman has recently given it the designation of race 222.

Using commercial varieties, tests at a temperature of about 70°F. showed that "Kendee" and "Charter" gave susceptible reactions, whilst "Celebration" and "Gabo" gave resistant reactions: the susceptibility of the last-named increased notably with high temperatures. On "Eureka" the rust is split into two entities at the usual temperatures, one biotype giving susceptible, whilst the other gives resistant reactions: these differences disappear at high temperatures. This behaviour parallels that shown by rs. 126 and 126B, and in the same way makes difficult the separation of the two components on "Eureka". For this reason some isolates giving a susceptible reaction and therefore those classified as 222BB in the survey may really have belonged to 222AB.

The increased frequency of isolates of 222BB and 222AB is mainly due to the widespread cultivation of the five new "resistant" varieties which thus served to screen out 126 and 126B. The latter, however, persist in crops of susceptible varieties like

"Bencubbin", from which these two rusts can commonly be isolated. This is also the case with *Hordeum leporinum* and *Agropyron scabrum*.

The new complex spread rapidly. In April, 1949, isolations were made from the north-west of New South Wales, a month later from Glen Innes, and in the following month from the Central West. As summer approached, its frequency increased throughout Queensland and New South Wales, and in December, 1949, it was found at Rutherglen, Vic. This was followed by isolations from Moriarty, Tas., in February, 1950. To date it has not been found in South Australia or Western Australia, but in the other States it is now well established.

Reports on the field behaviour of the "resistant" varieties during the recent two seasons when rust damage was severe, supplemented by examination of material submitted from the field, show that "Celebration" is highly resistant, although when grown under very favourable conditions, some rust develops on it. "Gabo" shows a higher rust development, and this increases progressively on "Charter", "Kendee", and "Yalta". The last-named is so susceptible that it is no longer recommended for cultivation.

Examination of varieties on hand showed that a number were resistant, and others have since become available. The gene relationships are being studied by Drs. I. A. Watson and E. P. Baker, and already it is clear that a number of useful resistances are available. Back-cross programmes designed to incorporate these in agronomic sorts are now being carried forward.

In addition to strains of *Agropyron* spp. and a number of inbred ryes which show remarkable self-fertility after 20 years of inbreeding, as well as resistance to all the known Australian races, resistant varieties of wheat include the following:

(*a*) 14-chromosome wheats: Abyssinian, Africano, Akrona, Alberta Red, Beladi (8 strains), Egypt (4 strains), Greece 11, Iumillo, Morocco 34, Nodak, Palestine (2 strains), Pinet, Poona (3 strains), Portugal (7 strains), Russian (3 strains).

(*b*) 21-chromosome wheats: Bokveld, Egypt, Fedweb, Frondosa, Frontana, Fronteira, Hochzucht, Hofed, Hope, numerous Hope derivatives, Kenya 117A, Kenya 744, La Estanzuela, Malakof, Marquillo, Newthatch, Rhodesian (2 strains), Thatcher, (Triticum × Agropyron), Sabanero, (Steinwedel × Khapli), Supreza, Webster.

In addition to this new and very important race complex, it is seen that five other races were found between 1941 and the present time. Just as was the case before that year, no one of the five that turned up became established. This second batch of five occurred with a very low frequency: each of these races was present only once in about 2,300 isolates examined. Presumably they also were unable to compete successfully with the established races.

Mixtures of Races.

Reference has already been made (p. 221) to the side-by-side occurrences of r.126 and r.126B. Much wider mixing occurs, although often a field collection will yield only the one race: the screening action of varieties having differential resistance is all-important in this regard. Where there is complete susceptibility the side-by-side occurrence of different races may be of considerable importance if hyphal anastomoses occur and nuclear migrations do produce new combinations of nuclei.

The race mixtures encountered in the work are set out in Table 12.

ORIGIN OF PHYSIOLOGIC RACES.

Since the investigations commenced, it is seen that 18 races or important biotypes have been determined. Of them, only half have been important in the crops: races 11, 14, 21, 33, 54, 55, 56, 59 and 222AA have been rather of the nature of curiosities, in so far as rust damage is concerned. Nevertheless their occurrence is important as showing that various changes in the fungus take place from time to time. Probably it is a continuing process of mutation. Aecidial formation, with its probability of hybridization, does not enter, and efforts have failed to demonstrate the production of new types of rust from anastomoses of the dicaryotic mycelium and nuclear interchange. In these experiments, dissimilar races (e.g., r.43 and r.34) have been cultured together on fully susceptible "Federation" wheat for 20 transfer generations: determinations on the differential hosts from time to time yielded only the original races that had been used. It is possible that new combinations of nuclei had occurred, but that these were not discernible in the normal race determinations that were made with the standard differential set. Again, it may be found that particular associations of races show affinities which lead to nuclear interchange. For example, r.11 and r.56 have been found as segregates from barberries inoculated with r.34, and there may be a greater affinity between these races than, say, between rs. 34 and 43.

No evidence of adaptation by the fungus to erstwhile resistant varieties has been obtained. This does not rule out the possibility that a race can adapt itself to the environment imposed by its growth on a partially resistant variety.

TABLE 12.

Frequency of Occurrence of Mixtures of Races of P. graminis tritici *on Wheat Collections Examined.*

Year of Collection.	Frequency of the Race Mixtures Found.											
	r.33 and 126.	r.59 and 126.	r.11 and 126.	r.45 and 126.	r.126 and 126B.	r.14 and 126B.	222BB and 126B.	222AB and 126B.	222BB and 222AB.	222BB, 222AB and 126B.	222BB, 222AB and 126.	222AB and 126.
1939 ..	4	1	2	1								
1940 ..			3	3								
1942 ..			2	1								
1945 ..					9							
1946 ..					8							
1947 ..					23							
1948 ..					36	1						
1949 ..					39		1	1				
1950 ..					43		12	1	175	11	1	1
1951 ..					4		17		22	5		1
Totals	4	1	7	5	162	1	30	2	197	16	1	2

It has been suggested that the various races and biotypes have been present in Australia all the time, and that only recent detailed work has brought to light their presence. Even so, this simply pushes further back the explanation of how the entities originated. But it is not easy to accept the suggestion that "Eureka", widely grown in the north-west and other areas over the years with complete resistance, should have required such a lapse of time to show the presence of 126B, if indeed this rust was actually present all the time on fully susceptible varieties. Actually "Eureka" had been previously grown—and found resistant—in the particular area where this biotype first occurred. The same applies to "Gabo", as a further example, in respect to both its stem and leaf rust resistance.

There is positive evidence of rust mutation. In the course of the investigations there have been seven occasions on which leaves of seedlings in the plant house have been noted producing a light-coloured uredo pustule amongst the normal-coloured pustules in that particular pot of seedlings. These light pustules have been "Cadmium yellow", Plate iii, or "Light Cadmium", Plate iv, of Ridgway's colour standards. In six of the cases, the race determinations showed that the light-pustuled culture was the same as the parent culture, but in the remaining seventh instance, the light-pustuled culture proved to be race 56. It arose from the stock culture of r.34, and it is not without significance that when teleutospores of r.34 have been used to infect the barberry, it has proved to be heterozygous, and one of the derived races is r.56.

Had it not been for the association of the colour difference with the changed physiology, the presence of r.56 would not have been detected in the culturing on the susceptible variety "Federation" which is used as the host for the rust cultures. The detection of a mutation may be quite fortuitous. If it has the capacity to attack a variety previously resistant or if it gives a resistant reaction on a variety that has been susceptible in previous tests, its presence will be observed. Otherwise it will be carried forward undetected on fully susceptible varieties. It is probable that many mutations, some of large, others of small magnitude, are occurring all the time. It is not easy to work out a method whereby they can be detected with certainty. In the plant-house work the opportunities of determining mutations are few because the quantity of material that can be handled is very limited. In the field, such enormous numbers of spores are produced that the chances of mutation occurring are vastly greater.

To state that the new rust races and biotypes have arisen by mutation is not to explain what happens. Apart from knowing *what* happens, we want to know *why* and *how* the changes take place. It is not known why changes in temperature can alter resistance to susceptibility, or why a variety may be resistant to one race but susceptible to another. The nature of resistance is unknown. It would seem that biochemical work of the highest order is needed, and in this regard, the stimulating work of Humphrey and Dufrenoy (1944) is of outstanding value and should be followed up.

With an understanding of what constitutes resistance, and with a fuller knowledge of the gene relationships in different wheats, the study of physiologic specialization will be placed on a different footing. What constitutes a "physiologic race" and what a "biotype" may well be clarified.

At present, our methods of study reveal all manner of variants in a rust. Using an empirically selected group of differential varieties, entities are sorted out that are termed "physiologic races" on the basis of the series of reactions shown by the particular rust under study. Standardization of the environmental conditions under which the tests are made is all important. Even so, similarity of reactions shown by two isolates does not mean that they are identical. Work with cultures of r.34, one from U.S.A. and one from Australia, has shown clearly that profound differences between them come to light when additional differential varieties are brought into use and when side-by-side comparisons are made under a range of environmental conditions (Waterhouse & Watson, 1941). The use of the present-day set of differentials gives a "rough" sort-up of the rust entities into physiologic races, and to this extent makes possible a comparison of results on a world basis. However, a much more accurate basis will be given when the selection of the differential series is based on a knowledge of the genes for resistance. At the present time it may be far more important for the breeder aiming at developing rust-resistant varieties to use in his country a set of differential varieties that are not recognized as being useful in another country. This has been brought out clearly in our work here.

Of course this raises a considerable difficulty in regard to classification and nomenclature of the rust entities. It is usual to style those which are determined on the accepted set of differential hosts as "physiologic races". Those which are sorted out from races by using additional differentials or which consistently give a minor variation from the reaction on a race differential which is recognized as characteristic for the race, are called "biotypes" of that particular race. Thus we have herein referred to "r.126B": whereas "Eureka", an extra-differential variety, gives a resistant reaction with r.126, it gives a susceptible reaction with r.126B. It might be more satisfactory to call them r.126A and r.126B.

This distinction between a "physiologic race" and a "biotype" is an arbitrary one, and leaves the present system of designating the rust entities in an unsatisfactory position. If, for example, a series of race determinations leads to a particular rust conforming to the reactions for, say, r.34, and the use of an additional variety separates out an isolate of r.34 which gives a susceptible, instead of the expected resistant reaction, it is designated r.34B. Now, suppose that yet another variety outside the differential series splits these biotypes further on the basis of the susceptible and resistant reactions now shown. These could be designated r.34BA and r.34BB, or as r.34C and r.34D. There is nothing to show which variety is used for the first separation and which for the second. Still further separations may be made involving the use of further letters to designate the biotypes. Confusion is likely unless some clear understanding is reached. Furthermore, a worker in another country using extra-differential varieties may give certain designations to his entities, quite unaware that these have already been used by another investigator. The need for a central institution to control and standardize the results of specialization studies has long been emphasized, and is more than ever evident. Problems caused by possible genetic differences between workers' stocks of the differentials used, as well as those due to environmental effects, would also be eliminated. Accurately determined cultures could be made available for comparative studies in any area where they are required.

LEAF RUST OF WHEAT.

Life History.

In dealing with other cereal rusts it has been emphasized that susceptible grass hosts may play a very important part in carrying over the rust from season to season. To date no common grass host of *P. triticina* has been found, and no infections of *Thalictrum* spp. have been observed, apart from those produced in controlled studies in the plant house. Thus in October 1943, *T. flavum* was inoculated with teleutospores of r.95 from straw which had been exposed to winter conditions at Armidale, N.S.W., and using the aecidial culture, r.95 was recovered from inoculations of "Federation" wheat. Earlier work (Waterhouse, 1932) had shown the derivation of races 96 and 97 from aecidial cultures produced on *Thalictrum* sp. in the plant house.

Specialization.

In earlier publications (Waterhouse, 1929, 1932, 1933, 1936, 1938, 1939) the position has been set out in regard to *P. triticina* in Australia, and attention called to the presence of two races which were then styled races 16 and 26. In the Revised Register (Johnston and Rodenhiser, 1951) they are now given the designations 26 and 95.

More recently the leaf rust survey has been carried forward with results in time and space as set out in Tables 13 and 14.

Table 13.

Summary of the Number of Isolations of Physiologic Races of P. triticina *Grouped According to Time of Collection.*

Race.	Season of Collection, Ending 31st March of Year Named.													Totals.
	1939.	1940.	1941.	1942.	1943.	1944.	1945.	1946.	1947.	1948.	1949.	1950.	1951.	
95	101	122	42	93	49	38	29	101	78	207	120	37	29	1046
26	21	38	13	13	8	6	4	9		18	19	16	7	172
135 and/or 138								6	3	31	93	10		143
135AB										63	13	105	63	244
138AB										62	14	149	51	276
135BB												14		14
138BB												7	6	13
53A				3								4		7
34A				2										2
98AA										3				3
Totals	122	160	55	111	57	44	33	116	81	384	259	342	156	1920

TABLE 14.

Summary of the Number of Isolations of Physiologic Races of P. triticina *Grouped According to their Source.*

Race.	Source of Material.								Totals.
	A.C.T.	N.S.W.	Vic.	Qld.	S.A.	W.A.	Tas.	N.Z.	
95	2	824	35	102	27	23	8	25	1046
26	1	121	9	20	4		1	16	172
135 and/or 138		119		22	2				143
135AB		171		61	11	1			244
138AB		215	2	52	4	3			276
135BB		8		6					14
138BB		8		5					13
53A								7	7
34A								2	2
98AA								3	3
Totals ..	3	1466	46	268	48	27	9	53	1920

The sources of the material used are as follows:

DETAILS OF THE OCCURRENCES OF THE RACES OF P. TRITICINA.

1939.

r.95.

N.S.W.: H.A. College, Gunnedah, Lindfield, Tottenham, South Gate, Scone, Buriquip, Albert, Tullamore, Alectown, Parkes, Peak Hill, Curlewis, Jumble Springs, Wee Waa, Pilliga, North Parramatta, Dubbo, Myall Creek, Bundella, Premer, Grafton, Nubrex, Narrabri, North Star, Cherry Tree Hill, Binnaway, Coonabarabran, Condobolin, Cowra, Trangie, Chatswood, Taree, Narromine, Oberly, Yeoval, Gilgandra, Trundle, Glen Innes, Goonumbla.

Qld.: Brookstead, Gatton, Roma, Oakey, Toowoomba.

S.A.: Yeelana.

Tas.: North West Coast.

r.26.

N.S.W.: Parkes, Gunnedah, H.A. College, Condobolin, Yeoval, Bathurst, Tichborne, Lindfield, Trangie, Temora.

Qld.: Brookstead, Toowoomba.

S.A.: Pinkawillinie.

1940

r.95.

N.S.W.: Lindfield, Condobolin, Parkes, Tullamore, Cobar, Gunnedah, Narrabri, H.A. College, Coolamon, Chatswood, Narrandera, Hay, Griffith, Junee, Mildura, Renmark, West Wyalong, Trangie, Forbes, Haberfield, Dernasser, Yallabie, Temora, Wyalong, Stockinbingal, Pallamallawa, Black Creek, Wirrinya, Inverell, Bingara, Sydney University, Singleton, Birriwa, Cobbarah, Tuchlan, Quirindi, Dunedoo, Wee Waa, Manly, The Rock, Henty, Osborne Creek, Gilgandra, Wellington, Dubbo, Yeoval, Narromine, Wyanga, Coboco, Wongarbon, Eumungerie, Cowra, Bathurst, Yanco, Mangoplah, Downside, Coreinbob, Mascot, Collingullie.

Qld.: Gatton, Pittsworth, Oaken, Cecil Plains.

S.A.: Waite, Waikeri, Roseworthy, Windsor, Port Wakefield, Blanchetown, Smithfield, Booleroo.

Vic.: Werribee, Walpeup, Swan Hill, Donald, Invergordon, Charlton, Salisbury.

W.A.: Salmon Gums.

A.C.T.: Canberra.

r.26.

N.S.W.: Tullamore, Lindfield, Manildra, Yallabie, Forbes, Singleton, H.A. College, Gilgandra, Narromine, Cowra, Coboco, Bathurst, Dubbo, Mangoplah, Coreinbob, Gunnedah, Mascot.

Qld.: Gatton.

Vic.: Werribee, Swan Hill, Donald, Invergordon, Charlton, Salisbury.

S.A.: Waite.

1941.

r.95.

N.S.W.: Bathurst, Lindfield, H.A. College, Garthowen, Cowra, Tamworth, Glen Innes, Inverell, Attunga, Quirindi, Milvale, Carroll, Tichborne.
Qld.: Kincora.
S.A.: Waite.
Vic.: Dookie, Salisbury, Longeronong, Werribee.
A.C.T.: Canberra.
N.Z.: Auckland.

r.26.

N.S.W.: Sydney University, H.A. College, Lindfield, Glen Innes, Inverell, Carroll.
Qld.: Kincora.
Vic.: Longeronong.
A.C.T.: Canberra.
N.Z.: Auckland.

1942.

r.95.

N.S.W.: Duri, Gunnedah, Kelso, Tichborne, Spring Ridge, H.A. College, Curlewis, Cowra, Gilgandra, Wongarbon, Narromine, Griffith, Manly, Campbelltown, Dunedoo, Bunaloo, Tambar Springs, Purlewaugh, Forbes, Yelindenie, Bathurst, Parkville, Tamworth, Mollyan, Tooraweenah, Lindfield, Urangeline.
W.A.: Merredin, Chapman.
S.A.: Waite.
Vic.: Walpeup, Rochester, Rutherglen, Dookie, Donald, Charlton.
N.Z.: Lincoln.

r.34A.

N.Z.: Lincoln.

r.53A.

N.Z.: Christchurch, Lincoln.

r.26.

N.S.W.: Gunnedah, H.A. College, Lindfield, Manly.
Vic.: Dookie.
Tas.: Wilmot.

1943.

r.95.

N.S.W.: H.A. College, Narrabri, Curlewis, Gunnedah, Tichborne, Coonabarabran, Somerton, Tambar Springs, Purlewaugh, Baradine, Bugaldie, Boggabri, Kelvin, Cowra, Spring Hill, Arthurville, Maryvale, Parkes, Lane Cove, Lindfield, Delungra, Bannockburn, Inverell, Manly.
Qld.: Gatton, Willawa, Winton.
Vic.: Fern Tree Gully, Walpeup, Werribee, Rutherglen.

r.26.

N.S.W.: H.A. College, Gunnedah, Inverell.
Qld.: Gatton.

1944.

r.95.

N.S.W.: Gunnedah, H.A. College, Tichborne, Milguy, Boggabri, Curlewis, Manly, Lindfield.
Qld.: Brookstead, Nankin.
W.A.: Merredin, Northampton, Quellington, Wongan Hills.
Tas.: Deloraine.

r.26.

N.S.W.: H.A. College.
Qld.: Brookstead.

1945.

r.95.

N.S.W.: Badgery's Creek, Mulgoa, Tichborne, H.A. College, Wallacia, Gunnedah, Coolatai, Curlewis, West Maitland, Grafton, Scone, Gosford.
Qld.: Gatton.

r.26.

N.S.W.: Mulgoa, H.A. College, Gunnedah.

1946.

r.95.

N.S.W.: H.A. College, Nea Siding, Parkville, Wingen, Inverell, Gunnedah, Curlewis, Garah, Lenmeal, Parkes, Dubbo, Bingara, Singleton, Scone, Muswellbrook, Gravesend, Emerald Hill, North Star, Wallangra, Warialda, Pallamallawa, Myall Creek, Bukulla, Cherry Tree Hill, Bellata, Edgeroi, Boggabri, Cowra, Premer, Tamworth, Moss Vale, Tichborne, Nelungaloo, Wee Waa, Alectown, Lindfield, Berrigal Creek, Coonabarabran, Narrabri, Castle Mountain, Young, Koorawatha, Temora, Milvale, Purlewaugh, Elong Elong, Waroo, Culcairn, Holbrook, Glen Innes.

Qld. : Dalby, Pittsworth, Brookstead.
W.A. : Merredin.
S.A. : Waite.
N.Z. : Lincoln.

r.26.

N.S.W. : Nea Siding, H.A. College.
N.Z. : Lincoln.

r.135 and/or 138.

N.S.W. : Wee Waa, Killara.
Qld. : Brookstead.

1947.

r.95.

N.S.W. : Tichborne, H.A. College, Mildura, Tomingley, Tamworth, Glenfield, Windsor, Penrith, Leeton, Bathurst, King's Plains, Mandurama, Gundagai, Gosford, Bungowanah, Gerogery, Killara, Lindfield, Hurstville, Richmond.
S.A. : Waite, Baroota, Pinnaroo.
Vic. : Walpeup, Lake Cullullmana.
Qld. : Lawes.
N.Z. : Springfield.

r.135 and/or 138.

N.S.W. : H.A. College.
Qld. : Lawes.

1948.

r.95.

N.S.W. : Glen Innes, Killara, Turramurra, Bathurst, H.A. College, Tichborne, Parkville, Aberdeen, Coonabarabran, Inverell, Bellata, Birriwa, Narrabri, Cowra, Rankin's Springs, Griffith, Tamworth, Crooble, Grafton, Westdale, Winton, Bective, Watermark, Breeza, Piallaway, Wagga, Mt. Euroa, Wellington, Wongarbon, Curlewis, Eumungerie, Toorawenah, Boggabri, Trangie, Condobolin, Orange, Gilgandra, Gosford, Walmer, Fingerpost, Temora, Scone, Dubbo, Suntop, Mudgee, Binnalong, Calimpa Siding, Forbes, Wallen Bullen, Peak Hill, Dandaloo, Lindfield, St. Elmo, Gerogery, Barraba, Quirindi, Currabubula, Blackheath, Armidale, Castle Hill, Gunnedah, Tambar Springs, Narrandera.
Qld. : Biloela, Mt. Tyson, Euanslea, Condamine Plains, Warwick, Lawes, Dalby, Brookstead, Hermitage.
S.A. : Waite, Roseworthy, Mt. Gambier, Penola.
W.A. : Northampton.
Tas. : Cressy, Campbelltown, Sassafras, Cambridge, Hobart, Latrobe.
N.Z. : Methven.

r.26.

N.S.W. : H.A. College, Curlewis, Trangie, North Star, Boggabri, Orange, Dandaloo, Tichborne.
Qld. : Brookstead, Oakens, Goombungee, Warwick, Dalby, Biloela.
S.A. : Waite.

r.98AA.

N.Z. : Lincoln, Canterbury.

r.135 and/or 138.

N.S.W. : Tichborne, Mt. Euroa, Wellington, Wongarbon, Eumungerie, Coonabarabran, Toorawenah, Curlewis, Boggabri, Suntop, Binnalong, Forbes, Calimpa Siding, Peak Hill, Lindfield, Dubbo, Gerogery, Barraba, Tamworth, Quirindi, Blackheath, Currabubula.
Qld. : Brookstead, Hermitage.
S.A. : Waite.

r.135AB.

N.S.W. : Killara, H.A. College, Parkville, Tichborne, Gunnedah, Rankin's Springs, Winton, Narrabri, Bective, Curlewis, Pallamallawa, North Star, Moree, Boggabri, Glen Innes, Tamworth, Grafton, Condobolin, Orange, Gilgandra, Gosford, Walmer, Temora, Scone.
Qld. : Brookstead, Oakens, Goombungee, Biloela, Mt. Tyson, Euanslea, Condamine Plains, Warwick, Dalby, Lawes.
S.A. : Roseworthy.
W.A. : Northampton.

r.138AB.

N.S.W. : Killara, H.A. College, Inverell, Tichborne, Crooble, Winton, Narrabri, Bective, Moree, Rankin's Springs, Pallamallawa, Curlewis, North Star, Boggabri, Glen Innes, Tamworth, Grafton, Orange, Condobolin, Gosford, Walmer, Temora, Scone.
Qld. : Brookstead, Biloela, Goombungee, Mt. Tyson, Lawes, Euanslea, Condamine Plains, Warwick, Dalby.
S.A. : Roseworthy.
W.A. : Northampton.

1949.

r.95.

N.S.W.: Tichborne, Dubbo, Coonabarabran, Boggabri, Gunnedah, Curlewis, Castle Hill, Yanco, Westdale, Winton, Parkes, H.A. College, Gerogery, Goonimbla, Gregra, Nelungaloo, Brolgan, Tamworth, Mullally, Gilgandra, Narrabri, Trangie, Birriwa, Dunedoo, Lyndhurst, King's Plains, Grenfell, Bribbaree, Temora, Colinroobie, Ariah Park, Leeton, Wagga, Gundagai, Yass, Narrandera, Ganmain, Coolamon, Yanco, Book Book, Trundle, Loomberah, Blackheath, Guyra, Tanja, Bellata, North Star, Bugaldie, Cowra.

Qld.: Toowoomba, Westbrook, Lawes, Jondaryan, Dalby, Mt. Tyson, Willowburn, Brookstead, Warwick, Hermitage, Wyreema.

N.Z.: Lincoln, Hororata, Greendale.

r.26.

N.S.W.: Curlewis, Castle Hill, Pallamallawa, Gulgong, Lindfield, Blayney, Cowra, Grenfell, Gundagai, Coolamon.

Qld.: Hermitage, Lawes.

N.Z.: Lincoln, Hororata, Greendale.

r.135 and/or 138.

N.S.W.: Dubbo, Boggabri, Gunnedah, Curlewis, Castle Hill, Westdale, H.A. College, Gerogery, Goonimbla, Gregra, Nelungaloo, Brolgan, Tamworth, Gilgandra, Coonabarabran, Mullally, Narrabri, Bellata, Boggabri, North Star, Pallamallawa, Gulgong, Bugaldie, Trangie, Lindfield, Dunedoo, Birriwa, Lyndhurst, Cowra, King's Plain, Blayney, Grenfell, Bribbaree, Marangarell, Temora, Colinroobie, Ariah Park, Leeton, Wagga, Yass, Narrandera, Yanco, Ganmain, Book Book, Trundle, Loomberah.

Qld.: Toowoomba, Jondaryan, Dalby, Mt. Tyson, Lawes, Willowburn, Brookstead, Warwick, Hermitage.

r.135AB.

N.S.W.: Curlewis, Grafton, H.A. College, Narrabri, Boggabri, North Star.

Qld.: Lawes, Mt. Tyson, Brookstead, Hermitage.

r.138AB.

N.S.W.: Curlewis, Grafton, H.A. College, Narrabri.

Qld.: Lawes, Brookstead, Hermitage.

1950.

r.95.

N.S.W.: Gunnedah, Blackheath, Curlewis, H.A. College, Tichborne, Leeton, Coolamon, Brocklesby, Illabo, Wagga, Junee, Noonbinna, Lyndhurst, Blayney, Bathurst, Spring Terrace.

Qld.: Allora, Hermitage, Lawes, Wyreema.

N.Z.: Lyalldale, Orari, Laghmor, Winchmore.

r.26.

N.S.W.: H.A. College, North Marota, Temora, Deniliquin, Illabo, Junee.

Qld.: Hermitage.

N.Z.: Lyalldale, Orari, Laghmor, Winchmore.

r.53A.

N.Z.: Lyalldale, Orari, Winchmore.

r.135 and/or 138.

N.S.W.: Gunnedah, Curlewis, H.A. College, North Marota.

Qld.: Allora, Hermitage, Lawes, Wyreema.

r.135AB.

N.S.W.: Curlewis, Birriwa, Castle Hill, Grafton, Gunnedah, Bellata, Scone, Narrabri, Stoney Creek, Wee Waa, Boggabri, H.A. College, West Wyalong, Gilgandra, Somerton, Baradine, Lindfield, Coonabarabran, Tambar Springs, Mendooran, Breelong, Leadville, Tintinhull, Attunga, Manilla, Spring Ridge, Armidale, Binnaway, Gosford, Inverell, Warialda, Berrigan, Bathurst, Temora, Henty, Glen Innes, Pine Cliff, Dunedoo.

Qld.: Lawes, Wyreema, Hermitage, Cambooya, Westbrook, Mt. Tyson, Wandoan, Bowenville.

S.A.: Waite.

r.138AB.

N.S.W.: Curlewis, Gunnedah, Ariah Park, Birriwa, Grafton, Narrabri, Castle Hill, Bellata, Scone, Stoney Creek, Boggabri, Wee Waa, West Wyalong, Culgoora, Gilgandra, Piallaway, Raleigh, Manilla, Somerton, Baradine, Lindfield, Coonabarabran, Tambar Springs, Mendooran, Breelong, Leadville, Tintinhull, Attunga, Armidale, Binnaway, Cudal, Gosford, Inverell, Warialda, Berrigan, Dunkeld, Cheeseman's Creek, Manildra, Tichborne, Reefton, Temora, Leeton, Deniliquin, Coolamon, Merton, Corowa, Balldale, Noonbinna, Lyndhurst, Blayney, Bathurst, Daysdale, Sandy Creek, Willow Tree, Spring Terrace, Glen Innes, Dunedoo.

Qld.: Lawes, Dalby, Hermitage, Cambooya, Westbrook, Mt. Tyson, Wandoan, Bowenville, Toowoomba, Nabby.

S.A.: Waite.

r.135BB.

N.S.W.: Attunga, Manilla, Curlewis, Glen Innes, Narrabri, Castle Hill.

Qld.: Westbrook, Hermitage, Lawes, Nabby, Toowoomba.

r.138BB.

N.S.W.: Pine Cliff, Dunedoo, Glen Innes, Curlewis.
Qld.: Hermitage, Lawes.

1951.

r.95.

N.S.W.: Boorowa, Gilgandra, Glen Innes, Tichborne, Wagga, Parkes, H.A. College, Talbragar, Peak Hill, Mogriguy, Alectown, Tomingley, Trewilga, Lindfield, Orange, Castle Hill.
Qld.: Hermitage, Warwick.
S.A.: Port Lincoln.
Vic.: Werribee, Longeronong.
N.Z.: Massey.

r.26.

N.S.W.: Glen Innes, Tichborne, H.A. College.
N.Z.: Massey.

r.135AB.

N.S.W.: Boorowa, Gilgandra, Curlewis, Narrabri, Trangie, Castle Hill, West Wyalong, Gunnedah, Blue Vale, Cowra, Tichborne, Goonumbla, Coonabarabran, Parkes, H.A. College, Manildra, Dubbo, Maitland, Temora, Boggabri, Tamworth, Grafton.
Qld.: Hermitage, Warwick, Toowoomba, Gympie, Dalby, Ayr.
S.A.: Waite, Port Lincoln.

r.138AB.

N.S.W.: Gilgandra, Gunnedah, Curlewis, Narrabri, Trangie, Tamworth, Coolamon, Boggabri, Wagga, Ardlethan, Blue Vale, Orange, Parkes, Tichborne, Manildra, Talbragar, Mogriguy, Peak Hill, Dubbo, Alectown, Tomingley, Trewilga, Temora, Grafton.
Qld.: Hermitage, Toowoomba, Dalby, Warwick.
S.A.: Waite, Port Lincoln.
W.A.: Merredin.
Vic.: Longeronong.

r.138BB.

N.S.W.: Gunnedah, Gilgandra.
Qld.: Hermitage, Toowoomba, Dalby.

The complete results since the specialization work started are shown in Tables 15 and 16, and are valuable as giving the overall picture of the position.

The recent work shows that races 26 and 95 were again present—and to the extent of 63% of the isolates—in all the areas except Western Australia, where r.26 did not occur. Actually its absence has had an appreciable effect upon the plant-breeding programme in that State, where, up to the present, varieties susceptible to this race but resistant to others have given satisfactory resistance to leaf rust. This position must be regarded as precarious, and would, of course, be altered by the appearance in that area of a race like r.26.

The New Zealand position is also different from that in Australia. Races 26 and 95 occur there—and with the greatest frequency—but in addition, three other races which have not been recorded for Australia have been found there. *Thalictrum* infections have not been observed, so the origin of these variants remains obscure. No work has been undertaken to find varieties resistant to them that could be used in a breeding programme. Again, in New Zealand, there has so far been no occurrence of races 135 and 138 which now are so important in Australia. This is borne out by the fact that "Gabo" is still valuable for leaf-rust resistance in the Dominion. It is going to be particularly interesting to see whether these races turn up in New Zealand.

In the time distribution it will be seen that until 1946, only races 26 and 95 were recorded in Australia. When the variety "Gabo" was released for cultivaton it was completely resistant to leaf rust (races 26 and 95) as well as to stem rust.

In October 1945, Mr. J. A. O'Reilly, of Gunnedah, forwarded from Wee Waa, N.S.W., "Gabo" plants heavily infected with leaf rust. Tests showed that it was a new rust capable of attacking "Gabo". Next month it was present in rusted material from Brookstead, Qld., and was also collected by Dr. I. A. Watson from his experimental plot in Killara, N.S.W. In no one of these localities are *Thalictrum* plants known to be present. To postulate mutation as a cause of the change in the rust flora does not really explain this happening. What really is mutation?

The rust spread rapidly, its wide host range accelerating dissemination. In determining its presence, tests with "Gaza"—the resistant durum parent used in the breeding

TABLE 15.

Summary of the Number of Isolations of the Physiologic Races of P. triticina *Grouped According to Time of Collection.*

Physiologic Races.	Season of Isolation, Ending 31st March of the Year Stated.												
	1927.	1928.	1929.	1930.	1931.	1932.	1933.	1934.	1935.	1936.	1937.	1938.	1939.
95	3	52	60	20	35	63	58	54	107	87	75	48	101
26	3	70	71	20	34	50	56	45	80	63	54	25	21
135 and/or 138													
135AB													
138AB													
135BB													
138BB													
53A													
34A													
98AA													
Totals ..	6	122	131	40	69	113	114	99	187	150	129	73	122

Physiologic Races.	Season of Isolation, Ending 31st March of the Year Stated.												Totals.
	1940.	1941.	1942.	1943.	1944.	1945.	1946.	1947.	1948.	1949.	1950.	1951.	
95	122	42	93	49	38	29	101	78	207	120	37	29	1708
26	38	13	13	8	6	4	9		18	19	16	7	743
135 and/or 138							6	3	31	93	10		143
135AB									63	13	105	63	244
138AB									62	14	149	51	276
135BB											14		14
138BB											7	6	13
53A			3								4		7
34A			2										2
98AA									3				3
Totals	160	55	111	57	44	33	116	81	384	259	342	156	3153

TABLE 16.

Summary of the Number of Isolations of the Physiologic Races of P. triticina *Grouped According to their Source.*

Physiologic Race.	Source of Material.								Totals.
	A.C.T.	N.S.W.	Vic.	Qld.	S.A.	W.A.	Tas.	N.Z.	
95	24	1337	68	127	64	32	10	46	1708
26	12	582	34	35	42	5	2	31	743
135 and/or 138		119		22	2				143
135AB		171		61	11	1			244
138AB		215	2	52	4	3			276
135BB		8		6					14
138BB		8		5					13
53A								7	7
34A								2	2
98AA								3	3
Totals ..	36	2440	104	308	123	41	12	89	3153

of "Gabo"—were found to give clearer reactions, and this variety has therefore been used throughout in the plant-house tests.

Recent overseas results are not without interest. In studies at Minnesota, U.S.A., Levine, Ausemus and Stakman (1951) found that "Gabo" was resistant to 21 races of leaf rust that were used in the work. "Gaza" was susceptible to four of the races to which "Gabo" was resistant, and it seems likely that the resistance to the four races is derived from Bobin W39 which is the other parent of "Gabo". These four races, viz., 28, 31, 35 and 52, have not been recorded in Australia so that it is not possible to check on this point.

Investigations of leaf rust present in Uruguay and the Upper Mid-West areas of U.S.A. (Boasso and Levine, 1951) showed that "Gabo" was resistant to the 15 races used in the tests.

Canadian workers (Aitken, Fisher and Anderson, 1951) have recorded "Gabo" as being leaf rust resistant as well as producing high quality grain under their conditions.

At the outset, susceptibility of "Gaza" was taken as sufficient evidence of the presence of the new race. The other variety then involved was "Thew", which is used to differentiate races 26 and 95. It was resistant to the "Gaza"-attacking rust. At a later stage, determinations on the recognized set of leaf rust differentials were made. The occurrence of "4" and "1" reactions on "Webster" was noted, and separations proved that two races were present. The two could be sorted readily at low temperatures, but at higher temperatures the resistant reaction to r.135 changed to near-susceptibility and made differentiation difficult. In the survey, where there was no clear-cut difference, the rust was recorded as r.138.

This variation in reaction caused by alterations in temperature has already been referred to (Waterhouse, 1929), and is a matter of extreme importance in the determination of a particular race. Unless standard conditions are maintained during the rust tests it becomes impossible to make valid comparisons between isolates.

Furthermore, there are cases in which the first seedling leaf gives reactions which are higher than those of the mature leaves. Thus with two isolates of r.135, "Einkorn" gave "4" reactions on a number of plants but only "flecks"—as expected—on the others. These "susceptible" seedling plants, when grown on, showed "flecks" on the older leaves. Again, a wheat like "Chinese White" is completely resistant as a mature plant in the field, but gives fully susceptible reactions on the seedling leaves. "Gabo" shows a very marked gradation with age. Extensive series of plants were used in an experiment in which successive leaves as they developed were inoculated with races 26 and 95. Commencing with a seedling reaction of "X+" there was mounting resistance rising to "flecks" on mature leaves.

In 1949 the first culture giving "Gaza" susceptibility and "Thew" susceptibility was definitely sorted out, although there had been earlier indications that this rust was present. Further studies showed that this dual susceptibility was associated with either susceptibility or resistance in "Webster", and hence the "Gabo"-attacking leaf rust can be one of four entities, viz., races 135AB, 135BB, 138AB, and 138BB. Characteristics of the races dealt with in this paper are set out in Table 17.

Identities of Races.

Cultural studies using the standard set of differential varieties have given the foregoing results under favourable testing conditions, i.e., with a temperature approximating to 70°F.

It will be noted that the variety "Norka" has been retained, and the varieties "Thew" and "Gaza" incorporated in the set. In our work "Norka" has not given the same reactions as "Malakof", although U.S.A. workers have reported that these varieties give similar results. From the Australian plant breeders' point of view, "Thew" and "Gaza" are extremely important in sorting out the races present, and must be included as differentials.

The determination of just what varieties shall be used as differentials in sorting out races or biotypes creates difficulties. It is probably the case that an unlimited number of these entities could be separated out if sufficiently large numbers of host varieties were used in the testing work. Clearly an arbitrary selection must be made, and this set of differentials is usually accepted as an adequate group. But local conditions will often call for special treatment. Here, for example, it is essential to use "Thew" and "Gaza" as additional varieties. Such a procedure introduces a difficulty in the nomenclature. On the basis of the reactions shown on the accepted set of differentials, a particular number is used to designate the race represented by that rust. With the addition of an extra differential, the components it sorts out may be regarded as biotypes of that race, and designated by the letters "A" for resistance and "B" for susceptibility. Thus we have r.135A and r.135B as entities of r.135, characterized by

TABLE 17.

Typical Reactions of certain Physiologic Races of P. triticina *expressed as Means of Rust Infections on selected Differential Varieties.*

Physiologic Race.	Norka C.1.4377.	Malakof C.1.4898.	Carina C.1.3756.	Brevit C.1.3778.	Webster C.1.3780.	Loros C.1.3779.	Mediterranean C.1.3332.	Hussar C.1.4843.	Democrat C.1.3384.	Thew C.1.5002.	Gaza.
1A	0	0	0	0	0	0	1	1	0	0	
1B	0	0	0	0	0	0	1	1	0	4	
10A	4	4	4	4	4	4	1	1	1	0	
10B	4	4	4	4	4	4	1	1	0	4	
12B	0	0	4	4	1	4	4	4	4	4	
15A	0	0	0	1	0	1	4	1	4	0	
15B	0	0	0	1	0	1	4	1	4	4	
20B	4	4	4	4	4	4	0	4	0	4	
26	0	0	4	4	0	4	0	4	0	4	0
34A	0	0	0	0	1	1	4	x	4	0	
53A	0	0	1	2	1	1	0	3	0	0	0
70B	4	x	4	4	4	4	0	x	0	4	
72A	0	0	4	4	x	4	1	x	1	0	
95	0	0	4	4	0	4	0	4	0	0	0
96	4	1	4	4	4	4	1	1	0	4	
97	1	1	4	4	4	4	1	1	0	0	
98AA	0	0	2	4	1	x	x	x	x	0	0
133A	0	0	x	1	1	4	0	4	0	0	
134B	4	1	x	4	4	4	1	1	0	4	
135A	0	0	x	x	x	x	0	x	0	0	
135B	0	0	x	x	x	x	0	x	0	4	
135AB	0	0	x	x	x	x	0	x	0	0	4
135BB	0	0	x	x	x	x	0	x	0	4	4
136A	0	0	1	1	x	x	4	x	4	0	
137B	0	0	x	x	x	x	x	x	0	4	
138AB	0	0	x	x	4	x	0	x	0	0	4
138BB	0	0	x	x	4	x	0	x	0	4	4

their resistance and susceptibility respectively on "Thew". Now with the further addition of "Gaza" separating out still further entities, additional letters "A" and "B" are used to designate them, so that we have, for example, r.135AB and r.138AB, meaning that whilst "Thew" is resistant to each of the two races, "Gaza" is susceptible to both. Instead of this system, the letters "A" and "B" might have been reserved for "Thew" reactions, and "C" and "D" set apart for the "Gaza" reactions, and so on. Each system is somewhat cumbersome, but for the present the use is preferred of the two letters "A" and "B" side by side, one referring to reactions shown by the first variety ("Thew"), and the other to the reactions of the second variety ("Gaza").

SPORE MEASUREMENTS.

Measurements were made under standard conditions of 200 uredospores of r.138AB lightly shaken from fully susceptible pustules on "Gaza". They showed a range of 22–30μ, a mean of 26·06μ, and a standard deviation of 2·08μ for length; and a range of 20–26μ, a mean of 22·39μ, and a standard deviation of 1·39μ for breadth.

Measurements of 200 teleutospores developed on the variety "Gabo" showed a range of 27–52μ, a mean of 43·6μ, and a standard deviation of 4·1μ for length; and a range of 8–17μ, with a mean of 11·7μ, and a standard deviation of 1·5μ for breadth. Details of measurements of other races are not available, but McAlpine (1906) gives for *P. triticina* teleutospores, 39–57 × 15–18μ, average 48 × 16μ. So far as comparison is possible, this probably means that the race in question has teleutospores that are significantly narrower than those recorded by McAlpine.

Frequency of Occurrence of Races.

For a comparative study of the race frequencies, a truer picture is given if the totals of the r.135 and r.138 components are taken in relation to the totals for races 26 and 95. Over the whole period this gives r.95 1,042 isolations (55%), r.26 169 isolations (9%), and rs.135 and 138, 688 isolations (36%). If the years from 1946 onwards (when the "Gabo"-attacking rust first was determined) are taken, there were 568 isolates of r.95 (43%), 66 of r.26 (5%), and 688 of rs.135 and 138 (52%). The rapid build-up of the "Gabo"-attacking rust is very striking and is accounted for largely by the popularity of this variety and its widespread cultivation, as well as by the wide host range of this rust.

Effects on Breeding Programme.

Naturally the breeding programme was seriously affected by this change in the rust flora. Tests soon brought to light a number of varieties which are resistant to all our Australian races, and these include: "Einkorn", "White Beardless Spelt", "Iumillo", "Norka", "Kawvale", "Salt Wheat", "Hope", "Hofed" and numerous other "Hope" derivatives, "H.44–24", "Argentine", "Klein", "Mentana", "Kleintrou", "Uruguay", and ("Steinwedel" × "Timopheevi").

Several of these are being used in the back-cross programme, and studies are in progress by Drs. I. A. Watson and E. P. Baker, designed to show what genes for resistance are involved and their relationships. Up to the present, efforts to get teleutospores of the new races to germinate have failed, so that nothing is yet known of their genetics.

Leaf Rust from England.

In 1948 and 1949 material for determination was sent from Cambridge and Buckinghamshire. In the first case the rust proved to be r.67 and in the second r.72. Both gave resistant reactions on the varieties "Thew" and "Gaza".

Leaf Rust from Burma.

In 1947 rust on wheat was forwarded for determination by the Local Services Officer at Maymyo, Burma. Stem and leaf rusts were sorted out from the uredospore cultures that were developed from inoculations of wheat.

Race Determinations.

As usual, the variety "Federation" was used for the stock culture, but it was noticed that it showed both susceptible and resistant reactions to the leaf rust. Cultures of the former showed that it was r.20, with "Thew" and "Norka" susceptible. The resistant reactions gave trouble at the outset, because the development of 0; and 1 reactions on "Federation" had not previously been seen, and a search had to be made to find a susceptible variety on which to maintain the rust. Finally it was found that "Argentine W1060" and several other varieties which are completely resistant to Australian races were fully susceptible to this Burma leaf rust. This made it possible to build up the culture with safety. Tests with the differential hosts proved that it was r.1. When the variety "Thew" was added, "4" and "1" reactions were produced and separations of these showed that there were the two components of race 1, otherwise not separable on the usual differentials. These are styled r.1A and r.1B.

Numerous varietal tests have been made, and this classification reveals that many wheats which are resistant to the other leaf rust races available retain their resistance to race 1. It is, however, very striking to find a previously resistant wheat like "Argentine W1060" completely susceptible, whilst "Federation", which is regarded as a most susceptible variety, is so strongly resistant. This accords with earlier reports that in India and Burma this Australian variety was found to be resistant.

Spore Morphology.

Under standard conditions, measurements were made of 200 uredospores lightly shaken from fully susceptible pustules developed on "*Aegilops divaricata*". The range of length was 22–34μ, with a mean of 27·38μ and a standard deviation of 2·56μ; and the breadth ranged from 20 to 26μ, with a mean of 22·56μ and a standard deviation of 1·4μ.

It is helpful to compare measurements with certain other races, and these are set out in Table 18.

Table 18.

Spore Measurements. Constants for Uredospore Measurements of Four Races of P. triticina.

Race.	Length in μ.			Breadth in μ.		
	Mean.	Standard Deviation.	Range.	Mean.	Standard Deviation.	Range.
1	27·38	2·56	22–34	22·56	1·40	20–26
95	24·35	1·97	21–28	20·61	1·37	17–24
26	25·13	1·77	22–30	19·51	1·40	17–22
138AB	26·06	2·08	22–30	22·39	1·39	20–26

In making these measurements, a striking feature was the frequent occurrence of pyriform mesospores. Determinations of the frequency of their occurrence in 1,000 random spores produced on susceptible varieties under similar conditions for all four races gave the following results:

Table 19.

Frequency of Occurrence of Mesospores in Four Races of Leaf Rust.

Race.	Percentage of Mesospores.
1	13·3
95	7·4
26	7·0
138AB	4·7

The greatly increased production of mesospores by race 1 could not be ascribed to differences in the environmental conditions. No record has been found of this as a characteristic of any particular race.

Mixtures of Races.

The simultaneous occurrence of different rusts on a host may be a matter of considerable importance. Stem and leaf rusts commonly occur together. Dealing only with leaf rust, frequently a field collection yields only the one rust, especially where a particular variety, e.g., "Gabo", screens out other races to which it is resistant. But the side-by-side occurrence of different races in susceptible varieties commonly takes place, and if anastomoses of the uredo mycelia should take place between different entities, new types may result from nuclear interchange.

Results to date are set out in Table 20, in which the four components which attack "Gabo" are grouped together. It is considered that the newness of the work of sorting them out and the consequent paucity of the numbers involved make this desirable.

The more frequent association of r.95 with rs.135 and 138 than of r.26 with r.135 and r.138 is accounted for by the happening to which attention has been called in a previous paper (Waterhouse, 1938), viz., that r.26 is very uncommon early in the rust season, but develops later. This is not traceable to any screening action on the part of certain varieties, and at present no adequate explanation of the happening can be given.

TABLE 20.

Frequency of Occurrence of different Mixtures of Races of P. triticina *in the Various Years.*

Year.	Mixtures of Races and Frequency of Occurrence.			
	r.95 with r.26.	r.95 with r.135 and 138.	r.26 with r.135 and 138.	r.26, 95 with r.135 and 138.
1939	18			
1940	35			
1941	11			
1942	8			
1943	6			
1944	2			
1945	4			
1946	4			
1947		2		
1948	4	72	13	1
1949	8	82	6	2
1950	4	21	6	
1951	1	16	1	
Totals	105	193	26	3

OAT STEM RUST.

LIFE HISTORY.

The uredospore stage of *P. graminis avenae* E. & H. is present on self-sown or volunteer oats or susceptible grasses all the year round. To date no barberry infections have been found under natural conditions. However, it is clear that the Australian oat stem rust has not lost its capacity to attack the barberry. In one experiment in 1949, heavily rusted *Avena fatua* at Canberra, A.C.T., was found to be infected by r.1 and/or r.2. Teleutospores developed later, and the straw was exposed there to the full winter conditions. In the spring, viable teleutospores were used to inoculate barberries in the plant house, and this led to the production of abundant spermogonia and aecidia. Spores from the latter were used to inoculate oats, and tests with this uredospore culture showed that the race present was r.1 and/or r.2.

SPECIALIZATION.

In the studies, "Joanette", obtained originally from Dr. E. C. Stakman in 1925, has been used as one of the differentials. Canadian and American workers have latterly used "Sevenothree" in its place. Seed of this variety was kindly supplied by Dr. T. Johnson of Winnipeg in 1944, and the two varieties have since been under study, both being used in the regular differential sowings. Sowings of the original seed of "Sevenothree" gave seedlings of which some were resistant, others susceptible, to a particular culture of stem rust. A number of single plant selections were therefore made, and at the same time similar selections were made of "Joanette". Both series have been carried forward with appropriate rust testing of the single plants taken each season and with morphological comparisons with the "parent" varieties. Many of the selections gave identical results, but others were clearly different. Three of them have been used widely in our testing work.

Typical results given by the three stock races are set out in Table 21.

The results show that although there is morphological similarity between the selections which are typical of the original variety, there are clear physiological differences between them. Thus there are at least two types of "Joanette" and three of "Sevenothree", of which "Joanette 1" and "Sevenothree 3" give the same results, as do also "Joanette 2" and "Sevenothree 5". It is evident that apart altogether from temperature variations making a difference between determinations of r.1 and r.2 and again between r.3 and r.7, the particular selection of the differential host used can make this difference.

This single plant work has also shown the occurrence of biotypes within the recognized races. On individual leaves of "Sevenothree 8" it was noticed that occasionally "3" and "1" reactions developed. Single pustules were taken to build up cultures which were then used to inoculate pots of seedlings. This has shown that sometimes a race determined as either r.1 or 2, r.3 or 7, or r.8 consists of a complex of which one component shows resistance, and another shows susceptibility when tested with "Sevenothree 8". Six isolates from New South Wales and two from Queensland have shown this behaviour, five of the occurrences applying to r.8, two to r.3 or 7, and one to r.1 or 2.

TABLE 21.

Typical Reactions Given by Certain Selections of " Joanette " and " Sevenothree " to Three Races of P. graminis avenae.

Varietal Selection.	Typical Reactions to Races of *P. graminis avenae.*		
	r.1 or 2.	r.3 or 7.	r.8.
Joanette 1	1	1	3+
Joanette 2	3+	3+	3+
Sevenothree 3	1	1	3+
Sevenothree 5	3+	3+	3+
Sevenothree 8	3+	1	x−

That a race is further separable into other entities (biotypes) is also shown by results in F3 tests of cross-bred material obtained from a cross between "Fulghum" and "Garry". The former is susceptible and the latter resistant to r.8. In numerous cases particular F3 plants inoculated with r.8 have shown a mixture of "3+" and "1" pustules. Cultures built up from each type, when used to inoculate the differential set of hosts, have given typical r.8 results and have been inseparable on this basis. The origin of these entities, whether by mutation or otherwise, is quite obscure, but it is quite important to recognize their existence. It may be that tests with other varieties of oats would show some to be resistant to one biotype but susceptible to another, and this could have an important bearing on a breeding programme.

RACE DETERMINATIONS.

Already six races of *P. graminis avenae* have been recorded for Australia (Waterhouse, 1929, 1936, 1938, 1939), and it has been shown that of these races, 1 and 2 can be separated on the differential "Joanette" (or "Sevenothree") only at low temperatures, and that the same applies to races 3 and 7. This fine differentiation has been found so far to be unimportant in the breeding work, and hence in the rust survey the races are recorded as r.2 (not r.1 and/or 2) in the one case, and r.7 (not r.3 and/or 7) in the other. Both could be present instead of only the one.

In the current work, the only other race found has been r.8. The race formerly recorded (Waterhouse, 1929) as r.6 has not been determined during this period.

The typical reactions shown by these races are set out in Table 22.

The distribution of these races in time and space is set out in Tables 23 and 24.

TABLE 22.
Typical Infection Types produced by Physiologic Races of P. graminis avenae *on Differential Varieties of* Avena *spp.*

Physiologic Race.	Mean Reaction on Differential Varieties.		
	White Tartar.	Richland.	Joanette.
1	2	1	1
2	2	1	4
3	4	1	1
7	4	1	4
8	2	4	4

TABLE 23.
Summary of the Number of Isolations of the Physiologic Races of P. graminis avenae *Grouped According to Time of Collection.*

Race.	Season of Isolation Ending on 31st March of the Year Named.													Totals.
	1939.	1940.	1941.	1942.	1943.	1944.	1945.	1946.	1947.	1948.	1949.	1950.	1951.	
1 or 2	58	44	33	47	8	47	16	65	28	67	18	63	34	528
3 or 7	22	50	19	22	16	21	4	29	8	56	15	46	19	327
8	2	12	6		1	1		1	2	10	5	13	23	76
Totals	82	106	58	69	25	69	20	95	38	133	38	122	76	931

TABLE 24.
Summary of Number of Isolations of Physiologic Races of P. graminis avenae *Grouped According to their Source.*

Race.	Source of Material.								Totals.	Per-centage.
	A.C.T.	N.S.W.	Vic.	Qld.	S.A.	W.A.	Tas.	N.Z.		
1 or 2	5	354	15	50	13	32	30	29	528	57
3 or 7	4	272	10	27	2	1	10	1	327	35
8	1	58	3	11			3		76	8
Totals ..	10	684	28	88	15	33	43	30	931	100

The localities within the States from which the collections actually come are shown for each of the years as follows:

DETAILS OF THE OCCURRENCES OF THE RACES OF P. GRAMINIS AVENAE.

1939.

r.1 or 2.

N.S.W.: Tullamore, Curlewis, Glen Innes, Pilliga, H.A. College, Grafton, Gum Flat, Condobolin, Gunnedah, Cowra, Trangie, Uralla, Bathurst, Dubbo, Tichborne, Nelegeloo, Sydney University.
Qld.: Gatton.
Tas.: Cressy.
N.Z.: Winton, St. Romans, Mataura, Kingston Crossing.

r.3 or 7.

N.S.W. : Bemboka, H.A. College, Curlewis, Condobolin, Uralla, Cowra, Bathurst, Dubbo, Tichborne, Guyra, Nelegeloo, Glen Innes, Red Range, Ben Lomond.
A.C.T. : Canberra.
Qld. : Gatton.
Tas. : Cressy.

r.8.

N.S.W. : Glen Innes.
A.C.T. : Canberra.

1940.

r.1 or 2.

N.S.W. : Gunnedah, Junee, Trangie, Temora, Stockinbingal, Werris Creek, Ardglen, Tamworth, Boggabri, H.A. College, Colinroobie, Cowra, Bathurst, Dubbo, Chullora, Downside, Old Junee.
A.C.T. : Duntroon.
Qld. : Gatton.
S.A. : Port Victoria, Murray Bridge, Booleroo, Waite.
Vic. : Walpeup, Invergordon, Charlton, Werribee.

r.3 or 7.

N.S.W. : Glen Innes, Gunnedah, Junee, Trangie, Temora, Dernasser, Tamworth, Boggabri, Colinroobie, Yerong Creek, Cowra, Bathurst, Dubbo, The Rock, H.A. College, Chullora, Uranquinty, Downside, Wagga, Grafton, Armidale.
Qld. : Gatton.
Vic. : Werribee, Invergordon, Charlton.

r.8.

N.S.W. : Glen Innes, Trangie, Bathurst, Dubbo, The Rock, Uranquinty, Wagga.
Vic. : Werribee.

1941.

r.1 or 2.

N.S.W. : H.A. College, Lindfield, Katoomba, Glen Innes, Guyra, Attunga, Boggabri, Milvale, Bathurst, Tichborne.
Vic. : Werribee.
A.C.T. : Canberra.
N.Z. : Christchurch, West Courtney.

r.3 or 7.

N.S.W. : Lindfield, H.A. College, Glen Innes, Guyra, Gunnedah, Tichborne, Bathurst.
Vic. : Werribee.

r.8.

N.S.W. : Glen Innes, Bungarley.
Vic. : Werribee.

1942.

r.1 or 2.

N.S.W. : Bellalia, Griffith, Gunnedah, Kelso, Tichborne, Cowra, Campbelltown, H.A. College, Manly, Lindfield, Spring Hill, Glen Innes, Forbes, Bathurst.
S.A. : Waite.
W.A. : Merredin.
Vic. : Werribee, Werrimull.
Tas. : Wesley Vale, Staverton, Deloraine, Wilmot, West Pine, Tunnack, Parattah, Mount Seymour, Lilydale.

r.3 or 7.

N.S.W. : Inverell, Gunnedah, Cowra, H.A. College, Spring Hill, Glen Innes.
A.C.T. : Canberra.
Vic. : Werribee.
Tas. : Wesley Vale, Staverton, Wilmot, Mount Seymour.

1943.

r.1 or 2.

N.S.W. : H.A. College, Baradine, Tichborne, Lindfield.
Qld. : Gatton.
Vic. : Footscray.

r.3 or 7.

N.S.W. : H.A. College, Lindfield, Gunnedah, Tichborne, Baradine, Cowra, Inverell.
Qld. : Gatton.
Vic. : Footscray.

r.8.

N.S.W. : Inverell.

1944.

r.1 or 2.

N.S.W.: Beecroft, Lindfield, H.A. College, Bathurst, Cowra.
S.A.: Waite.
Qld.: Burdekin River, Gatton, Brookstead.
W.A.: Merredin, Elabbin, Nalkain, Wael, Wongan Hills, South Borden.
Vic.: Walpeup, Dookie, Werribee.
A.C.T.: Canberra.
N.Z.: Ashburton.

r.3 or 7.

N.S.W.: Hurlstone Park, Yanco, H.A. College, Curlewis, Grong Grong, Spring Hill, Blackheath.
S.A.: Bridgetown.
Qld.: Gatton, Brookstead.
A.C.T.: Canberra.
W.A.: Merredin.
N.Z.: Otautau.

r.8.

N.S.W.: H.A. College.

1945.

r.1 or 2.

N.S.W.: Wallacia, Lindfield, H.A. College, Manly, St. Ives, Glen Innes.
Qld.: Gatton.

r.3 or 7.

N.S.W.: St. Ives, Glen Innes.
Qld.: Gatton.

1946.

r.1 or 2.

N.S.W.: Spring Hill, Lindfield, Epping, Glen Innes, H.A. College, Scone, Curlewis, Wingen, Campbelltown, Lenmeal, Dubbo, Nea Siding, Muswellbrook, Aberdeen, Singleton, Gunnedah, Wean, Gravesend, Baradine, Warrumbungle, Manilla, Tichborne, Cowra, Glenfield, Wee Waa, Narrabri, Armidale, Tomingley West, Gilgandra.
Qld.: Lawes, Brookstead.

r.3 or 7.

N.S.W.: Curlewis, Wingen, H.A. College, Nea Siding, Muswellbrook, Gunnedah, Pallamallawa, Wee Waa, Tamworth, Narrabri, Coonabarabran, Baradine, Warrumbungle, Cowra, Scone, Tomingley West, Spring Hill, Tenterfield, Armidale, Kelso.
Qld.: Brookstead.

r.8.

N.S.W.: Glen Innes.

1947.

r.1 or 2.

N.S.W.: Tichborne, Lindfield, Windsor, Castlereagh, Glenfield, Albury, Finley, Grafton.
Vic.: Lake Cullulleraine.
S.A.: Kingston, Gawler, Mount Gambier, Waite, Narracoorte.
W.A.: Mayanup.

r.3 or 7.

N.S.W.: Windsor, Taree, Finley, Grafton, Lindfield, Glenfield.

r.8.

N.S.W.: Taree.

1948.

r.1 or 2.

N.S.W.: Curlewis, Inverell, Glen Innes, Bogan Gate, Gunnedah, Lindfield, Yanco, Wongarbon, Eumungerie, Tooraweenah, Coonabarabran, Boggabri, Leeton, North Star, Grafton, Nemingha, Gilgandra, Wallen Bullen, Trangie, Willow Tree, Cowra, Manly, Bodalla, Castle Hill, Bemboka, Kelso.
Qld.: Brookstead, Hermitage, Murgon, Biloela, Mt. Tyson, Bongeen, Warwick, Wellcamp, Lawes, Dalby, Condamine Plains.
W.A.: Wongan Hills.
Tas.: Launceston, Cressy, Deloraine, Cambridge, Kindred, Elliott.

r.3 or 7.

N.S.W.: Glen Innes, Inverell, Curlewis, Bowral, Nelungaloo, Parkville, Breeza, Nea Siding, Murrurundi, Gunnedah, Winton, Coonabarabran, Tooraweenah, Boggabri, North Star, Gilgandra, Concord, Wallen Bullen, Grafton, Willow Tree, Manly, Tichborne, Bodalla, Castle Hill, Blackheath, Bemboka, Kelso.
Qld.: Brookstead, Biloela, Bongeen, Warwick, Wellcamp, Cambooya, Hermitage.
Tas.: Launceston.
S.A.: Bordertown.

r.8.

N.S.W.: Glen Innes, Gunnedah, Griffith, Nowra, Tichborne.
Qld.: Brookstead.

1949.

r.1 or 2.

N.S.W.: Curlewis, Castle Hill, Tichborne, H.A. College, Temora, Leeton, Glen Innes, Tanja, Armidale.
Qld.: Lawes, Nabby.
W.A.: Carnavon.
N.Z.: Lincoln.

r.3 or 7.

N.S.W.: Kelso, Castle Hill, Curlewis, Lindfield, Tamworth, Leeton, Armidale.
Tas.: King Island.
Qld.: Jondaryan, Nabby.

r.8.

N.S.W.: Glen Innes.
Qld.: Jondaryan.

1950.

r.1 or 2.

N.S.W.: Lindfield, Spring Hill, Curlewis, Grafton, Yanco, Concord, Bellata, Appleby, Attunga, Dubbo, Gunnedah, Leeton, Carroll, Tamworth, Bective, West Wyalong, Berrigan, Manildra, Narrandera, Urana, Brocklesby, H.A. College, Cootamundra, Barmedman, Spring Terrace, Kelso.
Qld.: Greenmount, Hermitage, Westbrook, Mt. Tyson, Dalby.
Vic.: Rutherglen.
S.A.: Huddleston.
Tas.: Wattle Grove, Sheffield, Ulverstone.
A.C.T.: Canberra.

r.3 or 7.

N.S.W.: Spring Hill, Curlewis, Wee Waa, Nemingha, Castle Hill, Gunnedah, Carroll, Tamworth, Bective, Gilgandra, West Wyalong, Borenore, Manildra, Temora, Leeton, Urana, Walbundrie, Cootamundra, Barmedman, H.A. College, Spring Terrace, Kelso.
Qld.: Hermitage.
Vic.: Rutherglen.
Tas.: Springfield, Ulverstone.

r.8.

N.S.W.: Curlewis, Leeton, Walbundrie, Spring Terrace, Glen Innes.
Qld.: Hermitage, Lawes, Pittsworth.

1951.

r.1 or 2.

N.S.W.: Kelso, Curlewis, Tamworth, Cowra, Tichborne, Trangie, Gilgandra, Kosciusko, Yanco, Leeton, Gunnedah, Narrabri.
Qld.: Hermitage, Warwick.
S.A.: Waite.
Tas.: Cressy, Oaklands, Longford, Ulverstone, Kingston.
N.Z.: Massey College.

r.3 or 7.

N.S.W.: Kelso, Narrabri, Curlewis, Boggabri, Tamworth, Concord, Cowra, Trangie, Tichborne, Gunnedah.
A.C.T.: Canberra.
Tas.: Kingston.

r.8.

N.S.W.: Canowindra, Curlewis, Tichborne, Goonumbla, Badgery's Creek, Wagga, Cowra, Gunnedah.
Qld.: Warwick, Gympie.
Tas.: Cressy, Ulverstone.

It will be seen that the r.1 or 2 isolates have occurred most commonly. This rust does not attack the "Tartarian" or "Richland" types, and its widespread occurrence is due to the wide cultivation of susceptible varieties like "Algerian" and "Fulghum". There is a clear trend in the direction of an increasing frequency of the r.3 or 7 rust, characterized by its ability to attack the "Tartarian" types and of r.8 which attacks the "Richland" types, although both these types of oats are relatively restricted in cultivation.

A comparison of these specialization phenomena is given with the total results to date, which are set out in Tables 25 and 26 in respect of the time and space distributions.

The overall percentage figures show that whereas r.1 or 2 was present in 69%, r.3 or 7 in 25·5%, r.6 in 0·5%, and r.8 in 5% of all the determinations made, these figures for the first period of 14 years are respectively 86%, 12·5%, 1% and 0·5%, and for the second period of 13 years 57% of r.1 and 2, 35% of r.3 or 7 and 8% of r.8.

TABLE 25.

Summary of the Number of Isolations of the Physiologic Races of P. graminis avenae *Grouped According to Time of Collection.*

Physiologic Race.	Season of Isolation, Ending 31st March of the Year Stated.															
	1925.	1926.	1927.	1928.	1929.	1930.	1931.	1932.	1933.	1934.	1935.	1936.	1937.	1938.	Totals.	1939.
1 and/or 2	30	3	21	38	39	38	62	54	48	34	72	66	55	45	605	58
6				2	6								1			9
3 and/or 7				7	4	2	13	5	6	5	5	8	9	25	89	22
8														3	3	2
Totals ..	30	3	21	47	49	40	75	59	54	39	77	74	65	73	706	82

Physiologic Race.	Season of Isolation, Ending 31st March of the Year Stated.												Totals.	Grand Totals.
	1940.	1941.	1942.	1943.	1944.	1945.	1946.	1947.	1948.	1949.	1950.	1951.		
1 and/or 2	44	33	47	8	47	16	65	28	67	18	63	34	528	1133
6														9
3 and/or 7	50	19	22	16	21	4	29	8	56	15	46	19	327	416
8	12	6		1	1		1	2	10	5	13	23	76	79
Totals ..	106	58	69	25	69	20	95	38	133	38	122	76	931	1637

TABLE 26.

Summary of the Number of Isolations of Physiologic Races of P. graminis avenae *Grouped According to their Source.*

Physiologic Race.	Source of Material.								Totals.	Percentage.
	A.C.T.	N.S.W.	Vic.	Qld.	S.A.	W.A.	Tas.	N.Z.		
1 and/or 2	22	826	40	82	44	40	38	41	1133	69
6		7	2						9	0·5
3 and/or 7	7	345	14	29	2	1	16	2	416	25·5
8	1	61	3	11			3		79	5
Totals ..	30	1239	59	122	46	41	57	43	1637	100

It is clear that varieties which have been bred for resistance using "Richland" as the "resistant" parent cannot be relied upon: although at present they are limited in their cultivation they may well be contributing to the build up of race 8. Because of the screening action of differential varieties, and the further important effects of competition between races (Watson, 1942), the aim in breeding must be to incorporate resistance to all known races. In our work, the Canadian variety "Garry" has been used as a source of resistance, even though it is susceptible to the serious American disease caused by *Helminthosporium victoriae*, which is not known at present in Australia. It has the added value of being resistant to the races of *P. coronata* that are present in Australia: this resistance is inherited independently of the resistance to stem rust so that types with the combined resistances can readily be obtained from "Garry" crosses. Its resistance to many races of oat smut further enhances its value.

Mixtures of Races.

It has been a common occurrence to find more than one race present in a single collection of rusted material. Obviously a variety like "Richland" has yielded only the one race; with fully susceptible varieties the situation is quite different. During the current investigations, a mixture of r.1 or 2 with r.3 or 7 has been found each year in a single collection: altogether 165 such mixtures have occurred. A mixture of r.3 or 7 with r.8 has shown up 19 times, and r.1 or 2 with r.8 nine times. On three occasions r.1 or 2, r.3 or 7, and r.8 have together been present in the one field collection.

Grass Hosts.

Previously it has been pointed out that oat stem rust attacks a number of grasses, native and introduced. In the period under review the occurrences are set out in Tables 27 and 28.

Table 27.

Distribution in Time of the Number of Physiologic Races of P. graminis avenae *Found on Grasses.*

Race.	Season of Isolation Ending 31st March of the Year Named.													Totals.	Percentage.
	1939.	1940.	1941.	1942.	1943.	1944.	1945.	1946.	1947.	1948.	1949.	1950.	1951.		
1 or 2	6	9	9	15	1	24	6	24	6	20	6	29	11	166	60
3 or 7		11	4	5	4	4	1	5	1	26	7	16	11	95	34
8	1	2	1		1					2		2	8	17	6
Totals ..	7	22	14	20	6	28	7	29	7	48	13	47	30	278	100

It is not unexpected to find that the "wild oats" have been the commonest hosts. In most cases the rusted material was clearly *A. fatua*, but in collections where no head specimens were included, the designation given by the collector was accepted. Those of *A. sterilis* and *A. barbata* were definitely correct. These species are not as widely dispersed as the first named, but tests have shown that members of all three are susceptible to our races.

The other grasses listed have shown striking variation in resistance within a given species. Thus in cases like that of *Phalaris tuberosa* or *Bromus unioloides*, a single rusted plant gave cultures of r.1 or 2, which when used to inoculate pots of seedlings from commercial seed gave only resistant reactions. On seedlings from grain of the original susceptible plant, a few proved susceptible but most were completely resistant. It is clear that in this, as in many of the other grasses listed, there is marked variability in the inherent resistance of individuals within the species, although no morphological differences are apparent. This has been described in some detail in a recent paper (Waterhouse, 1951).

TABLE 28.

Distribution of Physiologic Races of P. graminis avenae *Found on Grasses.*

Grass Host.	Total of Isolates.	Source of Material and Numbers of Each Race Found.																								Totals of Each Race.		
		A.C.T.			N.S.W.			Vic.			Qld.			S.A.			W.A.			Tas.			N.Z.					
		1 or 2	3 or 7	8	1 or 2	3 or 7	8	1 or 2	3 or 7	8	1 or 2	3 or 7	8	1 or 2	3 or 7	8	1 or 2	3 or 7	8	1 or 2	3 or 7	8	1 or 2	3 or 7	8	1 or 2	3 or 7	8
Avena fatua L.	115				51	39	4	2	2		7	1		3	1		4						1			68	43	4
A. sterilis L.	23				6	9	1				4	3														10	12	1
A. barbata Brot.	2				2																					2		
Lamarckia aurea (L.) Moench. ..	35				17	13	1										3	1								20	14	1
Hordeum leporinum Link. ..	31				14	14	2										1									15	14	2
H. marinum Huds.	1				1																					1		
Dactylis glomerata L.	17	1		1	6	2	1													4		2				11	2	4
Amphibromus Neesii Steud. ..	10				6	3											1									7	3	
Lolium spp.	8				4	1	1										1			1						6	1	1
Vulpia bromoides (L.) S. F. Gray	6				2	1											3									5	1	
V. Myuros (L.) Gmel.	1						1																					1
Arrhenatherum elatius (L.) J. & C. Presl.	5				1	1											2			1						4	1	
Bromus Gussonii Parl.	2																2									2		
B. arenarius Labill.	2					1	1																				1	1
B. hordeaceus L.	1						1																					1
B. macrostachys L.	1				1																					1		
B. unioloides H.B.K.	1					1																					1	
Koeleria phleioides (Vill.) Pers.. .	2				1	1																				1	1	
Phalaris minor Retz.	2				1	1																				1	1	
P. tuberosa L.	1				1																					1		
Calamagrostis epigeios (L.) Roth.	2				2																					2		
Agropyron scabrum (Labill.) Beauv.	1				1																					1		
Agrostis avenacea Gmel. ..	1						1																					1
Dichelachne sp.	1				1																					1		
Echinopogon caespitosus C. E. Hubbard	1				1																					1		
Elymus glaucus Buckl.	1				1																					1		
Heteropogon contortus Pers. ..	1				1																					1		
Hierochloë redolens R.Br. ..	1				1																					1		
Lagurus ovatus L.	1				1																					1		
Poa bulbosa L.	1				1																					1		
Sporobolus capensis Kunth. ..	1				1																					1		
Totals	278	1		1	125	87	14	2	2		11	4		3	1		17	1		6		2	1			166	95	17

Mixing of Races.

As in the case of the cultivated oats, many cases came to light in which a particular grass collection yielded more than one race of rust. As might be expected, the wild oats showed the greatest frequency. The results are shown in Table 29.

Table 29.

Frequency of Occurrence of Mixtures of Races of Oat Stem Rust on Grasses.

Grass Host.	Number of Isolations of Mixtures of Races.		
	r.1 or 2 with r.3 or 7.	r.1 or 2 with r.8.	r.3 or 7 with r.8.
Avena fatua	21		1
A. sterilis	7		
Hordeum leporinum . .	2		1
Dactylis glomerata . .	1	2	
Lamarckia aurea . .	8		1
Arrhenatherum elatius . .	1		
Amphibromus Neesii . .	3		

Admixture with other rusts occurs. In *Hordeum leporinum* isolates there were 19 mixtures of *P. graminis avenae* and *P. graminis tritici*; in *Amphibromus Neesii* 1; and *Agropyron scabrum* 1. There have also been more than 100 instances in which *P. graminis lolii* has been mixed with *P. graminis avenae*, as set out in a recent paper (Waterhouse, 1951).

In addition there have been very many cases of leaf rust occurring with stem rust, both in oats and various grasses.

CROWN RUST OF OATS.

Great damage to oat crops may be caused by this rust, *Puccinia coronata avenae* F. & L., especially in coastal areas. In favourable seasons it has completely ruined crops and has many times been found to kill out wild oats.

Life History.

The alternate host, *Rhamnus* spp., is not present in Australia, except perhaps in some of the Botanic Gardens. Nevertheless, it is a potential source of danger. Thus, in the plant house, viable teleutospores of race 6 were used in an inoculation experiment on *R. cathartica* L.: this led to the production of spermogonia and aecidia from which uredospore cultures were obtained on oats.

As a rule, teleutospores exposed to favourable winter conditions on the Tablelands have failed to germinate, and numerous attempts to break the dormancy of the spores by freezing the material in the refrigerator have failed, even with spores formed late in the season under relatively low temperatures. It may be found that different races behave differently in this regard.

In the absence of the alternate host, it seems probable that under Australian conditions new physiologic races arise by mutation or possibly by "hybridization" brought about by nuclear interchange in the dicaryotic phase, or it may be by adaptive response to different hosts.

The carry-over from season to season takes place on self-sown or "volunteer" oats and on wild oats. Collections of *P. coronata* on *Lolium* spp., *Holcus lanatus* L., *Agrostis avenacea* Gmel., and *Polypogon monspeliensis* (L.) Desf. have been found incapable of attacking oats and are therefore to be regarded as different sub-species of *P. coronata*.

Importance of Wild Oats.

Collections on wild oats have given results comparable with those obtained from the cultivated forms. Both have come to hand in between cropping seasons. The race determinations from wild oats have been recorded separately and these results are set out in Tables 30 and 31.

Table 30.

Summary of the Number of Isolations of Physiologic Races of P. coronata avenae *on Wild Oats Grouped According to Time of Collection.*

Race.	Season of Collection, Ending 31st March of the Year Named.														Totals.
	1936.	1937.	1938.	1939.	1941.	1942.	1944.	1945.	1946.	1947.	1948.	1949.	1950.	1951.	
1				1			1								2
3		3		1	1	1	1	5	1			1	1	2	17
6	2	4	1	2		1	3	4	11	5	7	1	5	8	54
7			1	1	1	2		1	5	2	1		2	2	18
102										3	4	2	3	5	17
103										2			1		3
40	1	2					1								4
57												1			1
Totals ..	3	9	2	5	2	4	6	10	17	12	12	5	12	17	116

Table 31.

Summary of the Number of Isolations of P. coronata avenae *on Wild Oats Grouped According to their Source.*

Host.	Totals.	Source of Material.													
		N.S.W. Races.							Qld. Races.		N.Z. Races.				
		1	3	6	7	102	103	40	102	103	3	6	7	102	103
Avena fatua ..	96	2	13	42	12	10	2	4	1	1	2	3	2	1	1
A. sterilis ..	10		2	5	1	2									
A. barbata ..	10			4	3	3									
Totals ..	116	2	15	51	16	15	2	4	1	1	2	3	2	1	1

The host material was in many instances determined definitely in so far as the species was concerned by reason of the fact that panicles or grain were included with the specimens. This applies to all collections listed under *A. sterilis* and *A. barbata*. In other instances the label simply stated "*A. fatua*" and the material was accepted as such. In some of these cases one or other of the remaining species was almost certainly involved: plant house tests have shown that they are susceptible to the races recorded, although many occurrences of both resistant and susceptible reactions on the same leaf of a wild oat plant show that different races may behave differently on wild oats.

It is seen that in only two of the years under review were rusted wild oats not recorded. Eight of the 13 races known to occur have been present. Of these, race 6 was by far the commonest, the frequency of this race and of the others being not unlike that of the totals of all the isolations. The remaining five have been found only rarely on cultivated oats, as shown in Tables 33 and 34.

There have been many cases in which a single collection has contained a mixture of races.

In the case of *A. fatua* collections, seven contained a mixture of three races, these comprising four of races 6, 7, and 102, and one each respectively of 1, 3, and 7; 3, 6, and 40; and 3, 6, and 57. Thirty-five of the collections yielded pairs of races, occurring in many different combinations.

A. sterilis gave one mixture of three races, viz., 6, 7, and 102, and two collections in which two races were present.

Collections of *A. barbata* closely paralleled those of *A. sterilis*, giving one mixture of races 6, 7, and 102, and two others in which a pair of races occurred together.

TABLE 32.

Typical Reactions of Certain Physiologic Races of P. coronata avenae *Expressed as Means of the Rust Infections.*

Physiologic Race No.	Mean of Reactions on Differential Varieties.												
	Ruakura.	Green Russian.	Hawkeye.	Anthony.	Sunrise.	Victoria.	Green Mountain.	White Tartar.	Red Rust Proof.	Sterisel.	Belar.	Bond.	Glabrota.
1	4	4	4	4	4	1	4	4	4	4	3	0	0
3	0	4	4	4	0	1	4	4	0	0	0	0	0
6	0	4	4	4	4	1	4	4	4	4	4	0	0
7	4	4	0	0	4	1	0	0	4	4	4	0	0
9	1	2	3	3	2	0	3	3	1	1	2	0	0
40	4	4	0	0	4	1	4	0	4	4	4	0	0
45	4	4	3	3	4	2	3	3	4	4	4	4	0
47	1	4	0	1	4	2	0	1	4	4	4	0	0
57	1	3	4	3	4	2	4	3	4	4	4	4	0
77	3	0	4	4	4	1	4	4	4	4	4	0	0
102	0	0	4	4	4	1	4	4	4	4	4	0	0
103	4	2	0	0	4	1	0	0	4	4	4	0	0
104	4	2	2	4	4	1	4	4	4	4	4	0	0

SPECIALIZATION STUDIES WITH RUSTS FROM OATS.

The first studies were made in 1925 on a collection of heavily rusted "Richland" oats growing at Glen Innes. Its reactions were determined on a number of oat varieties then on hand. In 1932 similar material was received from New Zealand and a comparison made with the reactions already recorded from the Glen Innes collection. No differences were found between them. The former rust has been maintained in culture until the present time, and is our stock culture of race 6.

In 1934, grain of the differential varieties used in U.S.A. was received from Dr. H. B. Humphrey of the U.S.D.A., and a commencement made with detailed specialization studies. From the outset it became evident that environmental effects, and especially temperature fluctuations, produced most marked variations in the rust reactions shown on the differentials: very numerous cases came to light in which sharp resistance given at low temperatures during the winter changed to susceptibility when the summer temperatures prevailed. For this reason the separation of races can only be carried out satisfactorily under relatively low temperature conditions.

IDENTITY OF RACES DEALT WITH.

Recent word from Dr. H. C. Murphy states that a new revised set of differential oat varieties is being used in North American determinations, commencing with the

1951 collections. The revised set is being adopted because the old set does not, in some cases, give the help needed in the breeding programme. Seed of the new set is expected to be available here in the near future, when the effort will be made to co-ordinate results given by the two sets. It is to be hoped that as far as possible the races determined on the new set in North America will be correlated with those already recognized under the existing scheme. This would give a wider overall picture of the specialization behaviour over a long period of time, apart from linking up with investigations being carried forward elsewhere with the older set of differentials.

It will be seen that, using the older set, a number of races have been determined, and of them 102, 103, and 104 are new records. Their typical reactions are set out in Table 32.

The distributions in time and space are shown in Tables 33 and 34.

TABLE 33.

Summary of the Number of Isolations of Physiologic Races of P. coronata avenae *Grouped According to Time of Collection.*

Race.	Season of Collection, Ending 31st March of the Year Named.																	Totals.
	1935.	1936.	1937.	1938.	1939.	1940.	1941.	1942.	1943.	1944.	1945.	1946.	1947.	1948.	1949.	1950.	1951.	
1		3		5	8	1		1		1					3	2		24
3		2	15	8	3	2	1	1		5	7	11			4	2	3	64
6	4	17	20	17	11	6	1	6	4	9	21	34	14	22	16	39	40	281
7		3		5	3		2	2	1	4	2	21	4	7	4	9	12	79
40		4	12	9						1	2					2		30
45															1	1		2
47		1		1		1				1								4
77															2	2		4
9														1	1			2
102													6	15	14	10	19	64
103													3		5	1	1	10
57															2	1		3
Totals ..	4	30	47	45	25	10	4	10	5	21	32	66	27	45	52	69	75	567

TABLE 34.

Summary of the Number of Isolations of Physiologic Races of P. coronata avenae *Grouped According to their Source.*

Race.	Source of Material.								Totals.
	A.C.T.	N.S.W.	Vic.	Qld.	S.A.	W.A.	Tas.	N.Z.	
1		16		3				5	24
3	1	54		1	1	1		6	64
6		229	1	30	2	1	4	14	281
7		66		5		1		7	79
40		26		1				3	30
45		2							2
47		1			1			2	4
77		4							4
9		1		1					2
102		51		10	2			1	64
103		8		2					10
57		2						1	3
Totals	1	460	1	53	6	3	4	39	567

The actual locations from which the collections came year by year are shown as follows:

DETAILS OF THE OCCURRENCES OF THE RACES OF P. CORONATA AVENAE.

1935.

r.6.

N.S.W.: Ulmarra, Ryde, H.A. College, Wollongong.

1936.

r.1.

N.S.W.: H.A. College, Campbelltown.

r.3.

N.S.W.: Sydney University.

r.6.

N.S.W.: Lindfield, Grong Grong, Taree, H.A. College, Nowra, Chatswood, Campbelltown, Sydney University, Cowra, Concord, Glen Innes, Killara.
Qld.: Lawes.
N.Z.: Palmerston North.

r.7.

N.S.W.: Taree, H.A. College, Concord.

r.40.

N.S.W.: Pennant Hills, Glen Innes, Killara.
N.Z.: Palmerston North.

r.47.

N.Z.: Palmerston North.

1937.

r.3.

N.S.W.: Chatswood, Sydney University, H.A. College, Glen Innes.

r.6.

N.S.W.: Roseville, Chatswood, Sydney University, H.A. College, Condobolin, Taree, Glen Innes, Koonadan.

r.40.

N.S.W.: Roseville, Chatswood, H.A. College.

1938.

r.1.

N.Z.: Palmerston.

r.3.

N.S.W.: Sydney University, H.A. College, Granville, Hammondville.
N.Z.: Palmerston.

r.6.

N.S.W.: Sydney University, Roseville, H.A. College, Granville, Hammondville, Leeton, Glen Innes.
N.Z.: Palmerston, Amberley, Lincoln, Willoughby.

r.7.

N.Z.: Palmerston, Amberley, Willoughby.

r.40.

N.S.W.: Roseville, H.A. College, Granville, Hammondville.
N.Z.: Palmerston, Lincoln.

r.47.

N.S.W.: Leeton.

1939.

r.1.

N.S.W.: H.A. College, Robertson, Kyogle, Bemboka, Chatswood.
Qld.: Lawes.

r.3.

N.S.W.: Taree, Sydney University.

r.6.

N.S.W.: Bemboka, H.A. College, Chatswood, Robertson, Kyogle, Urbenville, Oakwood.
Qld.: Lawes.

r.7.

N.S.W.: Taree, Sydney University.

1940.

r.1.

N.S.W.: Trangie.

r.3.

A.C.T.: Duntroon.
S.A.: Waite.

r.6.

N.S.W.: Taree, Rankin's Springs, Trangie, Temora.
Qld.: Lawes.
Vic.: Werribee.

r.47.

S.A.: Waite.

1941.

r.3.

N.S.W.: Lindfield.

r.6.

N.S.W.: Taree.

r.7.

N.S.W.: Taree, Lindfield.

1942.

r.1.

N.S.W.: Gilgandra.

r.3.

N.S.W.: Sydney University.

r.6.

N.S.W.: Gunnedah, Tichborne.
N.Z.: Auckland, Blenheim.

r.7.

N.S.W.: Sydney University.
N.Z.: Auckland.

1943.

r.6.

N.S.W.: H.A. College.
Qld.: Lawes.

r.7.

N.S.W.: H.A. College.

1944.

r.1.

N.S.W.: Lindfield.

r.3.

N.S.W.: Sydney University, Strathfield, H.A. College.
W.A.: Perth.

r.6.

N.S.W.: Lindfield, Sydney University, H.A. College, Blackheath.
Qld.: Nankin, Wellington Point.
N.Z.: Ashburton.

r.7.

N.S.W.: H.A. College, Strathfield.
Qld.: Nankin.
W.A.: Perth.

r.40.

N.S.W.: Blackheath.

r.47.

N.Z.: Ashburton.

1945.

r.3.

N.S.W.: Sydney University, Murwillumbah, Miller's Forest, Chatswood, Lindfield, Manly.

r.6.

N.S.W.: Lismore, Alphadale, Murwillumbah, Grafton, Taree, Richmond River, H.A. College, West Maitland, Flemington, Miller's Forest, Chatswood, Lindfield, Sydney University, Anna Bay.
Qld.: Lawes.

r.7.

N.S.W.: Murwillumbah, Manly.

r.40.

N.S.W.: H.A. College, Grafton.

1946.

r.3.

N.S.W.: Taree, Singleton, Wingen, Aberdeen, Muswellbrook, Maitland, Mayfield, Lindfield, H.A. College.
Qld.: Brookstead.

r.6.

N.S.W. : Glen Innes, H.A. College, Lindfield, Badgery's Creek, Wingen, Robertson, Campbelltown, Lenmeal, Kurrajong, Singleton, Aberdeen, Muswellbrook, Maitland, Mayfield, Gravesend, Pallamallawa, Cherry Tree Hill, Gunnedah.
Qld. : Lawes, Brookstead.

r.7.

N.S.W. : H.A. College, Lindfield, Badgery's Creek, Wingen, Robertson, Taree, Kurrajong, Singleton, Maitland, Aberdeen, Muswellbrook, Mayfield.
Qld. : Brookstead.

1947.

r.6.

N.S.W. : Glen Innes, Parramatta, Fairfield, Castle Hill, Killara, Bringelly, Luddenham, Windsor, Taree, Castlereagh.
Qld. : Lawes.

r.7.

N.S.W. : Fairfield, Parramatta, Castle Hill, Windsor.

r.102.

N.S.W. : Parramatta, Castle Hill, Lindfield, Dundas, Sydney University, Killara.

r.103.

N.S.W. : Lindfield, Windsor.

1948.

r.6.

N.S.W. : Lindfield, Turramurra, Glen Innes, Bowral, Dundas, Murrurundi, Killara, Alstonville, Sydney University, H.A. College, Nowra, Grafton, Eumungerie, Curlewis.
Qld. : Biloela, Warwick, Lawes.
S.A. : Penola.

r.7.

N.S.W. : Glen Innes, Badgery's Creek, Lindfield, H.A. College, Sydney University.
Qld. : Biloela.

r.9.

Qld. : Warwick.

r.102.

N.S.W. : Glen Innes, Badgery's Creek, Lindfield, Turramurra, Killara, Nowra, Grafton, Eumungerie, Bowral.
Qld. : Lawes.
S.A. : Penola.

1949.

r.1.

N.S.W. : Castle Hill, Grafton, H.A. College.

r.3.

N.S.W. : Grafton, H.A. College.
N.Z. : Lincoln.

r.6.

N.S.W. : Castle Hill, Grafton, H.A. College, Glen Innes.
Qld. : Lawes, Yeerongpilly, Glenore Grove.
Tas. : King Island.

r.7.

N.S.W. : Grafton, H.A. College, Castle Hill.

r.9.

N.S.W. : Grafton.

r.45.

N.S.W. : Castle Hill.

r.57.

N.S.W. : H.A. College.
N.Z. : Lincoln.

r.77.

N.S.W. : H.A. College, Castle Hill.

r.102.

N.S.W. : Castle Hill, Grafton, H.A. College, Lindfield.
Qld. : Glenore Grove.
N.Z. : Lincoln.

r.103.

N.S.W. : Grafton, Castle Hill, H.A. College.

1950.

r.1.

N.S.W.: Curlewis.
Qld.: Lawes.

r.3.

N.Z.: Winchmore, Laghmor.

r.6.

N.S.W.: Lindfield, Muswellbrook, Singleton, H.A. College, Castle Hill, Glenorie, North Marota, Penrith, Grafton, Kameruka, Aberdeen, Gunnedah, Stroud, Dunedoo, Armidale, Leeton, Bemboka, Glen Innes, Kurrajong, Gilgandra.
Qld.: Toowoomba, Biddeston, Lawes, Westbrook.
W.A.: Boyup Brook.
N.Z.: Winchmore, Laghmor, Orari.
Tas.: Kimberley, Sheffield.

r.7.

N.S.W.: H.A. College, Lindfield, Kurrajong, Castle Hill, Gunnedah.
Qld.: Lawes.
N.Z.: Winchmore.

r.40.

N.S.W.: H.A. College.
Qld.: Westbrook.

r.45.

N.S.W.: Spring Terrace.

r.57.

N.S.W.: Castle Hill.

r.77.

N.S.W.: Singleton, Cootamundra.

r.102.

N.S.W.: Curlewis, H.A. College, Lindfield, Grafton, Stroud.
Qld.: Toowoomba, Biddeston, Lawes, Pittsworth.

r.103.

Qld.: Pittsworth.

1951.

r.3.

N.S.W.: Kelso, Castle Hill, Narrabri.

r.6.

N.S.W.: Kelso, Curlewis, Castle Hill, Tamworth, H.A. College, Coolamon, Ariah Park, Lindfield, Blue Vale, Gunnedah, Tichborne, Goonumbla, Peak Hill, Grafton, Badgery's Creek, Maitland, Bodalla, Narrabri.
Qld.: Killarney, Ayr, Warwick, Lawes, Lawnton, Gympie.
S.A.: Waite.
Tas.: Elliott.

r.7.

N.S.W.: H.A. College, Castle Hill, Blue Vale, Gunnedah, Curlewis, Tichborne, Lindfield, Peak Hill, Badgery's Creek, Bodalla.
Qld.: Lawnton.

r.102.

N.S.W.: Kelso, Curlewis, Castle Hill, Tamworth, H.A. College, Boggabri, Lindfield, Blue Vale, Gunnedah, Tichborne, Peak Hill.
Qld.: Killarney, Lawnton, Ayr.
S.A.: Waite.

r.103.

Qld.: Killarney.

On the basis of frequency of isolation and wideness of distribution, race 6 is the most important, occurring in 50% of the determinations. It is the only one of the races that has been present in each of the years during which tests have been made, and is also unique in that it has been found in each of the States of the Commonwealth as well as in New Zealand. Races 3 and 7 come next in importance in both time and space distributions. Only within the past five years have the last six races listed shown up. It has been striking to find so many cases in which the differential variety "Green Russian" has given the mixed susceptible and resistant reactions from which the particular two races have been sorted out. Although many of the races have been found infrequently, their occurrence is important: probably they show that mutation is going on all the time.

Mixtures of Races.

It has been quite usual to find that a single collection of crown rust has yielded more than one race. To date there have been three instances in which four races were sorted out, these being respectively 1, 6, 7, and 57; 3, 6, 7, and 102; and 3, 7, 9, and 103. In 37 cases there was a mixture of three races: 11 of them comprised races 3, 6, and 40, the remainder being various combinations of 3. There were 144 collections in which two races were present: these occurred in varied combinations of which that of races 6 and 7 was the commonest. Details of the groupings are set out in Table 35.

Table 35.

Frequency of Occurrence of Mixtures of Races of P. coronata avenae *on Oats.*

Frequency of Isolates.		Grouping of Races.
13	..	1 and 6
2	..	1 and 7
1	..	1 and 45
19	..	3 and 6
16	..	3 and 7
3	..	3 and 40
1	..	3 and 102
36	..	6 and 7
14	..	6 and 40
2	..	6 and 47
1	..	6 and 77
31	..	6 and 102
1	..	6 and 103
1	..	7 and 102
1	..	77 and 103
2	..	102 and 103
1	..	1, 3 and 7
1	..	1, 6 and 102
8	..	3, 6 and 7
11	..	3, 6 and 40
1	..	3, 6 and 57
1	..	3, 6 and 102
4	..	6, 7 and 102
9	..	6, 102 and 103
1	..	77, 102 and 103
1	..	1, 6, 7 and 57
1	..	3, 6, 7 and 102
1	..	3, 7, 9 and 103

There has been no significant correlation between the size of the collection (i.e., quantity of rusted material used) and the amount of mixing present. Throughout the groupings, the frequency of occurrence of race 6 is outstanding, but there is no evidence of its particular association with any other particular race or races.

At present nothing is known of the genetic constitution of any of the races. A considerable amount of work with the aecidial stage was planned but was held up by the paucity of germination of the teleutospores.

Breeding Results.

It will be noticed that the variety "Victoria" is resistant to all the recorded races and it has therefore been used as a parent in the crossing work. It is, of course, susceptible to the races of stem rust that are present in Australia. This has made it a valuable variety to use where stem rust has to be separated from crown rust in a collection. The extreme susceptibility of this variety to *Helminthosporium victoriae* in U.S.A. gives it a doubtful value as a parent here.

"Bond" was similarly used, but the discovery of races 45 and 57 in 1949 alters the situation. To date these races have turned up infrequently, but they must be regarded as potential sources of danger to "Bond" material. Apart from "Victoria" and "Bond" there are several other resistant 14- and 21-chromosome varieties available for use in the breeding programme. "Garry" from Canada is being used with promising results.