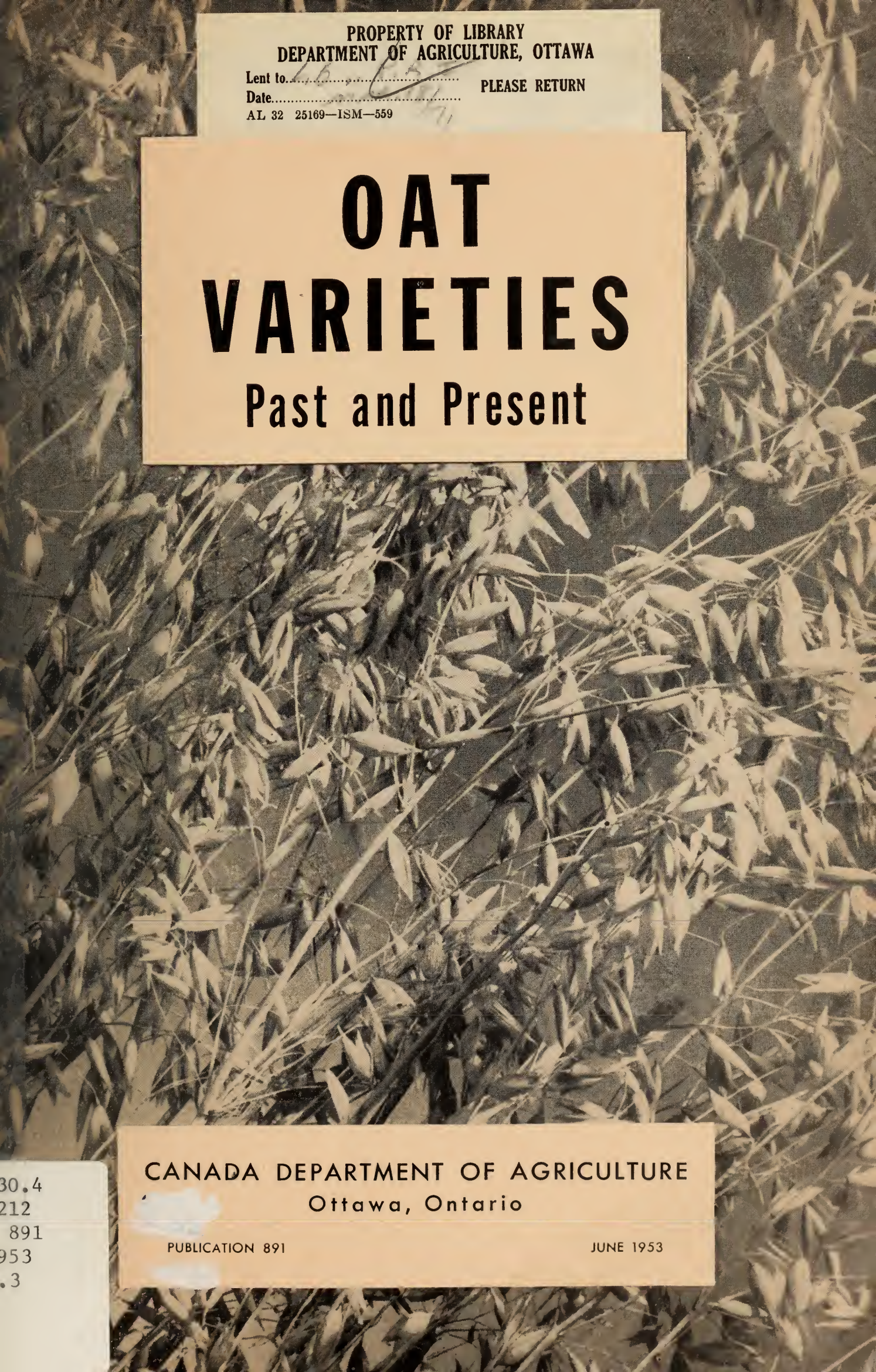
OAT VARIETIES

Past and Present



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OAT VARIETIES—PAST AND PRESENT

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Introduction

The oat crop is of major importance in many countries of the world. It ranks second in value to wheat in Canada, and in the United States is exceeded in value only by wheat and corn. It was in cultivation prior to the beginning of the Christian Era, as oats were found among the remains of the Swiss lake dwellers of the Bronze Age. Evidently, through the centuries, enterprising agriculturalists selected out superior types, a process that is still going on and one through which the majority of the older varieties evolved. Improvement through breeding is a method of comparatively recent origin being closely associated with the development of genetics.

In the earlier days of oat improvement work in North America little attention was given to breeding or selecting for disease resistance. It was not until the early 1920's that a concerted effort was made to produce disease-resistant oat varieties. Since that time a number of them have been developed in Canada and the United States, or introduced from other countries. Recent chemical tests have shown that oat varieties differ in protein and other chemical constituents and because of this fact breeding for higher nutritive value should become a standard practice.

The plant breeder is continually searching for new sources of breeding material. The studies herein reported were undertaken with the hope that a knowledge of the disease reaction and nutritive value of many of the older untested Canadian varieties would reveal new sources of germ plasm. Moreover, such data, together with a history and description of each variety, would provide a useful biography of all the varieties that were ever of importance in Canadian agriculture. In addition to these varieties a number produced in the United States are included, and some that were introduced from other countries into Canada or the United States as sources of breeding material.

Approximately ninety varieties were tested in the field, over a five-year period, for their reaction to the rusts, smuts, bacterial diseases, grey speck, and common root-rot; and in the seedling stage, in the greenhouse, to *Helminthosporium victoriae* Meehan and Murphy, *Fusarium culmorum* (W. G. Smith) Sacc. and powdery mildew *Erysiphe graminis* DC. The reaction to the different races of the rusts and smuts was also determined for a number of varieties which had not been previously tested. In addition, the chemical composition of sixty varieties was determined at four locations over a three-year period.

Diseases

A number of diseases attack oats. Some are more prevalent in certain areas than others, and most of them depend upon suitable environmental conditions for development. Although all of them reduce crop yields, the rusts and smuts are considered to be the most serious, especially in Canada and the United States. A great deal of research has been done on these diseases from the

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standpoint of determining the different physiologic races, and the breeding for resistance to them. The reaction of the varieties to eight diseases is given in Table 1. These and other diseases are briefly discussed.

Stem Rust

Stem rust, *Puccinia graminis avenea* Erikss. and Henn., is world-wide in its distribution on oats. As the name indicates it is essentially a disease of the stem, but infections may occur on the leaves in an exceptionally severe epidemic. Two stages of the rust occur on oats and certain grasses. The red or uredial stage is characterized by the presence of large, reddish-brown pustules, usually oblong in shape. The pustules produce spores (urediospores) which are blown about by the wind, and infect neighbouring oat plants and grasses. It is this stage that causes the damage to the oat crop. The black or telial stage which develops later is the resting or overwintering stage. The black spores (teliospores), which overwinter on oat stubble, germinate in the spring to produce small, delicate spores (sporidia) which cannot infect oats but can infect certain species of barberry, especially the common barberry, *Berberis vulgaris* L. From the barberry the rust may spread to oats in the early summer. If barberry bushes are not present the rust cannot complete its life cycle.

As there are very few barberry bushes in Western Canada, rust infections in that area are not the result of this method of spore dissemination. Some infections arise from this source in Eastern Canada as there are more barberry bushes in that part of the country. The main source of infection in Canada, however, is from spores blown by the wind northward from the United States. In that country many barberries still exist in spite of an eradication program that has been carried on for a number of years. Furthermore, in the southern part of the United States, the barberry is not essential for the completion of the rust life cycle; because of the mildness of the climate the rust can live over in the red or urediospore stage. Incidentally, spores can be blown southward from Canada in the fall, thereby causing infection on the winter oat crop.

TABLE 1.—REACTION OF VARIETIES TO EIGHT DISEASES[1]

Varieties	Crown Rust	Stem Rust	Smut	Bacterial Diseases[2]	Grey Speck	Common Root-Rot[3]		Victoria Blight	Powdery Mildew
						Field	Greenhouse		
C.A.N. 233[4]	S	S	R	S	MR	MR	S	R	R
C.A.N. 789	MR	R	R	R	—	—	VR	R	S
C.A.N. 790	MR	R	R	R	—	—	VR	R	S
C.A.N. 791	MR	R	R	R	—	—	VR	R	S
Abegweit	S	MR	MS	R	MS	MR	MR	R	S
Abundance	S	S	VS	S	S	MR	S	R	S
Achilles	R	MR	R	—	—	—	VR	S	S
Acton	S	S	S	R	MR	R	MS	R	S
Advance	MR	MR	R	R	—	—	VR	R	—
Ajax	MR	MS	MR	R	R	MR	MR	R	S
Alaska	S	S	S	MR	MR	MR	MS	R	S
Andrew	MR	MR	R	S	S	MS	MS	R	S
Anthony	MS	MR	VS	MR	MR	MR	MR	R	S
Ardri	S	S	S	S	S	MR	R	R	S
Bambu	S	S	S	R	MR	MR	MS	R	S
Banner	S	S	S	R	S	R	S	R	S
Beacon	R	MR	S	R	S	MR	MR	S	S
Beaver	MR	MR	MS	R	MS	MS	MS	R	S
Benton	MR	MR	R	R	MR	MS	MR	R	S
Big Four	S	S	S	MS	MS	R	MS	R	S
Black Mesdag	S	S	R	S	R	MR	MR	R	S
Bond	MR	S	VR	S	S	MS	R	R	S
Bonda	MR	MR	VR	S	S	S	MR	R	S
Bonham	MR	MR	R	S	—	—	R	R	—
Branch	MR	MR	R	—	—	—	VR	R	—
Brighton	S	S	VR	MR	MR	MR	VS	R	S
Canuck	S	R	S	R	MS	MR	S	R	S

TABLE 1.—REACTION OF VARIETIES TO EIGHT DISEASES[1]—*Concluded*

Varieties	Crown Rust	Stem Rust	Smut	Bacterial Diseases[2]	Grey Speck	Common Root-Rot[3]		Victoria Blight	Powdery Mildew
						Field	Greenhouse		
Cartier	S	S	S	MR	S	MR	MR	R	S
Cherokee	MR	MR	R	MR	—	—	VR	R	—
Clinton	MR	MR	R	R	MR	MS	MR	R	S
Colo	MR	MR	R	S	—	—	R	R	—
Dasix	S	S	VS	MR	S	MS	MS	R	S
Eagle	S	S	S	S	S	R	MS	R	S
Early Miller	S	S	VS	S	S	MS	MR	R	S
Eaton	MR	MR	R	R	—	—	R	R	—
Erban	MS	S	MR	S	S	R	MR	R	S
Exeter	S	MR	MS	MR	R	MR	MS	R	S
Fortune	S	MR	VR	S	S	MR	MR	R	S
Garry	R	R	VR	S	S	MR	MR	S	S
Garry Sel.	MR	R	R	S	—	—	VR	R	S
Gold Rain	S	S	S	R	S	MR	R	R	S
Gopher	S	S	MS	R	MR	MS	MR	R	S
Green Mountain	MS	MR	S	MR	—	—	MR	R	—
Green Russian	MS	MR	S	MR	—	—	MR	R	—
Grey Winter	S	S	S	MR	MR	MR	MR	R	S
Hajira	S	Seg	VS	R	S	MR	R	R	S
James	MR	MR	VR	R	—	—	VS	R	S
Jostrain	S	S	S	R	S	R	MR	R	S
Kent	MR	MR	R	R	—	—	VR	R	—
Klein	MR	S	S	R	R	MR	MR	R	S
Lanark	MR	MR	R	S	S	MS	R	R	S
Landhafer	R	S	S	R	R	R	MR	R	S
Larain	S	S	S	R	MR	MR	MR	R	S
Laurel	S	S	S	R	R	MR	MR	R	S
Legacy	S	S	S	R	MR	MR	MR	R	S
Liberty	S	S	VS	S	S	R	VS	R	S
Mabel	S	S	S	MR	R	MR	MS	R	S
Marion	MS	MR	R	—	—	—	S	R	—
Markton	S	S	R	R	MR	MR	MR	R	S
Mindo	MR	MR	R	R	S	S	MR	R	S
Mohawk	MR	MR	R	MR	—	—	R	R	—
Nakota	S	MR	VR	R	MR	MS	VS	R	S
Nemaha	MR	MR	R	R	—	—	R	R	—
Onward	S	S	S	S	S	MS	MR	R	S
O.A.C. 3	S	S	S	S	S	MR	MR	R	S
O.A.C. 72	S	S	S	S	S	MR	MS	R	S
O.A.C. 144	S	S	R	R	MR	MR	S	R	S
Rainbow	S	MR	S	MR	S	MR	S	R	S
Richland	S	MR	MS	R	S	MS	S	R	S
Ripon	S	S	R	MR	MR	MR	MS	R	S
Roxton	MS	S	MS	R	MS	R	MR	R	S
Rusota	S	MR	S	R	S	MR	MS	R	S
Saia	MR	R	R	R	—	—	R	R	S
Santa Fe	R	S	S	R	R	R	MR	R	S
Shelby	MR	MR	VR	—	—	—	VR	R	S
Sixty Day	S	S	VS	R	MR	MS	MS	R	S
Tama	R	MR	VR	MR	S	MS	MS	S	S
Trispernia	R	S	R	MR	S	MR	MR	R	S
Ukraine	MR	MR	S	MR	MR	R	MS	R	S
Valor	S	S	R	MR	S	S	S	R	S
Vanguard	S	MR	VS	R	S	MR	MS	R	S
Vieland	R	MR	VR	MR	S	MS	MR	S	S
Victoria	R	S	VR	R	S	MS	MR	S	S
Victory	S	S	S	S	S	R	MR	R	S
White Cross	S	S	S	MR	S	MS	MR	R	S
White Russian	MS	MR	S	S	—	—	S	R	—
Zephyr	MR	MR	VR	S	S	MS	R	R	S
R.L. 524	S	R	S	R	MR	MR	MR	R	S
R.L. 2123	MR	R	R	MR	—	MS	VR	R	S

[1] VR=very resistant; R=resistant; MR=moderately resistant; MS=moderately susceptible; S=susceptible; VS=very susceptible.

[2] Halo blight and stripe blight.

[3] *Field.*—Principally *Fusarium* species; natural infection; adult stage. *Greenhouse.*—Pure culture of *Fusarium culmorum*; artificial infection; seedling stage.

[4] Varieties with C.A.N. belong to the species *A. strigosa.*

Oat stem rust is not a single entity, but is composed of several physiologic races that may arise through mutation or by hybridization on the barberry. Fourteen of these have been identified in North America but not all of them have appeared in epidemic proportions. Until 1943, races 1, 2, and 5 were the most common ones in Canada and the United States. In that year, races 8, 10, and 11 appeared in greater proportions than usual, and by 1951 were more prevalent than races 1, 2, and 5. In 1950 and 1951, race 7 was more prevalent than usual in both countries and is causing some concern, as varieties with the White Russian type of resistance to stem rust, such as Clinton and Lanark, are susceptible to it. Also of concern to the plant breeder is the fact that race 7A, a biotype of race 7, was identified for the first time at Winnipeg in 1952. This race attacks Canuck, R.L. 524, and R.L. 2123,[1] varieties that have been used extensively in breeding for stem rust resistance.

The reaction of a number of varieties to thirteen races of stem rust is given in Table 2. The source of this information is Newton *et al.* (18) and unpublished data by Dr. T. Johnson, Laboratory of Plant Pathology, Winnipeg, Man. According to the data, the varieties can be classified into five groups according to their reaction to the different races. In Group I, Ajax, Abegweit, Andrew, Beacon, Beaver, Eaton, Exeter, Fortune, Marion, Nakota, Rainbow, Richland, Rusota, Tama, Vanguard, and Vicland are resistant to races 1, 2, 3, 5, 7, 7A, and 12; in Group II, Advance, Anthony, Benton, Bonda, Bonham, Cherokee, Clinton, Colo, James, Kent, Lanark, Mindo, Mohawk, Nemaha, Shelby, Zephyr, Green Mountain, Green Russian, and White Russian are resistant to races 1, 2, 5, 8, 10, and 11; in Group III, Jostrain and Roxton are resistant to certain races but susceptible to the most common ones; in Group IV, Canuck, R.L. 524, and R.L. 2123 are resistant to all races except race 7A; in Group V, Garry, Saia, and three other Strigosa types, C.A.N. 789, C.A.N. 790, and C.A.N. 791, are resistant to all stem rust races.

Race 9 was not included in Table 2 as cultures of this race have not been identified in Canada for a number of years. However, according to Dickson (2) it would appear that the varieties in Group I above give an indeterminate reaction to this race, whereas the varieties in the other three groups, with the exception of Roxton for which no data are available, are resistant.

Of these varieties, Hajira has proved to be important as a source of resistance. From it, Canuck, Garry, and the Hajira × Banner and R.L. 5174 × Roxton selections received their high degree of resistance. It will be noticed in the table that Hajira gives a resistant reaction to races 1, 2, 3, 5, 7, and 12, and a segregating one to races 4, 6, 7A, 8, 10, 11, and 13. According to Welsh and Johnson (35) 12 per cent of the plants in this variety were resistant to the twelve races identified at that time. This investigation did not include race 7A which was not observed until 1952. Subsequent tests, however, indicate that the majority of the plants in Hajira are resistant to this race.

Inheritance studies have shown that these highly resistant plants in Hajira differ genetically. Two factors were found to govern the inheritance in some crosses, and a single factor in others. Resistance was dominant in all crosses.

Crown Rust

Crown rust or leaf rust, *Puccinia coronata avenae* Erikss., occurs in most countries where oats are grown. It is primarily a disease of the leaf, but infections also occur on the stems and it appears to be more destructive in areas of relatively high humidity. It is called crown rust on account of the presence of crown-like appendages on the teliospores (Fig. 1). The disease is not so destructive in Western Canada as in the Eastern Provinces, or in many parts of the United States. On the prairies, infections as high as 75 per cent have been

[1] Since this manuscript was submitted, R.L. 2123 was licensed in Canada and named "Rodney".

observed in some years on susceptible varieties with little apparent reduction in yield. The same amount of stem rust, in any year, would cause much greater damage to the crop. There have been years, notably 1927 and 1938, when crown rust did cause heavy losses to the oat crop in Western Canada. In both of these years moisture was abundant. The reason why crown rust does not appear

TABLE 2.—SEEDLING REACTION OF OAT VARIETIES TO THIRTEEN PHYSIOLOGIC RACES OF STEM RUST

Varieties	Physiologic races of stem rust												
	1	2	5	3	7	12	7A	8	10	11	4	6	13
Group I—													
Ajax	R	R	R	R	R	R	R	S	S	S	S	S	S
Abegweit	R	R	R	R	R	R	R	S	S	S	S	S	S
Andrew	R	R	R	R	R	R	R	S	S	S	S	S	S
Beacon	R	R	R	R	R	R	R	S	S	S	S	S	S
Beaver	R	R	R	R	R	R	R	S	S	S	S	S	S
Branch	R	R	R	R	R	R	R	S	S	S	S	S	S
Eaton	R	R	R	R	R	R	R	S	S	S	S	S	S
Exeter	R	R	R	R	R	R	R	S	S	S	S	S	S
Fortune	R	R	R	R	R	R	R	S	S	S	S	S	S
Marion	R	R	R	R	R	R	R	S	S	S	S	S	S
Nakota	R	R	R	R	R	R	R	S	S	S	S	S	S
Rainbow	R	R	R	R	R	R	R	S	S	S	S	S	S
Richland	R	R	R	R	R	R	R	S	S	S	S	S	S
Rusota	R	R	R	R	R	R	R	S	S	S	S	S	S
Tama	R	R	R	R	R	R	R	S	S	S	S	S	S
Vanguard	R	R	R	R	R	R	R	S	S	S	S	S	S
Vicland	R	R	R	R	R	R	R	S	S	S	S	S	S
Hajira	R	R	R	R	R	R	Seg	Seg	Seg	Seg	Seg	Seg	Seg
Group II—													
Advance	R	R	R	S	S	S	S	R	R	R	S	S	S
Anthony	R	R	R	S	S	S	S	R	R	R	S	S	S
Benton	R	R	R	S	S	S	S	R	R	R	S	S	S
Bonda	R	R	R	S	S	S	S	R	R	R	S	S	S
Bonham	R	R	R	S	S	S	S	R	R	R	S	S	S
Cherokee	R	R	R	S	S	S	S	R	R	R	S	S	S
Clintafe	R	R	R	S	S	S	S	R	R	R	S	S	S
Clinton	R	R	R	S	S	S	S	R	R	R	S	S	S
Colo	R	R	R	S	S	S	S	R	R	R	S	S	S
James	R	R	R	S	S	S	S	R	R	R	S	S	S
Kent	R	R	R	S	S	S	S	R	R	R	S	S	S
Lanark	R	R	R	S	S	S	S	R	R	R	S	S	S
Mindo	R	R	R	S	S	S	S	R	R	R	S	S	S
Mohawk	R	R	R	S	S	S	S	R	R	R	S	S	S
Nemaha	R	R	R	S	S	S	S	R	R	R	S	S	S
Shelby	R	R	R	S	S	S	S	R	R	R	S	S	S
Zephyr	R	R	R	S	S	S	S	R	R	R	S	S	S
Green Mountain	R	R	R	S	S	S	S	R	R	R	S	S	S
Green Russian	R	R	R	S	S	S	S	R	R	R	S	S	S
White Russian	R	R	R	S	S	S	S	R	R	R	S	S	S
Group III—													
Jostrain	R	S	MR	R	S	MR	S	S	MS	R	R	S	MR
Roxton	R	S	S	S	S	S	S	S	R	R	S	S	S
Group IV—													
Canuck	R	R	R	R	R	R	MS	R	R	R	R	R	R
R.L. 524	R	R	R	R	R	R	Seg	R	R	R	R	R	R
Torch	R	R	R	R	R	R	S	R	R	R	R	R	R
R.L. 2123	R	R	R	R	R	R	Seg	R	R	R	R	R	R
Group V—													
Garry	R	R	R	R	R	R	R	R	R	R	R	R	R
Garry Sel	R	R	R	R	R	R	R	R	R	R	R	R	R
Saia	R	R	R	R	R	R	R	R	R	R	R	R	R
C.A.N. 789[1]	R	R	R	R	R	R	R	R	R	R	MR	R	R
C.A.N. 790	R	R	R	R	R	R	R	R	R	R	MR	R	R
C.A.N. 791	R	R	R	R	R	R	R	R	R	R	MR	R	R

[1] Varieties with C.A.N. belong to the species *A. strigosa*.

to do much damage in some years, even though the disease is present, could be attributed to the fact that the rust comes too late to cause much damage, or that the proper environment for development, such as adequate humidity, may be lacking.

Crown rust appears on oats earlier than stem rust. The pustules are smaller and are yellowish-orange in colour. These pustules are filled with spores (urediospores), which are blown about by the wind, infecting other oat plants and susceptible grasses. In the black or telial stage, which develops later, the pustules form a hard, glossy surface, differing from stem rust in this respect.

Fig. 1.—Teliospores of crown rust showing the characteristic crown-like appendages.

The teliospores overwinter on stubble and susceptible grasses and on germination in the spring, produce sporidia which can infect several species of buckthorn. Of the susceptible buckthorns *Rhamnus cathartica* L. and *R. lanceolata* Pursh. are the most important ones in North America. These or some other susceptible species must be present for crown rust to complete its life cycle. *R. cathartica* was introduced from Northern Asia and is cultivated in the Northern United States and Canada. It is used as an ornamental shrub and as a hedge in cities and many farm areas. *R. lanceolata* is native in the United States, but is not used as an ornamental shrub. It is most commonly found in moist soil along small streams and therefore seldom found near oat fields, according to Melhus *et al.* (15). Grasses, however, can be infected from this source. In Canada, *R. cathartica* is the only buckthorn that is of importance in the spread of crown rust, and it is of more importance in the East than in the West. In the West there are comparatively few buckthorn bushes, with the result that the main source of infection is from wind-borne spores blown northward from the United States. In the East, infections are attributable to these wind-borne spores and to buckthorn bushes and hedges which are numerous in that part of Canada. In the northern spring-oat areas of North America and Europe, the yellow or urediospore stage does not overwinter. In milder areas, such as the southern United States, and in countries like Australia and New Zealand, these spores develop throughout the winter on oats and grasses.

As in stem rust, crown rust is not a single entity, but is composed of a large number of physiologic races that may arise through mutation or by hybridization on the buckthorn. Over 100 races have been identified in North America and of this number approximately 26 have been identified in Canada. The Canadian races are 1, 2, 3, 4, 5, 6, 24, 34, 38, 45, 54, and 57, including a number of biotypes as 1A, 2B, 2C, 3A, 3B, 3C, 4A, 6A, 34A, 34B, 34C, 38A, and 1946-1, 1947-1, and 1948-1. For a number of years, races 1 and 4 were the most prevalent in Western Canada, and 2 and 3 in Eastern Canada. Races 34, 45, and 57, however, which have increased in prevalence since 1948 in both Canada and the United States, became the most common races in Western Canada in 1951. The identification of races is carried on in other countries as well, but a culture of rust identified as a certain race in one country, might be identified as a different race in another. This is because the same varieties are not used the world over for identification purposes. There are indications that the varieties used in North America for this purpose are inadequate, and on this account the pathologists in Canada and the United States have recently agreed on the use of a new set of differential varieties. Under the new system the present races will be given new numbers commencing at 201. (See footnote Table 3.)

The reaction of a number of varieties to the different crown rust races is given in Table 3. On the basis of these reactions the varieties are divided into the following eight groups:

Group I.—Varieties with the Bond type of resistance; highly resistant to many of the crown-rust races, but susceptible to races 34, 45, and 57. Some of the varieties with this type of resistance are Andrew, Benton, Bonda, Clinton, James, Lanark, Mindo, Shelby, and Zephyr.

Group II.—Varieties with the Victoria type of resistance; resistant to almost all known crown-rust races, but susceptible to Victoria blight, which is associated with the Victoria type of resistance to crown rust. Varieties reacting like Victoria are Beacon and Garry in Canada, and Tama and Vicland, among others in the United States.

Group III.—Includes Trispernia, which is resistant to most of the crown-rust races in North America, and two more recently introduced varieties, Landhafer and Santa Fe, which so far have been resistant to all of the crown-rust races identified in North America. All three varieties resistant to Victoria blight. On account of their excellent resistance to crown rust, Landhafer and Santa Fe extremely valuable in breeding for resistance to this disease in North America; apparently not so resistant in South America (34).

Group IV.—Varieties reacting like White Russian, such as Anthony, Green Mountain, and Green Russian; resistant to races 2, 4, 5, 34, and 38.

Group V.—Selections made at Winnipeg from hybrids and varieties of Victoria parentage that are resistant to Victoria blight and to race 45 and certain other races that are included with it in inheritance. A number of Garry selections, and selections from the cross R.L. 1574 × Roxton included in this group.

Group VI.—Five varieties, Jostrain, Mabel, Roxton, Klein, and Ukraine, which cannot be placed in any of the other groups because of their miscellaneous reaction to the various races.

Group VII.—Varieties of *Avena strigosa*; resistant to many races, but susceptible to some of the newer biotypes as indicated in Table 3, in this respect differing from the varieties in Group III.

Group VIII.—Varieties Ajax, Beaver, and Erban, more or less susceptible to all races in the seedling stage, but acquiring a certain degree of resistance in the adult or more advanced stage of growth.

TABLE 3.—SEEDLING REACTION OF OAT VARIETIES TO SIXTEEN PHYSIOLOGIC RACES OF CROWN RUST AND TO VICTORIA BLIGHT

Varieties	Physiologic races of crown rust[1]																Victoria blight
	1	1A	2	2B	3	3B	4	5	6	6A	24	34	34A	38	45	57	
Group I—																	
Advance	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Andrew	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Benton	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Bond	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Bonda	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Bonham	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Cherokee	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Clinton	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Colo	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Eaton	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
James	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Kent	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Lanark	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Mohawk	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Mindo	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Nemaha	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Shelby	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Zephyr	R	R	R	R	R	R	R	R	R	R	R	S	S	R	S	S	R
Group II—																	
Beacon	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S
Garry	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S
Tama	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S
Vicland	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S
Victoria	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S
Group III—																	
Clintafe	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Landhafer	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Santa Fe	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Trispernia	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Group IV—																	
Anthony	S	S	R	R	S	S	R	R	S	S	S	R	R	R	S	S	R
Green Mountain	S	S	R	R	S	S	R	R	S	S	S	R	R	R	S	S	R
Green Russian	S	S	R	R	S	S	R	R	S	S	S	R	R	R	S	S	R
White Russian	S	S	R	R	S	S	R	R	S	S	S	R	R	R	S	S	R
Group V—																	
Garry Sel	S	R	R	R	R	MR	S	S	R	S	R	R	S	R	R	S	R
R.L. 2123	S	R	R	R	R	MR	S	S	R	S	R	R	S	R	R	S	R
Branch	S	R	R	R	R	MR	S	S	R	S	R	R	S	R	R	S	R
Group VI—																	
Jostrain	S	S	R	R	R	S	S	R	R	—	R	S	S	R	S	S	R
Klein	S	—	R	—	R	R	R	S	R	—	—	R	—	—	R	R	R
Mabel	S	—	R	R	R	S	S	R	S	S	R	S	—	R	S	S	R
Roxton	S	—	R	R	R	S	S	R	R	—	S	S	S	R	S	S	R
Ukraine	R	S	R	S	R	S	R	R	R	S	R	R	R	MR	R	R	R
Group VII[2]—																	
C.A.N. 789	R	—	R	S	R	—	R	R	—	—	—	R	—	—	R	R	R
C.A.N. 790	R	—	R	S	R	—	R	R	—	—	—	R	—	—	R	R	R
C.A.N. 791	R	—	R	S	R	—	R	R	—	—	—	R	—	—	R	R	R
Saia	R	—	R	S	R	S	R	R	—	—	—	R	—	—	R	R	R
Group VIII[3]—																	
Ajax	R	—	MR	—	MR	—	R	MR	R	—	—	—	—	R	—	—	R
Erban	S	—	R	—	R	—	S	S	R	—	—	—	—	R	—	—	R

[1] Under the new system of race identification the new numbers for the above races are given in parenthesis: 1 and 6 (237); 1A and 6A (226); 2 and 38 (239); 2B (229); 3 and 24 (240); 3B (232); 4 and 5 (238); 34 (201); 34A (211); 45 and 57 (202).

[2] Varieties with C.A.N. belong to the species *A. strigosa*.

[3] Adult resistance only.

The existence of physiologic races complicates breeding for resistance. Until the introduction of varieties such as Landhafer and Santa Fe, two other varieties, Victoria and Bond, were used primarily in breeding for crown-rust resistance. Unfortunately, the crown-rust resistance of Victoria was found to be linked with susceptibility to Victoria blight, a recently identified soil-borne disease. Because of this linkage, the growing of varieties with the Victoria resistance to crown rust, such as Garry and Beacon in Canada, and Tama and Vicland in the United States, was discouraged. Bond is resistant to Victoria blight, so greater reliance was placed on it as a source of resistance for breeding purposes. Unfortunately, it is susceptible to the three new races, 34, 45, and 57, which have been the cause of heavy infections on varieties with the Bond resistance, such as Clinton.

The varieties used most extensively at the present time in breeding for crown-rust resistance are Trispernia, Landhafer, and Santa Fe. Since the development of varieties for distribution purposes from initial crosses involving these varieties is considered to be remote, the backcross method of breeding appears to be the most satisfactory approach to the problem. In the United States the variety, Clintafe, which has the Santa Fe resistance, was produced by this method. In Canada, varieties with the above sources of resistance are in the early stages of development and will not be available for distribution in the immediate future. In the meantime, varieties such as those in Group V, which give a moderately resistant reaction in the field, will offer greater resistance than the varieties now grown commercially.

Inheritance studies with crown rust have been conducted over the years by a number of investigators, mainly under field conditions. The results range from the simple to the more complicated type of inheritance.

At Winnipeg, Welsh, Peturson, and Machacek (unpublished data) using the Victoria source of resistance to crown rust, studied the inheritance of reaction to a number of races and their association with Victoria blight. Resistance to race 4 was found to be dominant and controlled by a single gene. Resistance to this race, and others associated with it in inheritance, was found to be linked with susceptibility to Victoria blight. Resistance to race 45 was also dominant, but the inheritance was more complex than that to race 4. There was a factor for high resistance that was independent of Victoria blight and a factor for a weaker type of resistance (similar to that of race 4) that appeared to be linked with susceptibility to Victoria blight. The thirteen races studied fell into two groups, those that were similar in their reaction to race 4 and those that were similar to race 45.

Smut

Oats and related grasses are subject to infection by two types or species of smut; namely, covered (*Ustilago kolleri* Wille) (Fig. 2) and loose (*U. avenae* (Pers.) Rosts.) (Fig. 3), both of which are world-wide in their distribution. In prairie regions covered smut is predominant while in parkland and other more humid areas loose smut is more prevalent. Both smuts destroy all the parts of oat florets, including seed and both inner and outer glumes, producing a mass of dark brown spores in each individual floret. In covered smut each mass of spores is enveloped by a more or less persistant greyish membrane, while in loose smut there is a delicate membrane that disintegrates soon after the emergence of an infected panicle, leaving masses of spores uncovered. Owing to the presence of intermediate types of smut, as a result of natural crossing between the two species, and the variations in the persistence of spore-covering membranes on different varieties of oats, it is often difficult to identify the type of smut by visual observations alone.

In both species of smut, spores are disseminated by wind, rain, and threshing machines, during the ripening and harvesting of the crop. They adhere to the

FIG. 2.—Covered smut: panicles at left and right are infected; panicle in centre is smut free.

FIG. 3.—Loose smut: panicles at left and right are infected; panicle in centre is smut free.

surface of the grain or they may lodge underneath the hull. Under favourable moisture conditions, spores may germinate and develop strands of mycelium under the hull, which constitute the most effective inoculum. When smutty seed is planted and begins to germinate, spores or the strands of mycelium develop infection hyphae that penetrate the young coleoptile and eventually reach the growing point of the seedling. From then on the mycelium continues to develop with the growing point of the plant without any conspicuous external symptoms until the emergence of the smutted heads.

Since, in both species of oat smut, the inoculum is carried on the surface of the grain or underneath the hull, both may be controlled by the proper use of recommended seed disinfectants. The development of resistant varieties appears to be the most effective method of control.

As in the production of rust-resistant varieties, the production of smut-resistant varieties is complicated by the existence of physiologic specialization within each of the two species of smut. According to Holton and Rodenhiser (10) seven races of covered, and fifteen of loose smut have been identified in the United States. In Canada at least two races of covered and ten of loose smut can be differentiated on the same group of oat varieties that was used by Holton and Rodenhiser. An addition of two other varieties of oats to the differential group more than doubles the number of races of oat smuts that can be differentiated. Physiologic races of covered smut are rather constant in their pathogenicity on a given set of differential hosts and are relatively few in number,

whereas races of loose smut are greater in number and much more variable in pathogenicity. In this respect, loose smut resembles the leaf rusts of cereals.

The reactions of approximately 90 varieties were studied under field conditions over a period of five years, all varieties being tested for at least two years (Table 1). The kernels were dehulled and dusted with dry spores that contained a mixture of races of both smuts. In addition, 28 varieties were inoculated with 4 races of covered smut, and 6 races of loose smut. The results of the latter test are presented in Table 4.

TABLE 4.—PERCENTAGE SMUT INFECTION OF OAT VARIETIES INOCULATED WITH SIX PHYSIOLOGIC RACES OF LOOSE SMUT AND FOUR OF COVERED SMUT AT WINNIPEG IN 1951

Variety	Races of loose smut (*U. avenae*) and covered smut (*U. kolleri*)									
	1	2	3	4	5	6	1	2	3	4
Ajax	21·3	32·5	23·4	27·8	51·8	7·8	9·2	6·7	3·1	0·0
Andrew	8·5	1·0	4·8	3·2	6·2	3·0	4·0	0·0	3·3	6·7
Benton	3·0	2·6	0·0	0·3	1·9	8·9	0·6	0·8	0·0	0·6
Bond	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
Bonda	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	1·0	0·0
Brighton	0·0	0·0	1·7	0·0	0·0	0·0	0·0	0·0	0·0	0·0
Clinton	0·0	1·2	0·0	1·5	14·2	0·0	1·4	0·3	1·3	0·0
Exeter	28·3	0·0	9·5	25·4	29·2	28·0	20·4	26·5	24·8	28·6
Erban	6·5	0·0	9·3	18·9	22·6	21·3	0·0	13·6	19·4	0·0
Fortune	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·4
Gopher	64·2	0·0	12·0	28·8	27·6	47·4	24·1	17·1	21·5	39·4
Garry	0·0	0·9	0·0	0·0	0·0	0·6	0·0	0·6	2·0	0·0
James	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
Markton	1·8	0·0	1·5	0·3	1·2	0·0	0·8	0·0	0·8	0·8
Mindo	0·0	0·0	0·0	0·0	0·3	0·0	0·5	0·0	0·0	0·0
Mohawk	0·0	0·0	0·0	1·5	1·8	0·0	7·1	1·0	1·0	1·3
Nakota	0·5	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
O.A.C. 144	0·0	0·0	0·0	0·7	7·1	0·0	0·0	0·0	2·3	0·6
Ripon	0·0	0·0	0·3	7·8	9·8	6·0	0·0	0·3	0·8	3·5
Roxton	27·3	46·7	27·5	34·3	58·4	35·8	26·9	27·7	16·3	25·4
Shelby	0·0	1·1	0·0	0·0	0·0	0·0	0·0	0·0	0·3	0·0
Tama	0·0	0·8	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
Trispernia	5·0	9·1	6·7	0·6	4·3	2·5	3·5	5·0	1·5	2·8
Vicland	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·3
Valor	0·0	5·4	0·0	0·6	0·8	0·0	0·6	1·2	0·5	0·0
Victoria	0·0	0·0	0·0	0·5	0·0	0·0	0·0	0·0	0·0	0·0
Zephyr	0·0	0·6	0·0	0·6	0·0	0·0	0·0	0·0	0·0	0·0
Anthony	43·8	76·7	33·6	18·6	50·7	60·8	53·4	68·5	38·0	75·8

The smut classes recorded in Table 1 were based mainly on the reaction to a mixture of races as in the larger tests and to some extent on the reactions to individual races. The definition of the several smut classes is based on the following infection class intervals: O = resistant; 20 per cent = moderately resistant; 40 per cent = moderately susceptible; 60 per cent = susceptible; and 80 per cent = very susceptible. The "very resistant" class is based on added information from Table 4, which gives the reactions of certain varieties to ten races. In this table, varieties that give an immune reaction to all races, or a very light reaction to one or two of them are classed as (VR). This classification refers only to those varieties included in Table 4.

Varieties such as Black Mesdag, Bond, Markton, and Victoria, are the sources from which the majority of the varieties under discussion derived their resistance. The exceptions are Erban, O.A.C. #144, Ripon, and Valor. According to R. Keegan of the Ontario Agricultural College (unpublished data), it is quite possible that Erban (Banner × Early Ripe) derived its resistance from both parents. In the original Banner, under conditions of natural infection, the occurrence of smut in the plots was much less frequent than in many other varieties. Under the same conditions, the occurrence of smut in the plots of Early Ripe was so infrequent that the variety was considered to be highly

resistant. The Early Ripe is thought to be different from the one grown under that name on Experimental Farms in Canada. Valor derived its resistance from Sunrise while both O.A.C. #144 and Ripon apparently obtained their resistance indirectly from O.A.C. #72, a variety that is classed as susceptible. O.A.C. #72 was selected from Siberian, a variety which apparently contained a few resistant plants. O.A.C. #144 and O.A.C. #72-214, the latter one of the parents of Ripon, are apparently plants of this type as both of them are resistant selections made from O.A.C. #72. Other sources of resistance are to be found in varieties and strains of *A. strigosa.*

Victoria Blight

This disease, which is also referred to as Helminthosporium blight, is caused by a seed- and soil-borne fungus named *Helminthosporium victoriae* Meehan and Murphy. It attacks susceptible varieties at all stages of growth. The disease was observed for the first time on cereals in 1944 at the Iowa Experiment Station on Tama oats (14). Experiments conducted at Iowa demonstrated that only Victoria and related varieties possessing its crown-rust resistance are susceptible. Hence the name Victoria blight.

In 1945, traces of the disease were observed in several areas of the United States although little damage was reported. By 1946, however, it showed an almost phenomenal spread as many fields sown to Victoria-related oats were severely damaged over a wide area. In Canada the disease was observed in

Fig. 4.—Reaction of Garry selections to Victoria blight. Left to right: resistant and susceptible.

1947 on Beacon and Garry oats. The further growing of these varieties was discouraged as there was evidence to show that the organism was widespread in Canada.

The disease is recognized in a number of ways. In the immature stage, infected plants show a longitudinal yellow striping of the leaves and a rotting of the crown and roots. Plants so infected usually lodge and, under severe epidemic conditions, many plants are stunted. Towards maturity, diseased plants are recognized by a discoloration of the stem in the neighbourhood of the nodes, and by the presence of black spore masses at the base of the plants. At this stage, many plants break over at the nodes and excessive lodging may take place following rotting of the crown and the roots.

Studies at Winnipeg have shown that it is possible to select from Garry and other sources of Victoria parentage, lines that are resistant to Victoria blight (Fig. 4). The studies also revealed that Garry contained three types of plants: (i) plants susceptible to Victoria blight and resistant in the seedling and adult stage to practically all of the crown rust races; (ii) plants resistant to Victoria blight and resistant to only certain crown rust races; and (iii) plants resistant to Victoria blight and susceptible to all crown rust races in the seedling stage, but that show some resistance to this disease in the adult stage. Poehlman and Kingsolver (22) in the United States have also obtained selections of Victoria parentage that are resistant to Victoria blight. These were found to be intermediate in their reaction to races 1 and 45 of crown rust in the seedling stage in the greenhouse, and moderately resistant under field conditions. Shands and Arny (27) report that the variety Branch, which has Victoria in its parentage, is resistant to Victoria blight and moderately resistant to crown rust in the field.

Inheritance studies conducted by a number of investigators, Murphy and Meehan (17), Litzenberger (12), Welsh, Peturson, Machacek (unpublished data) demonstrated that susceptibility to Victoria blight was dominant, and that a single gene governed the inheritance of reaction to the disease.

There appears to be another disease caused by a Helminthosporium that has many symptoms in common with Victoria blight. It is referred to as culm rot (5) because the infection progresses along the culm, sometimes into the rachis. There is very little reddening or striping of the plants, and susceptibility is not confined to varieties of Victoria parentage.

Leaf Blotch

Leaf blotch is caused by the fungus *Pyrenophora avenae* Ito and Kuribay. (*Helminthosporium avenae* Eidam). It is a common and destructive disease of oats in moist and cool areas of North America and Europe, and has also been reported from Asia and South Africa. The fungus is primarily seed-borne and causes a pre-emergence blight and a characteristic bending of the seedlings at the points of infection. Elongated yellow blotches, which turn brown and coalesce to form stripes, occur on the first leaf. Succeeding leaves show fewer symptoms and the fourth or fifth leaf is generally disease-free. After the panicle appears, the plant again becomes susceptible and blotches may occur on any leaf. These secondary leaf spots produce spores that infect the seed. The disease may be controlled by application to the seed of organic mercury fungicides, and to some extent by crop rotation. This fungus does not infect other cereals.

Fusarium Blight (Common Root-Rot)

Fusarium root-rots of oats are caused by several species of *Fusarium*. In Canada, the Northern United States, and Northern Europe, the fungus usually isolated is *Fusarium culmorum* (W. G. Smith) Sacc. In warmer climates *F. graminearum* Schwabe [*Gibberella zeae* (Schw.) Petch] is frequently isolated. Since these fungi are on the seed and in the soil, the disease can appear at any time, causing either pre-emergence seedling blight, post-emergence seedling blight, or pre-maturity blight. Although roots can be infected, it is more usual to find the brown lesions on the sub-terminal internode, the crown, and the base of the culm. Severe infection causes the plant to wilt and die, especially under dry conditions. The fungi causing this disease also infect other cereals and grasses, so that crop rotation is ineffective as a means of control. Seed treatment with organic mercury compounds destroys the fungi on the seed and also protects it for a period of about two weeks from the organisms that are in the soil.

A large number of varieties were tested for their reaction to root-rot under both field and greenhouse conditions (Table 1). In the field 67 varieties were tested for two years at four locations in Manitoba, under conditions of natural infection. The amount of infection on the roots and other basal parts was determined following the heading stage. The infections were comparatively

light, ranging from 5 to 20 per cent. These light infections may be explained to some extent by the fact that during the years these tests were carried on there was an abundance of moisture, a condition that is not favourable to root-rot in Western Canada.

Under these conditions Acton, Banner, Big Four, Eagle, Erban, Jostrain, Landhafer, Liberty, Roxton, Santa Fe, Ukraine, and Victory were classed as resistant. Three varieties, Bonda, Mindo, and Valor were classed as susceptible, while of the remaining varieties 33 were classed as moderately resistant and 19 as moderately susceptible.

The main object of the greenhouse tests was to devise a suitable technique by which the seedling reaction of the varieties could be readily determined under controlled conditions to a number of isolates of *Fusarium culmorum*. The results herein reported are for a single isolate that was taken from roots of Vanguard oats in 1948. Preliminary tests on a few varieties with a second isolate did not reveal any appreciable difference in the reaction of the varieties. However, there is no guarantee that other isolates may not be more pathogenic. In these tests the seed of 89 varieties was planted in 4-inch pots, 25 seeds per pot, and the soil inoculated with a pure culture of *Fusarium culmorum*. The inoculum in the form of artificially inoculated chopped oat straw was spread over the seed and covered with earth in the usual manner. The tests were repeated several times with infections ranging from 2 to 90 per cent.

Of the varieties tested 11 gave a very resistant reaction. This group included Cherokee, a number of other varieties of similar parentage, and Garry Selection. Twelve varieties were classed as resistant among which were Bond and certain varieties of Bond parentage in addition to Gold Rain, Hajira, and Saia. Nine varieties were classed as susceptible including Banner, Canuck, and Valor. The remaining varieties were either moderately resistant or moderately susceptible. With the exception of Laurel, which was classed as moderately resistant, the hulless varieties were very susceptible. Germination tests showed that a great many kernels of these varieties had injured germ ends which could account for their greater susceptibility. The contrast between varieties classed as very resistant and those classed as susceptible is shown in Fig. 5.

Fig. 5.—Seedling reaction of varieties to a culture of *F. culmorum*. First and second rows, inoculated soil; third row, uninoculated check. Left to right: Onward, Richland, and Rainbow (susceptible); C.A.N. 761, Cherokee, and Nemaha (very resistant).

The field and greenhouse tests are not necessarily comparable because in the field other pathogenic organisms, in addition to *F. culmorum*, may be present. However, the agreement between the two tests is considered to be reasonably close if it is assumed that the difference in reaction of those varieties classed as (MR) in one test and (MS) in the other is not great. Of the varieties that were classed as resistant in the field, Erban, Jostrain, Landhafer, Roxton, Santa Fe, and Victory gave a moderately resistant reaction in the greenhouse, indicating a fairly close agreement, while Acton, Banner, Big Four, and Liberty were susceptible. Of the three varieties classed as susceptible in the field, Bonda and Mindo were moderately resistant in the greenhouse, while Valor was susceptible.

Browning Root-Rot

This is a seedling disease caused by the fungi known as *Pythium* species, among which *P. graminicola* Subrm., *P. arrhenomanes* Drechsler, and *P. tardicrescens* Vanterpool are most frequently isolated from diseased plants in Western Canada. In each case the fungus is in the soil and invades the tips of the seminal and crown roots, which later show brown, water-soaked lesions. Microscopic examination of the rootlets reveals the presence of mycelium and oospores in the tissues. The disease is most conspicuous in June, when the lower leaves of the plants turn yellow and then brown. Infected plants are retarded and tillering is reduced with a consequent reduction in yield. Oats sown on fallow are more subject to infection than when sown on stubble. Phosphatic fertilizers applied to the soil give some measure of control; seed treatment is not effective.

Anthracnose

Anthracnose, caused by *Colletotrichum graminicola* (Ces) Wils. is not so common on oats as on other cereals and grasses. The disease is associated with conditions of low or unbalanced soil fertility, open coarse soils, and continuous grass-cereal culture. It is a fairly common disease in certain sections of the Southern United States. It also occurs in Europe and has been observed in Canada (26).

The disease causes a general reduction in plant vigour and premature ripening of the plants. The base of the culms and crown tissue become bleached in appearance, then turn brown. Later, the black acervuli develop on the surface of the lower leaf sheaths and culms, and when moisture is plentiful also develop on the leaf blades of the dead plants. In severe attacks, seedling and crown infections also occur. The fungus is saprophytic on crop residues from which primary and secondary infections arise. Infected seed is also a possible source of seedling root and crown infection. Crop rotation and soil improvement aid in the control of this disease.

Damping-off

This disease is caused by the fungus *Rhizoctonia solani* Kuehn [*Pellicularia filamentosa* (Pat.) Rogers]. It occurs in greenhouse soils and under field conditions may attack oats in stubble. High temperature and low soil moisture seem to favour its occurrence. Sulphate of ammonia applied to the soil may reduce the damage.

Other fungi causing root diseases of oats are *Ophiobolus graminis* var. *avenae* Turner and *Cercosporella herpotrichoides* Fron. Thus far, these diseases have not been very important on oats.

Bacterial Diseases

There are two bacterial diseases of oats, halo blight, *Pseudomonas coronafaciens* (Elliott) Stapp (6) and stripe blight, *Pseudomonas striafaciens* (Elliott) Burkholder (7), both of which attack the leaves chiefly. In the more severe

infections, the sheaths and panicles are also attacked. Both diseases are widespread in North America and both vary in severity according to weather conditions and variety sown. Halo blight has been reported also from Europe (20) New Zealand (24), and South America (33).

Halo blight produces round to oblong, pale green, centrally water-soaked lesions on the leaves, which later turn light brown throughout (Fig. 6). As the number of lesions increases, they coalesce, forming an irregular affected area. Stripe blight produces lesions that are characteristically linear and water-soaked with little or no chlorosis. These lesions also turn light brown, thus making the two diseases difficult to distinguish in late stages of development.

FIG. 6.—Halo blight on Anthony oats. Chlorotic areas surround the infections.

Following very moist conditions, a bacterial exudate may be produced on stripe blight lesions, but this has not been observed in halo blight. The bacteria of both diseases are seed-borne and may also overwinter on infected crop residue. Infection takes place through the water pores or stomata and through wounds such as may be made by insects. Abundant moisture, as from heavy dews or rains, is necessary for the rapid development of both diseases.

The two best methods of control appear to be seed treatment with hot water and the use of resistant varieties. The common surface disinfection methods of seed treatment are ineffective, but satisfactory results are obtained with a ten minute steep in water at 57° C. This method is laborious and time consuming and useful mainly for small seed lots. Fortunately, the chief varieties grown in Canada and the United States at present are resistant to these two diseases. As it is often difficult to distinguish between them, both have been treated as one disease in Table 1, in which the varietal reactions for bacterial diseases are based on disease development following field inoculation with both organisms.

Mildews

Downy mildew, *Sclerospora macrospora* Sacc., attacks oats and other cereals and related grasses, causing various contortions and distortions of leaves and other above-ground parts of the affected plant. Diseased plants usually fail to head but when heads do emerge they are badly deformed and little, if

any, seed develops. The disease is favoured by high humidity and is usually confined to low-lying areas of the field where excessive moisture conditions prevail. It was first found on oats in the United States in 1939, but so far it has not been reported in Canada.

Powdery mildew, *Erysiphe graminis* DC., as the name implies, is characterized by a powdery appearance caused by the creamy-white conidia which develop in blotches on the surface of the leaves and leaf-sheaths. This disease is favoured by dry, cool weather and is frequently found in Eastern Canada and in British Columbia. In the Prairie Provinces with extreme weather conditions, the disease apparently cannot perpetuate itself and it has not been found in the field.

Powdery mildew of oats has not been studied sufficiently to establish physiologic specialization within this variety of the organism. Two cultures from British Columbia and one from Quebec were tested on approximately a hundred oat varieties and hybrids and all three proved identical in their pathogenicity. Only a variety of *Avena strigosa* proved highly resistant in the seedling stage to the cultures of powdery mildew.

Speckled Leaf Blotch

Speckled leaf blotch (*Septoria avenae* Frank = *Leptosphaeria avenaria*, Weber), which is also referred to (23) as black stem, is a disease that occurs in oats and some closely related wild grasses. It caused severe damage in parts of Eastern Canada and in sections of the United States in 1951 and 1952. It attacks both the leaves and the stems, with cool, wet weather favouring its development. The blotches on the leaves have an indefinite margin of light yellow to straw-coloured areas intermingled with green. Later the area turns light brown and small black pycnidia develop in the necrotic portion. On the stems the disease is characterized by greyish-brown to shiny black lesions on the upper internodes, particularly underneath the leaf sheath. The breaking of the culm at the point of infection is a common occurrence. The fungus overwinters in crop residue.

Ajax, Beaver, Bonda, Branch, Clinton, Richland, and Shelby showed varying degrees of resistance in Iowa in 1951 (23). Bond, Saia, and Trispernia also appear to be resistant according to independent observations by R. A. Derick, Experimental Farm, Ottawa, and Dr. T. Johnson, Laboratory of Plant Pathology, Winnipeg.

Brown Stripe

This disease is caused by the organism *Scolecotrichum graminis* Fckl. var. *avenae* Erikss. It occurs on oats and a large number of related and unrelated grasses, especially orchard grass and timothy. It is widespread in Europe and America in humid and semi-humid areas, especially on soils low in fertility. Oblong to linear reddish-brown to brownish-purple blotches with regular margins develop on the leaves. The necrotic area is dry and sunken with conspicuous rows of conidiophores that emerge through the stomata. Conidial production on most oat varieties is sparse.

The disease develops as a saprophyte on crop refuse, producing conidia which infect the leaves whenever weather conditions are favourable. Knowledge of the life cycle of this disease is incomplete.

Virus Diseases

Virus diseases, of which the mosaic pattern is characteristic, are known to occur in the southern winter-oat area of the United States, and in similar sections of Europe and Asia. Some of the symptoms of these diseases are yellow, light green, or almost cream-coloured striping and mottling of the leaves, which in some cases turn reddish brown in the later stages. In severe cases, the plants become stunted and in addition may fail to head, a condition referred to as the rosette reaction.

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Atkinson (1) describes a mosaic in which the streaks are cream in colour in contrast to the usual green or yellow. Rosen (25) describes a red spot mosaic observed in Arkansas that produces a red spotting and mottling of the leaves. Later, the leaves turn yellowish to reddish brown in colour, with the brown predominant. McKinney (13) describes two mosaics, eye spot, *Marmor terrestre oculatum*, and apical, *Marmor terrestre typicum*. Eye spot induces fusiform and spindle-shaped spots with light green to ashen-grey borders and green centres. Apical mosaic is described as producing light green to yellow narrow streaks paralleling the long axis of the leaf, and sometimes chlorotic mottling. The chlorotic patterns are usually most evident in or near the apical portion of the three upper leaves, tending to fade as the leaves develop. These two maladies are considered to be the result of soil-borne viruses. Oswald and Houston (19) describe a mosaic known as yellow dwarf, which was prevalent on the barley crop in California in 1951. Within a week after the disease appeared on barley, stunting of wheat and the reddening of oats was observed. They established that it could be transmitted to oats by aphids. The first symptom of the disease on oats is the development of irregular yellowish green blotches on the older leaves, principally near the tip. These spots later take on a reddish cast and eventually the leaf tip and often the entire leaf becomes reddish brown in colour. Associated with this discoloration is extreme dwarfing and longitudinal striping of the new leaves.

Seasonal conditions, principally the cooler temperatures, appear to favour the amount of mosaic and under suitable conditions the disease is capable of causing severe damage to certain oat varieties.

Red Leaf

Oat plants, in which the leaves turn red, have been observed from time to time in experimental plots. Since the early 1940's, however, this red leaf condition has been prevalent, in some seasons, in many parts of the United States. A similar condition has been observed in Ontario and studies are under way at the Cereal Division, Central Experimental Farm, Ottawa, Ont., to determine its cause. In 1939 Sprague (28) reported the occurrence of leaf reddening in oats in Oregon. This writer attributes the condition to environmental factors, such as high soil acidity, excessive moisture, low temperatures, insect damage, and diseases such as root-rot. On the other hand, a red leaf condition observed in Minnesota by Moore (16) is considered to be caused by a virus and to be transmissible by aphids. Except for this "red leaf" condition and the one observed in the oat crop in California in 1951, which is attributed to a virus by Oswald and Houston (19) the cause of the leaf reddening observed elsewhere has not been specifically determined, although much of it is thought to be the result of environmental conditions.

In this connection there appear to be two distinct types of "leaf reddening". In one the leaves turn red in the early part of the growing season but recover with warmer weather. This condition is usually associated with a cold wet spring. In the other type the leaves turn red in the early part of the growing season, then, about heading time, turn grey and die. With both conditions there is a definite varietal response, as some varieties and hybrids appear to be resistant. The varieties of Bond parentage, however, appear to be particularly susceptible to the latter condition.

Red Leather Leaf

This "red leaf" disease is caused by a leaf-spotting fungus, *Pseudodiscosia avenae* Sprague and Johnson. According to Sprague (28) it is very abundant in certain parts of Oregon during late winter and early spring. The leaves do not show any well defined spots but are scalded to an intense red colour. They dry, taking on a semi-leathery appearance, with the tips and sometimes the whole leaf

becoming brown. While the fungus is actively parasitic during the rainy weather of late winter and early spring it is checked by the dry weather that follows. A few sunny days usually stop its progress and permit the oats to make a rapid recovery. In spite of this fact it inhibits the growth of winter oats, particularly those of the red group.

Snow Mould

Snow mould, *Fusarium nivale* (Fr.) Ces., attacks winter-sown crops. It occurs in the United States, Europe and Asia, but has never been reported in Canada. It occurred during the winter of 1948 in the oat plots at the New Jersey Agricultural Experiment Station (9), under which conditions oat varieties, Winter Turf, Forkedeer, Lee, Pioneer, and Stanton were resistant, and Traveler and Wintok susceptible. On the susceptible varieties the diseased leaves at first appeared water-soaked and were matted together by the cobwebby mycelial growth. Later, heavy sporulation of the fungus gave a pinkish colour to the crowns of the collapsed plants.

Blast

Blast is a non-parasitic disease that is common on oats in most countries. It affects the panicle or head of the plant on which white, thread-like tissue developes in place of the grain, a condition that occurs mainly on the lower branches of the panicle. According to Johnson and Brown (11), who studied the etiology of this disease and have given a comprehensive review of the literature, the critical period for the formation of blasted spikelets appears to be from the time the spikelets are being developed until just prior to the emergence of the panicle. Deficiency of available moisture at this time results in the blasting of a large number of the more immature spikelets at the base of the panicle. This is because the uppermost spikelets are in the more advanced stages of development and, therefore, secure the bulk of the food supply. Other factors such as excessive light, deficiency of soil nutrients, and leaf injury resulting from diseases or insects may also cause a blasting of the spikelets.

Although some varieties are less affected by blast than others, in general, the early maturing ones are less susceptible than the later ones. It is characteristic of these later maturing varieties to have very large panicles that cannot always be carried to full development. Apparently the critical period for panicle developed in the later maturing varieties more often coincides with the adverse conditions responsible for blasting. In some areas the dominant factor is hot, dry weather, causing conditions wherein there are insufficient nutrients for complete spikelet development.

The loss in yield resulting from blast is difficult to measure as varieties like Victory and Exeter, which are subject to it, are noted for their ability to produce high yields. However, it is likely that such varieties would produce higher yields if blast were not present. On the other hand, it is also possible that nature has a way of compensating for the presence of blasted spikelets in that the available food supply can produce larger and plumper kernels than if all spikelets in a panicle developed.

Grey Speck

Grey speck is a non-parasitic disease caused primarily by a deficiency of available manganese in the soil. It appears to be more common in Europe and Australia than in the major oat-growing areas of North America, but the increasing number of areas recognized as affected in Western Canada suggests that the damage done often escapes recognition as resulting from grey speck. This disease occurs most frequently on naturally calcareous or over-limed soils, high in organic matter. When affected with grey speck, the oat plant lacks vigour and develops irregular light green to grey spots on the leaves. The first signs of disease do not usually occur until the fourth or fifth seedling leaf

has been produced. A characteristic sign is a breaking-over of the leaf at about two-thirds of the distance back from its tip. As the disease progresses, the affected areas enlarge, dry out, and become whitish to brown in colour. Frequently small oval whitish lesions occur in a linear distribution between the veins of the leaf (Fig. 7). The extent to which the spots enlarge depends on the variety and severity of the soil deficiency. It may include the entire leaf area. The severity of the attack may range through leaf spots with little effect on the grain, more severe leaf and sheath damage with a reduced set of seed, to a very severe loss of vigour with no "heading". Under conditions of still greater deficiency the plant dies early.

The disease can be controlled by fertilizing the crop with manganese in a soluble form, by means of soil amendments that make manganese available to

Fig. 7.—Grey speck on Victoria × R.L. 524 Selection. Necrotic spots intersperse the veins.

the plant, and by the use of resistant varieties. Fortunately, some varieties possess sufficient adaptability to "grey speck sick" soil to yield satisfactorily under all but the worst conditions of manganese deficiency. Under certain conditions this appears to be attributable to fewer manganese-fixing bacteria in and around the roots of a resistant variety. Stiles (32) gives a comprehensive review of the literature on manganese deficiency in plants.

The data on grey speck resistance as given in Table 1 are based on replicated tests in a farmer's field at Oak Bank, Man., in which a good response to manganese sulphate was obtained before and during the years of the test.

Chemical Composition of Oat Grain as Related to Variety and Environment

In addition to breeding for disease resistance, high yield, and other desirable agronomic characteristics, nutritional value should also be taken into consideration. With this object in mind 60 varieties and species of oats, chosen to represent a wide diversity of types were grown in replicated plot tests at Ottawa,

Winnipeg, Scott, and Agassiz in 1947, 1948, and 1949. Each year at each Station a composite sample of grain from the bulking of replicates from each variety was ground in a hammer mill and analysed for moisture, protein, ether extract, ash, and crude fibre. The data were converted to a dry-matter basis

TABLE 5.—AVERAGE CHEMICAL COMPOSITION (% dry matter) OF THE GRAIN OF SIXTY VARIETIES AT FOUR STATIONS FOR THE THREE YEARS 1947, 1948 AND 1949

Varieties	Protein (N × 6·25)	Ether extract (fat)	Ash	Carbohydrates	
				Crude fibre	N.-free extract
C.A.N. 233	17·07	4·97	3·78	11·62	62·56
Abundance	15·73	4·96	3·57	10·78	64·96
Acton	16·85	5·17	3·49	10·33	64·16
Ajax	16·01	4·67	3·51	11·55	64·26
Alaska	17·16	4·94	3·64	9·57	64·69
Anthony	15·39	5·07	3·72	12·06	63·76
Ardri	15·60	4·07	3·51	12·77	64·05
Bambu	15·31	3·97	3·59	12·16	64·97
Banner	15·61	4·35	3·60	11·69	64·75
Beacon	15·53	5·24	3·39	12·93	62·91
Beaver	16·43	4·85	3·57	10·77	64·38
Benton	17·20	4·69	3·52	10·21	64·38
Big Four	15·08	5·48	3·86	11·59	63·99
Bond	16·24	4·50	3·91	11·81	63·54
Bonda	17·25	4·94	3·69	11·18	62·94
Black Mesdag	16·28	4·59	3·94	13·11	62·08
Brighton	19·25	6·61	2·36	3·09	68·69
Canuck	17·47	6·42	3·54	9·51	63·06
Cartier	17·43	4·68	3·71	10·64	63·54
Clinton	17·06	4·24	3·50	11·45	63·75
Dasix	15·12	3·74	3·51	11·87	65·76
Eagle	14·86	5·02	3·56	11·57	64·99
Early Miller	16·14	5·40	3·03	10·69	64·74
Erban	16·83	4·85	3·75	11·71	62·86
Exeter	14·08	2·76	3·47	12·88	66·81
Garry	15·92	5·62	3·47	11·62	63·37
Gold Rain	15·88	4·79	3·48	11·13	64·72
Gopher	16·11	5·01	3·57	11·27	64·04
Grey Winter	14·77	4·78	3·64	11·81	65·00
Hajira	16·42	5·71	3·62	11·24	63·01
Jostrain	15·18	5·67	3·53	10·12	65·50
Hajira × Banner	16·04	4·62	3·63	12·06	63·65
Larain	17·16	4·82	3·55	9·80	64·67
Laurel	19·94	4·30	2·32	2·71	70·73
Legacy	15·94	3·50	3·43	12·30	64·83
Liberty	19·65	6·56	2·45	2·91	68·43
Mabel	16·64	6·44	3·59	9·57	63·76
Markton	14·97	6·26	3·75	11·40	63·62
Mindo	16·09	6·14	3·82	11·71	62·24
Nakota	18·66	5·64	2·61	4·35	68·74
Onward	14·30	3·58	3·25	14·06	64·81
O.A.C. 3	16·71	4·88	3·73	10·27	64·41
O.A.C. 72	15·29	4·76	3·77	11·83	64·35
O.A.C. 144	15·26	5·71	3·65	11·67	63·71
Rainbow	16·22	3·59	3·55	10·68	65·96
Richland	16·39	3·95	3·60	12·07	63·99
Ripon	15·43	5·38	3·58	10·55	65·06
Roxton	14·54	5·84	3·17	8·86	67·59
Rusota	15·25	3·56	3·48	11·42	66·29
Sixty Day	16·99	4·11	3·60	11·34	63·96
Tama	16·37	5·31	3·31	12·72	62·29
Trispernia	17·11	6·33	3·35	10·10	63·11
Ukraine	15·53	5·47	3·68	11·42	63·90
Valor	17·08	4·95	3·60	11·45	62·92
Vanguard	16·12	3·66	3·48	11·50	65·24
Vicland	16·39	5·17	3·28	13·43	61·73
Victoria	15·47	5·79	3·60	12·53	62·61
Victory	15·56	4·51	3·70	12·11	64·12
White Cross	16·21	4·06	3·63	11·95	64·15
Significant Difference	1·17	0·38	0·26	1·08	1·33

and analysed statistically for each year and for the three years combined. The data on 60 varieties given in Table 5 are the averages for three years at four Stations. Of varieties not included in the table, one year's results are available for Abegweit, Andrew, Fortune, Lanark, Zephyr, a number of Garry selections, and selections from the cross R.L. 1574 × Roxton. Of this group, only certain selections of the latter cross are low in protein.

The data in Table 5 show that varieties differ in chemical composition and that hulless varieties are higher in protein and nitrogen-free extract and lower in crude fibre and ash than the hulled ones. In the hulled varieties the range in chemical composition was from 14.08 to 17.47 per cent for protein, 2.76 to 6.44 for fat, 3.03 to 3.86 for ash, and 8.46 to 14.06 for crude fibre. Such variations should not be overlooked in considering oats as a feed for livestock and they emphasize the need for considering nutritional value as well as yield and disease resistance in an oat breeding program. The varieties producing less than 15 per cent protein are Eagle, Exeter, Grey Winter, Markton, Onward, and Roxton. Of these, Exeter and Onward are the lowest in fat. Approximately 20 varieties fall within the 15 to 16 per cent range which includes Abundance, Banner, Victory, Beacon, Garry, Gold Rain, Rusota, and Dasix. Other well-known named varieties falling within the 16 to 17.5 per cent range are Alaska, Cartier, Ajax, Beaver, Erban, Gopher, Larain, Richland, and Vanguard. In this connection it is of interest to note that two varieties, Canuck and Trispernia, that are valuable as rust-resistant breeding material, are high in both protein and fat. Also high in nutritive value are varieties of American origin, such as Clinton, and varieties of similar parentage.

Protein content was found to be associated with a number of other characters. Preliminary investigations indicate that the later maturing varieties are, in general, lower in protein than the earlier maturing ones. High protein was found to be associated with low fibre and high fat content, the exception being Roxton, which is low in protein and fibre but high in fat. There are indications also, on the basis of one year's results at a single station, that the varieties highest in protein are also high in phosphorus and magnesium.

The investigations revealed that the protein content varied with locality, year, annual and summer precipitation, hours of sunshine, temperature, and elevations. The other chemical constituents varied relatively little with the above factors. Although the protein content varied with the above-mentioned environments there was no significant change in the relative protein content of the varieties. Low protein was found to be associated with high precipitation and low elevations, while high protein content was found to be associated with light rainfall, greater hours of sunshine, and high elevation. As a result of these associations, the average protein content was decidedly low at Agassiz (12.78), high at Scott (18.77) and Winnipeg (17.68), and medium at Ottawa (15.71). Evidently the Prairie Provinces produce oats higher in protein than other parts of Canada, because of limited rainfall, greater hours of sunshine, and higher elevation. This observation is in accordance with the facts known to be true for wheat.

Varieties

Oats belong to the genus, *Avena*, one of the numerous subdivisions of the great grass family, the Gramineæ. There are several species of oats and within each species there are a number of varieties. The species differ morphologically and cytologically. Morphologically the species differ in height, pubescence, basal articulation, colour of grain, and other characters. With regard to colour, oats may be white, yellow, red, grey, or black. Cytologically oats may possess 42, 28, or 14 chromosomes in the diploid phase. Species in the 42 chromosome group are: *A. sativa* (common oat); *A. orientalis* (side-panicled oat); *A. nuda*

(hulless); *A. fatua* (wild oat); *A. sterilis*, and *A. byzantina* (cultivated form of *A. sterilis*). Species with 28 chromosomes are *A. barbata and A. abyssinica*, while two of the species with 14 chromosomes are *A. strigosa* and *A. brevis*.

In general the oat varieties grown in North America are of the *A. sativa* type, the exception being the varieties of *A. byzantina* which are grown in the southern part of the United States. These red oats had their origin in the Mediterranean area, probably North Africa. Oats of this type have furnished the plant breeder with valuable breeding material resistant to crown rust and smut. Hulless oats are used on this continent principally as feed for chickens and weanling pigs, as they are more easily digested. These oats are not used for oatmeal mainly on account of the ease with which dust particles adhere to the unprotected groat. The common oat, which is dehulled by mechanical means, is preferred. Oat hulls are used commercially in the production of furfural, which is widely used as a solvent in manufacturing processes. Side-panicled oats are grown as

TABLE 6.—ACCESSION NUMBERS OF OAT VARIETIES

Varieties	R.L.[1] No.	C.A.N.[3]	C.I.[3]	Varieties	R.L. No.	C.A.N.	C.I.
A. strigosa	1042	233	....	Hajira Sel	559·16	810	....
"	124	789	....	James	116	787	5015
"	125	790	....	Jostrain	561	763	2660
"	126	791	....	Kent	119	805	3909
Abegweit	114	693	4970	Klein	92	749	4118
Abundance	844	526	1493	Lanark	123	733	4981
Acton	1320	451	3625	Landhafer	91	750	3522
Advance	117	725	3845	Larain	198	692	4611
Ajax	1114	660	4157	Laurel	167	461	2231
Alaska	165	458	1710	Legacy	193	460	2232
Andrew	94	726	4170	Liberty	760	462	845
Anthony	1075	216	2143	Mabel	1314	542	3630
Ardri	80	744	....	Marion	42	662	3247
Bambu	81	657	4609	Markton	353	524	2053
Banner	179	342	1729	Mindo	78	751	4328
Beacon	58	696	4608	Mohawk	96	702	4327
Beaver	11	672	4521	Nakota	1309	666	2883
Benton	79	745	3910	Nemaha	121	804	4301
Big Four	82	329	1158	O.A.C. 3	197	16	1948
Black Mesdag	784	432	1877	O.A.C. 72	168	468	846
Bond	1130	326	2733	O.A.C. 144	171	39	2476
Bonda	77	746	4329	Onward	12	753	....
Bonham	118	803	4676	Rainbow	1066	361	2345
Branch	145	808	5013	Richland	172	4	787
Brighton	1321	668	4160	Ripon	20	655	4135
Canuck	811	747	4024	Roxton	48	658	4134
Cartier	633	133	2565	Rusota	371	327	2343
Cherokee	128	811	5444	Saia	84	788	4639
Clintafe	143	813	5869	Santa Fe	90	754	4518
Clinton	66	698	3971	Shelby	112	737	4372
Colo	122	806	3972	Sixty Day	318	100	1887
Dasix	47	656	4161	Tama	55	683	3502
Eagle	1131	457	4113	Torch	173	812	....
Early Miller	1304	650	3269	Trispernia	3	755	4009
Eaton	120	729	3908	Ukraine	64	752	3259
Erban	1307	647	3838	Valor	43	633	4137
Exeter	53	661	4158	Vanguard	7	651	3837
Fortune	101	686	5226	Vicland	49	664	3611
Garry	1692	699	4801	Victoria	1006	445	2401
Garry Sel	1692·27	809	6662	Victory	159	124	1145
Gold Rain	827	196	2194	White Cross	645	108	2026
Gopher	58	14	2027	White Russian	177	1	551
Green Mountain	929	245	1892	Zephyr	95	724	4800
Green Russian	1093	807	2890	Hajira × Banner	524	748	....
Grey Winter	83	180	1241	R.L. 1574 × Roxton	2123	761	6661
Hajira	559	249	1001				

[1] R.L. Accession number of Laboratory of Cereal Breeding, Winnipeg.
[2] C.A.N. Canadian accession number.
[3] C.I. Accession number of the United States Department of Agriculture.

a crop in Northern Europe and Asia. *A. strigosa* is found in the United Kingdom, France, Spain, and Portugal and is grown as a crop in the light sandy soils. This species is important from the standpoint of plant breeding as a number of *Strigosa* introductions are known to be resistant to the rusts and smuts, as well as to other diseases. Varieties of this species usually have small black or grey kernels, and are heavily awned. *A. brevis*, known as the short oat, is found cultivated and as a weed in Spain and Portugal, in certain regions of France and Belgium, and in a few places in Germany.

The varieties under discussion are of the *A. sativa*, *A. byzantina*, and *A. strigosa* species, with the majority belonging to *A. sativa*. These are listed in alphabetical order and are dealt with according to history, general characteristics, disease resistance, and nutritive value, where this latter information is available. The Canadian and American accession numbers are given in Table 6.

Abegweit

History.—Vanguard × Erban; cross made at the Cereal Division, Central Experimental Farm, Ottawa, in 1937; distributed in 1947 and application for registration made in 1949.

General Characteristics.—Well adapted to the Maritime Provinces, particularly to Prince Edward Island; two to three days later than Beaver, which is of the same parentage, has a slightly shorter straw, and a kernel that is not so plump or so thin in the hull.

Disease Resistance.—Resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust, resistant to halo blight and Victoria blight; has some mature-plant resistance to crown rust probably inherited from Erban, a variety that Peturson (21) found to be resistant in the adult stage to races 2, 3, 6, and 38.

Nutritive Value.—Medium in protein, fat, and fibre.

Abundance

History.—White August × White Swedish; a production of Garton Bros., Warrington, England; introduced into general agriculture there in 1892, later brought to Canada where it enjoyed a certain amount of popularity for a limited length of time.

General Characteristics.—A little earlier than Victory, but less productive; most outstanding characteristic its medium short, broad, white, plump kernel.

Disease Resistance.—Resistant to Victoria blight.

Nutritive Value.—Medium in protein, fat, and fibre.

Acton

History.—Fifty Pound Black × Alaska; cross made at Macdonald College, Que., in 1913; not a licensed variety.

General Characteristics.—Moderate yielding, medium early maturing with strong straw and thin hull, its two most noteworthy characteristics.

Disease Resistance.—Resistant to halo blight, and Victoria blight, and moderately resistant to grey speck.

Nutritive Value.—High in protein, medium in fat, and low in fibre.

Advance

History.—D 69 × Bond. Cross made at the Iowa Agricultural Experiment Station in 1932 and the variety distributed by Cornell University in 1949; not licensed for sale in Canada; D 69 originated from a cross between Richland and Green Russian CI 2890 made at Ames about the year 1917.

General Characteristics.—Lower yielding than Ajax in Canada but somewhat similar in length and strength of straw; kernels medium large, light yellow in colour, and low in hull content; bushel weight satisfactory.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust and to many races of crown rust; susceptible to race 7 of stem rust and to races 34, 45, and 57 of crown rust, which recently have become prevalent in Canada and the United States; resistant to smut, Victoria blight, and halo blight.

Nutritive Value.—No data.

Ajax

History.—Victory × Hajira; cross made at Laboratory of Cereal Breeding, Winnipeg, Man., in 1930; licensed in 1941 and distributed in 1942.

General Characteristics.—A widely adapted, high yielding, early maturing variety; yields well in many parts of Canada and the United States; has a moderately tall strong straw, small white kernels, medium thin hulls, and medium high bushel weight.

Disease Resistance.—Resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust, resistant to halo blight, grey speck, and Victoria blight; although classed as moderately resistant to smut has greater resistance to covered smut than to loose smut; susceptible to all races of crown rust in the seedling stage, but resistant to races 1, 4, 6, and 38, and moderately resistant to races 2, 3, and 5, in the adult stage, Peturson (21); under field conditions shows some resistance to this disease in Canada and the United States.

Nutritive Value.—Medium in protein, fat, and fibre.

Alaska

History.—Parentage unknown; introduced into Canada by Ontario Agricultural College, Guelph, Canada, from the United States in 1900.

General Characteristics.—A moderate yielding, very early maturing variety popular at one time in Eastern Canada on account of its earliness; has a tall strong straw, white kernels of medium size, very thin hulls, and medium bushel weight.

Disease Resistance.—Resistant to Victoria blight and moderately resistant to halo blight and grey speck.

Nutritive Value.—High in protein, medium in fat, and low in fibre.

Andrew

History.—Bond × Rainbow; cross made at the University of Minnesota in 1933; named in 1947 and distributed in Minnesota in 1949; not licensed for sale in Canada.

General Characteristics.—Earlier maturing than Ajax but has not yielded so well in tests conducted in most parts of Canada; has a short strong straw, yellow kernels of medium size and hull content, and medium bushel weight.

Disease Resistance.—Resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust, and to the majority of the crown-rust races; susceptible to race 8 of stem rust and to races 34, 45, and 57 of crown rust, which have become prevalent in Canada and the United States; resistant to smut and Victoria blight.

Nutritive Value.—High in protein; no data on other chemical constituents.

Anthony

History.—White Russian × Victory; cross made at the University of Minnesota in 1918 and the variety distributed in the United States in 1929; introduced into Canada a short time later.

General Characteristics.—A high yielding, late maturing variety, with fair length and strength of straw, white kernel of medium size, thick hull, and medium bushel weight, in Canada distribution confined to Manitoba and parts of Saskatchewan mainly on account of its rust resistance; although a satisfactory yielding variety, never became a widely adapted one; present distribution in Canada negligible.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust and to certain races of crown rust; susceptible to race 7 of stem rust and to a number of crown-rust races including 45 and 57; resistant to halo blight and Victoria blight; very susceptible to smut.

Nutritive Value.—Medium in protein, fat, and fibre.

Ardri

History.—Glasnevin Sonas × Victory; the former parent from the cross (Canadian Banner × Black Tartary). Ardri obtained by the Cereal Division, Ottawa, in 1934 from University College, Dublin, Ireland.

General Characteristics.—Has outstanding straw strength and thus valuable as a parent in a plant breeding program; mediocre in other respects.

Disease Resistance.—Resistant to Victoria blight.

Nutritive Value.—Medium in protein and fat, high in fibre.

Avena Strigosa

History.—Appears to be of European or Asiatic origin.

General Characteristics.—All varieties of *A. strigosa* inferior agronomically on this continent; kernels very small, grey in colour, and usually heavily awned; all types have 14 chromosomes, crosses between them and normal 42 chromosome oats difficult to make; some varieties or types of this species resistant to a number of diseases, others susceptible to most of them; resistant types could be valuable as new sources of disease resistance.

Disease Resistance.—Some sorts resistant to the smuts and rusts as C.A.N. 789, C.A.N. 790, C.A.N. 791; C.A.N. 233 susceptible to the rusts and smuts, but resistant to mildew.

Nutritive Value.—High in protein, medium in fat and fibre.

Bambu

History.—(Abundance-Victory) × (Victory-Great Mogul); developed by the Swedish Seed Association, Svalov, Sweden; licensed for sale in Canada in 1946.

General Characteristics.—Very stiff straw the outstanding characteristic; in the medium maturity class, has white plump kernels, medium low in bushel weight; distribution limited to the coastal regions of British Columbia.

Disease Resistance.—Resistant to halo blight and Victoria blight and moderately resistant to grey speck.

Nutritive Value.—Medium in protein, low in fat, and medium in fibre.

Banner

History.—Banner said to have been an old re-named oat, originating from a small lot of seed of obscure origin; placed on the market in the United States in 1886 as American Banner by seedsman James Vick of Rochester, N.Y.; introduced into Canada about the year 1890 by the Ontario Agricultural College, from the John A. Salzer Seed Company of LaCrosse, Wisconsin; several selections made from this variety superior to the original. Selection described herein Banner (Ottawa 49).

General Characteristics.—A high yielding, late maturing variety widely grown in Canada before the advent of the newer rust-resistant varieties; possesses good length and fair strength of straw, and white, elongated, medium large, thick-hulled kernels; bushel weight medium high.

Disease Resistance.—Resistant to halo blight and Victoria blight.

Nutritive Value.—Medium in protein, fat, and fibre.

Beacon

History.—(Gold Rain-Alaska) × (Legacy-Victoria) × (R.L. 453-Vanguard); cross made at the Cereal Division, Ottawa, in 1936; variety distributed in 1947.

General Characteristics.—A high yielding, mid-season variety with a medium short strong straw and white kernels that are medium in size and hull content; bushel weight satisfactory; susceptibility to Victoria blight limits its distribution.

Disease Resistance.—Resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust, and to all of the prevalent crown-rust races; resistant to halo blight and, although classed as a smut-susceptible variety, resistant to a few races of loose smut.

Nutritive Value.—Medium in protein, high in fat and fibre.

Beaver

History.—Vanguard × Erban; cross made at the Cereal Division, Ottawa; variety distributed in 1945 and accepted for registration in 1946.

General Characteristics.—A high yielding, medium maturing variety with average length and strength of straw, an attractive, large white kernel, medium thin hull, and medium high bushel weight.

Disease Resistance.—Resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust, and resistant to halo blight, and Victoria blight; some mature-plant resistance to crown rust under field conditions in Eastern Canada.

Nutritive Value.—High in protein, medium in fat and fibre.

Benton

History.—D 69 × Bond; cross made in 1932 at the Iowa Agricultural Experiment Station, Ames, Iowa; released for distribution in the United States by the Iowa and Indiana Agricultural Experiment Stations in 1946; not licensed for sale in Canada.

General Characteristics.—High yielding in the United States, only moderate yielding in Canada; early maturing, comparatively short strong straw, medium large yellow kernels, moderately thin hull, and medium high bushel weight.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust, and to the majority of the crown-rust races; susceptible to race 7 of stem rust and to races 34, 45, and 57 of crown rust, which have become increasingly prevalent in Canada and the United States; resistant to smut, halo blight, and Victoria blight, and moderately resistant to grey speck.

Nutritive Value.—High in protein, medium in fat, and low in fibre.

Big Four

History.—Early history obscure but known to have been introduced into Wisconsin by the Salzer Seed Company in 1899; apparently spread into Canada as a variety of that name; often found growing in Prince Edward Island.

General Characteristics.—A mid-season oat with no qualities superior to other varieties grown commercially.

Disease Resistance.—Resistant to Victoria blight.

Nutritive Value.—Low in protein, high in fat, and medium in fibre.

Black Mesdag

History.—A selection made by Louis de Vilmorin from Black President, a variety introduced into France from the Netherlands; introduced into the United States many years ago from Vilmorin-Andrieux et Cie, Paris, France.

General Characteristics.—A low yielding, black-grained variety, used mainly in breeding for smut resistance.

Disease Resistance.—Resistant to smut, grey speck, and Victoria blight.

Nutritive Value.—Medium in protein and fat, high in fibre.

Bond

History.—Red Algerian × Gold Rain; cross made in Australia and the variety introduced into the United States in 1929; like its parent Red Algerian, Bond belongs to the species *A. byzantina.*

General Characteristics.—A low yielding, very early maturing variety with a short very strong straw, and large reddish-coloured kernels; resistance to crown rust and smut makes it valuable as breeding material.

Disease Resistance.—Resistant to the majority of the crown-rust races, but susceptible to races 34, 45, and 57, which have become prevalent in Canada and the United States; also resistant to smut and Victoria blight.

Nutritive Value.—Medium in protein, fat, and fibre.

Bonda

History.—Bond × Anthony; cross made at the University of Minnesota in 1931; variety named in 1945 and released for distribution in Minnesota in 1946; not licensed for sale in Canada.

General Characteristics.—A moderate yielding variety in Canada, early maturing, has a medium tall strong straw, large white thick hulled kernels, and medium high bushel weight.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust and to the majority of the crown-rust races; susceptible to race 7 of stem rust and to races 34, 45, and 57, which recently have become prevalent in Canada and the United States; resistant to smut and Victoria blight.

Nutritive Value.—High in protein, medium in fat and fibre.

Bonham

History.—D 69 × Bond; cross made at the Iowa Experiment Station in 1932 and variety distributed by the Michigan Agricultural Experiment Station in 1948; not licensed for sale in Canada.

General Characteristics.—Moderate yield in Canada, early maturing, has a short strong straw, large brownish-coloured kernels, thin hulls and medium high bushel weight.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust and to the majority of the crown-rust races; susceptible to race 7 of stem rust and to races 34, 45, and 57 of crown rust that have become prevalent in Canada and the United States; resistant to smut and Victoria blight; very susceptible to halo blight.

Nutritive Value.—No data.

Branch

History.—Forward[2] × (Victoria-Richland); cross made in 1939 at the Wisconsin Agricultural Experiment Station and the variety distributed in 1951.

General Characteristics.—Has not been tested sufficiently in Canada to evaluate properly; it has yielded slightly less than Ajax in Wisconsin over a

three-year period, but appears to be similar in maturity, height, and strength of straw; the kernel medium in size and off-white in colour; bushel weight average.

Disease Resistance.—Resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust; resistant to smut and Victoria blight; has moderate resistance to crown rust and *Septoria avenae* (black stem).

Nutritive Value.—No data.

Brighton

History.—Markton × Laurel; cross made in 1932 at the Cereal Division, Ottawa; released for distribution in 1941.

General Characteristics.—A high yielding, mid-season, hulless variety with a medium tall comparatively weak straw, large kernels, and high bushel weight.

Disease Resistance.—Resistant to smut and Victoria blight, and moderately resistant to halo blight and grey speck.

Nutritive Value.—Very high in protein and fat, very low in fibre.

Canuck

History.—Hajira × Jostrain; cross made in 1926 at Laboratory of Cereal Breeding, Winnipeg; originally accessioned as R.L. 811, named Canuck in 1949.

General Characteristics.—A low yielding, mid-season variety with a short straw of medium strength and small greyish-coloured kernels; unimportant commercially, but valuable as breeding material owing to its high degree of resistance to stem rust; for this reason included in the rust nurseries in both Canada and the United States.

Disease Resistance.—Resistant to all of the races of stem rust that have been identified in Canada and the United States with the exception of race 7A, identified for the first time in 1952 at Winnipeg. Has a gene for resistance to twelve races of stem rust, inherited from Hajira, and a gene for resistance to races 1, 4, and 11, inherited from the Jostrain parent; resistant to halo blight and Victoria blight.

Nutritive Value.—High in protein and fat, low in fibre.

Cartier

History.—Alaska × Early Triumph; cross made in 1913 at Macdonald College, Que.; accepted for registration in 1931 and distributed in 1932.

General Characteristics.—A moderate yielding, very early maturing variety with straw of average length and strength and a medium large, rather short white kernel, thin hull, and high bushel weight; has been grown widely in Quebec and parts of Ontario, but replaced in many areas by the more recently distributed rust-resistant varieties.

Disease Resistance.—Resistant to Victoria blight and moderately resistant to halo blight.

Nutritive Value.—High in protein, medium in fat and fibre.

Cherokee

History.—D 69 × Bond; cross made at the Iowa Agricultural Experiment Station in 1932; distributed by the Kansas Agricultural Experiment Station in 1948; not licensed for sale in Canada.

General Characteristics.—Not a high yielding variety in Canada; very early maturing, with short stiff straw, large light brown kernels, thin hull, and good bushel weight.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust and the majority of the crown-rust races; susceptible to race 7 of stem rust and

to races 34, 45, and 57 of crown rust, four races now prevalent in Canada and the United States; resistant to smut and Victoria blight and highly resistant to a culture of *Fusarium culmorum* with which it was inoculated in the greenhouse.

Nutritive Value.—No data.

Clintafe

History.—Santa Fe × Clinton[4]; cross made at the Iowa Experiment Station; distributed to farmers in Iowa in fall of 1952.

General Characteristics.—Similar to Clinton in appearance, but approximately two days later in maturing and two inches taller; under Iowa conditions has produced higher yields than Clinton over a three-year period; variety under test in Canada.

Disease Resistance.—Resistant to all crown-rust races in North America and to races 1, 2, 5, 8, 10, and 11 of stem rust; resistant to smut and Victoria blight and has some resistance to *Septoria avenae* (black stem).

Nutritive Value.—No data.

Clinton

History.—D 69 × Bond; cross made in 1932 at the Iowa Agricultural Experiment Station, Ames, Iowa; distributed in the United States in 1946 by the Iowa, Illinois, and Indiana Agricultural Experiment Stations; licensed for sale in Canada in 1947.

General Characteristics.—Moderate yielding in Canada, very early maturing, comparatively short strong straw, yellow kernels, comparatively thin hull, and medium high bushel weight; in Canada grown mainly in southwestern Ontario.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust, and resistant to the majority of the crown rust races; susceptible to race 7 of stem rust and to races 34, 45, and 57, which have become increasingly prevalent in Canada and the United States; resistant to smut, halo blight, and Victoria blight, and moderately resistant to grey speck.

Nutritive Value.—High in protein, medium in fat and fibre.

Colo

History.—Hancock × (Morota-Bond); cross made at the Iowa Agricultural Experiment Station in 1932; variety unofficially distributed in Iowa by a seed company in 1945; not licensed for sale in Canada.

General Characteristics.—Yielding ability of this variety in Canada not determined; medium maturing, two to three inches taller than Clinton but not quite so stiff in the straw; kernels off-white in colour, medium in size, and thin in the hull; tends to be comparatively low in bushel weight.

Disease Resistance.—Resistant to smut and Victoria blight and gives the same reaction to the races of stem rust and crown rust as Clinton.

Nutritive Value.—No data.

Dasix

History.—A selection from Sixty Day made in 1925 at the Ontario Agricultural College, Guelph; distributed to farmers in 1942 and accepted for license and registration the same year.

General Characteristics.—A moderate yielding, early maturing variety grown mainly in Ontario; comparatively weak straw, white kernels of medium size, medium thin hull, and medium bushel weight.

Disease Resistance.—Resistant to Victoria blight and moderately resistant to halo blight.

Nutritive Value.—Low in protein and fat, medium in fibre.

Eagle

History.—Victory × Von Lochow's Yellow; cross made in Sweden; licensed in Canada in 1937 and accepted for registration in 1943.

General Characteristics.—Similar to Victory in many respects but a little earlier and has a shorter and much stronger straw; distribution appears to be limited to Alberta and British Columbia.

Disease Resistance.—Resistant to Victoria blight.

Nutritive Value.—Low in protein, medium in fat and fibre.

Early Miller

History.—Potato × Record; variety produced by the Scottish Institute of Research.

General Characteristics.—Attractive, large, white plump kernel, and high bushel weight, but mediocre in other respects; grown to a limited extent in Alberta.

Disease Resistance.—Resistant to Victoria blight.

Nutritive Value.—Medium in protein, high in fat, and medium in fibre.

Eaton

History.—Iogold × Bond; cross made at the Iowa Agricultural Experiment Station in 1932; variety distributed by the Michigan Agricultural Experiment Station in that state in 1946; not licensed for sale in Canada.

General Characteristics.—Moderate to low yielding in Canada, very early maturing, has a short strong straw, yellowish-white kernels of medium size, thin hull, and medium bushel weight.

Disease Resistance.—Resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust and to the majority of the crown-rust races; susceptible to race 8 of stem rust and to crown-rust races 34, 45, and 57; resistant to smut, Victoria blight, and halo blight.

Nutritive Value.—No data.

Erban

History.—Banner × Early Ripe; cross made at the Ontario Agricultural College, Guelph, in 1907; distributed in 1935 and accepted for registration in 1937; Banner parent used originally introduced in 1890; Early Ripe parent introduced by the Ontario Agricultural College in 1899 from A. W. Livingstone of Columbus, Ohio.

General Characteristics.—A high yielding, mid-season variety with medium length and strength of straw, large white kernels, medium thin hull, and high bushel weight; adapted to sections of Eastern Canada where stem rust not injurious.

Disease Resistance.—Resistant to smut and Victoria blight; susceptible to all races of crown rust in the seedling stage, but resistant to races 2, 3, 6, and 38 in the adult stage; in Eastern Canada some tolerance to crown rust under field conditions.

Nutritive Value.—High in protein, medium in fat and fibre.

Exeter

History.—Victory × Rusota; cross made at Laboratory of Cereal Breeding, Winnipeg, in 1928; accepted for registration in 1941 and distributed to the farmers during the winter of 1942-1943.

General Characteristics.—A high yielding, medium late maturing variety grown mainly in Manitoba and Saskatchewan; has medium tall weak straw, large white kernels, thick hull, and medium high bushel weight.

Disease Resistance.—Resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust, resistant to grey speck and Victoria blight, and moderately resistant to halo blight.

Nutritive Value.—Low in protein and fat, high in fibre.

Fortune

History.—Victory × (Victory-Richland) × (Markton-Victory); cross made at the University of Saskatchewan in 1939; variety licensed and accepted for registration in 1948.

General Characteristics.—Not so high yielding as Exeter but a day or two earlier and slightly stronger in the straw; has a large white kernel, medium thick hull, and satisfactory bushel weight.

Disease Resistance.—Resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust; resistant to smut and Victoria blight.

Nutritive Value.—Medium in protein, fat, and fibre.

Garry

History.—Victory × (Victoria × (Hajira-Banner)); the strain of Hajira × Banner used in this cross R.L. 524; cross made in 1939 at Laboratory of Cereal Breeding, Winnipeg; distributed in 1947 and licensed and accepted for registration the same year.

General Characteristics.—The original variety distributed disappointing from the standpoint of yield; had a strong straw of average length, large white kernels, and a comparatively high bushel weight; susceptibility to Victoria blight thought to be the cause of its unsatisfactory yield. A number of selections from this variety resistant to Victoria blight and to approximately half of the crown-rust races found in Canada, in addition to being resistant to stem rust and smut; some of these selections higher yielding than the parent variety and one of them, R.L. 1692.27, released in 1952 as Foundation Stock of Garry.

Disease Resistance.—The original Garry resistant to all races of stem rust and to practically all races of crown rust and smut that occur in North America; selections resistant to Victoria blight also have superior resistance to stem rust and smut but resistant to only certain races of crown rust.

Nutritive Value.—Medium in protein, high in fat, and medium in fibre.

Gold Rain

History.—A selection made in Sweden from the German variety, Milton; introduced into Canada in 1911 by Dr. L. H. Newman, then Secretary of the Canadian Seed Growers' Association; a sister strain of Victory.

General Characteristics.—A high yielding, mid-season variety with straw of medium length and strength, and large plump yellow kernels; was considered a good quality oat, and popular at one time.

Disease Resistance.—Resistant to halo blight and Victoria blight.

Nutritive Value.—Medium in protein, fat, and fibre.

Gopher

History.—Selection from Sixty Day made at the University of Minnesota in 1917; distributed to the farmers in the United States in 1923.

General Characteristics.—A high yielding, early maturing variety, with a rather short medium strong straw, small white kernels, medium thin hull, and medium bushel weight; well adapted to many sections of Western Canada and at one time the leading early maturing oat variety in that area; since replaced by rust-resistant varieties.

Disease Resistance.—Resistant to halo blight and Victoria blight, and moderately resistant to smut and grey speck.

Nutritive Value.—Medium in protein, fat, and fibre.

Green Mountain

History.—Origin obscure, but probably introduced from Europe; according to Ethridge (8) specimens of the variety found under the following additional names: Read's Green Mountain, White Russian, and White Tartar; belongs to the species, *A. sativa orientalis.*

General Characteristics.—A side-panicled oat late in maturing and weak in the straw; of no agronomic importance but has some value as breeding material as it is resistant to certain races of stem rust and crown rust; similar to White Russian, except that the awns are more numerous.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust, and under Canadian conditions of race identification to races 2, 3, 4, 5, 34, and 38 of crown rust; resistant to Victoria blight.

Nutritive Value.—No data.

Green Russian

History.—Origin obscure but probably brought to the United States by settlers from Europe.

General Characteristics.—Two Green Russian varieties belonging to the *A. sativa* species differ mainly in their reactions to stem rust and crown rust.

From one type found growing on farms in North Dakota the North Dakota Agricultural Experiment Station in 1923 selected Rainbow, Rusota, and Morota varieties resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust but susceptible to crown rust.

The other Green Russian type, formerly designated as Ia. 96 and now accessioned as C.I. 2890 and as R.L. 1093, resistant to races 1, 2, 5, 8, 10, and 11 of stem rust and to a few races of crown rust; crossed with Richland it produced D 69 which is one of the parents of Clinton and other recent United States productions.

Disease Resistance.—In addition to rust resistance, both types of Green Russian are resistant to Victoria blight and have considerable resistance to halo blight.

Nutritive Value.—No data.

Grey Winter

History.—Introduced into Canada by the Cereal Division, Ottawa, from the Welsh Plant Breeding Station, Aberystwyth, Wales, in 1928. Thought to be an importation to the British Isles from Europe.

General Characteristics.—A winter oat with greyish coloured kernels.

Disease Resistance.—Resistant to Victoria blight and moderately resistant to halo blight and grey speck.

Nutritive Value.—Low in protein, medium in fat and fibre.

Hajira

History.—Obtained from Egypt in 1904 by the South African Government and introduced into the United States in 1919.

General Characteristics.—A low yielding, very early maturing variety, with a short straw of medium strength and small yellow kernels; has been exceptionally valuable as breeding material being the source from which the majority of the Canadian varieties derived their resistance to stem rust.

Disease Resistance.—Hajira apparently contains three types: (1) those resistant to seven races of stem rust as in Vanguard; (2) those resistant to twelve

races, but susceptible to race 7A as in Canuck; and (3) those resistant to all known races as in Garry. It is also resistant to halo blight and Victoria blight.

Nutritive Value.—High in protein and fat, medium in fibre.

James

History.—(Bond × Double Cross Bond, C.I. 3650) × Nakota; cross made at the Iowa Agricultural Experiment Station, Ames, Iowa, in 1940; variety developed at the South Dakota Experiment Station, Brookings, South Dakota, and distributed from that station in 1950.

General Characteristics.—An early maturing hulless variety that yields well in comparison with other varieties in South Dakota. Compared with Nakota, James is an improvement in earliness, lodging resistance, leaf-rust resistance, and bushel weight; has not been tested to any great extent in Canada, but in the United States appears to be best suited to conditions in eastern South Dakota; at Winnipeg in 1951 it produced slightly higher yields than Nakota but lower than Laurel.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust, and to the majority of the crown-rust races; susceptible to race 7 of stem rust and to races 34, 45, and 57 of crown rust that have recently become prevalent; resistant to smut and Victoria blight.

Nutritive Value.—No data, but hulless varieties usually very satisfactory.

Jostrain

History.—A selection from Joanette made at the University of Minnesota by Dr. D. L. Bailey in the early 1920's; originally designated as Joanette Strain.

General Characteristics.—A low yielding variety with black kernels and little agronomic value; principal use as a differential host in identifying the races of oat stem rust; has also been used in breeding for stem-rust resistance.

Disease Resistance.—Resistant to races 1, 3, 4, and 11 and moderately resistant to races 5, 10, 12, and 13 of stem rust; also resistant to a few races of crown rust and to halo blight and Victoria blight.

Nutritive Value.—Low in protein, high in fat, and low in fibre.

Kent

History.—D 69 × Bond. Cross made at the Iowa Agricultural Experiment Station in 1932; variety distributed in Michigan in 1946 by the Michigan Agricultural Experiment Station; not licensed for sale in Canada.

General Characteristics.—Moderate yield in Canada, very early maturing, has a short strong straw, and medium large light brown kernels; appears to be similar to Eaton.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust, and to the majority of the crown-rust races; susceptible to race 7 of stem rust and to races 34, 45, and 57 of crown rust that have recently become prevalent; resistant to smut, Victoria blight, and halo blight.

Nutritive Value.—No data.

Klein

History.—A selection from the common yellow oat of Argentine made by Dr. E. Klein in 1929; introduced into the United States from Australia in 1940 and into Canada from the United States in 1948.

General Characteristics.—A late maturing, medium tall, red oat of the Red Algerian type (*avena byzantina*); inferior agronomically but valuable as a parent in breeding for disease resistance.

Disease Resistance.—Resistant to a number of crown-rust races, halo blight, grey speck, and Victoria blight.

Nutritive Value.—No data.

Lanark

History.—Onward × (Anthony-Bond); the cross made at the Plant Research Bureau, Department of Scientific and Industrial Research, Lincoln, New Zealand, in 1938; crossed seeds sent to the Cereal Division, Ottawa, for propagation in the summer of 1939; with permission of the New Zealand authorities, a few seeds retained at Ottawa from which a number of selections were made; final selection made in 1945 and variety licensed for sale in 1950.

General Characteristics.—A moderate yielding, early maturing variety that has a strong straw of medium height, medium large creamy-white kernels, often with brownish discoloration, thin hull, and high bushel weight; recommended mainly for eastern Ontario.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust and most races of crown rust; susceptible to race 7 of stem rust and to races 34, 45, and 57 of crown rust that have recently become prevalent; resistant to smut and Victoria blight.

Nutritive Value.—High in protein and fat, medium in fibre.

Landhafer

History.—Introduced into the United States from Germany under the name of Landhafer aus Uruguay; probably brought to Germany from South America; in 1945 accessioned as C.I. 3522 and the name shortened to Landhafer; introduced into Canada from the United States in 1948.

General Characteristics.—A low yielding, late maturing variety of the species *Avena byzantina;* no agronomic value, but useful in breeding for disease resistance and as a differential host in the identification of crown-rust races.

Disease Resistance.—Resistant to crown rust, halo blight, grey speck, and Victoria blight.

Nutritive Value.—No data.

Larain

History.—Alaska × Gold Rain; cross made at the Cereal Division, Ottawa, in 1927; variety selected and developed at the Dominion Experimental Station, Lacombe, Alta.; distributed in 1945 and accepted for registration in 1947.

General Characteristics.—An early maturing variety that has a medium tall strong straw, large white kernels, thin hull, and heavy bushel weight; suited to areas in central Alberta where early fall frosts are common.

Disease Resistance.—Resistant to halo blight and Victoria blight, and moderately resistant to grey speck.

Nutritive Value.—High in protein, medium in fat, and low in fibre.

Laurel

History.—Banner × Chinese Hulless; cross made at the Cereal Division, Central Experimental Farm, Ottawa, Canada, in 1906; variety distributed in 1922.

General Characteristics.—A hulless type that yields well in comparison with other hulless varieties; late maturing, has a strong straw of medium length, large kernels, and produces grain of very high bushel weight in comparison with the hulled varieties.

Disease Resistance.—Resistant to halo blight, grey speck, and Victoria blight.

Nutritive Value.—Very high in protein, medium in fat, and very low in fibre.

Legacy

History.—Banner (Ott. 49) × 80 Day (Ott. 42); cross made at the Cereal Division, Ottawa, in 1906; variety distributed in 1920 and accepted for registration in 1934.

General Characteristics.—Produces satisfactory yields in central Alberta where grown almost exclusively; mid-season in maturity; average length and strength of straw; white kernels of medium size and hull content; bushel weight average.

Disease Resistance.—Resistant to halo blight and Victoria blight and moderately resistant to grey speck.

Nutritive Value.—Medium in protein, low in fat, and high in fibre.

Liberty

History.—Chinese Naked × Swedish Select. Cross made at the Cereal Division, Ottawa, in 1906; variety distributed in 1914.

General Characteristics.—One of the earlier hulless varieties that has since been replaced by others of superior quality.

Disease Resistance.—Resistant to Victoria blight.

Nutritive Value.—Very high in protein and fat; very low in fibre.

Mabel

History.—O.A.C. 72-214 × Early Ripe 213; cross made at Macdonald College, Que., in 1919; variety licensed for sale and accepted for registration in 1939.

General Characteristics.—An early maturing variety grown chiefly in Quebec; has fair length and strength of straw, light brown kernels of medium size, very thin hull, and medium bushel weight.

Disease Resistance.—Resistant to certain races of crown rust but has little tolerance to this disease under epidemic conditions; resistant to grey speck and Victoria blight, and moderately resistant to halo blight and covered smut.

Nutritive Value.—High in protein and fat, low in fibre.

Marion

History.—Markton × Rainbow; cross made at the Arlington Experimental Farm, Virginia, in 1928 and the variety distributed by the Iowa Agricultural Experiment Station about 1939; not licensed for sale in Canada.

General Characteristics.—A moderate yielding variety in Canada, early maturing, straw of medium length and strength, kernels yellowish-white, of medium size, medium thin hull, and satisfactory bushel weight; popular in the United States until Clinton was released, but owing to susceptibility of the latter to the now prevalent races of stem rust and crown rust, has regained some of its popularity because of its resistance to race 7 of stem rust and of partial resistance to race 45 of crown rust in the adult stage.

Disease Resistance.—Resistant to race 1, 2, 3, 5, 7, 7A, and 12 of stem rust and appears to have some resistance to race 45 of crown rust under field conditions; resistant to smut and Victoria blight.

Nutritive Value.—No data.

Markton

History.—A selection made at the Sherman County Branch Station, Moro, Oregon, in 1911, from an unnamed oat variety introduced into the United States from Turkey in 1903.

General Characteristics.—Variety grown commercially at one time in the United States; moderately low yielding in Canada, but valuable for breeding

purposes on account of its superior smut resistance; fairly early maturing with white kernels of medium size.

Disease Resistance.—Resistant to smut, halo blight, Victoria blight, and moderately resistant to grey speck.

Nutritive Value.—Low in protein, high in fat, and medium in fibre.

Mindo

History.—Bond × [(Minota-White Russian) × Black Mesdag]; cross made at the University of Minnesota in 1931 and variety distributed to the farmers in that state in 1946; not licensed for sale in Canada.

General Characteristics.—A very early maturing variety, not so high yielding in Canada as Ajax, very short strong straw, yellowish-white kernels of medium size, a comparatively thick hull, and medium bushel weight.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust, to most races of the crown rust, and to smut, halo blight, and Victoria blight; susceptible to race 7 of stem rust and to races 34, 45, and 57 of crown rust, that have recently become prevalent.

Nutritive Value.—Medium in protein, high in fat, and medium in fibre.

Mohawk

History.—Bond × D 69; cross made at the Iowa Agricultural Experiment Station in 1932 and variety released for distribution by Cornell University in 1948; not licensed for sale in Canada.

General Characteristics.—Moderate to low yielding in Canada, early maturing, has a short stiff straw, yellow kernels of medium size, medium thin hull, and medium high bushel weight.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust and most races of crown rust; susceptible to race 7 of stem rust and to races 34, 45, and 57 of crown rust that have recently become prevalent; resistant to smut and Victoria blight.

Nutritive Value.—No data.

Nakota

History.—(Markton-Richland) × (Swedish Select-Kilby); cross made at the South Dakota Agricultural Experiment Station, Brookings, South Dakota; variety distributed in the United States in 1939.

General Characteristics.—A moderate yielding, early maturing hulless variety with short strong straw, comparatively small kernels, and low bushel weight in comparison with other hulless varieties; although popular in South Dakota, will probably be replaced in that area by James, a newer hulless variety.

Disease Resistance.—Resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust, resistant to smut, halo blight, Victoria blight, and moderately resistant to grey speck.

Nutritive Value.—Very high in protein, high in fat, and very low in fibre.

Nemaha

History.—(Victoria-Richland) × (Morota-Bond); cross made at the Iowa Agricultural Experiment Station in 1936; variety distributed by the Kansas and Nebraska Agricultural Experiment Stations in 1948; not licensed for sale in Canada.

General Characteristics.—Moderate to low yielding in Canada, early maturing, with short stiff straw, medium large brownish-coloured kernels, fairly thin hull, and high bushel weight.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust and to many races of crown rust; susceptible to race 7 of stem rust and to races 34, 45, and 57 of crown rust, four races that recently have become prevalent; resistant to smut, halo blight, and Victoria blight.

Nutritive Value.—No data.

O.A.C. 3

History.—Selected out of Daubenay at the Ontario Agricultural College, Guelph, in 1903; distributed in 1913.

General Characteristics.—Moderate yielding, early maturing, has small white kernels, thin hulls, and medium bushel weight.

Disease Resistance.—Resistant to Victoria blight.

Nutritive Value.—High in protein, medium in fat, and low in fibre.

O.A.C. 72

History.—Selected from Siberian in 1903 at the Ontario Agricultural College, Guelph; distributed to Ontario farmers in 1911.

General Characteristics.—Resembles Banner in a number of panicle and grain characteristics, but is a little later maturing and weaker in the straw; never a widely adapted variety.

Disease Resistance.—Resistant to Victoria blight.

Nutritive Value.—Medium in protein, fat, and fibre.

O.A.C. 144

History.—An awnless selection out of O.A.C. 72 made in 1913 at the Ontario Agricultural College, Guelph; distributed to Ontario farmers in 1923.

General Characteristics.—Yielded well on the heavier soils of southwestern Ontario, but was never widely adapted; later maturing than O.A.C. 72 with somewhat longer and stronger straw; kernels of medium size, and white in colour with a characteristic pinkish tinge.

Disease Resistance.—Resistant to smut, halo blight, and Victoria blight.

Nutritive Value.—Medium in protein, high in fat, and medium in fibre.

Onward

History.—Marvelous × Superb; cross made by Garton Bros., England.

General Characteristics.—Low yield in Canada, medium maturity, has a medium tall weak straw, white plump kernels, thick hull, and average bushel weight; one of the parents of Lanark.

Disease Resistance.—Resistant to Victoria blight.

Nutritive Value.—Low in protein and fat, and high in fibre.

Rainbow

History.—Selected from Green Russian in 1923 at the North Dakota Agricultural Experiment Station, Fargo, North Dakota, and distributed to the farmers in North Dakota in 1929.

General Characteristics.—A moderately high yielding midseason variety with fair length and strength of straw; has yellow kernels of medium size, medium thin hulls, and medium low bushel weight; grown commercially in North Dakota but not in Canada; a Green Russian type grown in southern Manitoba at one time now replaced by the newer rust-resistant varieties.

Disease Resistance.—Resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust, resistant to Victoria blight, and moderately resistant to halo blight.

Nutritive Value.—Medium in protein, low in fat, and medium in fibre.

Richland

History.—Selected from Kherson at the Iowa Agricultural Experiment Station in 1906 and distributed as a variety in 1914; Kherson introduced into the United States from Russia in 1896.

General Characteristics.—Very early maturing variety but not so high yielding as Clinton; short medium-strong straw, and small yellow-coloured kernels; grown commercially in certain areas of the United States until the early 1940's and used there extensively as a parent in breeding for stem-rust resistance.

Disease Resistance.—Resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust and resistant to halo blight and Victoria blight.

Nutritive Value.—High in protein, low in fat, and medium in fibre.

Ripon

History.—(Siberian-Joanette) × (O.A.C. 72—214 M.C.); cross made at Macdonald College, Que., in 1918; never licensed or released to the farmers.

General Characteristics.—An intermediate maturing variety with good strength of straw and fair yield; its resistance to certain diseases could be useful in a breeding program.

Disease Resistance.—Resistant to smut and Victoria blight, and moderately resistant to halo blight and grey speck.

Nutritive Value.—Medium low in protein, high in fat, and medium in fibre.

Roxton

History.—(Siberian-Joanette) × (O.A.C. 72-Early Ripe); cross made at Macdonald College in 1927; variety distributed and accepted for registration in 1943.

General Characteristics.—A high yielding, late maturing variety with tall strong straw, medium large white kernels, thin hull, and medium bushel weight; adapted to areas in Eastern Canada where late maturity not a factor.

Disease Resistance.—Resistant to halo blight and Victoria blight and some resistance to root-rot under field conditions; resistant to certain races of crown rust and stem rust, but not sufficiently resistant to be classed as a resistant variety.

Nutritive Value.—Low in protein, high in fat, and low in fibre.

Rusota

History.—Selected from Green Russian in 1923 at the North Dakota Agricultural Experiment Station, Fargo, North Dakota; distributed to the farmers in North Dakota in 1935; a sister strain of Rainbow.

General Characteristics.—Higher yielding than Rainbow but later maturing and somewhat weaker in the straw; medium small yellow kernels, thin hulls, and medium bushel weight; has not been grown commercially in Canada.

Disease Resistance.—Resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust; resistant to halo blight and Victoria blight.

Nutritive Value.—Medium low in protein, low in fat, and medium in fibre.

Saia

History.—A selection from *A. strigosa;* introduced into the United States from Brazil by the University of Minnesota and received from that institution by Laboratory of Cereal Breeding, Winnipeg, in 1947.

General Characteristics.—Belongs to the species *A. strigosa*, is tall, late maturing, and weak in the straw; has value as breeding material owing to its disease resistance but as it has only seven pairs of chromosomes, crosses between it and varieties with higher chromosome numbers are difficult to make.

Disease Resistance.—Resistant to smut, all stem rust races, halo blight, the majority of the crown rust races, and Victoria blight.

Nutritive Value.—No data.

Santa Fe

History.—A pure line selection made in South America from an unnamed commercial oat variety; was developed at the Institute de Experimentacione Investigaciones Agricolas de Santa Fe and introduced into the United States in 1945; introduced into Canada from the United States in 1948.

General Characteristics.—Sample received in the United States represented a segregating or mixed population with two dominant colours a reddish oat resembling Red Algerian (*A. byzantina*) and a light greyish striped common oat (*A. sativa*). The Santa Fe oat now being used for breeding purposes is a very late, tall variety with long greyish-striped kernels, and dark coloured paleas; useful in breeding for disease resistance, particularly crown rust.

Disease Resistance.—Resistant to crown rust in North America; also resistant to halo blight, grey speck, and Victoria blight and has some resistance to *Septoria avenae* (black stem).

Nutritive Value.—No data.

Shelby

History.—Bond × Anthony; cross made at the Iowa Agricultural Experiment Station, Ames, Iowa, in 1932; distributed to farmers in the United States in 1950; not licensed for sale in Canada.

General Characteristics.—Has not been tested to any great extent in Canada but on the basis of tests so far conducted, appears to be a moderate yielding mid-season variety; in the United States considered to be higher yielding than Clinton, later maturing, and somewhat taller; has yellowish medium-sized kernels and a medium thin hull; bushel weight satisfactory.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust and to both loose and covered smut; resistant to many races of crown rust but susceptible to races 34, 45, and 57 that recently have become prevalent; resistant to Victoria blight.

Nutritive Value.—No data.

Sixty Day

History.—Introduced into the United States from Russia in 1901 and distributed to the farmers in that country in 1905.

General Characteristics.—A moderately high yielding, very early maturing variety that at one time gained considerable popularity in the corn belt of the United States and in parts of Western Canada; has a short fairly strong straw and small yellow kernels; Gopher and Dasix two white-kernelled selections from this variety.

Disease Resistance.—Resistant to halo blight and Victoria blight, and moderately resistant to grey speck.

Nutritive Value.—High in protein, medium in fat and fibre.

Tama

History.—Victoria × Richland; cross made at the Arlington Experiment Farm, Arlington, Virginia, 1930; variety developed co-operatively by the Iowa Agricultural Experiment Station, Ames, Iowa, and the United States Department of Agriculture; distributed in the United States in 1942.

General Characteristics.—A moderate yielding variety in Canada but high yielding in the United States; early maturing, short medium strong straw,

yellow kernels of medium size, medium thin hull, and medium high bushel weight; susceptible to Victoria blight and on this account its distribution in the United States has been discouraged.

Disease Resistance.—Resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust, and to most races of crown rust; resistant to smut and moderately resistant to halo blight; susceptible to Victoria blight.

Nutritive Value.—High in protein, fat, and fibre.

Torch

History.—Nakota × (Hajira-Joanette); cross made at the University of Saskatchewan in 1941; variety licensed for sale during the summer of 1952.

General Characteristics.—A satisfactory yielding hulless variety with medium late maturity and medium height; has stronger straw and higher bushel weight than Brighton but a smaller kernel; adaptability unknown, tested in Saskatchewan only.

Disease Resistance.—Resistant to smut and to all races of stem rust except race 7A; no other information.

Nutritive Value.—No data, but hulless varieties are usually very satisfactory.

Trispernia

History.—Introduced into Canada by the Cereal Division, Ottawa, from the Botanical Gardens, Cluj, Roumania, prior to 1936.

General Characteristics.—A low yielding, late maturing variety with a medium tall weak straw, and medium large yellowish-grey kernels; inferior agronomically but valuable in breeding for disease resistance, particularly crown rust and smut.

Disease Resistance.—Resistant to the majority of the crown-rust races, both smuts, Victoria blight, and moderately resistant to halo blight.

Nutritive Value.—High in protein and fat, low in fibre.

Ukraine

History.—Introduced into the United States from Russia in 1930 by Dr. J. G. Dickson, University of Wisconsin; accessioned as C.I. 3259 in 1935 under the designation "Russia No. 7 (Mutica Ukraine) 6809"; in 1947 name shortened to Ukraine by T. R. Stanton and H. C. Murphy, United States Department of Agriculture; introduced into Canada from the United States in 1945.

General Characteristics.—Late maturing, has a medium weak tall straw, and yellowish-white slender kernels, usually awnless; valuable as breeding material because of its resistance to certain races of crown rust.

Disease Resistance.—Resistant to crown-rust races 1, 2, 3, 4, 5, 24, 34, 38, 45, and 57; resistant to halo blight and Victoria blight and moderately resistant to grey speck.

Nutritive Value.—Medium in protein, high in fat, and medium in fibre.

Valor

History.—Sunrise × Banner; cross made at the University of Saskatchewan in 1927; licensed and distributed in 1941 and accepted for registration in 1943.

General Characteristics.—A moderate yielding, very early maturing variety with short strong straw, plump kernels of medium size, medium thin hull, and satisfactory bushel weight; in areas free from rust particularly useful when sown late in a weed control program.

Disease Resistance.—Resistant to smut and Victoria blight, and moderately resistant to halo blight.

Nutritive Value.—High in protein, medium in fat and fibre.

Vanguard

History.—Hajira × Banner. Cross made at Laboratory of Cereal Breeding, Winnipeg, in 1926; released for distribution in 1936 and accepted for registration in 1937; was the first stem-rust-resistant variety to be produced in Canada.

General Characteristics.—A medium high yielding mid-season variety with average length and strength of straw, white kernels of medium size, moderately thin hull, and comparatively low bushel weight; present grown in Manitoba and in parts of Eastern Canada where stem rust occurs.

Disease Resistance.—Resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust, resistant to halo blight and Victoria blight.

Nutritive Value.—Medium in protein, low in fat, and medium in fibre.

Vicland

History.—Victoria × Richland; cross made at the Arlington Experiment Farm, Arlington, Virginia,. in 1930; variety developed at the University of Wisconsin, Madison, Wisconsin, and distributed in that state in 1941; licensed in Canada in 1945.

General Characteristics.—Produces moderately low yield in Canada but a higher yield in the United States; very early maturing, with short straw of medium strength, medium small yellow kernels, medium thin hull, and medium bushel weight.

Disease Resistance.—Resistant to races 1, 2, 3, 5, 7, 7A, and 12 of stem rust and to most races of crown rust; resistant to smut and moderately resistant to halo blight; susceptible to Victoria blight.

Nutritive Value.—High in protein, medium in fat, and high in fibre.

Victoria

History.—Introduced into the United States from South America in 1927; seed obtained by Laboratory of Cereal Breeding, Winnipeg, in 1932, from the Iowa Agricultural Experiment Station, Ames, Iowa; belongs to the species, *A. byzantina.*

General Characteristics.—A low yielding, late maturing variety with a medium short weak straw, and large red kernels; has been used extensively in both Canada and the United States in breeding for resistance to crown rust and smut but owing to its susceptibility to Victoria blight no longer used for this purpose.

Disease Resistance.—Resistant to crown rust, smut, and halo blight.

Nutritive Value.—Medium in protein, high in fat and fibre.

Victory

History.—Selected from the German variety, Milton, by the Swedish Seed Association, Svalov, Sweden; introduced into Canada in 1911 by Dr. L. H. Newman.

General Characteristics.—A high yielding, late maturing variety that possesses a tall weak straw, large white kernels, and thick hull; bushel weight high; formerly one of the leading varieties in Canada and still popular in Alberta; in other areas has been replaced by the newer rust-resistant varieties.

Disease Resistance.—Resistant to root-rot and Victoria blight.

Nutritive Value.—Medium in protein, fat, and fibre.

White Cross

History.—Big Four × Sixty Day; cross made at the University of Wisconsin, Madison, Wisconsin, in 1911; variety distributed by that institution to the farmers in the United States in 1918.

General Characteristics.—An early maturing variety with medium length and strength of straw and exceptionally white, rather long, and somewhat slender kernels; best adapted to conditions in northern Alberta where it is being grown to some extent on account of its earliness.

Disease Resistance.—Resistant to Victoria blight and moderately resistant to halo blight.

Nutritive Value.—Medium in protein, fat, and fibre.

White Russian

History.—History obscure but in all probability brought to the United States many years ago by settlers from Europe; also known as White Tartar.

General Characteristics.—A low yielding, late maturing, side-panicled oat used mainly for breeding purposes owing to its resistance to a number of races of stem rust and crown rust.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust and to a few races of crown rust.

Nutritive Value.—No data.

Zephyr

History.—Bond × Anthony; cross made at the University of Minnesota in 1930; variety named in 1947 and distributed in Minnesota in 1949.

General Characteristics.—Moderately high yielding in Canada, is mid-season in maturity, has fair length and strength of straw, and medium-sized greyish-coloured kernels; medium in hull content and bushel weight.

Disease Resistance.—Resistant to races 1, 2, 5, 8, 10, and 11 of stem rust and to many of the crown-rust races but not 34, 45, and 57 that have recently become prevalent; resistant to smut and Victoria blight.

Nutritive Value.—High in protein; no other data available.

R. L. 524 (C.A.N. 748)

History.—Hajira × Banner; cross made in 1926 at the Laboratory of Cereal Breeding, Winnipeg.

General Characteristics.—Can be classed as medium from the standpoint of yield, maturity, length and strength of straw, hull content, and bushel weight has a white kernel of average size and has been valuable mainly as breeding material because of its superior resistance to stem rust.

Disease Resistance.—Resistant to all races of stem rust except race 7A to which it gives a segregating reaction; resistant to Victoria blight, and moderately resistant to grey speck.

Nutritive Value.—Medium in protein, fat, and fibre.

R.L. 2123 (C.A.N. 761)

History.—[(Victoria-R.L. 524) × (Victory-Hajira)] × Roxton; cross made at the Laboratory of Cereal Breeding, Winnipeg, in 1943.

General Characteristics.—A high yielding, late maturing variety with a medium tall strong straw, and very large white kernels, medium thin hull, and very high bushel weight.

Disease Resistance.—Resistant to all races of stem rust except to race 7A, to which it gives a segregating reaction; also resistant to both smuts, Victoria blight, and to approximately half the crown-rust races that have been identified in Canada.

Nutritive Value.—Low in protein. No other data available.

History of Oat Improvement

In the earlier days of North American agriculture oat improvement was based mainly on introduction and selection, with a few varieties being developed by hybridization.

In Canada, some of the better known commercial varieties introduced from other countries were Banner, Victory, Abundance, Gold Rain, Sixty Day, Alaska, Gopher, Green Russian and Anthony (3, 4). Of these varieties, Banner and Victory were the most widely grown, and Victory is still the most widely grown variety in Alberta. Varieties produced by hybridization included Legacy, Laurel, and Liberty, arising out of crosses made in 1906 at the Central Experimental Farm, Ottawa, Canada. All of the above-mentioned varieties are more or less susceptible to smut and, with the exception of Green Russian and Anthony which are moderately resistant to stem rust, are susceptible to the rusts.

Since 1935, seventeen varieties have been developed in Canada. In order of year distributed they are: Erban, Vanguard, Mabel, Valor, Brighton, Ajax, Dasix, Exeter, Roxton, Beaver, Larain, Abegweit, Beacon, Garry, Fortune, Lanark, and Torch. This group of varieties is, with the exception of Ajax, satisfactory from the standpoint of kernel size, with a few like Beaver, Erban, Larain, and Garry being superior in this respect. Dasix, Exeter, and Brighton have a decidedly weak straw, while Valor and Lanark are particularly strong. The other varieties are strong to medium strong. Erban, Valor, and Brighton are resistant to smut, but susceptible to the rusts. Fortune is resistant to smut, only moderately resistant to stem rust, and susceptible to crown rust. Lanark is also resistant to smut and although it has resistance to a number of races of both rusts, it is susceptible to those that recently have become prevalent; namely, race 7 of stem rust and races 34, 45, and 57 of crown rust. Garry is resistant to smut and highly resistant to both rusts, but is susceptible to Victoria blight. It was the first variety to be distributed that was resistant to all known races of stem rust, as well as being resistant to crown rust and smut. In addition, it had good strength of straw and grain of good quality.

Fortunately it was possible to select from Garry and other crosses in which Victoria was a parent, lines that are resistant to Victoria blight. Resistance to this disease, however, was accompanied by a loss of resistance to about half the races of crown rust that have been identified in Canada. Susceptibility to these particular races, among which are 1, 4, 5, and 57, is linked with resistance to Victoria blight. Races 2, 3, 6, 34, 38, and 45 on the other hand are independent of the reaction to Victoria blight. Under field conditions, when rust infection is heavy, these lines are more resistant to crown rust than varieties containing the Bond resistance, such as Lanark and Clinton.

According to information by Stanton (29) some of the varieties that played an important part in the earlier days of oat improvement in the United States were Red Rustproof, Kherson, Sixty Day, and Green Russian. A selection from Red Rustproof made by J. A. Fulghum in the State of Georgia gave rise to the variety, Fulghum, from which a number of other named varieties were selected. These oats belong to the species, *A. byzantina*, and are grown in the southern part of the United States at the present time. Kherson was introduced from Russia in 1896 and distributed as a variety in 1901. Some of the more prominent varieties selected from it were Richland, Iogold, and State Pride. Richland and Iogold were selected at the Iowa Agricultural Experiment Station in 1906. The former variety was distributed in 1914 and the latter in 1926. State Pride was selected at the Wisconsin Agricultural Experiment Station in 1906 and distributed as a variety in 1912. Sixty Day was introduced from Russia in 1901 and distributed as a variety in 1905. Gopher is one of the more important selections made from this variety. The origin of Green Russian is

obscure but two of the selections made from it, Rainbow and Rusota, were productive stem-rust-resistant varieties which were grown mainly in North Dakota.

The various strains and selections of Kherson and Sixty Day represent the most important group of early common oats introduced into the United States. The original Kherson and Sixty Day were early, productive, and drought-escaping varieties. Almost immediately upon introduction they became widely grown in the Corn Belt, where the later and larger midseason varieties were not satisfactory.

A number of other varieties were grown during the period under review. Worthy, which was selected from Improved American in 1906, was distributed in Michigan in 1911. Another variety, Wolverine, which was selected from Silvermine in 1911, was distributed in Michigan in 1917. Upright, a selection from American Beauty, and Ithacan, a Silvermine type, were distributed in New York State in 1918 and 1922, respectively. Wayne, a hybrid of unknown origin, was a high producer in Ohio. Wisconsin Wonder and Forward were the two standard varieties in Wisconsin at one time. Both varieties were selections from Silvermine. Wisconsin Wonder was selected in 1901 and distributed in 1909, while Forward was selected in 1912 and distributed in 1920. In Minnesota a variety named Minota was selected from an unnamed commercial variety in 1906 and distributed in 1919. Gopher, Anthony, and Minrus were also distributed in Minnesota. Gopher was distributed in 1917 and Anthony in 1929. Minrus was distributed in 1931 and originated from a cross made in 1918 between Minota and White Russian. In addition to the above, well known varieties such as Banner, Gold Rain, Swedish Select, and Victory were also grown.

One of the first varieties to be developed by hybridization in the United States was Pringles Progress. It was from the cross Excelsior × Chinese Hulless made by Cyrus G. Pringle of Charlotte, Vermont. He originated several varieties of which this variety, which was distributed in 1875, was the most important. Improvement through hybridization did not gather momentum until early in the 1920's. Richland, Iogold, White Russian, and Rainbow were used mainly as the stem-rust-resistant parents, and Black Mesdag and Markton as the smut-resistant parents. The cross, Markton × Rainbow, gave rise to the varieties, Marion and Hancock. With the introduction of the two crown-rust-resistant varieties, Victoria and Bond, breeding for combined resistance to both rusts was accelerated. Victoria was first used in crosses in 1930 and Bond in 1932. A number of varieties were developed from a cross between Victoria and Richland (30). Boone and Control were distributed in Iowa in 1940; Vicland in Wisconsin in 1941; Tama in Iowa in 1942; Cedar in Nebraska and Vikota in South Dakota in 1947. However, the susceptibility of these varieties to Victoria blight largely curtailed their popularity. Fortunately, the processing of varieties with the Bond resistance to crown rust was well advanced, as reported by Stanton and Coffman (31). Clinton and Benton were distributed in 1945; Mindo, Bonda, Colo, and Eaton in 1946; Nemaha, Bonham, Mohawk, and Cherokee in 1948; Advance, Andrew, Shelby, and Zephyr in 1949; Branch in 1951; and Clintafe in 1953.

Clintafe is resistant to all races of crown rust, whereas the other varieties that depend on Bond for their resistance are susceptible to the races of crown rust that have become prevalent since 1947, and can no longer be classed as resistant varieties. In addition, Andrew and Eaton are susceptible to race 8 of stem rust, while all of the other varieties are susceptible to race 7 of stem rust, which has become prevalent since 1950 and to race 7A which was identified in 1952.

From the foregoing, it is apparent that the varieties grown commercially in Canada and the United States are not sufficiently resistant to the rusts.

It is also apparent that there is a shift in the physiologic race population following the distribution of new varieties. When Vanguard was released in Canada in 1937 it was resistant to the then common races of stem rust. Later, race 8 to which it is susceptible became prevalent. With the distribution of Clinton and other varieties of similar resistance in the United States race 7 of stem rust and race 45 of crown rust became prevalent, two races to which the varieties in question are susceptible. Varieties like Garry, as well as a number of hybrids, all of which trace their resistance to Hajira, are being used in breeding for resistance to all stem rust races, while the varieties, Landhafer and Santa Fe, are being used in breeding for resistance to all crown rust races that have been identified in North America.

In Canada, early generation lines that are resistant to crown rust, and to all races of stem rust, as well as to both smuts, have been obtained from crosses involving these varieties. The best of these lines are being used in crosses with a number of standard varieties. As this breeding program is still in the early stages, varieties with this greater crown rust resistance will not be available in the immediate future.

In the interim, selections from Garry and lines from other crosses of Victoria parentage that are resistant to Victoria blight, to all races of stem rust, and to a few races of crown rust, are in the advanced stages of testing and increase. They would provide better resistance, and be just as productive under normal conditions, as the highest yielding commercial varieties now being grown.

In the United States, lines with the Landhafer and Santa Fe resistance to crown rust are also in the advanced stages of processing. All of them are resistant to smut and stem rust. Some are resistant to all races of stem rust, and other to only certain races. A number of these lines are the result of three or four backcrosses with high yielding standard varieties.

Although the varieties now being developed have superior resistance to the rusts and the smuts, there is no guarantee that some new race or races, to which they are susceptible, may not appear sometime in the future. To be prepared for such an eventuality there are at least three possible methods of approach. One is to build up a single variety resistance from as many different sources as possible. A variety with such an accumulation of genes for resistance to any one disease might have resistance, or at least moderate resistance, to any new race or races that might appear, due to the effect of any one gene or to the additive effect of all of them. A second approach would be to seek sources of immunity. Such a search would involve a study of the oat species still growing wild in nature and also of the more closely related grasses. A third method would be to examine carefully all oat introductions for new sources of germ plasm. Varieties such as Kherson, Sixty Day, Hajira, and Victoria, are examples of varieties from which superior selections have been made.

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