which takes them as directly as possible to the field of their special chemical interests.

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FUNGI

British Stem- and Leaf-Fungi (Coelomycetes). A Contribution to our Knowledge of the Fungi Imperfecti Belonging to the Sphaeropsidales and Melanconiales. Volume 1. Sphaeropsidales, to the end of the Sphaerioideae which have Colourless or Nearly Colourless Spores. By W. B. GROVE. xx + 488 pp. 31 text figures. Cambridge, England, at the University Press; New York, the Macmillan Company, 1935; $7.00.

AMERICAN mycologists who have used "British Rust Fungi," published by this author more than twenty years ago, will welcome the appearance of this new book. Though dealing with a different group of parasitic fungi, it resembles its predecessor in the view-point revealed, in method of presentation and in general appearance. Written to serve as a handbook in the British Isles, it will find a much wider field of usefulness, due to the extensive range of many of these organisms. It is to be followed by a companion volume which will cover the remainder of the Sphaeropsidales and Melanconiales. The Hyphomycetes will not be incorporated. The book is clearly printed on a good grade of paper and is attractively bound. It is inadequately illustrated, the few text-figures provided adding little to its usefulness. Good indices to host plants and to genera and species of fungi are given. Also there are included Latin diagnoses of twenty-four species described as new.

The author follows M. C. Cooke in the use of the old-fashioned and somewhat misleading name Coelomycetes. The older writer in his "Handbook of British Fungi," which appeared in 1871, discussed 200 species of these fungi. An indication of the tremendous increase in knowledge of the group is given by the statement of Grove that there are now 2,000 reputed British species. He calls attention to the economic significance of these fungi as "despoilers of our field crops, our orchards, and our woods," and emphasizes the fact that many fungi are actively parasitic only in their imperfect stage. The book is written, however, more from the standpoint of the mycologist than the plant pathologist. The descriptions of species stress morphological rather than pathological or cultural features.

Fifty genera are covered in this volume. Under each, the British species are arranged in definite sequence by host genera. Unfortunately, the host genera are listed alphabetically rather than systematically. This brings together the species occurring on species of a given host genus, but fails to place in proximity those to be found on related hosts. Each species is described briefly, and data covering host range, season of fruiting and distribution are incorporated. Relatively less space than usual is used in citation of exsiccati and other herbarium material examined. The author has been collecting these fungi for many years, and his personal collection of over 3,000 specimens has served as a basis for his work. In addition he has made the necessary comparisons with authentic materials in various historical herbaria. The book has the stamp, however, of having been written by a field mycologist rather than a herbarium worker. It fills a long-felt need for a handy reference work on these fungi.

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SPECIAL ARTICLES

BREEDING RUST-RESISTANT SPRING WHEATS

CALAMITOUS epidemics of stem rust occurred in 1904 and 1916 and again in 1935. Urediospores, overwintering in Texas, found optimum conditions for increase in their progress from south to north and finally the full force of the impact of the parasite fell upon the spring wheat fields of South Dakota, Minnesota and North Dakota. The loss in North Dakota alone, due mainly to rust, approached 100 million dollars. Before and following the epidemic of 1916 it was thought that catastrophes of this sort could be combatted by two methods, (1) the eradication of the common barberry, alternate host of *Puccinia graminis*, and (2) by breeding varieties of the other host, the wheat plant, which would be resistant to the parasite. After the 1935 epidemic, we know that breeding must be a major recourse.

Twenty years ago no variety of common wheat (*Triticum vulgare*) was known to have resistance to stem rust. The writers[1] discovered in 1917, in a durum introduction from Russia, plants of common wheat somewhat resistant to stem rust, which they selected and named Kota. Waldron crossed Kota wheat with Marquis, producing the Ceres variety, which has since become the principal hard spring wheat grown in the United States. Both the Kota parent and Ceres possess only moderate resistance to stem rust. While Ceres successfully withstood ordinary epidemics, it

[1] L. R. Waldron and J. A. Clark, *Jour. Amer. Soc. Agron.*, 11: 187, 1919.

suffered severely in the present epidemic but less than did its Marquis parent.

Greater resistance to stem rust is found in a few of the tetraploid wheats, the durums and emmers. Carleton[2] noted that some durum varieties and especially Yaroslav emmer (C. I. 1526) showed almost complete freedom from rust in the major epidemic of 1904, in contrast to marked susceptibility of others.

Starting with the rust-resistant durum Iumillo in 1914, Hayes, Parker and Kurtzweil,[3] in cooperative experiments at the Minnesota station, reported crosses with Marquis from which several rust-resistant hexaploid strains were obtained, one of which was increased and named Marquillo. While not possessing as much resistance as the Iumillo parent, the new variety indicated that successful rust-resistant common wheats could be obtained when a durum variety was used as one parent. As Marquillo carried the high carotin pigment of Iumillo in its flour the variety did not become a commercial success.

At the Dominion Rust Research Laboratory at Winnipeg, Manitoba, after the 1916 epidemic, the red-kerneled durum variety Pentad was crossed with Marquis. Some of the resulting selections carried the strong resistance of the Pentad parent, but because of lack of quality or yielding capacity none of the strains has been distributed.

In 1916, McFadden,[4] in South Dakota, crossed Marquis wheat and Yaroslav emmer (C. I. 1526) and by 1920 had isolated hexaploid strains, which later showed the same reaction possessed by the emmer parent in the mature plant stage. He distributed one of the strains, naming it Hope. While it possesses resistance to both rust and smut and has fairly good milling and baking qualities, it is not commercially successful, owing to susceptibility to heat and drought and to its lack of yielding capacity in ordinary years.

In addition to the cross which produced Marquillo, Marquis was crossed with the winter wheat Kanred,[5] and selections from a double cross Marquis-Iumillo × Kanred-Marquis were carried through in cooperative experiments at the Minnesota station. From among the many resulting strains one was named Thatcher and distributed by the Minnesota station in 1934. As an average of 4 trials in 4 localities in North Dakota in 1935, Thatcher averaged 23.2, Ceres 14.5 and Marquis 8.7, bushels per acre. Thatcher is the third named variety to be distributed having in its ancestry a resistant tetraploid wheat. Very recently the Canadian experiment station at Saskatoon has announced a new variety, Apex, derived in part from Iumillo and from H-44 (see below) through a complex cross.

Hope wheat has been crossed with susceptible and resistant common wheats, and a few of the immediate hybrid selections were promising in ordinary rust years in comparison with Ceres. The results from the heavy rust year of 1935 indicate that many of these hybrids, having Hope or H-44 (an allied strain of Hope) as one parent, carry essentially the near immunity of the emmer parent. The best measure of this in 1935 was at Langdon, N. Dak., where perhaps the epidemic reached its maximum intensity, and where Ceres and Marquis yielded only 3.3 and 0.4 bushels per acre, respectively, and the rust readings approached 100 per cent. Hope showed but a trace of rust, yielding 15.5 bushels, and various hybrids, with Hope as one parent, also had low rust readings and yielded as high as 18.7 bushels. Hope hybrids which have failed have done so mainly because of lack of drought resistance and yielding capacity, low bushel weight or susceptibility to certain diseases other than stem rust, such as black chaff. A few of these hybrids, such as Hope × Ceres, show good yielding capacity, as indicated at Langdon, and other desirable characters, especially quality. One of these immediate hybrid strains may be named and distributed for commercial growing.

Waldron has introduced the Australian variety Florence into a further cross, using with it Hope and Ceres. From this combination selections have been made which retain essentially the rust resistance of the Hope parent. In addition to this, the bushel weight is satisfactory and the yielding capacity good. In 1935 one of these Ceres × Hope-Florence strains yielded 23.3 bushels in the experiment at Langdon just mentioned. Apparently, in these hybrid selections, and doubtless also in others of different origin, it has been possible to retain the very important rust reaction found in the Hope parent and at the same time to eliminate those undesirable characters hitherto found associated with Hope or H-44 and with most of their hybrid descendants.

Besides Hope and Marquillo, only one named variety of excellent resistance, Thatcher, had been distributed previous to the 1935 epidemic, but in addition a considerable number of very promising hybrids were then under trial, and these met the crucial rust test with marked success. Thus this breeding program of 20 years' standing saw its culmination in the 1935 catastrophe. The emmer parent, which has supplied the near-immunity carried by most of the present hybrids, has been known for at least 50 years to possess this character, and there is every indication that it has behaved in this manner for a much longer period of

[2] M. A. Carleton, *U. S. D. A. Farm Bull.*, 219, 1905.
[3] H. K. Hayes, J. H. Parker and C. Kurtzweil, *Jour. Agric. Res.*, 19: 523, 1920.
[4] E. S. McFadden, *Jour. Amer. Soc. Agron.*, 22: 1020, 1930.
[5] O. S. Aamodt, *Phytopath.*, 17: 573–609, 1927.

time. One need scarcely fear that the reaction to stem rust now found in Hope and in so many of its descendants is but a temporary character.

When so many different physiologic forms of rust were being identified by Stakman and his associates it was held that breeding against rust had become a very complicated problem. At first it was felt necessary to breed for resistance to one form and later to groups of forms. Melchers and Parker[6] were the first to show that the reactions in wheat seedlings, used in determining rust forms, might not be the reactions of the maturing plant. Later this finding was amply verified for spring wheats by Goulden *et al.*[7] and by other workers. Thus, while Hope is susceptible to certain rust forms in the seedling stage in the greenhouse, it has shown freedom in the field from year to year both in the seedling stage and while approaching maturity. Generally the existence of many rust forms has not seriously complicated the breeding program.

The experiences of the past 20 years have taught many things that bear upon future breeding work. One of these is that farmers will not grow a wheat variety merely because it may be resistant to, or nearly immune from, stem rust. It also must have resistance to drought, must yield well and be of good quality; otherwise, the losses in non-rust years may overbalance the gains in heavy-rust years.

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EFFECT OF CYSTINE DISULFOXIDE ON SPONTANEOUS TUMORS OF THE MOUSE

THE principle that "The sulfhydryl—partially oxidized sulfhydryl groups comprise the chemical elements of a naturally occurring chemical equilibrium through which growth by increase in cell number is regulated"[1] having been established with vertebrates—and the stimulation side (–SH) in mice and men—a next step was trial of the retarding phase (–SO) in cancer growth of the mouse.

Preliminary tests with transplanted tumors had given results consistent with the postulate, but the data were inadequate in material methods and compounds.

Differential results with compounds not naturally a part of living economy are inconclusive—particularly so are results with sodium salts of inorganic sulfur acids, since these are unpredictably sensitive to oxidative and hydrolytic changes in water solution. Extension of the principle to vertebrates depends on demonstration of proliferation retardation by partially oxidized derivatives of a *naturally occurring* sulfhydryl compound.

Preparation of these is a research problem in itself. Three years ago report was here made of the retarding action of one such—a cystine sulfinate—on proliferative growth in *Obelia gen.*[2] This was not available in sufficient amount or purity for other trials. Since that time Drs. Toennies and Lavine have prepared a cystine disulfoxide in pure form and adequate amount. They will report the chemical details elsewhere.

This note is concerned with the growth of 91 spontaneous tumors from mice injected almost daily with 0.0085 gm. of cystine disulfoxide, as compared with that of 65 tumors from untreated mice simultaneously living under like conditions of diet and environment.

The test data show that the administration of this amount was accompanied in this experiment by a lesser maximum tumor size, a lesser maximum percentage increase in size, a slower tumor growth, fewer tumors reaching a stated percentage increment, tumors with fewer cells, tumor cells with larger nuclei, a greater red cell anemia at the end and a 25 per cent. prolongation of life beyond that expected from the control data. There was no essential difference in initial maximum or terminal body weight between tests and controls.

Of significance is the fact that cell nuclei in tumors from injected mice were larger than those of controls. This result is identical with that found in other material and is correlative evidence of proliferation retardation.[3] The fact—which always appears in work of this sort—that cell size is smaller when proliferation is speeded up by sulfhydryl and larger when retarded by its partially oxidized derivatives is evidence incontrovertibly inconsistent with any hypothesis which would attribute to sulfhydryl a forwarding action on assimilatory protein synthesis—or growth by increase in cell size or mass.

Since these results demonstrate the proliferation retarding action of cystine disulfoxide in mice, they allow extension to vertebrates of the postulate developed from earlier work.

The degree of change from the usual, however, though consistent on all counts, was too small to allow any prediction as to future practical possibilities.

This was a cooperative work. Conduct of the mouse experiments was guided by S. P. Reimann. Solutions

[6] L. M. Melchers, J. H. Parker, *U. S. D. A. Bul.*, 1046, 1922.

[7] C. H. Goulden, Margaret Newton and M. A. Brown, *Sci. Agric.*, 11: 9, 1930.

[1] *Protoplasma*, 11: 382, 1930.

[2] SCIENCE, 77: 190, 1933.

[3] *Protoplasma*, 7: 535, 1929.