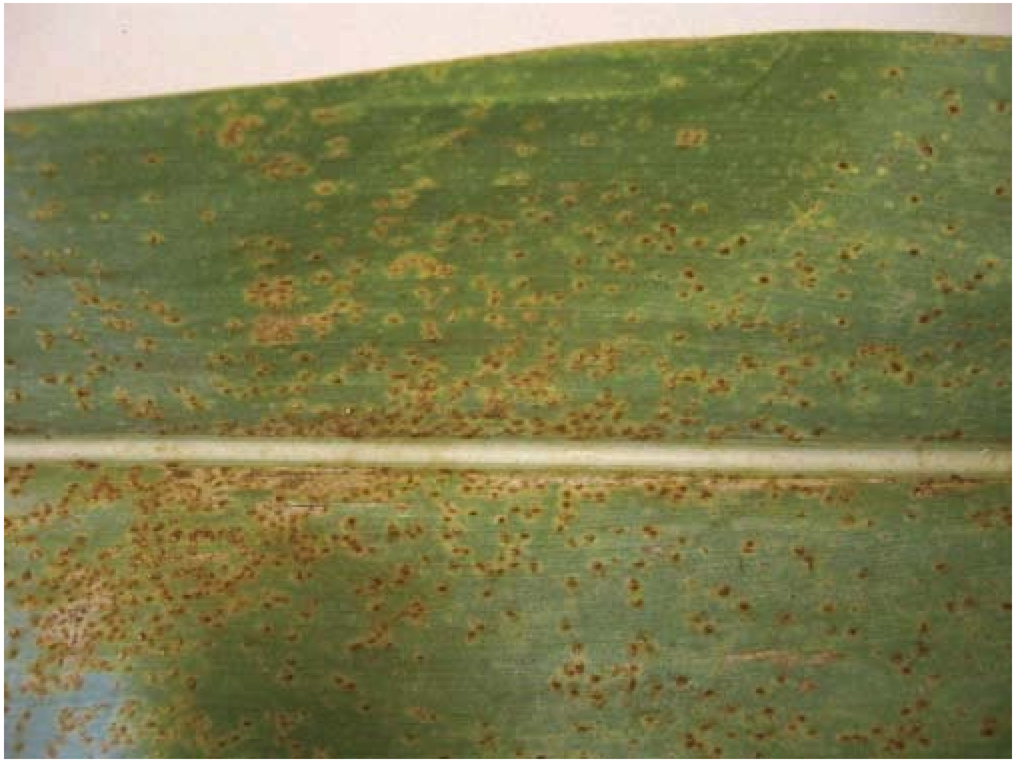
Resistance to Sothern Rust

A chronological summary of the literature



http://www.ipm.iastate.edu/ipm/icm/2007/9-10/southernrust.html

- Periodic nature of SCR outbreaks makes breeding for resistance challenging
- Likewise it makes mapping genes conferring resistance a challenge.

First report

Storey and Ryland 1954 Nature173:7

5. A further complication may result in animals where more than one sugar is present in the blood[3], for preliminary results suggest that the corpuscular/plasma sugar distribution may be different for glucose and fructose.

From these results, it is clear that, in fœtal and neonatal physiology, the term 'blood-sugar' should be used only in a strictly literal sense. Figures derived from blood-sugar estimations cannot be legitimately compared, either for different species or for different ages of one species, without allowing for the particular characteristics of the red cell in each sample.

I am indebted to Dr. R. Scarisbrick, who not only directed my attention to this problem, but suggested that it should be developed in this way.

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[1] Hitchcock, M. W. S., *J. Physiol.*, **108**, 117 (1949).
[2] Andreen-Svedberg, A., *Skand. Arch. Physiol.*, **66**, 113 (1933).
[3] Goodwin, R. F. W., *Nature*, **170**, 750 (1952).

Resistance to the Maize Rust, *Puccinia polysora*

During 1953 we have studied resistance in maize to the form of the rust fungus, *Puccinia polysora* Underw., that recently appeared in East Africa[1]. Our results augment the information given by Stanton and Cammack[2].

Table 1. Selfed Progenies

Parent		Family No.	Pr
Country of origin	Line No.		Plant resista
Mexico	24	(1) (2)	9 9
	27	(1) (2)	13 9
Colombia	28	(1)	23
	29	(1)	16
	30	(1) (2)	6 20
	31	(1) (2)	7 7
	32	(1)	6
Totals			125
Expectation on 3 : 1 ratio			130

None of our material has given evidence from invasion by the fungus.

The resistant reaction was not foun forty-two maize varieties and lines r sources in Africa. It was found in a few collections originating in Mexico (recei Dr. W. Stanton) and in Colombia (Dr. L Agricultural Experiment Station, Me twenty-five varieties and lines from t fifteen gave only the susceptible react

equipment, and to Dr. G. E. R. Deacon and the captain and officers of R.R.S. *Discovery II* for their part in making the observations.

[1] Young, F. B., Gerrard, H., and Jevons, W., *Phil. Mag.*, **40**, 149 (1920).
[2] Longuet-Higgins, M. S., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **5**, 285 (1949).
[3] Von Arx, W. S., Woods Hole Papers in Phys. Oceanog. Meteor., **11** (3) (1950).
[4] Ekman, V. W., *Arkiv. Mat. Astron. Fysik. (Stockholm)*, **2** (11) (1905).

MOLECULAR STRUCTURE OF NUCLEIC ACIDS

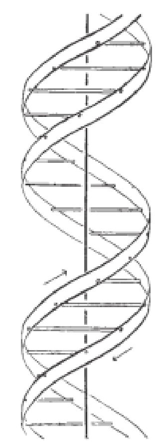
A Structure for Deoxyribose Nucleic Acid

We wish to suggest a structure for the salt of deoxyribose nucleic acid (D.N.A.). This structure has novel features which are of considerable biological interest.

A structure for nucleic acid has already been proposed by Pauling and Corey[1]. They kindly made their manuscript available to us in advance of publication. Their model consists of three intertwined chains, with the phosphates near the fibre axis, and the bases on the outside. In our opinion, this structure is unsatisfactory for two reasons: (1) We believe that the material which gives the X-ray diagrams is the salt, not the free acid. Without the acidic hydrogen atoms it is not clear what forces would hold the structure together, especially as the negatively charged phosphates near the axis will repel each other. (2) Some of the van der Waals distances appear to be too small.

Another three-chain structure has also been suggested by Fraser (in the press). In his model the phosphates are on the outside and the bases on the inside, linked together by hydrogen bonds. This structure as described is rather ill-defined, and for this reason we shall not comment on it.

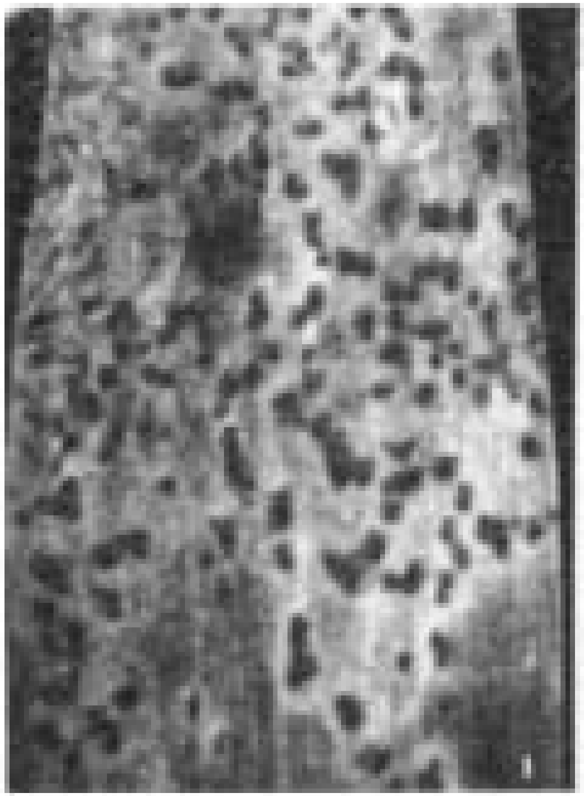
We wish to put forward a radically different structure for the salt of deoxyribose nucleic acid. This structure has two helical chains each coiled round the same axis (see diagram). We have made the usual chemical assumptions, namely, that each chain consists of phosphate diester groups joining β-D-deoxyribofuranose residues with 3′,5′ linkages. The two chains (but not their bases) are related by a dyad perpendicular to the fibre axis. Both chains follow right-handed helices, but owing to the dyad the sequences of the atoms in the two chains run in opposite directions. Each chain loosely resembles Furberg's[2] model No. 1; that is, the bases are on the inside of the helix and the phosphates on the outside. The configuration of the sugar and the atoms near it is close to Furberg's 'standard configuration', the sugar being roughly perpendicular to the attached base. There



This figure is purely diagrammatic. The two ribbons symbolize the two phosphate—sugar chains, and the horizontal rods the pairs of bases holding the chains together. The vertical line marks the fibre axis

- Reported one major gene

- Some evidence for quantitative resistance



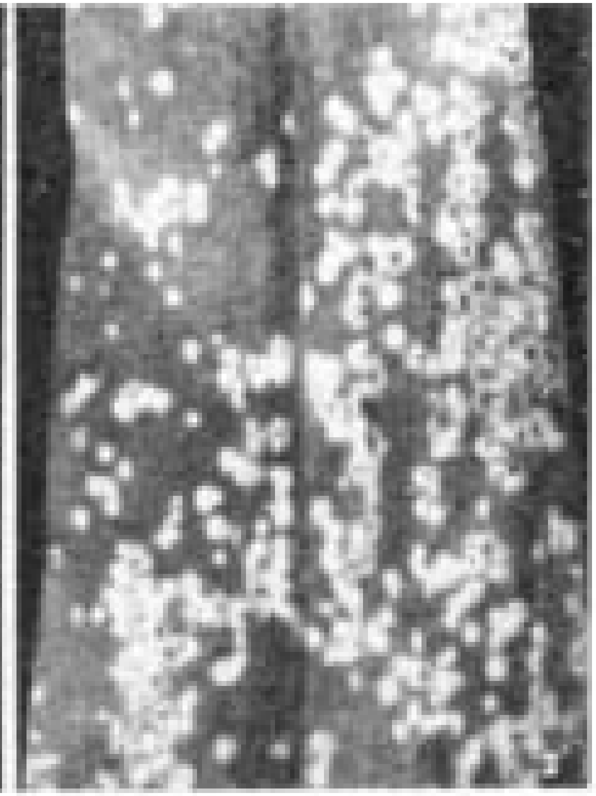


Fig. 1. *Puccinia polysora*. Susceptible reaction in maize leaf. Large spreading sori. (× 1·75)

Fig. 2. *Puccinia polysora*. Resistant reaction in maize leaf. Necrotic areas with some small sori. (× 1·75)

Races of Fungi

- Ryland and Storey 1955 Nature 176:655

- Identified two races; EA1, EA2

- Eventually reported a third, EA3
  - Storey and Howland (1967) Ann. Appl. Biol. 60:297-303

Resistance Genes

- Storey and Howland Heredity 11:289-302
  - Reported Rpp1 and 2 derived from mexican lines (?)
  - Conferred resistance to EA1 and EA2 respectively

- Storey and Howland 1959 Heredity 13:61-65
  - Showed these genes were loosely linked
  - About 15cM apart
  - Not assigned to a chromosome

More Races

- Robert (1962) Phytopath52:1010-1012
  - Identified 6 new races, designated PP.3 through 8
  - All from the Americas

  - Ullstrup (1965)Phytopathology 55:425-28 designated a tenth race- PP9
  - Determined to be different from the other races
  - Overcomes Rpp1 and Rpp2

Rpp9

- I couldn't find anything more on Rpp1 and Rpp2

- IN 1965 a third resistance gene, **Rpp9** was identified- conferring resistance to PP9
  - From accession *PI186208*
  - *Rpp9 overcome by several previously identified races : EA1, EA3, PP3,PP4,PP6, PP7*

- Shown to be closely link on Chm 10 to Rp1
  - about 1.6cM away

Rpp10, Rpp11

- Storey and Howland (1967) Ann. Appl. Biol. 60:297-303
- From Central American stock.
- Rpp10 dominant, RPP11 partialy dominant both give resistance to EA1, EA3
- Not linked to each other or to Rpp1

- Another major gene conferring resistance to PP9 was identified
  - Futrell et al (1975)Crop Sci. 15:597-599
  - From accession B1138TRpp
  - Not clear whether this is the same gene as Rpp9
  - Both come from South African open-pollinated varieties

More sightings of Rpp9

- Several studies report strong resistance genes at the Rpp9 locus
  - Scott et al (1984) Crop Sci 24:265–267
  - Holland et al.(1998) TAG 96:232–241
  - Liu et al. (2003) Acta Genet Sinica 30:706–710
    - RppP25
  - Jines et al (2007) TAG 114:659-667
  - Chavez-Medina et al (2007)Plant Dis. 91:1489-1495
    - Allelic to Rpp9 by formal allelism test
  - Chen et al (2004) TAG 108:945–950 ***AND*** Zhou et al.(2007) Mol Genet. Genomics 278:723–728
    - RppQ
  - Zhang et al (2010) Mol. Breeding in Press
    - RppD

- In none of these cases was the gene shown to be distinguishable from Rpp9
  - Could do this by allelism tests
  - Or using different races to look at specificity
  - New names for resistance genes from Chinese publications simply based on different origin of the genes

Use of Rpp9

- Widespread in the US over the last 20 years
  - Resistance breaking strains observed in other parts of the world
  - Resistance breaking strains observed in GA in 2008
    - Dolezal et al (2009) 93:676

Quantitative Resistance

- The existence of quantitative SCR resistance has been reported several times
  - Zummo (1987) Plant Dis. 72:157-160
  - Bailey et al (1987) Plant Dis 71:518-521
  - Chavez-Medina et al (2007) Plant Dis. 91:1489-1495

Quantitative Resistance

- QTL for resistance have been reported in several publications
  - Holland et al(1998) TAG 96:232–241
    - Bins 3.05, 4.01
  - Jiang et al.(1999) TAG 99:1106–1119
    - 3.08, 4.05. 9.05
  - Brunelli et al (2002) Fitopatol Bras 27:134–140
    - 9.02