lates favorable genes in larger amounts, it never quite catches up (through S_1 to S_4) with plant 4, which had more favorable gene pairs in the homozygous condition to begin with.

Then if we accept, as a basis for separation, a top-cross test after S_3 or S_4 as a valid procedure, we must perforce assume that a similar test at S_0 level is equally valid, since the different S_0 plants maintain their relative positions in S_3 or S_4.

The data of Sprague and Bryan (*7*), Payne and Hayes (*6*), and Lonnquist (*5*) clearly contradict the theory.

Segregation of genes with small effects does not seem to be an adequate answer. Ten such genes in heterozygous condition would produce 1024 possible combinations of gametes, of which 66% are in the modal classes. The distribution being normal, any random sampling of the gametes would cancel advantages or disadvantages of selection outside the mode. It is doubtful if segregation of less than ten genes (with small effects) could be detected in top crosses. There appear to be two alternate assumptions.

a) The sample size used in test-crosses is inadequate for accurate appraisal of genetic theory. The author frankly admits his academic inability to evaluate the validity of the practices in use, except to point out that general adoption of a technique does not guarantee its adequacy. Sprague and Bryan (*7*) present data to indicate that segregation for top-cross combining ability was not significant in 1938 but was significant for 1939 and combined 1938–39 data.

b) A relatively few genes affect yield out of all proportion to their number. In some families these occur initially in the heterozygous state, and because of their small number their genetic distribution in a nursery row of 30–35 plants is fairly common. Thus some sublines would be selected which carried these genes in the homozygous (dominant or recessive) or heterozygous state.

It is unlikely that the effect of these postulated genes is concerned with vigor; otherwise they would be discarded visually. The effect is probably more in the realm of conditioning of vital processes which affect weight and moisture content of grain. Any investigator familiar with the light chaffy ears of stalk-rotted plants could well imagine the impact of a bad stalk-rot season on the yield of susceptible top crosses (*10*). Sprague and Bryan (*7*) report segregation for lodging (erect plants) and disease resistance (kernel damage) in addition to yield differences. There is little evidence, however, of a significant positive correlation between high-yielding sublines and low lodging or few damaged kernels.

A program for the production of disease-resistant corn envisages and employs pathological techniques which sort out resistant material in a breeding nursery from the onset of the breeding program. Its purpose is not unlike, nor unrelated to, early testing for combining ability in the same lot of material. The low gene frequency of certain types of resistance demands that screening for disease reaction be carried out first. The techniques for selecting disease-resistant corn are available. It is no more possible to select resistant corn plants without presence of disease than it is possible to select high-yielding lines without yield-testing.

There is a rapidly accumulating stockpile of resistant inbred material of a wide range of maturity which may serve as starting points in a breeding program. It is becoming increasingly apparent that native open-pollinated varieties are fertile sources of resistant material, although the gene frequency for resistance to *H. turcicum* is rather low.

Early testing for total disease is a sound program insofar as techniques are available. Segregation will occur in later generations. Early testing for yield is gaining in usage. Segregation in later generations has been demonstrated, but whether this reported segregation is permanent, as might be shown by progeny testing, or intermittent, because of unknown fluctuating environmental factors, has not been proved.

A delayed test involving S_1 or F_3 material is recommended for a combined program involving disease resistance. If genetic theory and the generally postulated effect of genes for yield in maize are correct, an additional top-cross test following further inbreeding is unnecessary.

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Manuscript received February 7, 1952.

Chemical Constitution and Biological Activity of some Organophosphorus Compounds

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The relationship of the chemical constitution of a substance to its biological activity has been the subject of investigation since Brown and Frazer (*1*) attempted a generalization connecting the physiological action of a substance with its chemical structure. Many specific relationships have since been elucidated,

[1] Abstracted from the thesis submitted by Dasu Ramaswami in partial fulfillment of the requirements for the Ph.D. degree. D. R. is indebted to the University of Illinois for a research fellowship.

some of them (*2–5*) in considerable detail. These correlations are now called structure activity relationships, or SAR (*3*).

The concept of SAR has been used as a guide in the search for new pharmacodynamic agents.

The phosphate radical as part of the coenzymes, nucleoproteins, ATP, phospholipids, etc., plays a vital role in biological processes. A number of phosphorus compounds are highly toxic, some of them being in use as insecticides and fungicides. The phosphoryl group P=O present in all these compounds may be the factor that renders them accessible to tissue receptors or points of attachment of the enzymes these compounds may be presumed to influence. Another biologically important chemical group is the carbonyl group, C=O, present in a number of pharmacodynamic agents that are substituted carbonic esters. Such esters have examples among local anesthetics (procaine), autonomic drugs (acetylcholine, atropine), and sedatives and hypnotics (barbiturates and urethanes). The resemblance between the two groups P=O and C=O in the above compounds in regard to structure and biological importance led to the assumption that they might be mutually replaceable without loss of biological activity. This assumption has been investigated.

Phenylurethane (ethyl phenylcarbamate) has been studied for its effect on experimental animal tumors (*6*), as a depressant, and in inhibiting the germination of seeds selectively (*7*). It should be interesting if its phosphoryl analog, diethyl anilidophosphate, proves to mimic all these effects since, possibly, different physicochemical mechanisms may be involved in each effect. In a preliminary study the diethyl anilidophosphate was found to possess two of these; namely, anticonvulsant effect and growth-inhibitory effect which was, however, feeble. In may be significant that phenylurethane possesses the peptide group —CONH— present in proteins and that the analog contains the group —PONH— present in phosphocreatine.

The study was extended to the homologs of diethyl anilidophosphate, the dialkyl anilidophosphates, which

TABLE 1

No.	Compound	Structural formula	Effect on germination		Effect in mice—IP		
			Oats	Charlock	MTD (mg/kg)	LD (mg/kg)	MED (mg/kg)
1	Phenyl urethane	$H_5C_2O—\overset{\overset{O}{\|}}{C}—NH—C_6H_5$	4 +	No effect	100	400	150
*2	Diethyl anilido phosphate	$(H_5C_2O)_2=\overset{\overset{O}{\|}}{P}—NH—C_6H_5$	1 +	" "	100	666	533
3	Di-*n*-propyl anilido phosphate	$(n\text{-Propyl-O})_2=\overset{\overset{O}{\|}}{P}—NHC_6H_5$	3 +	" "	125	500	300
*4	Di-isopropyl anilido phosphate	$(\text{Isopropyl-O})_2=\overset{\overset{O}{\|}}{P}—NHC_6H_5$	2 +	" "	300	1500	900
5	Di-*n*-butyl anilido phosphate	$(n\text{-butyl-O})_2=\overset{\overset{O}{\|}}{P}—NHC_6H_5$	3 +	" "	100	400	300
*6	Di-isobutyl anilido phosphate	$(\text{Isobutyl-O})_2=\overset{\overset{O}{\|}}{P}—NHC_6H_5$	2 +	" "	500	2000	1000
7	Di-*n*-amyl anilido phosphate	$(n\text{-amyl-O})_2=\overset{\overset{O}{\|}}{P}—NHC_6H_5$	2 +	" "	500	750	500
8	Di-isoamyl anilido phosphate	$(\text{Isoamyl-O})_2=\overset{\overset{O}{\|}}{P}—NHC_6H_5$	2 +	" "	1000	2000	1500
9	Phenobarbital sodium		Not tested		50	250	20

* Compounds previously reported in the chemical literature.
1 + —Slight retardation in growth of roots and shoot.
2 + —Root growth severely retarded, slight retardation in shoot growth.
3 + —Root growth inhibited and shoot growth severely retarded.
4 + —Root and shoot growth inhibited.
MTD = Dose at which minimal toxic signs were noticed (this dose gave no protection against metrazol convulsions).
LD = Dose which killed one mouse. This is *not* LD_{50}.
MED = Minimal effective dose against electroshock – 0.3 sec, 15 ma ; each compound was tested on a total of 18 mice.

Data on Germination

Oat seeds germinating, using distilled water (control)—45 out of 50.
Oat seeds germinating, using the compounds—44–48 out of 50.
Charlock seeds germinating, using distilled water (control)—23 out of 50.
Charlock seeds germinating, using the compounds—24–26 out of 50.

were synthesized and tested for the biological effects indicated by the present hypothesis. Results of the tests on mice and on the seeds of oat (*Avena sativa* L.), a monocotyledonous plant, and those of yellow charlock (*Brassica sinapis*), a dicotyledonous plant, are shown in Table 1.

In germination experiments the compounds were applied on a filter paper enclosed between two watch glasses and kept moist by a solution of a concentration of 1 g mol/million ml distilled water. The insolubility of compounds 5 to 8 called for treatment as follows: The weighed quantity was dissolved in ½ ml ethanol and 99½ ml distilled water quickly added to the flask, which was shaken vigorously.

Results of this investigation show a broad agreement with the postulated hypothesis in regard to the anticonvulsant effect and less strikingly the selective growth-inhibitory effect. However, neither phenylurethane nor its analogs compare well in their anticonvulsant effect with phenobarbital sodium, a well-known anticonvulsant structurally unrelated to the present series. Compounds 3 and 5 are the most potent of the series, both in inhibiting germination and in anticonvulsant activity; it would be of interest to find out if they mimic the third biological effect, namely, the retardation of experimental tumors, reported to be shown by phenylurethane and isopropyl phenylcarbamate (*6*).

This investigation is being continued.

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Manuscript received August 17, 1951.

The Recording of Flight Movements in Insects[1]

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In studies of insect flight, wing rates have been widely used to gauge physiological activity. As these may reach frequencies of 1000/sec (*1*), an inexpensive, accurate, and objective recording method is not easy to find. Of the methods discussed by Chadwick (*2*), the stroboscopic has been the choice in several recent studies (*3, 4*). Where continuous records of frequency are required, a crystal pickup may be used to convert thoracic movement into electrical current (*5*). The discoveries of Pringle (*6*) and Roeder (*5*) have stimulated interest in the neuromuscular mechanisms of insect flight and have made necessary the development of superior methods of recording flight movement.

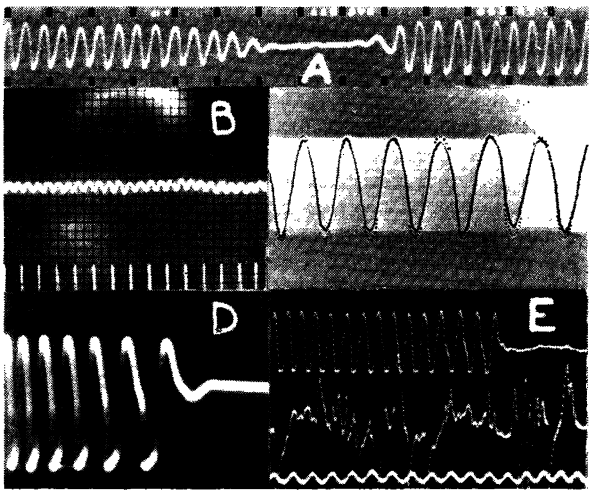

Fig. 1. *A*: Record of the movements of the scutellum of a fly during a stop and start; time calibration by film perforations, .014 sec. *B*: Electrostatic record of wing movement in a chironomid midge; time calibration, 1/300 sec. *C*: Superimposed simultaneous records of wing movements obtained by electrostatic method and of scutellum movements recorded by reflected light; solid line traced over cathode beam record; dotted, over light beam record. *D*: Record of movements of scutellum during a fast stop. *E*: Simultaneous records of wing movements by electrostatic method (upper trace) and of thoracic electrical activity (middle trace) during a fast stop; time calibration, 1/60 sec.

With insects of reasonable size, flight movements may be recorded photokymographically with a slit camera, using a beam of light reflected from a fragment of silvered cover slip sealed to the scutellum. In flies, the movements of the scutellum reflect closely the changes in length of the indirect muscles and the movements of the wings (*7*). Where continuous records are required, an Army surplus GASP 16 mm gun camera can be used, provided the framing mechanism is removed and additional film guides are installed in the magazine. This gives a constant maximum film speed of 520 mm/sec, attained in 1/10 sec. Fig. 1, *A* is a record of movements of the scutellum in normal flight; Fig. 1, *D*, in a fast stop.

A more convenient method that records wing movement and may be used with the smallest insects has been developed. This depends on the fact that moving electrostatistically charged bodies may act as variable condensers. The capacity charges induced by the rapidly moving, charged wings of an insect may be amplified and photographed from the screen of an oscillograph. The necessary charge is induced on the wings by the presence of a charged nonconductor. Voltages as high as 10 mv may be obtained. Even the frequency of flight movements in wingless insects has been recorded by this method. The wing frequency of untethered insects flying about in a jar may also be obtained. Fig. 1, *B* shows wing movements of 500/sec in a chironomid midge.

[1] Supported by a grant from the Graduate Research Fund of the University of Connecticut.

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